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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Abstract

Objectives: Since 2009, China has introduced policies, principally targeting health professionals, to reduce caesarean section (CS) overuse. This study investigated changes to CS rates in 2008-2018, and factors associated with CS use during the period of transition from the one-to-two child policy era.

Design: We used births data from cross-sectional National Household Health Services Surveys in 2013 and 2018.

Setting: Population-based national survey

Participants: Women who had the last live birth within the five years before the survey

Primary outcome measure: Caesarean section rate

Results: Overall CS use increased from 40.9% in 2008 to 47.2% in 2014 with significant increase in rural areas and the western region, and slightly decreased to 45.2% in 2018 with the greatest decrease among nulliparous women. Maternal request for CS by urban nulliparous women decreased from 36.8% in 2008-2009 to 22.2% in 2016-2018, but this change was not statistically significant in rural areas. Advanced maternal age and place of birth (private hospital) were associated with CS use among nulliparous women in 2016-2018. The CS rate among multiparous women increased over time. Individual socio-economic factors associated with CS use among multiparous women.

Conclusions: The CS rate rise in China in 2008-2018 is attributable to increased use in rural areas and the less developed Western region. The population policy shift, alongside facility policies for unnecessary CS reduction, are likely factors in CS reduction in urban areas. The challenge remains to reduce unnecessary CS, at the same time as providing safe, universal access to CSs for women in need.

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Strengths and limitations of this study

- This study used well-established population-based national survey data to examine the change of caesarean section rate in China by urban and rural areas, across regions and women's characteristics over the periods of population policy shift.
- This study provides unique insights into both mode of birth and whom households report proposed actual caesarean births.
- We are not able to conduct more sub-groups analysis such as previous caesarean section or others due to unavailable data.

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Introduction

Globally, Caesarean Section (CS) rates are rising in all regions with one of fifth of live births being by CS in 2015.[1] Complex social, cultural, economic, and medical factors are known drivers of CS use. Overuse and underuse of CS represent simultaneous challenges for many health systems. Overuse of CS, where CS is performed without or on the basis of ambiguous medical indications has been associated with increased risk of maternal and newborn adverse outcomes and increased costs for health systems and individuals.[2, 3] Meanwhile, the low use of CS implies limited accessibility to this life-saving procedures for women in need during childbirth.[1] The World Health Organization (WHO) Statement on Caesarean Section Rates suggests that CS rates at population level higher than 10% are not associated with reductions in maternal and newborn mortality rates, while every effort should be made to provide CS to women in need.[4]

China has witnessed a rapid increase in the use of CS since 1990s.[5-8] According to the data from the National Household Health Services Surveys (NHHSS) in China, the CS rate increased from 19.2% in 2003 to 36.3% in 2011.[6] This survey found that the CS rate in urban areas (46.8%) in 2011 was 1.4 times of that in rural areas, and the CS rate in 2011 was the highest in central region (44.7%), followed by eastern region (41.5%) and the lowest in less developed western region (25.0%). A recent study used the data from the National Maternal Near Miss Surveillance System (NMNMSS), and found a gradual decrease of CS rates from 45.3% in 2012 to 41.1% in 2016, particularly among nulliparous and multiparous births without a uterine scar, in correspondence with the relaxation of the only child policy in China.[8] In this study, the authors also indicated that urban population were over-represented in the NMNMSS.

Many CSs in China are not medically indicated.[9] There is evidence that individual, health system and socio-cultural factors are driving the use of CS.[10] Women may request CS because of fear of labor pain, fear of risk and adverse outcomes of vaginal delivery, perceived convenience of CS for birth plan and control and perceived CS as a safe option for childbirth.[10] In China, facility-based delivery is a national strategy to reduce risks of adverse outcomes for mothers and newborns. Almost all births occurred in health facilities by 2015. It has been argued that financial incentive and fear of malpractice may shape the preference of health professionals for performing CS in the hospital settings.[10, 11] Since 2009, the Chinese government has increasingly introduced policies and strategies at national and local levels to restrict the use of unnecessary CS.[8] These strategies largely targeted health professionals. They include revising clinical guideline to strict control of CS indications, strengthening training of midwifery care and audit of CS without medical indications, setting

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facility CS rate targets and removing financial incentives for CS. Few experimental studies have assessed how well these strategies work to optimize the use of CS.[7, 8]

China has gradually relaxed family planning policy since 2013, with all families being allowed and encouraged to have a second child in 2016. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS.[12, 13] The aim of this study was to investigate changes to CS rates between 2008 and 2018, by urban and rural location, and across socio-economic regions in China. It sought to examine maternal request for CS by the study periods, as well as demographic and socio-economic factors associated with use of CS during the period of transition from the one-to-two child policy era.

Methods

Data source

We used cross-sectional data obtained from National Household Health Services Surveys (NHHSS) conducted in 2013 and 2018 by the Center for Health Statistics and Information of the National Health Commission (NHC) of China (formerly the Ministry of Health). Each survey employed the same three-stage, stratified, cluster random sampling procedure. At the first stage, urban and rural location and socio-economic regions were used to classify cities and counties into six groups: eastern urban, eastern rural, central urban, central rural, western urban and western rural. Simple random sampling was used to select cities and counties from each group. The random sample process was repeated for three times to select the ones most close to the parameters (e.g. fertility rate, mortality rate and demographic structure etc.) representing the general. Then five sub-districts or townships were randomly selected from each city or county based on the rank of number of population. Finally, three communities or villages from each sub-district or township were randomly selected and all households in the selected sub-district or township were included in the survey. In total, 93,613 households were included in the survey of 2013 and 94,074 in the survey of 2018.

Data collection

The trained primary health workers administered face-to-face survey to each family member in the sampled households using structured questionnaire. The questionnaires used in the two surveys had a same structure and involved similar questions, which included the general demographic and socio-economic characteristics of the sampled households and family members, the utilization of and expenditures on health services. There is one section on the childbirth that asked questions about the use of antennal care, place of delivery, mode of

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delivery and caesarean delivery for maternal request. We included women who had the last live birth within the five years before the survey in this study.

Data analysis

The outcome measure was the percentage of births by CS. In the survey, the mode of delivery was asked with the following question: "How did the birth take place: a) vaginal delivery; b) caesarean section". If the answer was "caesarean section", the following question was "Who was the most important person of proposing CS: a) myself; b) husband; c) parent; d) doctor; e) others". We considered CS as a woman request in the analysis if the woman choose the option "a (myself)".

We examined factors associated with the use of CS that included: maternal age; maternal educational level; location of resident (urban, rural); living in different socio-economic region (developed Eastern, less developed Central, least developed Western); health insurance coverage; income quartile; parity, defined as the number of live births born by a woman; and place of delivery, defined as type of health facility where the live birth occurred. There are three basic health insurance schemes in China: Urban Employee Basic Health Insurance (UEBMI), Urban Residents Basic Health Insurance (URBMI) and rural New Cooperative Medical Scheme (NCMS). In recent years, URBMI was integrated with NCMS in some provinces renamed as Urban and Rural Residents Basic Medical Insurance (URRBMI). Overall, UEBMI provides better coverage for both inpatient and outpatient care compared to URRBMI. In the analysis, we grouped URBMI, NCMS and URRBMI into one category as "URRBMI', and other health insurances included free medical service scheme for special sectors or labor insurance. Annual household income in the calendar year that preceded the survey included savings and household expenditure on consumables during that year. We generated income quartile by dividing household income by the number of individuals in the household.

We investigated changes of CS rate in 2008-2018 by location of residents and across different socio-economic regions. We also examined CS rate among nulliparous and multiparous women by location and region. We studied change of women request for CS by parity that the time period 2008-2018 was divided into 2008-2009, 2010-2012, 2013-2015 and 2016-2018. Chi-square test was used to test the difference by the study period. We conducted bi-variate and multi-variate logistic regression analysis to study explanatory variables associated with the use of CS for all and in stratification of urban and rural areas and by socio-economic regions in 2008-2018. In addition, we also investigated factors associated with the use of CS in 2016-2018 after universal two-child policy in China for all and by nulliparous and multiparous women, by location and regions.

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Patient and Public Involvement

This study is based on a secondary data analysis. No patient involved.

Results:

Total 23,053 women who had a live birth in the study period 2008-2018 were included in the analysis (Table 1). The distribution of maternal age was relatively similar by the study periods, and more than 60% of women were aged at 25-34 years. The proportion of women who received high school and professional school or higher and those who had two or more children increased over time. Few women had no health insurance coverage, and a vast majority of women had enrolled in URRBMI. In addition, there were more women in urban areas giving birth than women in rural areas observed in the period of 2016-2018. The distribution of women living region was relatively similar over time. The majority of women gave birth in general hospital (county or higher level hospital) and this proportion increased over time. The proportion of women giving birth in community and township health centers decreased in both urban and rural areas across different socio-economic regions (Supplementary files: Table 1). In the 2018 survey, fewer women reported choosing to give birth in a private hospital.

CS rate

Nationwide, the CS rate increased from 40.9% in 2008 to 47.2% in 2014. After the scale-up of the two-child policy, the CS rate slightly decreased; it was 45.2% in 2018. In urban areas, the CS rate slightly increased from 50.4% in 2008 to 52.3% in 2014, and then slightly decreased to 47.8% in 2018. However, in rural areas the CS rate had significantly increased from 33.1% in 2008 to 43.8% in 2015. In rural areas there was also a slight decrease after the relaxation of the one-child policy. The CS rate in rural areas was 41.2% in 2018 (Figure 1a). A similar trend was found across different socio-economic regions (Figure 1b). We observed a significant increase in CS rate from 28.1% in 2008 to 38.6% in 2018 in the least developed western region. In the stratification of urban and rural areas by regions, in 2008 the CS rates in urban areas in the eastern, central and western regions were 50.9%, 62.3% and 37.4% respectively. The difference of CS rate in urban areas by region became very small in 2018 (48.1% in eastern, 49.2% in central and 46.6% in western region). The CS rates in rural areas across all regions increased between 2008 and 2018. The CS rates in the eastern and central rural areas were higher or close to the rate in urban areas in these two regions (Supplementary file: Figure 1).

Around half of nulliparous women in urban areas gave birth by CS between 2008 and 2014, and the proportion in rural areas grew significantly from 33.3% in 2008 to 49.6% in 2015.

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The CS rate among nulliparous women decreased rapidly in both urban (42.8% in 2018) and rural areas (37.5% in 2018) after the universal two-child policy (Figure 2a). The CS rate among multiparous women continued to increase from 35.3% in 2008 to 48.4% in 2018 with similar trends in both urban and rural areas (Figure 2b). We found similar finding in terms of the change of CS rate by parity across different socio-economic regions (Supplementary file: Figure 2).

Maternal request for CS

We examined maternal request for CS by the study periods (Table 2). According to women's self-report, the proportion of maternal request for CS among nulliparous women decreased from 35.8% in 2008-2009 to 24.4% in 2016-2018 (P<0.01). In the stratification of residents location, maternal request for CS significantly decreased in urban areas from 36.8% in 2008-2009 to 22.2% in 2016-2018 (p<0.01), however the change in rural areas was not statistically significant (from 33.5% in 2008-2009 to 29.4% in 2016-2018) (Supplementary files: Table 2). Among multiparous women, around one third of women reported maternal request for CS, and there was no significant change between 2008-2009 and 2016-2018.

In addition, the proportion of CS suggested by a doctor among nulliparous women increased from 63.3% in 2008-2009 to 72.7% in 2016-2018 (P<0.01), and there was no significant change of doctors' suggestion for CS among multiparous women by the study period. For both nulliparous and multiparous women, there were few CSs proposed by women's husband and others (Table 2).

Factors associated with the use of CS

Table 3 shows factors associated with the use of CS in China by urban and rural areas over the study period of 2008-2018. After adjusting for all explanatory variables, the use of CS was less common in urban areas in the survey of 2018 (OR 0.85, 95%CI 0.78-0.92) compared to the survey of 2013, however, it was more common in rural areas (OR 1.30, 95%CI 1.19-1.41) in the survey of 2018. Advanced maternal age (≥35), having secondary education or higher and giving birth at high level hospital or private hospital were significantly associated with the use of CS in both urban and rural areas. In rural areas, women from the highest income quartile were more likely to have CS (OR 1.69, 95%CI 1.47-1.95) compared to women from the lowest quartile, and multiparous women were less likely to have CS (OR 0.80, 95%CI 0.73-0.88) than nulliparous women. While these differences were not statistically significant in urban areas.

Across different socio-economic regions, the use of CS increased in western region in the survey of 2018 (OR 1.10, 95% CI 1.00-1.22) than the survey of 2013, while this difference

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was not statistically significant in eastern and central regions (Supplementary files: Table 3). Advanced maternal age ((≥35) and giving birth at high level hospital or private hospital were associated with the use of CS in all regions. In central and western regions, women who lived in rural areas, were from low income quartile household and had more than one child `were less likely to have CS.

Following the universal two-child policy in China (2016-2018), women in urban areas who were at advanced age ((≥35), multiparous and gave birth at county or high level hospital or private hospital were more likely to have CS (Supplementary files: Table 4). In rural areas, in addition to maternal age and place of delivery, maternal education attainment and household income were also positively associated with the use of CS. Factors associated with the use of CS in eastern and central regions at the same study period were found similar in urban areas and those in western region were found similar in rural areas (Supplementary files: Table 5).

We examined the factors associated with the use of CS by parity in the era of two-child policy. We found that advanced maternal age (≥35) and births occurred at private hospital were significantly associated with the use of CS among nulliparous women after adjusting for all explanatory variables, while the association between the use of CS and other socio-economic factors was not statistically significant (Table 4). For multiparous women, women who were older, had higher education attainment, had health insurance coverage, were from wealthy household, lived in urban areas or eastern region and gave birth at higher level hospital or private hospital were more likely to have CS after adjusting for all explanatory variables (Table 4).

Discussion

Summary of key findings

In China, the CS rate increased between 2008 and 2015, which was, to a great extent, attributable to a rapid increase of the use of CS in rural areas and the least developed western region. After the scale-up of two-child policy, the CS rate slightly decreased in both urban and rural areas and across socio-economic regions, particularly among nulliparous women. The proportion of maternal request for CS decreased among nulliparous women in urban areas over time, however, this proportion decreased slightly in rural areas that 30% of women underwent CS due to maternal request for CS in 2016-2018. In the era of two-child policy, advanced maternal age and births occurred in a private hospital were associated with the use of CS among nulliparous women. The CS rate among multiparous women continued

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to increase over time, and demographic and socio-economic factors were positively associated with the use of CS among multiparous women.

Strengths and limitations

This study contributes to what is known about rates of CS in China, where most existing studies are limited to a few hospitals or regions. It is a strength of this paper that with the increase of population size and urbanization in China over the past two decades, the National Household Health Services Survey adapted its sampling method in 2013 and increased the sample size to achieve reliable representativeness of the general population by urban and rural areas and across different socio-economic regions. It provides unique insights into both mode of birth and whom households report proposed actual caesarean births. However, several limitations in terms of data and analysis remain. First, all information was based on women's reports, and the reasons for maternal request or doctor suggestion for CS were not asked. We were not able to distinguish in this study how many CSs performed were medically indicated. Second, women's history of pregnancy (e.g. previous CS or others) was not available. We could not make a sub-group analysis on the use of CS among women with or without uterine scar. Third, we could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China. That said, we did observe a slight decrease of CS rate in line with the period of the universal two-child policy and the CS rate in urban areas and regions with a high baseline rate had a moderate change over time (2008-2018). Thus the interpretation of a decrease in CS rate following relaxation of the one-child policy should be made with caution.

Interpretations

We observed a rapid decrease of CS rate among nulliparous women in both urban and rural areas and across all regions in line with the period of universal two-child policy, which is consistent with the findings in other studies.[8,14] However, any causal association remains speculative, not least because of the nuances within the one-child policy itself. In 1979, China announced its family planning policy to strictly control population size. The policy included rules of governing marriage, contraception, number of births and spacing where a second child was permitted.[15] The one child rule was strictest for urban residents and employees of the government agencies. In rural areas, a second child was generally allowed after five years, especially if the first born was a girl. Some ethnic minorities were permitted a third child. With socio-economic development and change of demographic structure, the Chinese government gradually relaxed the one-child policy over a decade with the entire population encouraged to have a second child since 2016.[16]

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The CS rate increased moderately in urban areas and the eastern and central regions, which had a relatively high baseline CS rate. One plausible explanation is that this may be attributable to the introduction of policies and strategies aiming to reverse the high CS rate through a national top-down approach in China. Although, results of introducing comprehensive interventions to mitigate unnecessary CSs are mixed in previous studies.[7,8,17,18]

We found that the CS rate increased dramatically in rural areas by all socio-economic regions between 2008-2015. This rise may be associated with a significant increase in the number of births occurring at secondary or higher-level (tertiary) hospitals, reflecting an increase in availability and accessibility of these services in these areas. The Chinese government had made strong commitment to reduce maternal and child mortality to achieve Millennium Development Goal (MDG) targets by 2015.[19] The main strategy was to promote hospital delivery, particularly in rural and poor areas with largely financial support from the central government and partly from the provincial government.[19] In the context of deepening China's health system reform, the national plan of further strengthening the hospital delivery for rural women in 2009 highlighted to provide the financial compensation for hospital delivery through rural health insurance (NCMS), the earmarked government fund and medical assistance program for the poor women in order to reduce financial burden placed on the households.[20] By 2014, hospital delivery in rural areas was almost universal. Across countries, the shift from community to hospital births is known to result in an increase in CS rates for medically indicated and non-medical reasons.[21] In China, cross-sectional research has shown that while tertiary hospitals have the highest rates of CS for ambiguous indications (i.e. Non-reassuring foetal heart tracing; failure to progress), secondary level hospitals report greater use of CS for maternal request.[22]

Implications for practice

Previous studies report maternal request for CS as a contributor to a rapid increase of CS rate in China,[22-25] despite the validity of the concept being widely debated internationally. For women who reportedly prefer CS, the most common reasons for their preference are fear of labor pain, safer for their baby and for themselves.[10] In this context, family members (e.g. husband or parent) also supported this choice to avoid an adverse event, especially in the context of one child in a family policy. Moreover, in our study around one third of nulliparous women reported self-request for CS in the era of one-child policy. This proportion significantly decreased in urban areas over time, which may be associated with the shift from strict one child in a family in urban areas to universal two children, and promotion of vaginal births in hospital settings. This change did not occur in rural areas.

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Efforts to promote vaginal birth include midwifery care training (e.g. training more professional midwives, establishment of standardized evaluation scheme of midwifery practice etc.), pain relief for vaginal birth and informing women about benefits and risks of different mode of delivery.[26] Other studies, largely in big cities and tertiary hospitals report woman-centered pregnancy and childbirth care which includes provision of antenatal classes to shape women's beliefs and confidence to childbirth, build connection and trust between doctors, midwives and women as well as provide continuous supports during labor and birth.[14, 23, 27] At the same time, pharmacological and non-pharmacological options for labor pain management have become available. However, the midwifery workforce in China is insufficient. Quality of midwifery care can vary by hospitals, and urban-rural disparity in midwife numbers and training is anecdotally reported. Lack of support during labor, lack of pain relief and sub-optimal birth environment were reported as the main reasons that rural women requested for CS.[28] Hence, strengthening midwifery care to improve women's experience on childbirth, particularly in rural areas will be critical to optimize the use of CS in China.

Implications for further research

In the era of two-child policy, only advanced maternal age and giving birth in a private hospital were positively associated with the use of CS by nulliparous women. Since 2013 onward, the latest health-care delivery reform in China encouraged competition between public and private hospitals, and set out the target of private hospitals sharing 20% of market by 2015. The burgeoning of private hospital provision in China is driven by market forces, with providers charges unregulated unless contracted by the basic health insurance schemes.[29] Studies in other countries report much higher CSs rate in private hospitals due to profit driven behavior.[30-32] It needs further study to have a better understanding on the use of CS in private hospitals in China in order to propose evidence-based recommendations for relevant policy development. In addition, we found that CS rate among multiparous women continued to increase over time, especially in urban areas, which may be associated with the increase of women who underwent repeat CS. Based on the NMNMSS data, Liang and colleagues reported a high CS rate among multiparous women with a uterine scar and it was unchanged over time.[8] In China, repeat CS is often suggested and accepted for women with a previous CS to mitigate the risk of uterine rupture or other adverse event, despite repeat CS share similar risks. We can only speculate that there may be increasing referrals of women with a previous CS to high level or specialty hospitals. The accessibility, functional referral and affordability of such services as well as health outcomes, particularly for socio-economic vulnerable women should be rigorous assessed in further research.

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Conclusion

A rapid increase of CS rate in rural areas and less developed western region contributed to the increase of CS rate in China over the past decade. The population policy shift, alongside facility policies to limit the use of unnecessary CS, are likely factors contributing to the reduction of CS in urban areas. Strategies at system, organization and individual levels to mitigate unnecessary CSs should be continually strengthened, especially in rural areas and western region. Improving midwifery care will be fundamental to ensure safety and positive childbirth experience in the era of two-child in a family in China.

Research Ethics Approval Statement

We obtained the permission to access to data and conduct secondary data analysis.

Contributors

QL conceived and led the overall analysis and wrote the first manuscript draft. YGZ conducted the data analysis and commented on the manuscript. XJT and JZ contributed to the analysis and commented on the manuscript. CK contributed to the study concept and overall analysis and participated in the manuscript writing.

Conflicts of Interest

The authors declared no conflicts of interest.

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Table 1 Demographic and socioeconomic characteristics of women giving birth in China, 2008-2018

Characteristics	2008-2009 (n=2638)	2010-2012 (n=7015)	2013-2015 (n=6151)	2016-2018 (n=7249)	Total (n=23053)
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Age					
<25	146 (5.5)	1395 (19.9)	785 (12.8)	961 (13.3)	3287 (14.3)
25-34	1708 (64.7)	4514 (64.3)	3836 (62.4)	4775 (65.9)	14833 (64.3)
≥35	784 (29.7)	1106 (15.8)	1530 (24.9)	1513 (20.9)	4933 (21.4)
Educational level [a]					
Illiterate or primary school	493 (18.7)	1091 (15.6)	869 (14.1)	671 (9.3)	3124 (13.5)
Secondary school	128 (48.7)	337 (48.0)	250 (40.8)	250 (34.5)	9662 (41.9)
High school/ professional school or higher	861 (32.6)	2554 (36.4)	2773 (45.1)	4078 (56.3)	10266 (44.5)
Parity [b]					
1	1424 (54.0)	4068 (58.0)	2965 (48.2)	2937 (40.5)	11394 (49.4)
≥2	1213 (46.0)	2947 (42.0)	3184 (51.8)	4312 (59.5)	11656 (50.6)
Health insurance coverage [*]					
None	115(4.4)	366 (5.2)	334 (5.4)	386 (5.3)	1201 (5.2)
UEBMI	470 (17.8)	1112 (15.9)	1343 (21.8)	1953 (26.9)	4878 (21.2)
URRBMI	2007 (76.1)	5440 (77.5)	4270 (69.4)	4589 (63.3)	16306 (70.7)
Others	46 (1.7)	97 (1.4)	204 (3.3)	321 (4.4)	668 (2.9)
Location					
Urban	1234 (46.8)	3261 (46.5)	3133 (50.9)	4166 (57.5)	11794 (51.2)
Rural	1404 (53.2)	3754 (53.5)	3018 (49.1)	3083 (42.5)	11259 (48.8)
Region					
Eastern	878 (33.3)	2238 (31.9)	2133 (34.7)	2741 (37.8)	7990 (34.7)
Central	875 (33.2)	2309 (32.9)	1822 (29.6)	1957 (27.0)	6963 (30.2)

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Western	885 (33.5)	2468 (35.2)	2196 (35.7)	2551 (35.2)	8100 (35.1)
Place of delivery #					
County or higher level hospital	1416 (53.7)	4163 (59.3)	3755 (61.0)	4746 (65.5)	14080 (61.1)
Maternal and child health hospital	670 (25.4)	1743 (24.8)	1482 (24.1)	1678 (23.1)	5573 (24.2)
Township/community health center	552 (20.9)	1109 (15.8)	633 (10.3)	391 (5.4)	2685 (11.6)
Private hospital	--	--	281 (4.6)	434 (6.0)	715 (3.1)

* UEBMI: Urban Employee Basic Medical Insurance

URRBMI: Urban and Rural Resident Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

The private hospital was not included in the survey in 2013.

[a] Data were missing for one woman in 2013-2015

[b] Data were missing for one woman in 2008-2009, and two in 2013-2015

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Table 2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by parity in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Parity 1					
Women request	35.8	30.2	27.9	24.4	<0.001
Husband	0	0	1.3	1.6	<0.001
Doctor	63.3	68.8	69.5	72.7	<0.001
Others	0.9	1.0	1.3	1.3	0.877
Parity ≥2					
Women request	31.7	30.0	32.6	30.9	0.445
Husband	0	0	1.8	1.2	<0.001
Doctor	66.3	69.1	64.4	67.1	0.094
Others	2.0	0.9	1.2	0.8	0.243

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Table 3 Factors associated with use of caesarean section in China by location, 2008-2018

	All		Urban		Rural	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Year of the survey						
2013	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.16 (1.10-1.22)	1.03 (0.97-1.09)	0.92 (0.86-0.99)	0.85 (0.78-0.92)	1.38 (1.27-1.49)	1.30 (1.19-1.41)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.44 (1.33-1.55)	1.32 (1.21-1.43)	1.29 (1.14-1.46)	1.29 (1.13-1.47)	1.36 (1.23-1.51)	1.35 (1.20-1.52)
⩾35	2.03 (1.85-2.22)	2.02 (1.82-2.25)	1.93 (1.68-2.21)	2.05 (1.75-2.39)	1.78 (1.57-2.02)	2.00 (1.72-2.32)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.32 (1.21-1.43)	1.21 (1.10-1.32)	1.10 (0.94-1.29)	1.16 (0.98-1.36)	1.32 (1.19-1.46)	1.14 (1.02-1.27)
High school or higher	1.76 (1.62-1.92)	1.21 (1.10-1.34)	1.21 (1.05-1.41)	1.22 (1.03-1.44)	1.66 (1.48-1.86)	1.10 (0.96-1.26)
Residence						
Urban			--	--	--	--
Rural	0.61 (0.58-0.65)	0.75 (0.70-0.80)	--	--	--	--
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.18 (1.11-1.26)	1.25 (1.17-1.34)	1.38 (1.26-1.51)	1.35 (1.23-1.48)	1.01 (0.92-1.11)	1.12 (1.01-1.23)
Western	0.62 (0.58-0.66)	0.69 (0.64-0.73)	0.91 (0.83-0.99)	0.92 (0.84-1.01)	0.43 (0.39-0.47)	0.48 (0.43-0.53)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.52 (1.42-1.62)	0.98 (0.91-1.07)	1.11 (1.03-1.20)	1.01 (0.92-1.11)	1.91 (1.63-2.24)	1.13 (0.94-1.35)
None	1.25 (1.11-1.40)	0.96 (0.85-1.09)	0.94 (0.82-1.08)	0.91 (0.79-1.05)	1.42 (1.13-1.79)	1.27 (1.00-1.61)
Others	1.34 (1.15-1.57)	1.05 (0.90-1.24)	1.18 (0.97-1.43)	1.12 (0.92-1.36)	1.12 (0.84-1.47)	1.06 (0.79-1.42)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.39 (1.29-1.50)	1.24 (1.15-1.34)	1.43 (1.30-1.58)	1.10 (0.97-1.24)	1.43 (1.30-1.58)	1.28 (1.15-1.41)
Quartile 3	1.62 (1.50-1.74)	1.30 (1.21-1.41)	1.63 (1.47-1.80)	1.14 (1.02-1.29)	1.63 (1.47-1.80)	1.36 (1.22-1.52)
Quartile 4	1.76 (1.63-1.89)	1.26 (1.16-1.38)	2.04 (1.79-2.32)	1.07 (0.95-1.21)	2.04 (1.79-2.32)	1.69 (1.47-1.95)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	0.87 (0.83-0.92)	0.87 (0.82-0.93)	1.02 (0.95-1.10)	0.94 (0.86-1.02)	0.89 (0.83-0.96)	0.80 (0.73-0.88)
Place of delivery						

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Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.23 (2.03-2.44)	2.03 (1.85-2.24)	1.57 (1.36-1.81)	1.48 (1.27-1.72)	2.49 (2.21-2.81)	2.45 (2.16-2.78)
Maternal and child health hospital	2.02 (1.83-2.23)	1.76 (1.59-1.96)	1.41 (1.21-1.64)	1.34 (1.14-1.57)	2.02 (1.75-2.32)	1.98 (1.71-2.29)
Private hospital	2.55 (2.15-3.02)	2.31 (1.93-2.76)	1.94 (1.53-2.47)	1.91 (1.49-2.46)	2.46 (1.92-3.17)	2.44 (1.87-3.18)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table 4 Factors associated with use of caesarean section after relaxation of the one child policy in China by parity, 2016-2018

	All		Parity 1		Parity ≥2	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.78 (1.53-2.06)	1.62 (1.38-1.90)	1.52 (1.27-1.83)	1.52 (1.25-1.86)	2.37 (1.79-3.14)	2.06 (1.54-2.75)
≥35	2.89 (2.44-3.43)	2.58 (2.12-3.13)	2.41 (1.76-3.31)	2.40 (1.72-3.35)	3.73 (2.78-5.00)	3.19 (2.34-4.33)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.40 (1.18-1.67)	1.42 (1.18-1.71)	0.96 (0.65-1.41)	1.02 (0.69-1.51)	1.58 (1.30-1.93)	1.49 (1.21-1.84)
High school or higher	1.38 (1.17-1.64)	1.24 (1.02-1.51)	0.97 (0.67-1.39)	0.85 (0.58-1.25)	1.74 (1.43-2.12)	1.35 (1.08-1.70)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	0.78 (0.71-0.86)	0.84 (0.75-0.95)	0.81 (0.69-0.95)	0.85 (0.70-1.02)	0.72 (0.63-0.81)	0.84 (0.73-0.97)
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.01 (0.90-1.13)	1.01 (0.90-1.14)	0.99 (0.82-1.19)	1.03 (0.84-1.25)	1.01 (0.87-1.17)	1.00 (0.86,1.17)
Western	0.65 (0.58-0.73)	0.70 (0.62-0.78)	0.83 (0.69-0.98)	0.87 (0.72-1.04)	0.55 (0.48-0.64)	0.61 (0.52-0.71)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.19 (1.07-1.32)	0.95 (0.83-1.09)	1.17 (1.00-1.37)	1.05 (0.86-1.28)	1.34 (1.15-1.55)	0.91 (0.76-1.10)
None	0.92 (0.75-1.14)	0.81 (0.64-1.01)	1.07 (0.77-1.49)	0.99 (0.70-1.38)	0.85 (0.65-1.13)	0.69 (0.51-0.93)
Others	1.14 (0.91-1.44)	0.97 (0.76-1.23)	0.81 (0.54-1.22)	0.76 (0.50-1.14)	1.36 (1.03-1.81)	1.08 (0.80-1.47)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.22 (1.07-1.39)	1.12 (0.97-1.28)	1.12 (0.89-1.41)	1.07 (0.84-1.35)	1.28 (1.09-1.51)	1.12 (0.95-1.33)
Quartile 3	1.44 (1.27-1.64)	1.24 (1.07-1.43)	1.10 (0.89-1.37)	0.99 (0.79-1.25)	1.78 (1.51-2.10]	1.40 (1.17-1.68)
Quartile 4	1.28 (1.13-1.46)	1.04 (0.89-1.21)	1.13 (0.92-1.39)	0.94 (0.73-1.19)	1.51 (1.27-1.79)	1.10 (0.90-1.35)
Parity						
1	1.00	1.00	--	--	--	--
≥2	1.29 (1.18-1.42)	1.12 (1.01-1.25)	--	--	--	--
Place of delivery						
Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.03 (1.62-2.54)	2.09 (1.66-2.64)	1.36 (0.85-2.19)	1.27 (0.78-2.06)	2.45 (1.89-3.16)	2.34 (1.80-3.05)
Maternal and child health hospital	1.67 (1.32-2.12)	1.68 (1.32-2.15)	1.15 (0.70-1.88)	1.03 (0.62-1.70)	1.99 (1.51-2.62)	1.88 (1.42-2.51)

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Private hospital	2.16 (1.62-2.88)	2.26 (1.68-3.04)	1.45 (0.83-2.54)	1.52 (1.25-1.86)	2.56 (1.81-3.61)	2.55 (1.79-3.64)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

Caesarean section rate in urban areas slightly decreased between 2008 and 2018, while it had increased in rural areas. Across regions, a large increase occurred in less developed Western region.

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Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

Caesarean section rate among nulliparous women decreased around 2016 in both urban and rural areas, while there was a large increase in the number of multiparous women delivering by caesarean section.

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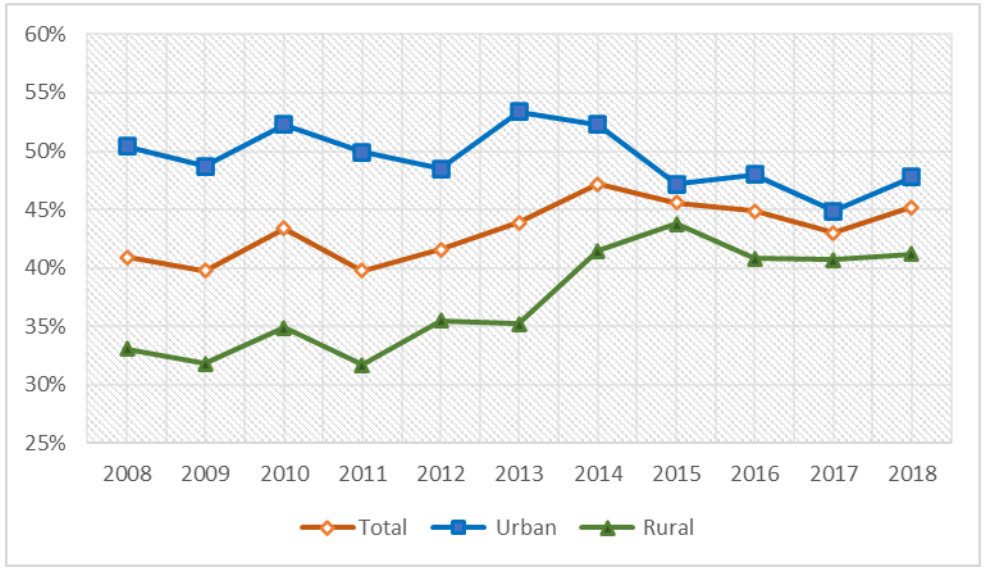
Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

a. Caesarean section rate by urban and rural



b. Caesarean section rate across regions

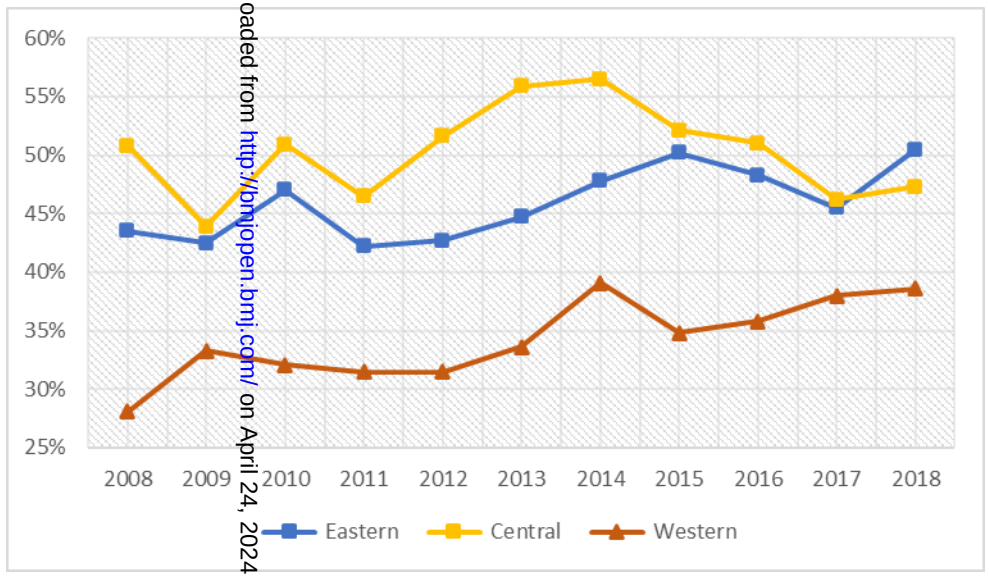


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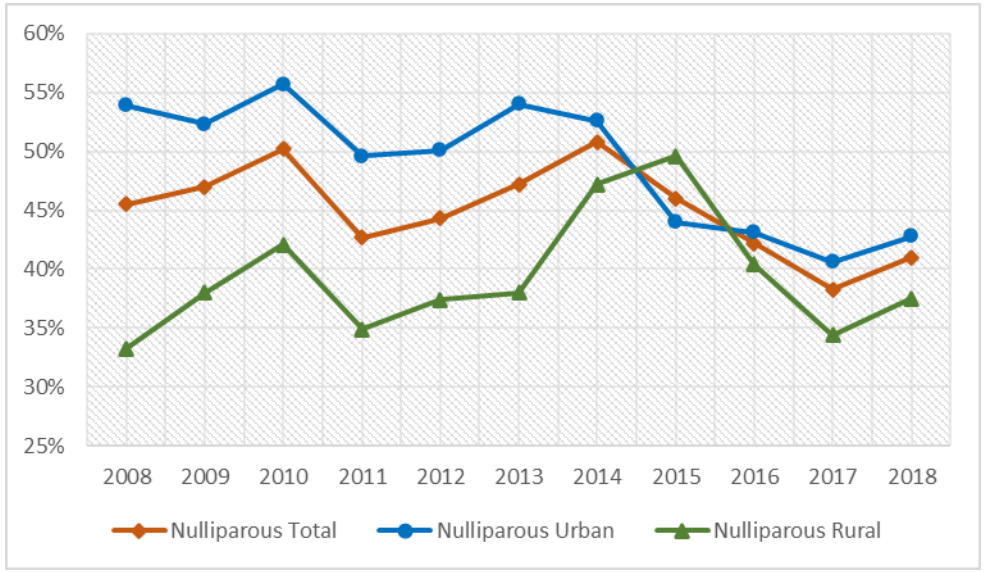
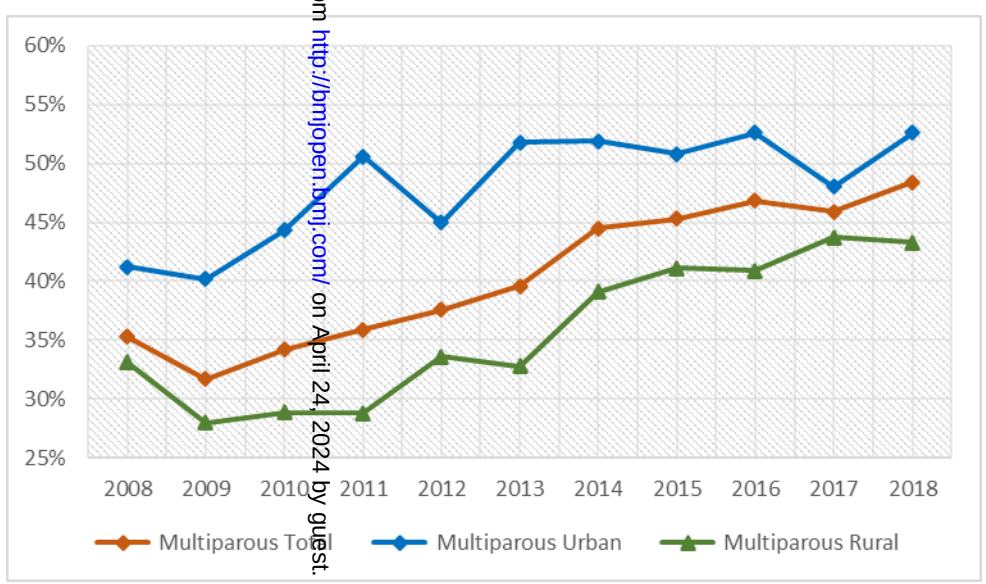
Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

a. Caesarean section rate among nulliparous women by urban and rural



b. Caesarean section rate among multiparous women by urban and rural



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Supplementary files:

Table S1 Place of women giving birth by urban and rural and by region, 2008-2018 (%)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of births	786	1852	1981	2219	2815	2462	1921	1768	2430	2819	2000
Rural											
County or higher level hospital	50.7	52.1	57.2	59.3	61.8	60.6	64.1	65.8	69.3	70.6	68.0
Maternal and child health hospital	21.8	19.8	18.1	21.6	18.3	20.0	17.9	16.7	15.5	17.2	20.6
Township/community health center	27.5	28.2	24.6	19.1	19.9	18.0	11.9	10.3	8.8	5.9	6.7
Private hospital	0	0	0	0	0	1.4	6.1	7.1	6.4	6.3	4.7
Urban											
County or higher level hospital	52.0	57.6	56.1	58.7	61.0	61.0	57.7	58.2	60.4	63.4	63.8
Maternal and child health hospital	34.7	29.7	31.8	31.4	30.6	29.6	29.5	29.3	28.0	26.7	27.3
Township/community health center	13.3	12.7	12.1	9.8	8.4	7.4	6.5	5.9	5.2	4.1	3.0
Private hospital	0	0	0	0	0	2.0	6.2	6.6	6.4	5.8	5.9
East											
County or higher level hospital	50.9	55.5	58.2	61.4	64.7	58.9	65.3	64.9	66.2	67.4	67.3
Maternal and child health hospital	27.3	23.2	22.2	24.5	20.4	24.9	23.0	21.3	21.7	22.0	22.5
Township/community health center	21.8	21.3	19.6	14.1	14.9	15.6	8.5	9.7	7.6	7.1	6.1
Private hospital	0	0	0	0	0	0.6	3.2	4.1	4.5	3.6	4.1
Central											
County or higher level hospital	50.8	52.4	55.0	55.6	58.3	63.3	57.8	58.8	60.3	66.4	64.7

Maternal and child health hospital	29.1	25.4	26.0	28.3	26.3	22.5	26.5	25.5	24.4	22.0	22.9
Township/community health center	20.2	22.2	19.1	16.1	15.4	11.5	7.7	5.2	5.9	2.5	3.8
Private hospital	0	0	0	0	0	2.6	8.1	10.5	9.4	9.0	8.6
West											
County or higher level hospital	52.1	56.2	56.9	60.1	61.5	60.3	58.2	61.0	64.8	65.8	64.4
Maternal and child health hospital	26.5	24.7	26.2	25.1	25.1	26.1	23.3	23.9	22.6	23.4	27.8
Township/community health center	21.4	19.1	16.9	14.8	13.4	11.8	10.7	8.6	6.3	4.4	3.5
Private hospital	0	0	0	0	0	1.8	7.8	6.6	6.3	6.4	4.3

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Table S2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by location and regions in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Urban					
Parity 1					
Women request	36.8	29.0	27.9	22.2	<0.001
Husband	0	0	1.6	14.7	<0.001
Doctor	62.3	70.1	69.9	75.5	<0.001
Others	0.9	0.86	0.6	0.86	0.899
Parity ≥2					
Women request	31.7	28.6	30.1	30.5	0.858
Husband	0	0	1.4	1.3	0.032
Doctor	65.5	70.7	67.0	67.4	0.564
Others	2.8	0.6	1.5	0.8	0.182
Rural					
Parity 1					
Women request	33.5	32.3	28.0	29.4	0.256
Husband	0	0	0.8	1.9	0.002
Doctor	65.5	66.6	68.7	66.6	0.725
Others	1.0	1.2	2.5	2.2	0.429
Parity ≥2					
Women request	31.8	31.1	35.0	31.4	0.279
Husband	0	0	2.1	1.0	0.001
Doctor	66.7	67.7	61.9	66.7	0.079
Others	1.6	1.2	1.0	0.9	0.743
Eastern					

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Parity 1					
Women request	34.8	31.7	27.7	23.6	0.002
Husband	0	0	1.5	1.3	0.006
Doctor	63.9	67.2	69.5	72.8	0.045
Others	1.2	1.1	1.3	2.32	0.494
Parity ≥2					
Women request	37.2	30.5	36.3	33.0	0.316
Husband	0	0	1.1	1.1	0.156
Doctor	60.6	68.9	61.6	65.4	0.142
Others	2.3	0.6	1.1	0.5	0.158
Central					
Parity 1					
Women request	37.6	30.3	30.7	27.0	0.020
Husband	0	0	1.0	1.6	0.005
Doctor	62.0	68.4	67.1	70.9	0.072
Others	0.4	1.3	1.2	0.6	0.502
Parity ≥2					
Women request	30.9	33.2	31.4	33.4	0.912
Husband	0	0	2.1	1.8	0.008
Doctor	67.9	65.7	65.0	64.2	0.776
Others	1.2	1.1	1.6	0.6	0.487
Western					
Parity 1					
Women request	34.8	28.2	24.3	23.3	0.029
Husband	0	0	1.6	2.0	0.005
Doctor	64.1	71.4	72.7	74.2	0.103
Others	1.1	0.4	1.3	0.5	0.383
Parity ≥2					

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Women request	26.0	24.7	29.9	24.9	0.302
Husband	0	0	2.2	0.7	0.012
Doctor	71.0	74.3	66.9	72.8	0.163
Others	3.0	1.0	1.0	1.6	0.515

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Table S3 Factors associated with use of caesarean section (CS) in China by region, 2008-2018

	Eastern		Central		Western	
	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)
Year of the survey						
2013	43.5	1.00	49.7	1.00	31.7	1.00
2018	48.1	1.07 (0.97-1.18)	50.7	0.93 (0.84-1.04)	37.4	1.10 (1.00-1.22)
Age						
<25	36.5	1.00	43.2	1.00	26.4	1.00
25-34	44.5	1.36 (1.16-1.59)	49.7	1.27 (1.09-1.47)	34.4	1.30 (1.13-1.50)
⩾35	55.4	2.15 (1.78-2.59)	55.9	1.74 (1.45-2.09)	42.4	2.02 (1.69-2.41)
Educational level						
Illiterate or primary school	46.2	1.00	48.5	1.00	23.6	1.00
Secondary school	44.8	0.99 (0.83-1.19)	46.9	0.92 (0.78-1.09)	31.9	1.43 (1.24-1.64)
High school or higher	46.8	0.94 (0.78-1.14)	54.0	0.95 (0.79-1.14)	44.0	1.50 (1.27-1.76)
Residence						
Urban	47.4	1.00	55.5	1.00	45.0	1.00
Rural	44.2	0.95 (0.85-1.06)	44.5	0.78 (0.70-0.87)	25.4	0.56 (0.51-0.63)
Region						
Eastern	46.0	--	--	--	--	--
Central	--	--	50.2	--	--	--
Western	--	--	--	--	34.6	--
Health insurance coverage [a]						
URRBMI	44.6	1.00	47.8	1.00	31.8	1.00
UEBMI	48.5	1.01 (0.89-1.15)	57.5	1.07 (0.92-1.25)	49.2	0.96 (0.82-1.13)
None	43.6	0.88 (0.73-1.06)	56.7	1.24 (0.99-1.55)	37.2	0.91 (0.70-1.18)
Others	52.2	1.20 (0.93-1.55)	56.3	1.18 (0.87-1.60)	35.2	0.88 (0.65-1.19)
Income quartile						
Quartile 1	43.6	1.00	45.3	1.00	24.9	1.00
Quartile 2	44.9	1.04 (0.90-1.21)	49.6	1.16 (1.01-1.32)	35.5	1.38 (1.21-1.57)
Quartile 3	47.2	1.12 (0.97-1.28)	52.5	1.21 (1.07-1.38)	40.0	1.44 (1.25-1.65)
Quartile 4	47.0	1.06 (0.91-1.23)	54.9	1.19 (1.02-1.39)	47.3	1.60 (1.37-1.87)
Parity						
1	45.4	1.00	51.9	1.00	38.0	1.00
≥2	46.7	0.91 (0.81-1.01)	48.5	0.87 (0.78-0.97)	31.6	0.84 (0.75-0.94)
Place of delivery						
Township/community health center	32.0	1.00	34.4	1.00	16.4	1.00
County or higher level hospital	49.1	1.98 (1.71-2.30)	52.6	1.90 (1.61-2.24)	37.2	2.37 (1.95-2.87)

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Maternal and child health hospital	44.2	1.62 (1.37-1.91)	51.9	1.77 (1.48-2.12)	34.5	2.02 (1.64-2.48)
Private hospital	55.8	2.57 (1.82-3.62)	52.7	1.97 (1.48-2.62)	40.9	2.82 (2.04-3.90)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S4 Factors associated with use of caesarean section (CS) after relaxation of the one child policy by urban and rural, 2016-2018

	Urban		Rural	
	Unadjusted	Adjusted*	Unadjusted	Adjusted*
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age				
<25	1.00	1.00	1.00	1.00
25-34	1.57 (1.25-1.98)	1.51 (1.19-1.92)	1.87 (1.53-2.28)	1.74 (1.40-2.17)
≥35	2.73 (2.12-3.51)	2.50 (1.90-3.29)	2.60 (2.02-3.35)	2.46 (1.84-3.28)
Educational level				
Illiterate or primary school	1.00	1.00	1.00	1.00
Secondary school	1.25 (0.90-1.74)	1.39 (0.99-1.94)	1.40 (1.13-1.73)	1.34 (1.07-1.67)
High school or higher	1.12 (0.82-1.53)	1.25 (0.90-1.75)	1.29 (1.04-1.61)	1.09 (0.85-1.40)
Residence				
Urban	--	--	--	--
Rural	--	--	--	--
Region				
Eastern	1.00	1.00	1.00	1.00
Central	1.13 (0.97-1.32)	1.08 (0.92-1.26)	0.86 (0.71-1.03)	0.89 (0.74-1.08)
Western	0.89 (0.77-1.03)	0.89 (0.77-1.04)	0.43 (0.36-0.52)	0.49 (0.41-0.59)
Health insurance coverage [a]				
URRBMI	1.00	1.00	1.00	1.00
UEBMI	1.03 (0.90-1.18)	0.98 (0.84-1.15)	1.29 (1.00-1.66)	0.96 (0.72-1.28)
None	0.76 (0.59-0.97)	0.78 (0.60-1.01)	1.25 (0.79-1.99)	1.14 (0.71-1.84)
Others	1.20 (0.91-1.59)	1.08 (0.81-1.45)	0.80 (0.53-1.23)	0.85 (0.54-1.31)
Income quartile				
Quartile 1	1.00	1.00	1.00	1.00
Quartile 2	1.06 (0.86-1.31)	1.03 (0.83-1.27)	1.24 (1.04-1.48)	1.11 (0.92-1.33)
Quartile 3	1.15 (0.95-1.40)	1.10 (0.89-1.35)	1.56 (1.29-1.89)	1.33 (1.08-1.64)
Quartile 4	1.00 (0.83-1.21)	0.95 (0.77-1.17)	1.41 (1.09-1.83)	1.20 (0.91-1.59)
Parity				
1	1.00	1.00	1.00	1.00
≥2	1.41 (1.25-1.60)	1.17 (1.02-1.34)	1.25 (1.07-1.46)	1.03 (0.86-1.23)
Place of delivery				

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Township/community health center	1.00	1.00	1.00	1.00
County or higher level hospital	1.54 (1.12-2.12)	1.62 (1.17-2.25)	2.53 (1.83-3.51)	2.60 (1.86-3.63)
Maternal and child health hospital	1.30 (0.93-1.80)	1.37 (0.98-1.93)	1.85 (1.29-2.65)	1.84 (1.27-2.67)
Private hospital	1.72 (1.16-2.56)	1.84 (1.22-2.76)	2.48 (1.61-3.81)	2.62 (1.68-4.07)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S5 Factors associated with use of C-section after relaxation of the one child policy across regions, 2016-2018

	Eastern		Central		Western	
	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.62 (1.22-2.16)	1.58 (1.17-2.14)	1.96 (1.47-2.60)	1.77 (1.31-2.39)	1.60 (1.27-2.00)	1.48 (1.16-1.88)
≥35	2.88 (2.11-3.95)	2.76 (1.94-3.91)	3.03 (2.18-4.21)	2.49 (1.72-3.61)	2.37 (1.80-3.11)	2.20 (1.60-3.01)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.05 (0.74-1.49)	1.20 (0.84-1.72)	0.92 (0.65-1.31)	1.04 (0.72-1.51)	1.67 (1.28-2.19)	1.62 (1.22-2.14)
High school or higher	0.79 (0.57-1.10)	0.98 (0.68-1.41)	0.91 (0.65-1.28)	0.90 (0.61-1.32)	2.04 (1.57-2.64)	1.51 (1.12-2.05)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.11 (0.95-1.30)	0.98 (0.81-1.17)	0.84 (0.70-1.01)	0.91 (0.73-1.13)	0.54 (0.46-0.64)	0.69 (0.57-0.84)
Region						
Eastern	--	--	--	--	--	--
Central	--	--	--	--	--	--
Western	--	--	--	--	--	--
Health insurance coverage						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	0.85 (0.72-1.00)	0.92 (0.75-1.14)	1.26 (1.01-1.56)	1.12 (0.86-1.44)	1.50 (1.22-1.83)	0.95 (0.74-1.22)
None	0.62 (0.47-0.82)	0.65 (0.48-0.88)	1.23 (0.75-2.01)	1.36 (0.82-2.27)	1.24 (0.76-2.02)	1.05 (0.64-1.73)
Others	1.10 (0.77-1.58)	1.15 (0.79-1.69)	1.23 (0.81-1.85)	1.03 (0.67-1.57)	0.84 (0.53-1.32)	0.77 (0.48-1.24)
Income quintiles						
Quintile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 2	0.90 (0.70-1.14)	0.97 (0.79-1.21)	0.93 (0.73-1.19)	0.94 (0.73-1.21)	1.62 (1.31-2.01)	1.37 (1.09-1.71)
Quintile 3	0.93 (0.74-1.17)	0.85 (0.68-1.06)	1.16 (0.91-1.48)	1.12 (0.87-1.45)	2.00 (1.60-2.50)	1.54 (1.21-1.98)
Quintile 4	0.77 (0.62-0.96)	1.16 (0.97-1.38)	1.09 (0.84-1.41)	1.01 (0.75-1.36)	1.93 (1.53-2.42)	1.33 (1.01-1.75)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	1.47	2.26	1.50	1.28	0.98	0.99

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	(1.26-1.72)	(1.63-3.14)	(1.25-1.81)	(1.04-1.57)	(0.84-1.16)	(0.82-1.20)
Place of delivery						
Township/community health center (ref.)						
County or higher level hospital	2.08 (1.52-2.85)	1.66 (1.16-2.36)	1.71 (1.06-2.74)	1.79 (1.11-2.90)	2.51 (1.58-3.97)	2.06 (1.28-3.29)
Maternal and child health hospital	1.55 (1.10-2.18)	2.64 (1.61-4.31)	1.55 (0.95-2.54)	1.61 (0.96-2.67)	2.19 (1.36-3.53)	1.70 (1.04-2.78)
Private hospital	2.49 (1.54-4.03)	2.55 (1.79-3.64)	1.26 (0.73-2.18)	1.36 (0.78-2.37)	3.78 (2.17-6.58)	3.25 (1.84-5.74)

* Adjusting for all explanatory variables

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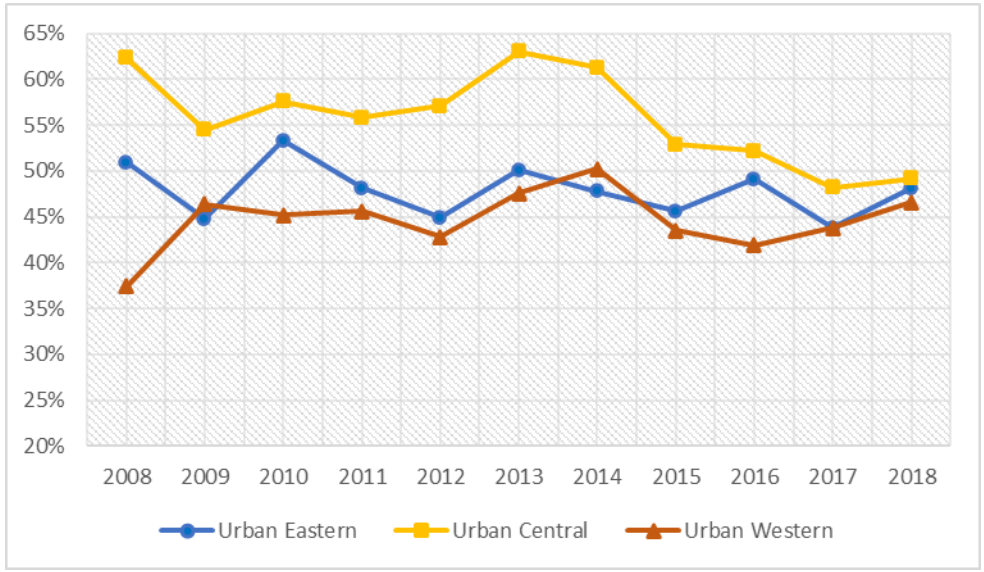
Figure S1 Proportion of women giving birth by caesarean section across regions by urban and rural, 2008-2018

a. Caesarean section rate in urban areas across regions



b. Caesarean section rate in rural areas across regions

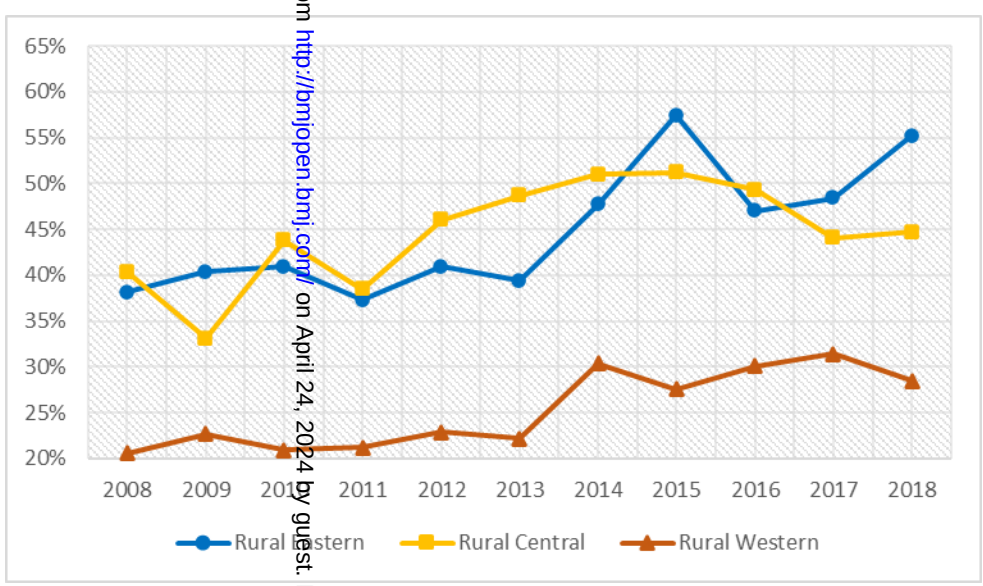


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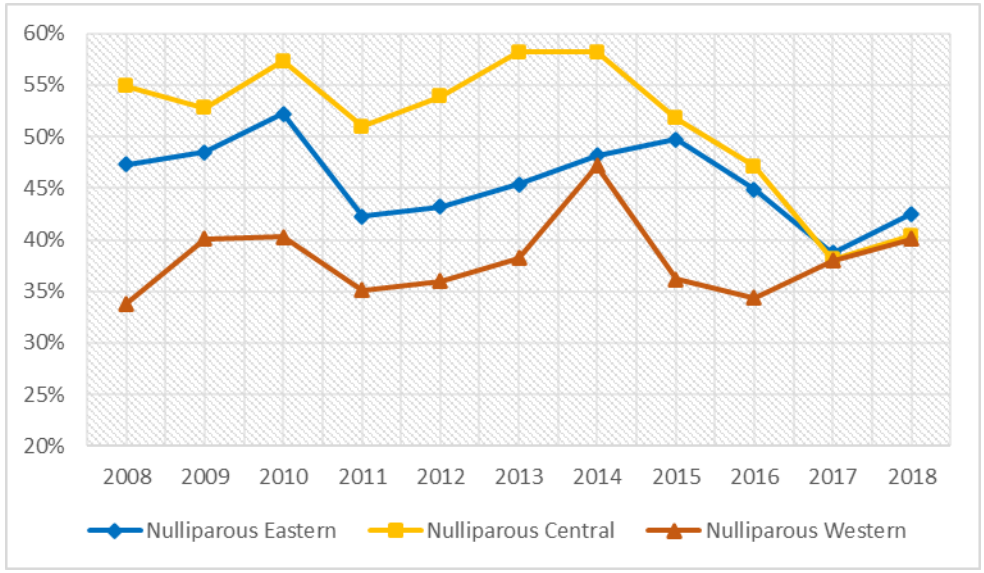
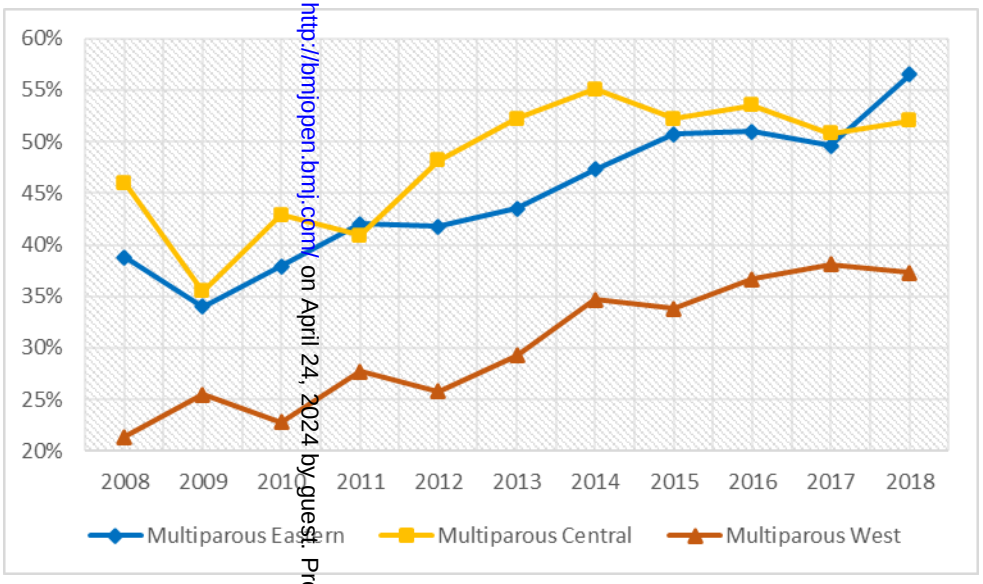
Figure S2 Proportion of women giving birth by caesarean section by parity across regions, 2008-2018

a. Caesarean section rate among nulliparous women across regions



b. Caesarean section rate among multiparous women across regions



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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	17 (Table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	7-8

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Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

The authors confirmed that the manuscript writing followed the STORBE checklist for cross-sectional studies.

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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Abstract

Objectives: Since 2009, China has introduced policies, principally targeting health professionals, to reduce caesarean section (CS) overuse. In 2016, China endorsed a universal two-child policy. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS. This study investigated changes to CS rates in 2008-2018, and factors associated with CS use during the period of transition from the one-to-two child policy era.

Design: We used births data from cross-sectional National Household Health Services Surveys in 2013 and 2018.

Setting: Population-based national survey

Participants: Women who had the last live birth within the five years before the survey

Primary outcome measure: Caesarean section rate

Results: Overall CS use increased from 40.9% in 2008 to 47.2% in 2014 with significant increase in rural areas and the western region, and slightly decreased to 45.2% in 2018 with the greatest decrease among nulliparous women. Maternal request for CS by urban nulliparous women decreased from 36.8% in 2008-2009 to 22.2% in 2016-2018, but this change was not statistically significant in rural areas. Maternal age over 35 years old (OR 2.40, 95%CI 1.76-3.31) and births occurred at private hospital(OR 1.52, 95%CI 1.25-1.86) were associated with CS use among nulliparous women in 2016-2018. The CS rate among multiparous women increased over time. Individual socio-economic factors associated with CS use among multiparous women.

Conclusions: The CS rate rise in China in 2008-2018 is attributable to increased use in rural areas and the less developed Western region. The population policy shift, alongside facility policies for unnecessary CS reduction, are likely factors in CS reduction in urban areas. The challenge remains to reduce unnecessary CS, at the same time as providing safe, universal access to CSs for women in need.

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Strengths and limitations of this study

- This study used well-established population-based national survey data to examine the change of caesarean section rate in China by urban and rural areas, across regions and women's characteristics over the periods of population policy shift.
- This study could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China.
- We are not able to conduct more sub-groups analysis such as previous caesarean section or caesarean section with or without medical indications due to unavailable data.

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Introduction

Globally, Caesarean Section (CS) rates are rising in all regions with one of fifth of live births being by CS in 2015.[1] Complex social, cultural, economic, and medical factors are known drivers of CS use.[2] Overuse and underuse of CS represent simultaneous challenges for many health systems. Overuse of CS, where CS is performed without or on the basis of ambiguous medical indications has been associated with increased risk of maternal and newborn adverse outcomes and increased costs for health systems and individuals.[3, 4] Meanwhile, the low use of CS implies limited accessibility to this life-saving procedures for women in need during childbirth.[1] The World Health Organization (WHO) Statement on Caesarean Section Rates suggests that CS rates at population level higher than 10% are not associated with reductions in maternal and newborn mortality rates, while every effort should be made to provide CS to women in need.[5]

China has witnessed a rapid increase in the use of CS since 1990s.[6-9] According to the data from the National Household Health Services Surveys in China, the CS rate increased from 19.2% in 2003 to 36.3% in 2011.[7] Many CSs in China are not medically indicated.[10] There is evidence that individual, health system and socio-cultural factors are driving the use of CS.[11] Women may request CS because of fear of labor pain, fear of risk and adverse outcomes of vaginal delivery, perceived convenience of CS for birth plan and control and perceived CS as a safe option for childbirth.[11] In China, facility-based delivery is a national strategy to reduce risks of adverse outcomes for mothers and newborns. Almost all births occurred in health facilities by 2015. It has been argued that financial incentive and fear of malpractice may shape the preference of health professionals for performing CS in the hospital settings.[11, 12]

Since 2009, the Chinese government has increasingly introduced policies and strategies at national and local levels to restrict the use of unnecessary CS.[9] These strategies largely targeted health professionals. They include revising clinical guideline to strict control of CS indications, strengthening training of midwifery care and audit of CS without medical indications, setting facility CS rate targets and removing financial incentives for CS. China has gradually relaxed family planning policy since 2013, with all families being allowed and encouraged to have a second child in 2016. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS.[13, 14]

Recent studies that used data from the National Maternal Near Miss Surveillance System (NMNMSS) reported a moderate decrease of CS rate in some big cities, which coincided with the period of relaxation of the one-child policy between 2012-2016.[8, 9] This decrease in

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CS rate may be attributable to facility strategies to reduce the use of CS without medical indications. However, the authors also acknowledged the limitation of NMNMSS data in over-representing urban populations. Little is known about trends of CS use in rural areas, across regions at different stages of socio-economic development, nor how facility strategies to mitigate unnecessary CS and the population policy shift have affected the use of CS in these places.

This study used cross-sectional data from the National Household Health Services Survey conducted in 2013 and 2018, which achieved reliable representativeness of the general population by urban and rural areas and across socio-economic development regions. We investigated changes to CS rates between 2008 and 2018, by urban and rural location, and across socio-economic regions in China. It sought to examine maternal request for CS by the study periods and by parity, as well as demographic and socio-economic factors associated with use of CS during the period of transition from the one-to-two child policy era.

Methods

Data source

We obtained the permission to access to birth dataset from National Household Health Services Surveys conducted in 2013 and 2018 . Each survey employed the same three-stage, stratified, cluster random sampling procedure. At the first stage, urban and rural location and socio-economic regions were used to classify cities and counties into six groups: eastern urban, eastern rural, central urban, central rural, western urban and western rural. Simple random sampling was used to select cities and counties from each group. The random sample process was repeated for three times to select the ones most close to the parameters (e.g. fertility rate, mortality rate and demographic structure etc.) representing the general. Then five sub-districts or townships were randomly selected from each city or county based on the rank of number of population. Finally, three communities or villages from each sub-district or township were randomly selected and all households in the selected sub-district or township were included in the survey. In total, 93,613 households were included in the survey of 2013 and 94,074 in the survey of 2018.

The trained primary health workers administered face-to-face survey to each family member in the sampled households using structured questionnaire. The questionnaires used in the two surveys had a same structure and involved similar questions, which included the general demographic and socio-economic characteristics of the sampled households and family members, the utilization of and expenditures on health services. There is one section on the childbirth that asked questions about the use of antenatal care, place of delivery, mode of

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delivery and caesarean delivery for maternal request. We included women who had the last live birth within the five years before the survey in this study to avoid overrepresentation of women who have one more child.

Measures

The outcome measure was the percentage of births by CS. In the survey, the mode of delivery was asked with the following question: “How did the birth take place: a) vaginal delivery; b) caesarean section”. If the answer was “caesarean section”, the following question was “Who was the most important person of proposing CS: a) myself; b) husband; c) parent; d) doctor; e) others”. We considered CS as a woman request in the analysis if the woman choose the option “a (myself)”.

We examined demographic and socio-economic factors associated with the use of CS that included: maternal age (<25, 25-34, ≥35); maternal educational level (illiterate or primary school, secondary school, high school/professional school or higher); location of resident (urban, rural); living in different socio-economic region (developed Eastern, less developed Central, least developed Western); health insurance coverage; income quartile; parity, defined as the number of live births born by a woman; and place of delivery, defined as type of health facility where the live birth occurred (county or higher level hospital, maternal and child health hospital, township/community health center, private hospital). There are three basic health insurance schemes in China: Urban Employee Basic Health Insurance (UEBMI), Urban Residents Basic Health Insurance (URBMI) and rural New Cooperative Medical Scheme (NCMS). In recent years, URBMI was integrated with NCMS in some provinces renamed as Urban and Rural Residents Basic Medical Insurance (URRBMI). Overall, UEBMI provides better coverage for both inpatient and outpatient care compared to URRBMI. In the analysis, we grouped URBMI, NCMS and URRBMI into one category as “URRBMI”. Health insurance coverage was grouped into: none coverage, UEBMI, URRBMI and others (including free medical service scheme for special sectors or labor insurance). Annual household income in the calendar year that preceded the survey included savings and household expenditure on consumables during that year. We generated income quartile by dividing household income by the number of individuals in the household, which reflected lowest income group (quartile 1), low income group (quartile 2), middle income group (quartile 3) and high income group (quartile 4).

Data analysis

We investigated changes of CS rate in 2008-2018 by urban and rural areas and across different socio-economic regions. We also examined CS rate among nulliparous and

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multiparous women by location and region in the study periods. We studied change of women request for CS by parity that the time period 2008-2018 was divided into 2008-2009, 2010-2012, 2013-2015 and 2016-2018. Chi-square test was used to test the difference by the study period. We conducted bi-variate and multi-variate logistic regression analysis to study explanatory variables associated with the use of CS for all and in stratification of urban and rural areas and by socio-economic regions in 2008-2018. In addition, we stratified data in 2016-2018 to study demographic and socio-economic factors associated with the use of CS after universal two-child policy in China for all and by nulliparous and multiparous women, by location and regions.

Ethical statement, patient and public involvement

This study is based on a secondary data analysis. The research team obtained the approval of the Center for Health Statistics and Information of the National Health Commission (NHC) of China (formerly the Ministry of Health) to access to de-identified birth dataset. No patient involved. Approval from an ethics committee was not required.

Results:

Total 23,053 women who had a live birth in the study period 2008-2018 were included in the analysis (Table 1). The distribution of maternal age was relatively similar by the study periods, and more than 60% of women were aged at 25-34 years. The proportion of women who received high school and professional school or higher and those who had two or more children increased over time. Few women had no health insurance coverage, and a vast majority of women had enrolled in URRBMI. In addition, there were more women in urban areas giving birth than women in rural areas observed in the period of 2016-2018. The distribution of women living region was relatively similar over time. The majority of women gave birth in general hospital (county or higher level hospital) and this proportion increased over time. The proportion of women giving birth in community and township health centers decreased in both urban and rural areas across different socio-economic regions (Supplementary files: Table 1). In the 2018 survey, fewer women reported choosing to give birth in a private hospital.

CS rate

Nationwide, the overall CS rate increased from 40.9% in 2008 to 47.2% in 2014. After the scale-up of the two-child policy, the CS rate slightly decreased; it was 45.2% in 2018.

1) CS rate by urban and rural areas and across regions

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In urban areas, the CS rate slightly increased from 50.4% in 2008 to 52.3% in 2014, and then slightly decreased to 47.8% in 2018. However, in rural areas the CS rate had significantly increased from 33.1% in 2008 to 43.8% in 2015. In rural areas there was also a slight decrease after the relaxation of the one-child policy. The CS rate in rural areas was 41.2% in 2018 (Figure 1a). A similar trend was found across different socio-economic regions (Figure 1b). We observed a significant increase in CS rate from 28.1% in 2008 to 38.6% in 2018 in the least developed western region. In the stratification of urban and rural areas by regions, in 2008 the CS rates in urban areas in the eastern, central and western regions were 50.9%, 62.3% and 37.4% respectively. The difference of CS rate in urban areas by region became very small in 2018 (48.1% in eastern, 49.2% in central and 46.6% in western region). The CS rates in rural areas across all regions increased between 2008 and 2018. The CS rates in the eastern and central rural areas were higher or close to the rate in urban areas in these two regions (Supplementary file: Figure 1).

2) CS rate by parity

Around half of nulliparous women in urban areas gave birth by CS between 2008 and 2014, and the proportion in rural areas grew significantly from 33.3% in 2008 to 49.6% in 2015. The CS rate among nulliparous women decreased rapidly in both urban (42.8% in 2018) and rural areas (37.5% in 2018) after the universal two-child policy (Figure 2a). The CS rate among multiparous women continued to increase from 35.3% in 2008 to 48.4% in 2018 with similar trends in both urban and rural areas (Figure 2b). We found similar finding in terms of the change of CS rate by parity across different socio-economic regions (Supplementary file: Figure 2).

Maternal request for CS

We examined maternal request for CS by the study periods (Table 2). According to women's self-report, the proportion of maternal request for CS among nulliparous women decreased from 35.8% in 2008-2009 to 24.4% in 2016-2018 (P<0.01). In the stratification of residents location, maternal request for CS significantly decreased in urban areas from 36.8% in 2008-2009 to 22.2% in 2016-2018 (p<0.01), however the change in rural areas was not statistically significant (from 33.5% in 2008-2009 to 29.4% in 2016-2018) (Supplementary files: Table 2). Among multiparous women, around one third of women reported maternal request for CS, and there was no significant change between 2008-2009 and 2016-2018.

In addition, the proportion of CS suggested by a doctor among nulliparous women increased from 63.3% in 2008-2009 to 72.7% in 2016-2018 (P<0.01), and there was no significant change of doctors' suggestion for CS among multiparous women by the study period. For

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both nulliparous and multiparous women, there were few CSs proposed by women's husband and others (Table 2).

Demographic and socio-economic factors associated with the use of CS

1) In the study period of 2008-2018

Table 3 shows factors associated with the use of CS in China by urban and rural areas over the study period of 2008-2018. After adjusting for all explanatory variables, the use of CS was less common in urban areas in the survey of 2018 (OR 0.85, 95%CI 0.78-0.92) compared to the survey of 2013, however, it was more common in rural areas (OR 1.30, 95%CI 1.19-1.41) in the survey of 2018. Advanced maternal age (≥35), having secondary education or higher and giving birth at high level hospital or private hospital were significantly associated with the use of CS in both urban and rural areas. In rural areas, women from the highest income quartile were more likely to have CS (OR 1.69, 95%CI 1.47-1.95) compared to women from the lowest quartile, and multiparous women were less likely to have CS (OR 0.80, 95%CI 0.73-0.88) than nulliparous women. While these differences were not statistically significant in urban areas.

Across different socio-economic regions, the use of CS increased in western region in the survey of 2018 (OR 1.10, 95% CI 1.00-1.22) than the survey of 2013, while this difference was not statistically significant in eastern and central regions (Supplementary files: Table 3). Advanced maternal age ((≥35) and giving birth at high level hospital or private hospital were associated with the use of CS in all regions. In central and western regions, women who lived in rural areas, were from low income quartile household and had more than one child were less likely to have CS.

2) In the study period of 2016-2018

Following the universal two-child policy in China (2016-2018), women in urban areas who were at advanced age ((≥35), multiparous and gave birth at county or high level hospital or private hospital were more likely to have CS (Supplementary files: Table 4). In rural areas, in addition to maternal age and place of delivery, maternal education attainment and household income were also positively associated with the use of CS. Factors associated with the use of CS in eastern and central regions at the same study period were found similar in urban areas and those in western region were found similar in rural areas (Supplementary files: Table 5).

We examined the factors associated with the use of CS by parity in the era of two-child policy. We found that advanced maternal age (≥35) and births occurred at private hospital

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were significantly associated with the use of CS among nulliparous women after adjusting for all explanatory variables, while the association between the use of CS and other socio-economic factors was not statistically significant (Table 4). For multiparous women, women who were older, had higher education attainment, had health insurance coverage, were from wealthy household, lived in urban areas or eastern region and gave birth at higher level hospital or private hospital were more likely to have CS after adjusting for all explanatory variables (Table 4).

Discussion

Summary of key findings

In China, the CS rate increased between 2008 and 2015, which was, to a great extent, attributable to a rapid increase of the use of CS in rural areas and the least developed western region. After the scale-up of two-child policy, the CS rate slightly decreased in both urban and rural areas and across socio-economic regions, particularly among nulliparous women. The proportion of maternal request for CS decreased among nulliparous women in urban areas over time, however, this proportion decreased slightly in rural areas that 30% of women underwent CS due to maternal request for CS in 2016-2018. In the era of two-child policy, advanced maternal age and births occurred in a private hospital were associated with the use of CS among nulliparous women. The CS rate among multiparous women continued to increase over time, and demographic and socio-economic factors were positively associated with the use of CS among multiparous women.

Strengths and limitations

This study contributes to what is known about rates of CS in China, where most existing studies are limited to a few hospitals or regions. It is a strength of this paper that with the increase of population size and urbanization in China over the past two decades, the National Household Health Services Survey adapted its sampling method in 2013 and increased the sample size to achieve reliable representativeness of the general population by urban and rural areas and across different socio-economic regions. It provides unique insights into both mode of birth and whom households report proposed actual caesarean births. However, several limitations in terms of data and analysis remain. First, all information was based on women's reports, and the reasons for maternal request or doctor suggestion for CS were not asked. We were not able to distinguish in this study how many CSs performed were medically indicated. Second, women's history of pregnancy (e.g. previous CS or others) was not available. We could not make a sub-group analysis on the use of CS among women with or without uterine scar. Third, we could not separate the

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effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China. That said, we did observe a slight decrease of CS rate in line with the period of the universal two-child policy and the CS rate in urban areas and regions with a high baseline rate had a moderate change over time (2008-2018). Thus the interpretation of a decrease in CS rate following relaxation of the one-child policy should be made with caution.

Interpretations

We observed a rapid decrease of CS rate among nulliparous women in both urban and rural areas and across all regions in line with the period of universal two-child policy, which is consistent with the findings in other studies.[9,15] However, any causal association remains speculative, not least because of the nuances within the one-child policy itself. In 1979, China announced its family planning policy to strictly control population size. The policy included rules of governing marriage, contraception, number of births and spacing where a second child was permitted.[16] The one child rule was strictest for urban residents and employees of the government agencies. In rural areas, a second child was generally allowed after five years, especially if the first born was a girl. Some ethnic minorities were permitted a third child. With socio-economic development and change of demographic structure, the Chinese government gradually relaxed the one-child policy over a decade with the entire population encouraged to have a second child since 2016.[17]

The CS rate decreased moderately in urban areas and the eastern and central regions, which had a relatively high baseline CS rate. One plausible explanation is that this may be attributable to the introduction of policies and strategies aiming to reverse the high CS rate through a national top-down approach in China. Although, results of introducing comprehensive interventions to mitigate unnecessary CSs are mixed in previous studies.[8,9,18]

We found that the CS rate increased dramatically in rural areas by all socio-economic regions between 2008-2015. This rise may be associated with a significant increase in the number of births occurring at secondary or higher-level (tertiary) hospitals, reflecting an increase in availability and accessibility of these services in these areas. The Chinese government had made strong commitment to reduce maternal and child mortality to achieve Millennium Development Goal (MDG) targets by 2015.[19] The main strategy was to promote hospital delivery, particularly in rural and poor areas with largely financial support from the central government and partly from the provincial government.[19] In the context of deepening China's health system reform, the national plan of further strengthening the hospital delivery for rural women in 2009 highlighted to provide the financial compensation for hospital delivery through rural health insurance (NCMS), the earmarked government fund and

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medical assistance program for the poor women in order to reduce financial burden placed on the households.[20] By 2014, hospital delivery in rural areas was almost universal. Across countries, the shift from community to hospital births is known to result in an increase in CS rates for medically indicated and non-medical reasons.[21] In China, cross-sectional research has shown that while tertiary hospitals have the highest rates of CS for ambiguous indications (i.e. Non-reassuring foetal heart tracing; failure to progress), secondary level hospitals report greater use of CS for maternal request.[22]

Implications for practice

Previous studies report maternal request for CS as a contributor to a rapid increase of CS rate in China,[22-25] despite the validity of the concept being widely debated internationally. For women who reportedly prefer CS, the most common reasons for their preference are fear of labor pain, safer for their baby and for themselves.[11] In this context, family members (e.g. husband or parent) also supported this choice to avoid an adverse event, especially in the context of one child in a family policy. Moreover, in our study around one third of nulliparous women reported self-request for CS in the era of one-child policy. This proportion significantly decreased in urban areas over time, which may be associated with the shift from strict one child in a family in urban areas to universal two children, and promotion of vaginal births in hospital settings. This change did not occur in rural areas, which indicate the needs of strengthening quality of maternity care including services delivery and women's experience in rural areas.

Efforts to promote vaginal birth in China included midwifery care training (e.g. training more professional midwives, establishment of standardized evaluation scheme of midwifery practice etc.), pain relief for vaginal birth and informing women about benefits and risks of different mode of delivery.[26] Other studies, largely in big cities and tertiary hospitals report woman-centered pregnancy and childbirth care which includes provision of antenatal classes to shape women's beliefs and confidence to childbirth, build connection and trust between doctors, midwives and women as well as provide continuous supports during labor and birth.[15, 23, 27] At the same time, pharmacological and non-pharmacological options for labor pain management have become available. However, the midwifery workforce in China is insufficient. Quality of midwifery care can vary by hospitals, and urban-rural disparity in midwife numbers and training is anecdotally reported. Lack of support during labor, lack of pain relief and sub-optimal birth environment were reported as the main reasons that rural women requested for CS.[28] Hence, strengthening midwifery care to improve women's experience on childbirth, particularly in rural areas will be critical to optimize the use of CS in China.

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Implications for further research

In the era of two-child policy, only advanced maternal age and giving birth in a private hospital were positively associated with the use of CS by nulliparous women. Since 2013 onward, the latest health-care delivery reform in China encouraged competition between public and private hospitals, and set out the target of private hospitals sharing 20% of market by 2015. The burgeoning of private hospital provision in China is driven by market forces, with providers charges unregulated unless contracted by the basic health insurance schemes.[29] Studies in other countries report much higher CSs rate in private hospitals due to profit driven behavior.[30-32] It needs further study to have a better understanding on the use of CS in private hospitals in China in order to propose evidence-based recommendations for relevant policy development. In addition, we found that CS rate among multiparous women continued to increase over time, especially in urban areas, which may be associated with the increase of women who underwent repeat CS. Based on the NMNMSS data, Liang and colleagues reported a high CS rate among multiparous women with a uterine scar and it was unchanged over time.[9] In China, repeat CS is often suggested and accepted for women with a previous CS to mitigate the risk of uterine rupture or other adverse event, despite repeat CS share similar risks. We can only speculate that there may be increasing referrals of women with a previous CS to high level or specialty hospitals. The accessibility, functional referral and affordability of such services as well as health outcomes, particularly for socio-economic vulnerable women should be rigorous assessed in further research.

Conclusion

A rapid increase of CS rate in rural areas and less developed western region contributed to the increase of CS rate in China over the past decade. The population policy shift, alongside facility policies to limit the use of unnecessary CS, are likely factors contributing to the reduction of CS in urban areas. Strategies at system, organization and individual levels to mitigate unnecessary CSs should be continually strengthened, especially in rural areas and western region. Improving midwifery care will be fundamental to ensure safety and positive childbirth experience in the era of two-child in a family in China.

Research Ethics Approval Statement

We obtained the permission to access to de-identified birth dataset. No patient was involved, and thus an approval from an ethics committee was not required.

Contributors

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QL conceived and led the overall analysis and wrote the first manuscript draft. YGZ conducted the data analysis and commented on the manuscript. XJT and JZ contributed to the analysis and commented on the manuscript. CK contributed to the study concept and overall analysis and participated in the manuscript writing.

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Conflicts of Interest

The authors declared no conflicts of interest.

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Table 1 Demographic and socioeconomic characteristics of women giving birth in China, 2008-2018

Characteristics	2008-2009 (n=2638)	2010-2012 (n=7015)	2013-2015 (n=6151)	2016-2018 (n=7249)	Total (n=23053)
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Age					
<25	146 (5.5)	1395 (19.9)	785 (12.8)	961 (13.3)	3287 (14.3)
25-34	1708 (64.7)	4514 (64.3)	3836 (62.4)	4775 (65.9)	14833 (64.3)
≥35	784 (29.7)	1106 (15.8)	1530 (24.9)	1513 (20.9)	4933 (21.4)
Educational level [a]					
Illiterate or primary school	493 (18.7)	1091 (15.6)	869 (14.1)	671 (9.3)	3124 (13.5)
Secondary school	128 (48.7)	337 (48.0)	250 (40.8)	250 (34.5)	9662 (41.9)
High school/ professional school or higher	861 (32.6)	2554 (36.4)	2773 (45.1)	4078 (56.3)	10266 (44.5)
Parity [b]					
1	1424 (54.0)	4068 (58.0)	2965 (48.2)	2937 (40.5)	11394 (49.4)
≥2	1213 (46.0)	2947 (42.0)	3184 (51.8)	4312 (59.5)	11656 (50.6)
Health insurance coverage [*]					
None	115(4.4)	366 (5.2)	334 (5.4)	386 (5.3)	1201 (5.2)
UEBMI	470 (17.8)	1112 (15.9)	1343 (21.8)	1953 (26.9)	4878 (21.2)
URRBMI	2007 (76.1)	5440 (77.5)	4270 (69.4)	4589 (63.3)	16306 (70.7)
Others	46 (1.7)	97 (1.4)	204 (3.3)	321 (4.4)	668 (2.9)
Location					
Urban	1234 (46.8)	3261 (46.5)	3133 (50.9)	4166 (57.5)	11794 (51.2)
Rural	1404 (53.2)	3754 (53.5)	3018 (49.1)	3083 (42.5)	11259 (48.8)
Region					
Eastern	878 (33.3)	2238 (31.9)	2133 (34.7)	2741 (37.8)	7990 (34.7)
Central	875 (33.2)	2309 (32.9)	1822 (29.6)	1957 (27.0)	6963 (30.2)

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Western	885 (33.5)	2468 (35.2)	2196 (35.7)	2551 (35.2)	8100 (35.1)
Place of delivery #					
County or higher level hospital	1416 (53.7)	4163 (59.3)	3755 (61.0)	4746 (65.5)	14080 (61.1)
Maternal and child health hospital	670 (25.4)	1743 (24.8)	1482 (24.1)	1678 (23.1)	5573 (24.2)
Township/community health center	552 (20.9)	1109 (15.8)	633 (10.3)	391 (5.4)	2685 (11.6)
Private hospital	--	--	281 (4.6)	434 (6.0)	715 (3.1)

* UEBMI: Urban Employee Basic Medical Insurance

URRBMI: Urban and Rural Resident Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

The private hospital was not included in the survey in 2013.

[a] Data were missing for one woman in 2013-2015

[b] Data were missing for one woman in 2008-2009, and two in 2013-2015

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Table 2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by parity in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Parity 1					
Women request	35.8	30.2	27.9	24.4	<0.001
Husband	0	0	1.3	1.6	<0.001
Doctor	63.3	68.8	69.5	72.7	<0.001
Others	0.9	1.0	1.3	1.3	0.877
Parity ≥2					
Women request	31.7	30.0	32.6	30.9	0.445
Husband	0	0	1.8	1.2	<0.001
Doctor	66.3	69.1	64.4	67.1	0.094
Others	2.0	0.9	1.2	0.8	0.243

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Table 3 Factors associated with use of caesarean section in China by location, 2008-2018

	All		Urban		Rural	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Year of the survey						
2013	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.16 (1.10-1.22)	1.03 (0.97-1.09)	0.92 (0.86-0.99)	0.85 (0.78-0.92)	1.38 (1.27-1.49)	1.30 (1.19-1.41)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.44 (1.33-1.55)	1.32 (1.21-1.43)	1.29 (1.14-1.46)	1.29 (1.13-1.47)	1.36 (1.23-1.51)	1.35 (1.20-1.52)
⩾35	2.03 (1.85-2.22)	2.02 (1.82-2.25)	1.93 (1.68-2.21)	2.05 (1.75-2.39)	1.78 (1.57-2.02)	2.00 (1.72-2.32)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.32 (1.21-1.43)	1.21 (1.10-1.32)	1.10 (0.94-1.29)	1.16 (0.98-1.36)	1.32 (1.19-1.46)	1.14 (1.02-1.27)
High school or higher	1.76 (1.62-1.92)	1.21 (1.10-1.34)	1.21 (1.05-1.41)	1.22 (1.03-1.44)	1.66 (1.48-1.86)	1.10 (0.96-1.26)
Residence						
Urban			--	--	--	--
Rural	0.61 (0.58-0.65)	0.75 (0.70-0.80)	--	--	--	--
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.18 (1.11-1.26)	1.25 (1.17-1.34)	1.38 (1.26-1.51)	1.35 (1.23-1.48)	1.01 (0.92-1.11)	1.12 (1.01-1.23)
Western	0.62 (0.58-0.66)	0.69 (0.64-0.73)	0.91 (0.83-0.99)	0.92 (0.84-1.01)	0.43 (0.39-0.47)	0.48 (0.43-0.53)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.52 (1.42-1.62)	0.98 (0.91-1.07)	1.11 (1.03-1.20)	1.01 (0.92-1.11)	1.91 (1.63-2.24)	1.13 (0.94-1.35)
None	1.25 (1.11-1.40)	0.96 (0.85-1.09)	0.94 (0.82-1.08)	0.91 (0.79-1.05)	1.42 (1.13-1.79)	1.27 (1.00-1.61)
Others	1.34 (1.15-1.57)	1.05 (0.90-1.24)	1.18 (0.97-1.43)	1.12 (0.92-1.36)	1.12 (0.84-1.47)	1.06 (0.79-1.42)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.39 (1.29-1.50)	1.24 (1.15-1.34)	1.43 (1.30-1.58)	1.10 (0.97-1.24)	1.43 (1.30-1.58)	1.28 (1.15-1.41)
Quartile 3	1.62 (1.50-1.74)	1.30 (1.21-1.41)	1.63 (1.47-1.80)	1.14 (1.02-1.29)	1.63 (1.47-1.80)	1.36 (1.22-1.52)
Quartile 4	1.76 (1.63-1.89)	1.26 (1.16-1.38)	2.04 (1.79-2.32)	1.07 (0.95-1.21)	2.04 (1.79-2.32)	1.69 (1.47-1.95)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	0.87 (0.83-0.92)	0.87 (0.82-0.93)	1.02 (0.95-1.10)	0.94 (0.86-1.02)	0.89 (0.83-0.96)	0.80 (0.73-0.88)
Place of delivery						

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Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.23 (2.03-2.44)	2.03 (1.85-2.24)	1.57 (1.36-1.81)	1.48 (1.27-1.72)	2.49 (2.21-2.81)	2.45 (2.16-2.78)
Maternal and child health hospital	2.02 (1.83-2.23)	1.76 (1.59-1.96)	1.41 (1.21-1.64)	1.34 (1.14-1.57)	2.02 (1.75-2.32)	1.98 (1.71-2.29)
Private hospital	2.55 (2.15-3.02)	2.31 (1.93-2.76)	1.94 (1.53-2.47)	1.91 (1.49-2.46)	2.46 (1.92-3.17)	2.44 (1.87-3.18)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table 4 Factors associated with use of caesarean section after relaxation of the one child policy in China by parity, 2016-2018

	All		Parity 1		Parity ≥2	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.78 (1.53-2.06)	1.62 (1.38-1.90)	1.52 (1.27-1.83)	1.52 (1.25-1.86)	2.37 (1.79-3.14)	2.06 (1.54-2.75)
≥35	2.89 (2.44-3.43)	2.58 (2.12-3.13)	2.41 (1.76-3.31)	2.40 (1.72-3.35)	3.73 (2.78-5.00)	3.19 (2.34-4.33)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.40 (1.18-1.67)	1.42 (1.18-1.71)	0.96 (0.65-1.41)	1.02 (0.69-1.51)	1.58 (1.30-1.93)	1.49 (1.21-1.84)
High school or higher	1.38 (1.17-1.64)	1.24 (1.02-1.51)	0.97 (0.67-1.39)	0.85 (0.58-1.25)	1.74 (1.43-2.12)	1.35 (1.08-1.70)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	0.78 (0.71-0.86)	0.84 (0.75-0.95)	0.81 (0.69-0.95)	0.85 (0.70-1.02)	0.72 (0.63-0.81)	0.84 (0.73-0.97)
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.01 (0.90-1.13)	1.01 (0.90-1.14)	0.99 (0.82-1.19)	1.03 (0.84-1.25)	1.01 (0.87-1.17)	1.00 (0.86,1.17)
Western	0.65 (0.58-0.73)	0.70 (0.62-0.78)	0.83 (0.69-0.98)	0.87 (0.72-1.04)	0.55 (0.48-0.64)	0.61 (0.52-0.71)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.19 (1.07-1.32)	0.95 (0.83-1.09)	1.17 (1.00-1.37)	1.05 (0.86-1.28)	1.34 (1.15-1.55)	0.91 (0.76-1.10)
None	0.92 (0.75-1.14)	0.81 (0.64-1.01)	1.07 (0.77-1.49)	0.99 (0.70-1.38)	0.85 (0.65-1.13)	0.69 (0.51-0.93)
Others	1.14 (0.91-1.44)	0.97 (0.76-1.23)	0.81 (0.54-1.22)	0.76 (0.50-1.14)	1.36 (1.03-1.81)	1.08 (0.80-1.47)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.22 (1.07-1.39)	1.12 (0.97-1.28)	1.12 (0.89-1.41)	1.07 (0.84-1.35)	1.28 (1.09-1.51)	1.12 (0.95-1.33)
Quartile 3	1.44 (1.27-1.64)	1.24 (1.07-1.43)	1.10 (0.89-1.37)	0.99 (0.79-1.25)	1.78 (1.51-2.10]	1.40 (1.17-1.68)
Quartile 4	1.28 (1.13-1.46)	1.04 (0.89-1.21)	1.13 (0.92-1.39)	0.94 (0.73-1.19)	1.51 (1.27-1.79)	1.10 (0.90-1.35)
Parity						
1	1.00	1.00	--	--	--	--
≥2	1.29 (1.18-1.42)	1.12 (1.01-1.25)	--	--	--	--
Place of delivery						
Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.03 (1.62-2.54)	2.09 (1.66-2.64)	1.36 (0.85-2.19)	1.27 (0.78-2.06)	2.45 (1.89-3.16)	2.34 (1.80-3.05)
Maternal and child health hospital	1.67 (1.32-2.12)	1.68 (1.32-2.15)	1.15 (0.70-1.88)	1.03 (0.62-1.70)	1.99 (1.51-2.62)	1.88 (1.42-2.51)

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Private hospital	2.16 (1.62-2.88)	2.26 (1.68-3.04)	1.45 (0.83-2.54)	1.52 (1.25-1.86)	2.56 (1.81-3.61)	2.55 (1.79-3.64)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

Caesarean section rate in urban areas slightly decreased between 2008 and 2018, while it had increased in rural areas. Across regions, a large increase occurred in less developed Western region.

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Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

Caesarean section rate among nulliparous women decreased around 2016 in both urban and rural areas, while there was a large increase in the number of multiparous women delivering by caesarean section.

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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Abstract

Objectives: Since 2009, China has introduced policies, principally targeting health professionals, to reduce caesarean section (CS) overuse. In 2016, China endorsed a universal two-child policy. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS. This study investigated changes to CS rates in 2008-2018, and factors associated with CS use during the period of transition from the one-to-two child policy era.

Design: We used births data from cross-sectional National Household Health Services Surveys in 2013 and 2018.

Setting: Population-based national survey

Participants: Women who had the last live birth within the five years before the survey

Primary outcome measure: Caesarean section rate

Results: Overall CS use increased from 40.9% in 2008 to 47.2% in 2014 with significant increase in rural areas and the western region, and slightly decreased to 45.2% in 2018 with the greatest decrease among nulliparous women. Maternal request for CS by urban nulliparous women decreased from 36.8% in 2008-2009 to 22.2% in 2016-2018, but this change was not statistically significant in rural areas. ~~Advanced m~~Maternal age over 35 years old (OR 2.40, 95%CI 1.76-3.31) and ~~place of~~ births occurred at ~~(~~private hospital~~)~~(OR 1.52, 95%CI 1.25-1.86) were associated with CS use among nulliparous women in 2016-2018. The CS rate among multiparous women increased over time. Individual socio-economic factors associated with CS use among multiparous women.

Conclusions: The CS rate rise in China in 2008-2018 is attributable to increased use in rural areas and the less developed Western region. The population policy shift, alongside facility policies for unnecessary CS reduction, are likely factors in CS reduction in urban areas. The challenge remains to reduce unnecessary CS, at the same time as providing safe, universal access to CSs for women in need.

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Strengths and limitations of this study

- This study used well-established population-based national survey data to examine the change of caesarean section rate in China by urban and rural areas, across regions and women's characteristics over the periods of population policy shift.
- ~~This study provides unique insights into both mode of birth and whom households report proposed actual caesarean births.~~
- This study could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China.
- We are not able to conduct more sub-groups analysis such as previous caesarean section or ~~others~~ caesarean section with or without medical indications due to unavailable data.

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Introduction

Globally, Caesarean Section (CS) rates are rising in all regions with one of fifth of live births being by CS in 2015.[1] Complex social, cultural, economic, and medical factors are known drivers of CS use.[2] Overuse and underuse of CS represent simultaneous challenges for many health systems. Overuse of CS, where CS is performed without or on the basis of ambiguous medical indications has been associated with increased risk of maternal and newborn adverse outcomes and increased costs for health systems and individuals.[2, 3, 4] Meanwhile, the low use of CS implies limited accessibility to this life-saving procedures for women in need during childbirth.[1] The World Health Organization (WHO) Statement on Caesarean Section Rates suggests that CS rates at population level higher than 10% are not associated with reductions in maternal and newborn mortality rates, while every effort should be made to provide CS to women in need.[5]

China has witnessed a rapid increase in the use of CS since 1990s.[6-8] According to the data from the National Household Health Services Surveys (NHHSS) in China, the CS rate increased from 19.2% in 2003 to 36.3% in 2011.[6, 7] Many CSs in China are not medically indicated.[10] There is evidence that individual, health system and socio-cultural factors are driving the use of CS.[10, 11] Women may request CS because of fear of labor pain, fear of risk and adverse outcomes of vaginal delivery, perceived convenience of CS for birth plan and control and perceived CS as a safe option for childbirth.[10, 11] In China, facility-based delivery is a national strategy to reduce risks of adverse outcomes for mothers and newborns. Almost all births occurred in health facilities by 2015. It has been argued that financial incentive and fear of malpractice may shape the preference of health professionals for performing CS in the hospital settings.[10, 11, 12]

Since 2009, the Chinese government has increasingly introduced policies and strategies at national and local levels to restrict the use of unnecessary CS.[8] These strategies largely targeted health professionals. They include revising clinical guideline to strict control of CS indications, strengthening training of midwifery care and audit of CS without medical indications, setting facility CS rate targets and removing financial incentives for CS. China has gradually relaxed family planning policy since 2013, with all families being allowed and encouraged to have a second child in 2016. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS.[13, 14]

Recent studies that used data from the National Maternal Near Miss Surveillance System (NMNMSS) reported a moderate decrease of CS rate in some big cities, which coincided with the period of relaxation of the one-child policy between 2012-2016.[8, 9] This decrease in

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CS rate may be attributable to facility strategies to reduce the use of CS without medical indications. However, the authors also acknowledged the limitation of NMNMSS data in over-representing urban populations. Little is known about trends of CS use in rural areas, across regions at different stages of socio-economic development, nor how facility strategies to mitigate unnecessary CS and the population policy shift have affected the use of CS in these places.

~~The~~ This study used cross-sectional data from the National Household Health Services Survey conducted in 2013 and 2018, which achieved reliable representativeness of the general population by urban and rural areas and across socio-economic development regions. ~~aim of this study was to~~We investigated changes to CS rates between 2008 and 2018, by urban and rural location, and across socio-economic regions in China. It sought to examine maternal request for CS by the study periods and by parity, as well as demographic and socio-economic factors associated with use of CS during the period of transition from the one-to-two child policy era.

Methods

Data source

We obtained the permission ~~used~~ to access to birth dataset ~~cross-sectional data obtained~~ from National Household Health Services Surveys ~~(NHHSS)~~ conducted in 2013 and 2018 ~~by the Center for Health Statistics and Information of the National Health Commission (NHC) of China (formerly the Ministry of Health)~~. Each survey employed the same three-stage, stratified, cluster random sampling procedure. At the first stage, urban and rural location and socio-economic regions were used to classify cities and counties into six groups: eastern urban, eastern rural, central urban, central rural, western urban and western rural. Simple random sampling was used to select cities and counties from each group. The random sample process was repeated for three times to select the ones most close to the parameters (e.g. fertility rate, mortality rate and demographic structure etc.) representing the general. Then five sub-districts or townships were randomly selected from each city or county based on the rank of number of population. Finally, three communities or villages from each sub-district or township were randomly selected and all households in the selected sub-district or township were included in the survey. In total, 93,613 households were included in the survey of 2013 and 94,074 in the survey of 2018.

~~*Data collection*~~

The trained primary health workers administered face-to-face survey to each family member in the sampled households using structured questionnaire. The questionnaires used in the

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two surveys had a same structure and involved similar questions, which included the general demographic and socio-economic characteristics of the sampled households and family members, the utilization of and expenditures on health services. There is one section on the childbirth that asked questions about the use of ~~antennal~~ antenatal care, place of delivery, mode of delivery and caesarean delivery for maternal request. We included women who had the last live birth within the five years before the survey in this study to avoid overrepresentation of women who have one more child.

~~*Data analysis*~~*Measures*

The outcome measure was the percentage of births by CS. In the survey, the mode of delivery was asked with the following question: "How did the birth take place: a) vaginal delivery; b) caesarean section". If the answer was "caesarean section", the following question was "Who was the most important person of proposing CS: a) myself; b) husband; c) parent; d) doctor; e) others". We considered CS as a woman request in the analysis if the woman choose the option "a (myself)".

We examined demographic and socio-economic factors associated with the use of CS that included: maternal age (<25, 25-34, ≥35); maternal educational level (illiterate or primary school, secondary school, high school/professional school or higher); location of resident (urban, rural); living in different socio-economic region (developed Eastern, less developed Central, least developed Western); health insurance coverage; income quartile; parity, defined as the number of live births born by a woman; and place of delivery, defined as type of health facility where the live birth occurred (county or higher level hospital, maternal and child health hospital, township/community health center, private hospital). There are three basic health insurance schemes in China: Urban Employee Basic Health Insurance (UEBMI), Urban Residents Basic Health Insurance (URBMI) and rural New Cooperative Medical Scheme (NCMS). In recent years, URBMI was integrated with NCMS in some provinces renamed as Urban and Rural Residents Basic Medical Insurance (URRBMI). Overall, UEBMI provides better coverage for both inpatient and outpatient care compared to URRBMI. In the analysis, we grouped URBMI, NCMS and URRBMI into one category as "URRBMI"~~,~~. Health insurance coverage was grouped into: none coverage, UEBMI, URRBMI and ~~and oo~~others ~~health insurances~~ (includ~~ed~~ing free medical service scheme for special sectors or labor insurance). Annual household income in the calendar year that preceded the survey included savings and household expenditure on consumables during that year. We generated income quartile by dividing household income by the number of individuals in the household, which reflected lowest income group (quartile 1), low income group (quartile 2), middle income group (quartile 3) and high income group (quartile 4).

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Data analysis

We investigated changes of CS rate in 2008-2018 by ~~location of residents~~urban and rural areas and across different socio-economic regions. We also examined CS rate among nulliparous and multiparous women by location and region in the study periods. We studied change of women request for CS by parity that the time period 2008-2018 was divided into 2008-2009, 2010-2012, 2013-2015 and 2016-2018. Chi-square test was used to test the difference by the study period. We conducted bi-variate and multi-variate logistic regression analysis to study explanatory variables associated with the use of CS for all and in stratification of urban and rural areas and by socio-economic regions in 2008-2018. In addition, we ~~also~~ stratified data in 2016-2018 to ~~investigated~~study demographic and socio-economic factors associated with the use of CS ~~in 2016-2018~~ after universal two-child policy in China for all and by nulliparous and multiparous women, by location and regions.

Ethical statement, patient and public involvement

This study is based on a secondary data analysis. The research team obtained the approval of the Center for Health Statistics and Information of the National Health Commission (NHC) of China (formerly the Ministry of Health) to access to de-identified birth dataset. No patient involved. Approval from an ethics committee was not required.

Results:

Total 23,053 women who had a live birth in the study period 2008-2018 were included in the analysis (Table 1). The distribution of maternal age was relatively similar by the study periods, and more than 60% of women were aged at 25-34 years. The proportion of women who received high school and professional school or higher and those who had two or more children increased over time. Few women had no health insurance coverage, and a vast majority of women had enrolled in URRBMI. In addition, there were more women in urban areas giving birth than women in rural areas observed in the period of 2016-2018. The distribution of women living region was relatively similar over time. The majority of women gave birth in general hospital (county or higher level hospital) and this proportion increased over time. The proportion of women giving birth in community and township health centers decreased in both urban and rural areas across different socio-economic regions (Supplementary files: Table 1). In the 2018 survey, fewer women reported choosing to give birth in a private hospital.

CS rate

Nationwide, the overall CS rate increased from 40.9% in 2008 to 47.2% in 2014. After the scale-up of the two-child policy, the CS rate slightly decreased; it was 45.2% in 2018.

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1) CS rate by urban and rural areas and across regions

In urban areas, the CS rate slightly increased from 50.4% in 2008 to 52.3% in 2014, and then slightly decreased to 47.8% in 2018. However, in rural areas the CS rate had significantly increased from 33.1% in 2008 to 43.8% in 2015. In rural areas there was also a slight decrease after the relaxation of the one-child policy. The CS rate in rural areas was 41.2% in 2018 (Figure 1a). A similar trend was found across different socio-economic regions (Figure 1b). We observed a significant increase in CS rate from 28.1% in 2008 to 38.6% in 2018 in the least developed western region. In the stratification of urban and rural areas by regions, in 2008 the CS rates in urban areas in the eastern, central and western regions were 50.9%, 62.3% and 37.4% respectively. The difference of CS rate in urban areas by region became very small in 2018 (48.1% in eastern, 49.2% in central and 46.6% in western region). The CS rates in rural areas across all regions increased between 2008 and 2018. The CS rates in the eastern and central rural areas were higher or close to the rate in urban areas in these two regions (Supplementary file: Figure 1).

2) CS rate by parity

Around half of nulliparous women in urban areas gave birth by CS between 2008 and 2014, and the proportion in rural areas grew significantly from 33.3% in 2008 to 49.6% in 2015. The CS rate among nulliparous women decreased rapidly in both urban (42.8% in 2018) and rural areas (37.5% in 2018) after the universal two-child policy (Figure 2a). The CS rate among multiparous women continued to increase from 35.3% in 2008 to 48.4% in 2018 with similar trends in both urban and rural areas (Figure 2b). We found similar finding in terms of the change of CS rate by parity across different socio-economic regions (Supplementary file: Figure 2).

Maternal request for CS

We examined maternal request for CS by the study periods (Table 2). According to women's self-report, the proportion of maternal request for CS among nulliparous women decreased from 35.8% in 2008-2009 to 24.4% in 2016-2018 (P<0.01). In the stratification of residents location, maternal request for CS significantly decreased in urban areas from 36.8% in 2008-2009 to 22.2% in 2016-2018 (p<0.01), however the change in rural areas was not statistically significant (from 33.5% in 2008-2009 to 29.4% in 2016-2018) (Supplementary files: Table 2). Among multiparous women, around one third of women reported maternal request for CS, and there was no significant change between 2008-2009 and 2016-2018.

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In addition, the proportion of CS suggested by a doctor among nulliparous women increased from 63.3% in 2008-2009 to 72.7% in 2016-2018 (P<0.01), and there was no significant change of doctors' suggestion for CS among multiparous women by the study period. For both nulliparous and multiparous women, there were few CSs proposed by women's husband and others (Table 2).

Demographic and socio-economic ~~F~~factors associated with the use of CS

1) In the study period of 2008-2018

Table 3 shows factors associated with the use of CS in China by urban and rural areas over the study period of 2008-2018. After adjusting for all explanatory variables, the use of CS was less common in urban areas in the survey of 2018 (OR 0.85, 95%CI 0.78-0.92) compared to the survey of 2013, however, it was more common in rural areas (OR 1.30, 95%CI 1.19-1.41) in the survey of 2018. Advanced maternal age (≥35), having secondary education or higher and giving birth at high level hospital or private hospital were significantly associated with the use of CS in both urban and rural areas. In rural areas, women from the highest income quartile were more likely to have CS (OR 1.69, 95%CI 1.47-1.95) compared to women from the lowest quartile, and multiparous women were less likely to have CS (OR 0.80, 95%CI 0.73-0.88) than nulliparous women. While these differences were not statistically significant in urban areas.

Across different socio-economic regions, the use of CS increased in western region in the survey of 2018 (OR 1.10, 95% CI 1.00-1.22) than the survey of 2013, while this difference was not statistically significant in eastern and central regions (Supplementary files: Table 3). Advanced maternal age ((≥35) and giving birth at high level hospital or private hospital were associated with the use of CS in all regions. In central and western regions, women who lived in rural areas, were from low income quartile household and had more than one child were less likely to have CS.

2) In the study period of 2016-2018

Following the universal two-child policy in China (2016-2018), women in urban areas who were at advanced age ((≥35), multiparous and gave birth at county or high level hospital or private hospital were more likely to have CS (Supplementary files: Table 4). In rural areas, in addition to maternal age and place of delivery, maternal education attainment and household income were also positively associated with the use of CS. Factors associated with the use of CS in eastern and central regions at the same study period were found similar in urban

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areas and those in western region were found similar in rural areas (Supplementary files: Table 5).

We examined the factors associated with the use of CS by parity in the era of two-child policy. We found that advanced maternal age (≥35) and births occurred at private hospital were significantly associated with the use of CS among nulliparous women after adjusting for all explanatory variables, while the association between the use of CS and other socio-economic factors was not statistically significant (Table 4). For multiparous women, women who were older, had higher education attainment, had health insurance coverage, were from wealthy household, lived in urban areas or eastern region and gave birth at higher level hospital or private hospital were more likely to have CS after adjusting for all explanatory variables (Table 4).

Discussion

Summary of key findings

In China, the CS rate increased between 2008 and 2015, which was, to a great extent, attributable to a rapid increase of the use of CS in rural areas and the least developed western region. After the scale-up of two-child policy, the CS rate slightly decreased in both urban and rural areas and across socio-economic regions, particularly among nulliparous women. The proportion of maternal request for CS decreased among nulliparous women in urban areas over time, however, this proportion decreased slightly in rural areas that 30% of women underwent CS due to maternal request for CS in 2016-2018. In the era of two-child policy, advanced maternal age and births occurred in a private hospital were associated with the use of CS among nulliparous women. The CS rate among multiparous women continued to increase over time, and demographic and socio-economic factors were positively associated with the use of CS among multiparous women.

Strengths and limitations

This study contributes to what is known about rates of CS in China, where most existing studies are limited to a few hospitals or regions. It is a strength of this paper that with the increase of population size and urbanization in China over the past two decades, the National Household Health Services Survey adapted its sampling method in 2013 and increased the sample size to achieve reliable representativeness of the general population by urban and rural areas and across different socio-economic regions. It provides unique insights into both mode of birth and whom households report proposed actual caesarean births. However, several limitations in terms of data and analysis remain. First, all information was based on women's reports, and the reasons for maternal request or doctor

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suggestion for CS were not asked. We were not able to distinguish in this study how many CSs performed were medically indicated. Second, women's history of pregnancy (e.g. previous CS or others) was not available. We could not make a sub-group analysis on the use of CS among women with or without uterine scar. Third, we could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China. That said, we did observe a slight decrease of CS rate in line with the period of the universal two-child policy and the CS rate in urban areas and regions with a high baseline rate had a moderate change over time (2008-2018). Thus the interpretation of a decrease in CS rate following relaxation of the one-child policy should be made with caution.

Interpretations

We observed a rapid decrease of CS rate among nulliparous women in both urban and rural areas and across all regions in line with the period of universal two-child policy, which is consistent with the findings in other studies.~~9~~8,15~~4~~ However, any causal association remains speculative, not least because of the nuances within the one-child policy itself. In 1979, China announced its family planning policy to strictly control population size. The policy included rules of governing marriage, contraception, number of births and spacing where a second child was permitted.1~~5~~6 The one child rule was strictest for urban residents and employees of the government agencies. In rural areas, a second child was generally allowed after five years, especially if the first born was a girl. Some ethnic minorities were permitted a third child. With socio-economic development and change of demographic structure, the Chinese government gradually relaxed the one-child policy over a decade with the entire population encouraged to have a second child since 2016.1~~6~~7

The CS rate ~~increased~~ decreased moderately in urban areas and the eastern and central regions, which had a relatively high baseline CS rate. One plausible explanation is that this may be attributable to the introduction of policies and strategies aiming to reverse the high CS rate through a national top-down approach in China. Although, results of introducing comprehensive interventions to mitigate unnecessary CSs are mixed in previous studies.~~8~~7,~~9~~8,~~17~~,18

We found that the CS rate increased dramatically in rural areas by all socio-economic regions between 2008-2015. This rise may be associated with a significant increase in the number of births occurring at secondary or higher-level (tertiary) hospitals, reflecting an increase in availability and accessibility of these services in these areas. The Chinese government had made strong commitment to reduce maternal and child mortality to achieve Millennium Development Goal (MDG) targets by 2015.[19] The main strategy was to promote

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hospital delivery, particularly in rural and poor areas with largely financial support from the central government and partly from the provincial government.[19] In the context of deepening China's health system reform, the national plan of further strengthening the hospital delivery for rural women in 2009 highlighted to provide the financial compensation for hospital delivery through rural health insurance (NCMS), the earmarked government fund and medical assistance program for the poor women in order to reduce financial burden placed on the households.[20] By 2014, hospital delivery in rural areas was almost universal. Across countries, the shift from community to hospital births is known to result in an increase in CS rates for medically indicated and non-medical reasons.[21] In China, cross-sectional research has shown that while tertiary hospitals have the highest rates of CS for ambiguous indications (i.e. Non-reassuring foetal heart tracing; failure to progress), secondary level hospitals report greater use of CS for maternal request.[22]

Implications for practice

Previous studies report maternal request for CS as a contributor to a rapid increase of CS rate in China,[22-25] despite the validity of the concept being widely debated internationally. For women who reportedly prefer CS, the most common reasons for their preference are fear of labor pain, safer for their baby and for themselves.[1,10] In this context, family members (e.g. husband or parent) also supported this choice to avoid an adverse event, especially in the context of one child in a family policy. Moreover, in our study around one third of nulliparous women reported self-request for CS in the era of one-child policy. This proportion significantly decreased in urban areas over time, which may be associated with the shift from strict one child in a family in urban areas to universal two children, and promotion of vaginal births in hospital settings. This change did not occur in rural areas, which indicate the needs of strengthening quality of maternity care including services delivery and women's experience in rural areas.

Efforts to promote vaginal birth in China included midwifery care training (e.g. training more professional midwives, establishment of standardized evaluation scheme of midwifery practice etc.), pain relief for vaginal birth and informing women about benefits and risks of different mode of delivery.[26] Other studies, largely in big cities and tertiary hospitals report woman-centered pregnancy and childbirth care which includes provision of antenatal classes to shape women's beliefs and confidence to childbirth, build connection and trust between doctors, midwives and women as well as provide continuous supports during labor and birth.[1,4, 23, 27] At the same time, pharmacological and non-pharmacological options for labor pain management have become available. However, the midwifery workforce in China is insufficient. Quality of midwifery care can vary by hospitals, and urban-rural disparity in

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midwife numbers and training is anecdotally reported. Lack of support during labor, lack of pain relief and sub-optimal birth environment were reported as the main reasons that rural women requested for CS.[28] Hence, strengthening midwifery care to improve women's experience on childbirth, particularly in rural areas will be critical to optimize the use of CS in China.

Implications for further research

In the era of two-child policy, only advanced maternal age and giving birth in a private hospital were positively associated with the use of CS by nulliparous women. Since 2013 onward, the latest health-care delivery reform in China encouraged competition between public and private hospitals, and set out the target of private hospitals sharing 20% of market by 2015. The burgeoning of private hospital provision in China is driven by market forces, with providers charges unregulated unless contracted by the basic health insurance schemes.[29] Studies in other countries report much higher CSs rate in private hospitals due to profit driven behavior.[30-32] It needs further study to have a better understanding on the use of CS in private hospitals in China in order to propose evidence-based recommendations for relevant policy development. In addition, we found that CS rate among multiparous women continued to increase over time, especially in urban areas, which may be associated with the increase of women who underwent repeat CS. Based on the NMNMSS data, Liang and colleagues reported a high CS rate among multiparous women with a uterine scar and it was unchanged over time.[98] In China, repeat CS is often suggested and accepted for women with a previous CS to mitigate the risk of uterine rupture or other adverse event, despite repeat CS share similar risks. We can only speculate that there may be increasing referrals of women with a previous CS to high level or specialty hospitals. The accessibility, functional referral and affordability of such services as well as health outcomes, particularly for socio-economic vulnerable women should be rigorous assessed in further research.

Conclusion

A rapid increase of CS rate in rural areas and less developed western region contributed to the increase of CS rate in China over the past decade. The population policy shift, alongside facility policies to limit the use of unnecessary CS, are likely factors contributing to the reduction of CS in urban areas. Strategies at system, organization and individual levels to mitigate unnecessary CSs should be continually strengthened, especially in rural areas and western region. Improving midwifery care will be fundamental to ensure safety and positive childbirth experience in the era of two-child in a family in China.

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Research Ethics Approval Statement

We obtained the permission to access to de-identified birth dataset. ~~and conduct secondary data analysis~~No patient was involved, and thus an approval from an ethics committee was not required.

Contributors

QL conceived and led the overall analysis and wrote the first manuscript draft. YGZ conducted the data analysis and commented on the manuscript. XJT and JZ contributed to the analysis and commented on the manuscript. CK contributed to the study concept and overall analysis and participated in the manuscript writing.

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Conflicts of Interest

The authors declared no conflicts of interest.

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Table 1 Demographic and socioeconomic characteristics of women giving birth in China, 2008-2018

Characteristics	2008-2009 (n=2638)	2010-2012 (n=7015)	2013-2015 (n=6151)	2016-2018 (n=7249)	Total (n=23053)
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Age					
<25	146 (5.5)	1395 (19.9)	785 (12.8)	961 (13.3)	3287 (14.3)
25-34	1708 (64.7)	4514 (64.3)	3836 (62.4)	4775 (65.9)	14833 (64.3)
≥35	784 (29.7)	1106 (15.8)	1530 (24.9)	1513 (20.9)	4933 (21.4)
Educational level [a]					
Illiterate or primary school	493 (18.7)	1091 (15.6)	869 (14.1)	671 (9.3)	3124 (13.5)
Secondary school	128 (48.7)	337 (48.0)	250 (40.8)	250 (34.5)	9662 (41.9)
High school/ professional school or higher	861 (32.6)	2554 (36.4)	2773 (45.1)	4078 (56.3)	10266 (44.5)
Parity [b]					
1	1424 (54.0)	4068 (58.0)	2965 (48.2)	2937 (40.5)	11394 (49.4)
≥2	1213 (46.0)	2947 (42.0)	3184 (51.8)	4312 (59.5)	11656 (50.6)
Health insurance coverage [*]					
None	115(4.4)	366 (5.2)	334 (5.4)	386 (5.3)	1201 (5.2)
UEBMI	470 (17.8)	1112 (15.9)	1343 (21.8)	1953 (26.9)	4878 (21.2)
URRBMI	2007 (76.1)	5440 (77.5)	4270 (69.4)	4589 (63.3)	16306 (70.7)
Others	46 (1.7)	97 (1.4)	204 (3.3)	321 (4.4)	668 (2.9)
Location					
Urban	1234 (46.8)	3261 (46.5)	3133 (50.9)	4166 (57.5)	11794 (51.2)
Rural	1404 (53.2)	3754 (53.5)	3018 (49.1)	3083 (42.5)	11259 (48.8)
Region					
Eastern	878 (33.3)	2238 (31.9)	2133 (34.7)	2741 (37.8)	7990 (34.7)
Central	875 (33.2)	2309 (32.9)	1822 (29.6)	1957 (27.0)	6963 (30.2)

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Western	885 (33.5)	2468 (35.2)	2196 (35.7)	2551 (35.2)	8100 (35.1)
Place of delivery #					
County or higher level hospital	1416 (53.7)	4163 (59.3)	3755 (61.0)	4746 (65.5)	14080 (61.1)
Maternal and child health hospital	670 (25.4)	1743 (24.8)	1482 (24.1)	1678 (23.1)	5573 (24.2)
Township/community health center	552 (20.9)	1109 (15.8)	633 (10.3)	391 (5.4)	2685 (11.6)
Private hospital	--	--	281 (4.6)	434 (6.0)	715 (3.1)

* UEBMI: Urban Employee Basic Medical Insurance

URRBMI: Urban and Rural Resident Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

The private hospital was not included in the survey in 2013.

[a] Data were missing for one woman in 2013-2015

[b] Data were missing for one woman in 2008-2009, and two in 2013-2015

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Table 2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by parity in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Parity 1					
Women request	35.8	30.2	27.9	24.4	<0.001
Husband	0	0	1.3	1.6	<0.001
Doctor	63.3	68.8	69.5	72.7	<0.001
Others	0.9	1.0	1.3	1.3	0.877
Parity ≥2					
Women request	31.7	30.0	32.6	30.9	0.445
Husband	0	0	1.8	1.2	<0.001
Doctor	66.3	69.1	64.4	67.1	0.094
Others	2.0	0.9	1.2	0.8	0.243

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Table 3 Factors associated with use of caesarean section in China by location, 2008-2018

	All		Urban		Rural	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Year of the survey						
2013	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.16 (1.10-1.22)	1.03 (0.97-1.09)	0.92 (0.86-0.99)	0.85 (0.78-0.92)	1.38 (1.27-1.49)	1.30 (1.19-1.41)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.44 (1.33-1.55)	1.32 (1.21-1.43)	1.29 (1.14-1.46)	1.29 (1.13-1.47)	1.36 (1.23-1.51)	1.35 (1.20-1.52)
⩾35	2.03 (1.85-2.22)	2.02 (1.82-2.25)	1.93 (1.68-2.21)	2.05 (1.75-2.39)	1.78 (1.57-2.02)	2.00 (1.72-2.32)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.32 (1.21-1.43)	1.21 (1.10-1.32)	1.10 (0.94-1.29)	1.16 (0.98-1.36)	1.32 (1.19-1.46)	1.14 (1.02-1.27)
High school or higher	1.76 (1.62-1.92)	1.21 (1.10-1.34)	1.21 (1.05-1.41)	1.22 (1.03-1.44)	1.66 (1.48-1.86)	1.10 (0.96-1.26)
Residence						
Urban			--	--	--	--
Rural	0.61 (0.58-0.65)	0.75 (0.70-0.80)	--	--	--	--
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.18 (1.11-1.26)	1.25 (1.17-1.34)	1.38 (1.26-1.51)	1.35 (1.23-1.48)	1.01 (0.92-1.11)	1.12 (1.01-1.23)
Western	0.62 (0.58-0.66)	0.69 (0.64-0.73)	0.91 (0.83-0.99)	0.92 (0.84-1.01)	0.43 (0.39-0.47)	0.48 (0.43-0.53)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.52 (1.42-1.62)	0.98 (0.91-1.07)	1.11 (1.03-1.20)	1.01 (0.92-1.11)	1.91 (1.63-2.24)	1.13 (0.94-1.35)
None	1.25 (1.11-1.40)	0.96 (0.85-1.09)	0.94 (0.82-1.08)	0.91 (0.79-1.05)	1.42 (1.13-1.79)	1.27 (1.00-1.61)
Others	1.34 (1.15-1.57)	1.05 (0.90-1.24)	1.18 (0.97-1.43)	1.12 (0.92-1.36)	1.12 (0.84-1.47)	1.06 (0.79-1.42)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.39 (1.29-1.50)	1.24 (1.15-1.34)	1.43 (1.30-1.58)	1.10 (0.97-1.24)	1.43 (1.30-1.58)	1.28 (1.15-1.41)
Quartile 3	1.62 (1.50-1.74)	1.30 (1.21-1.41)	1.63 (1.47-1.80)	1.14 (1.02-1.29)	1.63 (1.47-1.80)	1.36 (1.22-1.52)
Quartile 4	1.76 (1.63-1.89)	1.26 (1.16-1.38)	2.04 (1.79-2.32)	1.07 (0.95-1.21)	2.04 (1.79-2.32)	1.69 (1.47-1.95)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	0.87 (0.83-0.92)	0.87 (0.82-0.93)	1.02 (0.95-1.10)	0.94 (0.86-1.02)	0.89 (0.83-0.96)	0.80 (0.73-0.88)
Place of delivery						

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Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.23 (2.03-2.44)	2.03 (1.85-2.24)	1.57 (1.36-1.81)	1.48 (1.27-1.72)	2.49 (2.21-2.81)	2.45 (2.16-2.78)
Maternal and child health hospital	2.02 (1.83-2.23)	1.76 (1.59-1.96)	1.41 (1.21-1.64)	1.34 (1.14-1.57)	2.02 (1.75-2.32)	1.98 (1.71-2.29)
Private hospital	2.55 (2.15-3.02)	2.31 (1.93-2.76)	1.94 (1.53-2.47)	1.91 (1.49-2.46)	2.46 (1.92-3.17)	2.44 (1.87-3.18)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table 4 Factors associated with use of caesarean section after relaxation of the one child policy in China by parity, 2016-2018

	All		Parity 1		Parity ≥2	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.78 (1.53-2.06)	1.62 (1.38-1.90)	1.52 (1.27-1.83)	1.52 (1.25-1.86)	2.37 (1.79-3.14)	2.06 (1.54-2.75)
≥35	2.89 (2.44-3.43)	2.58 (2.12-3.13)	2.41 (1.76-3.31)	2.40 (1.72-3.35)	3.73 (2.78-5.00)	3.19 (2.34-4.33)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.40 (1.18-1.67)	1.42 (1.18-1.71)	0.96 (0.65-1.41)	1.02 (0.69-1.51)	1.58 (1.30-1.93)	1.49 (1.21-1.84)
High school or higher	1.38 (1.17-1.64)	1.24 (1.02-1.51)	0.97 (0.67-1.39)	0.85 (0.58-1.25)	1.74 (1.43-2.12)	1.35 (1.08-1.70)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	0.78 (0.71-0.86)	0.84 (0.75-0.95)	0.81 (0.69-0.95)	0.85 (0.70-1.02)	0.72 (0.63-0.81)	0.84 (0.73-0.97)
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.01 (0.90-1.13)	1.01 (0.90-1.14)	0.99 (0.82-1.19)	1.03 (0.84-1.25)	1.01 (0.87-1.17)	1.00 (0.86,1.17)
Western	0.65 (0.58-0.73)	0.70 (0.62-0.78)	0.83 (0.69-0.98)	0.87 (0.72-1.04)	0.55 (0.48-0.64)	0.61 (0.52-0.71)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.19 (1.07-1.32)	0.95 (0.83-1.09)	1.17 (1.00-1.37)	1.05 (0.86-1.28)	1.34 (1.15-1.55)	0.91 (0.76-1.10)
None	0.92 (0.75-1.14)	0.81 (0.64-1.01)	1.07 (0.77-1.49)	0.99 (0.70-1.38)	0.85 (0.65-1.13)	0.69 (0.51-0.93)
Others	1.14 (0.91-1.44)	0.97 (0.76-1.23)	0.81 (0.54-1.22)	0.76 (0.50-1.14)	1.36 (1.03-1.81)	1.08 (0.80-1.47)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.22 (1.07-1.39)	1.12 (0.97-1.28)	1.12 (0.89-1.41)	1.07 (0.84-1.35)	1.28 (1.09-1.51)	1.12 (0.95-1.33)
Quartile 3	1.44 (1.27-1.64)	1.24 (1.07-1.43)	1.10 (0.89-1.37)	0.99 (0.79-1.25)	1.78 (1.51-2.10]	1.40 (1.17-1.68)
Quartile 4	1.28 (1.13-1.46)	1.04 (0.89-1.21)	1.13 (0.92-1.39)	0.94 (0.73-1.19)	1.51 (1.27-1.79)	1.10 (0.90-1.35)
Parity						
1	1.00	1.00	--	--	--	--
≥2	1.29 (1.18-1.42)	1.12 (1.01-1.25)	--	--	--	--
Place of delivery						
Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.03 (1.62-2.54)	2.09 (1.66-2.64)	1.36 (0.85-2.19)	1.27 (0.78-2.06)	2.45 (1.89-3.16)	2.34 (1.80-3.05)
Maternal and child health hospital	1.67 (1.32-2.12)	1.68 (1.32-2.15)	1.15 (0.70-1.88)	1.03 (0.62-1.70)	1.99 (1.51-2.62)	1.88 (1.42-2.51)

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Private hospital	2.16 (1.62-2.88)	2.26 (1.68-3.04)	1.45 (0.83-2.54)	1.52 (1.25-1.86)	2.56 (1.81-3.61)	2.55 (1.79-3.64)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

Caesarean section rate in urban areas slightly decreased between 2008 and 2018, while it had increased in rural areas. Across regions, a large increase occurred in less developed Western region.

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Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

Caesarean section rate among nulliparous women decreased around 2016 in both urban and rural areas, while there was a large increase in the number of multiparous women delivering by caesarean section.

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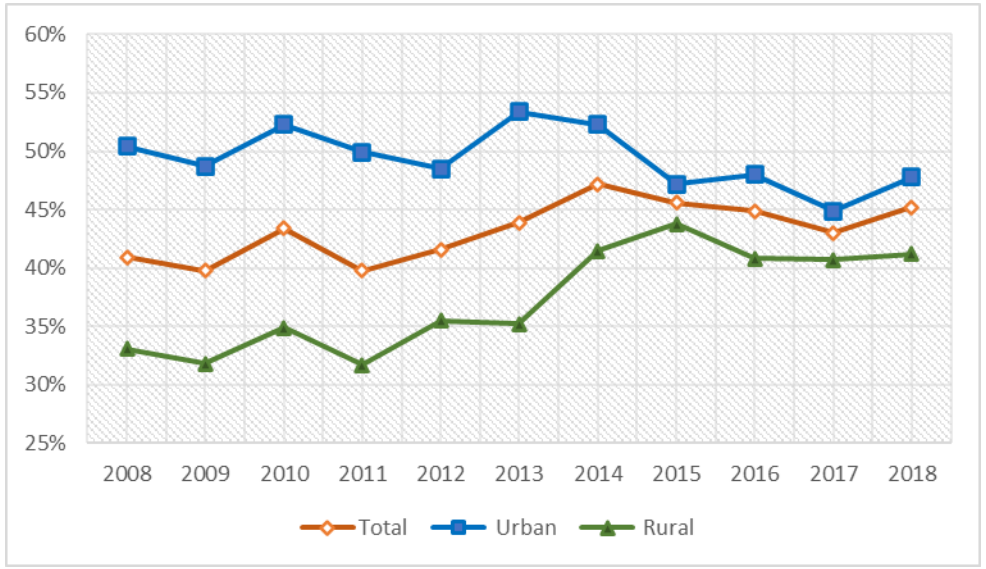
Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

a. Caesarean section rate by urban and rural



b. Caesarean section rate across regions

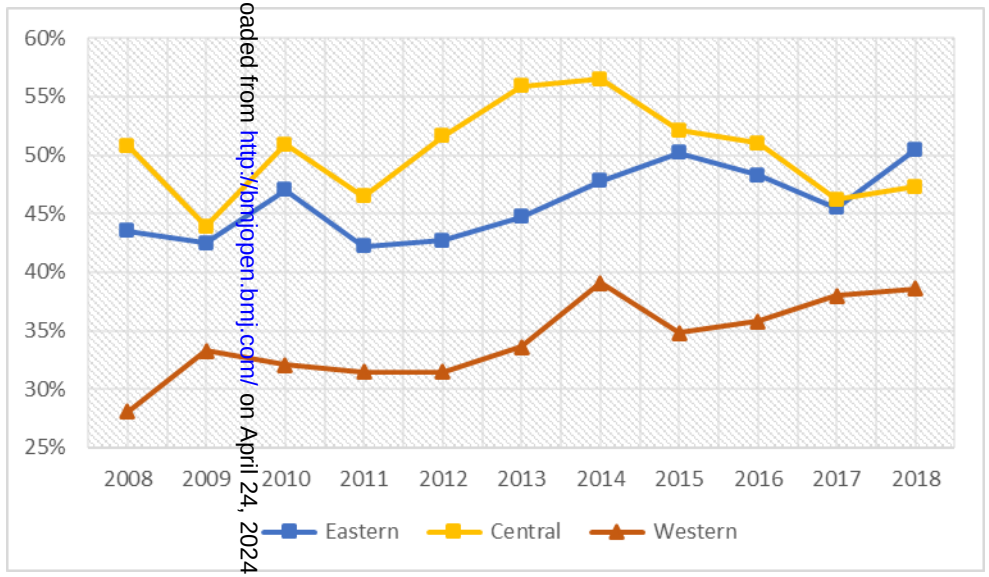


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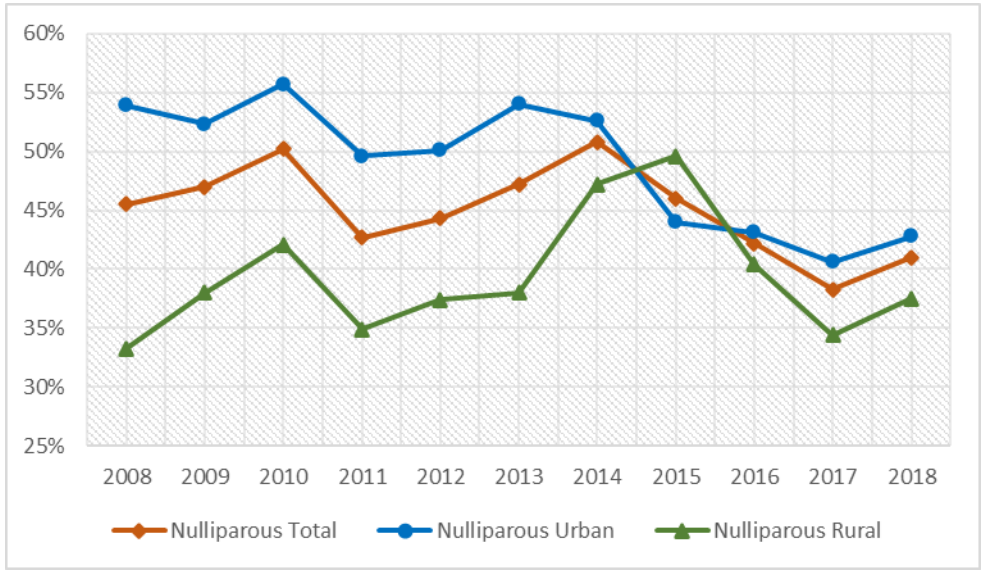
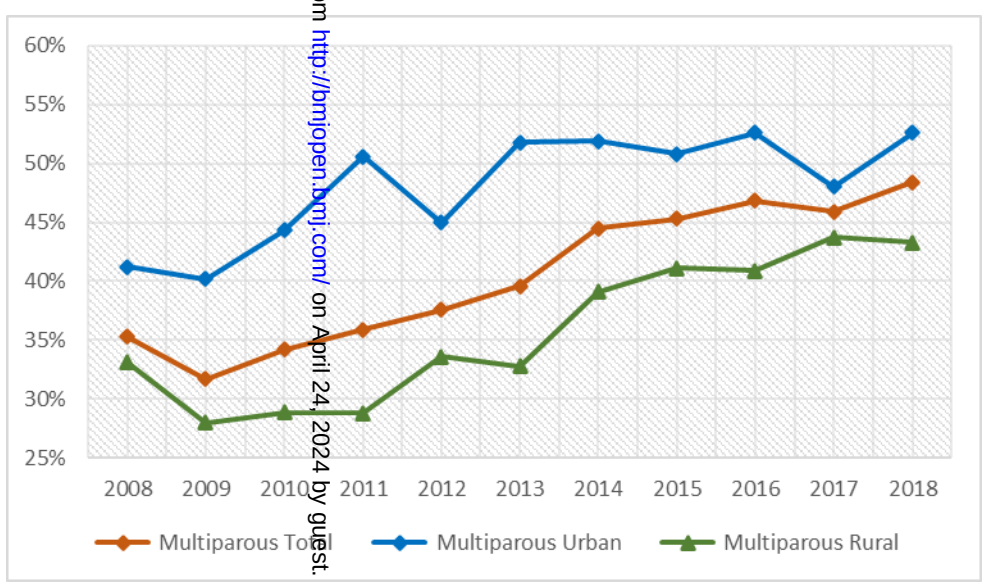
Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

a. Caesarean section rate among nulliparous women by urban and rural



b. Caesarean section rate among multiparous women by urban and rural



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Supplementary files:

Table S1 Place of women giving birth by urban and rural and by region, 2008-2018 (%)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of births	786	1852	1981	2219	2815	2462	1921	1768	2430	2819	2000
Rural											
County or higher level hospital	50.7	52.1	57.2	59.3	61.8	60.6	64.1	65.8	69.3	70.6	68.0
Maternal and child health hospital	21.8	19.8	18.1	21.6	18.3	20.0	17.9	16.7	15.5	17.2	20.6
Township/community health center	27.5	28.2	24.6	19.1	19.9	18.0	11.9	10.3	8.8	5.9	6.7
Private hospital	0	0	0	0	0	1.4	6.1	7.1	6.4	6.3	4.7
Urban											
County or higher level hospital	52.0	57.6	56.1	58.7	61.0	61.0	57.7	58.2	60.4	63.4	63.8
Maternal and child health hospital	34.7	29.7	31.8	31.4	30.6	29.6	29.5	29.3	28.0	26.7	27.3
Township/community health center	13.3	12.7	12.1	9.8	8.4	7.4	6.5	5.9	5.2	4.1	3.0
Private hospital	0	0	0	0	0	2.0	6.2	6.6	6.4	5.8	5.9
East											
County or higher level hospital	50.9	55.5	58.2	61.4	64.7	58.9	65.3	64.9	66.2	67.4	67.3
Maternal and child health hospital	27.3	23.2	22.2	24.5	20.4	24.9	23.0	21.3	21.7	22.0	22.5
Township/community health center	21.8	21.3	19.6	14.1	14.9	15.6	8.5	9.7	7.6	7.1	6.1
Private hospital	0	0	0	0	0	0.6	3.2	4.1	4.5	3.6	4.1
Central											
County or higher level hospital	50.8	52.4	55.0	55.6	58.3	63.3	57.8	58.8	60.3	66.4	64.7

Maternal and child health hospital	29.1	25.4	26.0	28.3	26.3	22.5	26.5	25.5	24.4	22.0	22.9
Township/community health center	20.2	22.2	19.1	16.1	15.4	11.5	7.7	5.2	5.9	2.5	3.8
Private hospital	0	0	0	0	0	2.6	8.1	10.5	9.4	9.0	8.6
West											
County or higher level hospital	52.1	56.2	56.9	60.1	61.5	60.3	58.2	61.0	64.8	65.8	64.4
Maternal and child health hospital	26.5	24.7	26.2	25.1	25.1	26.1	23.3	23.9	22.6	23.4	27.8
Township/community health center	21.4	19.1	16.9	14.8	13.4	11.8	10.7	8.6	6.3	4.4	3.5
Private hospital	0	0	0	0	0	1.8	7.8	6.6	6.3	6.4	4.3

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Table S2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by location and regions in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Urban					
Parity 1					
Women request	36.8	29.0	27.9	22.2	<0.001
Husband	0	0	1.6	14.7	<0.001
Doctor	62.3	70.1	69.9	75.5	<0.001
Others	0.9	0.86	0.6	0.86	0.899
Parity ≥2					
Women request	31.7	28.6	30.1	30.5	0.858
Husband	0	0	1.4	1.3	0.032
Doctor	65.5	70.7	67.0	67.4	0.564
Others	2.8	0.6	1.5	0.8	0.182
Rural					
Parity 1					
Women request	33.5	32.3	28.0	29.4	0.256
Husband	0	0	0.8	1.9	0.002
Doctor	65.5	66.6	68.7	66.6	0.725
Others	1.0	1.2	2.5	2.2	0.429
Parity ≥2					
Women request	31.8	31.1	35.0	31.4	0.279
Husband	0	0	2.1	1.0	0.001
Doctor	66.7	67.7	61.9	66.7	0.079
Others	1.6	1.2	1.0	0.9	0.743
Eastern					

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Parity 1					
Women request	34.8	31.7	27.7	23.6	0.002
Husband	0	0	1.5	1.3	0.006
Doctor	63.9	67.2	69.5	72.8	0.045
Others	1.2	1.1	1.3	2.32	0.494
Parity ≥2					
Women request	37.2	30.5	36.3	33.0	0.316
Husband	0	0	1.1	1.1	0.156
Doctor	60.6	68.9	61.6	65.4	0.142
Others	2.3	0.6	1.1	0.5	0.158
Central					
Parity 1					
Women request	37.6	30.3	30.7	27.0	0.020
Husband	0	0	1.0	1.6	0.005
Doctor	62.0	68.4	67.1	70.9	0.072
Others	0.4	1.3	1.2	0.6	0.502
Parity ≥2					
Women request	30.9	33.2	31.4	33.4	0.912
Husband	0	0	2.1	1.8	0.008
Doctor	67.9	65.7	65.0	64.2	0.776
Others	1.2	1.1	1.6	0.6	0.487
Western					
Parity 1					
Women request	34.8	28.2	24.3	23.3	0.029
Husband	0	0	1.6	2.0	0.005
Doctor	64.1	71.4	72.7	74.2	0.103
Others	1.1	0.4	1.3	0.5	0.383
Parity ≥2					

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Women request	26.0	24.7	29.9	24.9	0.302
Husband	0	0	2.2	0.7	0.012
Doctor	71.0	74.3	66.9	72.8	0.163
Others	3.0	1.0	1.0	1.6	0.515

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Table S3 Factors associated with use of caesarean section (CS) in China by region, 2008-2018

	Eastern		Central		Western	
	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)
Year of the survey						
2013	43.5	1.00	49.7	1.00	31.7	1.00
2018	48.1	1.07 (0.97-1.18)	50.7	0.93 (0.84-1.04)	37.4	1.10 (1.00-1.22)
Age						
<25	36.5	1.00	43.2	1.00	26.4	1.00
25-34	44.5	1.36 (1.16-1.59)	49.7	1.27 (1.09-1.47)	34.4	1.30 (1.13-1.50)
⩾35	55.4	2.15 (1.78-2.59)	55.9	1.74 (1.45-2.09)	42.4	2.02 (1.69-2.41)
Educational level						
Illiterate or primary school	46.2	1.00	48.5	1.00	23.6	1.00
Secondary school	44.8	0.99 (0.83-1.19)	46.9	0.92 (0.78-1.09)	31.9	1.43 (1.24-1.64)
High school or higher	46.8	0.94 (0.78-1.14)	54.0	0.95 (0.79-1.14)	44.0	1.50 (1.27-1.76)
Residence						
Urban	47.4	1.00	55.5	1.00	45.0	1.00
Rural	44.2	0.95 (0.85-1.06)	44.5	0.78 (0.70-0.87)	25.4	0.56 (0.51-0.63)
Region						
Eastern	46.0	--	--	--	--	--
Central	--	--	50.2	--	--	--
Western	--	--	--	--	34.6	--
Health insurance coverage [a]						
URRBMI	44.6	1.00	47.8	1.00	31.8	1.00
UEBMI	48.5	1.01 (0.89-1.15)	57.5	1.07 (0.92-1.25)	49.2	0.96 (0.82-1.13)
None	43.6	0.88 (0.73-1.06)	56.7	1.24 (0.99-1.55)	37.2	0.91 (0.70-1.18)
Others	52.2	1.20 (0.93-1.55)	56.3	1.18 (0.87-1.60)	35.2	0.88 (0.65-1.19)
Income quartile						
Quartile 1	43.6	1.00	45.3	1.00	24.9	1.00
Quartile 2	44.9	1.04 (0.90-1.21)	49.6	1.16 (1.01-1.32)	35.5	1.38 (1.21-1.57)
Quartile 3	47.2	1.12 (0.97-1.28)	52.5	1.21 (1.07-1.38)	40.0	1.44 (1.25-1.65)
Quartile 4	47.0	1.06 (0.91-1.23)	54.9	1.19 (1.02-1.39)	47.3	1.60 (1.37-1.87)
Parity						
1	45.4	1.00	51.9	1.00	38.0	1.00
≥2	46.7	0.91 (0.81-1.01)	48.5	0.87 (0.78-0.97)	31.6	0.84 (0.75-0.94)
Place of delivery						
Township/community health center	32.0	1.00	34.4	1.00	16.4	1.00
County or higher level hospital	49.1	1.98 (1.71-2.30)	52.6	1.90 (1.61-2.24)	37.2	2.37 (1.95-2.87)

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Maternal and child health hospital	44.2	1.62 (1.37-1.91)	51.9	1.77 (1.48-2.12)	34.5	2.02 (1.64-2.48)
Private hospital	55.8	2.57 (1.82-3.62)	52.7	1.97 (1.48-2.62)	40.9	2.82 (2.04-3.90)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S4 Factors associated with use of caesarean section (CS) after relaxation of the one child policy by urban and rural, 2016-2018

	Urban		Rural	
	Unadjusted	Adjusted*	Unadjusted	Adjusted*
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age				
<25	1.00	1.00	1.00	1.00
25-34	1.57 (1.25-1.98)	1.51 (1.19-1.92)	1.87 (1.53-2.28)	1.74 (1.40-2.17)
≥35	2.73 (2.12-3.51)	2.50 (1.90-3.29)	2.60 (2.02-3.35)	2.46 (1.84-3.28)
Educational level				
Illiterate or primary school	1.00	1.00	1.00	1.00
Secondary school	1.25 (0.90-1.74)	1.39 (0.99-1.94)	1.40 (1.13-1.73)	1.34 (1.07-1.67)
High school or higher	1.12 (0.82-1.53)	1.25 (0.90-1.75)	1.29 (1.04-1.61)	1.09 (0.85-1.40)
Residence				
Urban	--	--	--	--
Rural	--	--	--	--
Region				
Eastern	1.00	1.00	1.00	1.00
Central	1.13 (0.97-1.32)	1.08 (0.92-1.26)	0.86 (0.71-1.03)	0.89 (0.74-1.08)
Western	0.89 (0.77-1.03)	0.89 (0.77-1.04)	0.43 (0.36-0.52)	0.49 (0.41-0.59)
Health insurance coverage [a]				
URRBMI	1.00	1.00	1.00	1.00
UEBMI	1.03 (0.90-1.18)	0.98 (0.84-1.15)	1.29 (1.00-1.66)	0.96 (0.72-1.28)
None	0.76 (0.59-0.97)	0.78 (0.60-1.01)	1.25 (0.79-1.99)	1.14 (0.71-1.84)
Others	1.20 (0.91-1.59)	1.08 (0.81-1.45)	0.80 (0.53-1.23)	0.85 (0.54-1.31)
Income quartile				
Quartile 1	1.00	1.00	1.00	1.00
Quartile 2	1.06 (0.86-1.31)	1.03 (0.83-1.27)	1.24 (1.04-1.48)	1.11 (0.92-1.33)
Quartile 3	1.15 (0.95-1.40)	1.10 (0.89-1.35)	1.56 (1.29-1.89)	1.33 (1.08-1.64)
Quartile 4	1.00 (0.83-1.21)	0.95 (0.77-1.17)	1.41 (1.09-1.83)	1.20 (0.91-1.59)
Parity				
1	1.00	1.00	1.00	1.00
≥2	1.41 (1.25-1.60)	1.17 (1.02-1.34)	1.25 (1.07-1.46)	1.03 (0.86-1.23)
Place of delivery				

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Township/community health center	1.00	1.00	1.00	1.00
County or higher level hospital	1.54 (1.12-2.12)	1.62 (1.17-2.25)	2.53 (1.83-3.51)	2.60 (1.86-3.63)
Maternal and child health hospital	1.30 (0.93-1.80)	1.37 (0.98-1.93)	1.85 (1.29-2.65)	1.84 (1.27-2.67)
Private hospital	1.72 (1.16-2.56)	1.84 (1.22-2.76)	2.48 (1.61-3.81)	2.62 (1.68-4.07)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S5 Factors associated with use of C-section after relaxation of the one child policy across regions, 2016-2018

	Eastern		Central		Western	
	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.62 (1.22-2.16)	1.58 (1.17-2.14)	1.96 (1.47-2.60)	1.77 (1.31-2.39)	1.60 (1.27-2.00)	1.48 (1.16-1.88)
≥35	2.88 (2.11-3.95)	2.76 (1.94-3.91)	3.03 (2.18-4.21)	2.49 (1.72-3.61)	2.37 (1.80-3.11)	2.20 (1.60-3.01)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.05 (0.74-1.49)	1.20 (0.84-1.72)	0.92 (0.65-1.31)	1.04 (0.72-1.51)	1.67 (1.28-2.19)	1.62 (1.22-2.14)
High school or higher	0.79 (0.57-1.10)	0.98 (0.68-1.41)	0.91 (0.65-1.28)	0.90 (0.61-1.32)	2.04 (1.57-2.64)	1.51 (1.12-2.05)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.11 (0.95-1.30)	0.98 (0.81-1.17)	0.84 (0.70-1.01)	0.91 (0.73-1.13)	0.54 (0.46-0.64)	0.69 (0.57-0.84)
Region						
Eastern	--	--	--	--	--	--
Central	--	--	--	--	--	--
Western	--	--	--	--	--	--
Health insurance coverage						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	0.85 (0.72-1.00)	0.92 (0.75-1.14)	1.26 (1.01-1.56)	1.12 (0.86-1.44)	1.50 (1.22-1.83)	0.95 (0.74-1.22)
None	0.62 (0.47-0.82)	0.65 (0.48-0.88)	1.23 (0.75-2.01)	1.36 (0.82-2.27)	1.24 (0.76-2.02)	1.05 (0.64-1.73)
Others	1.10 (0.77-1.58)	1.15 (0.79-1.69)	1.23 (0.81-1.85)	1.03 (0.67-1.57)	0.84 (0.53-1.32)	0.77 (0.48-1.24)
Income quintiles						
Quintile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 2	0.90 (0.70-1.14)	0.97 (0.79-1.21)	0.93 (0.73-1.19)	0.94 (0.73-1.21)	1.62 (1.31-2.01)	1.37 (1.09-1.71)
Quintile 3	0.93 (0.74-1.17)	0.85 (0.68-1.06)	1.16 (0.91-1.48)	1.12 (0.87-1.45)	2.00 (1.60-2.50)	1.54 (1.21-1.98)
Quintile 4	0.77 (0.62-0.96)	1.16 (0.97-1.38)	1.09 (0.84-1.41)	1.01 (0.75-1.36)	1.93 (1.53-2.42)	1.33 (1.01-1.75)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	1.47	2.26	1.50	1.28	0.98	0.99

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	(1.26-1.72)	(1.63-3.14)	(1.25-1.81)	(1.04-1.57)	(0.84-1.16)	(0.82-1.20)
Place of delivery						
Township/community health center (ref.)						
County or higher level hospital	2.08 (1.52-2.85)	1.66 (1.16-2.36)	1.71 (1.06-2.74)	1.79 (1.11-2.90)	2.51 (1.58-3.97)	2.06 (1.28-3.29)
Maternal and child health hospital	1.55 (1.10-2.18)	2.64 (1.61-4.31)	1.55 (0.95-2.54)	1.61 (0.96-2.67)	2.19 (1.36-3.53)	1.70 (1.04-2.78)
Private hospital	2.49 (1.54-4.03)	2.55 (1.79-3.64)	1.26 (0.73-2.18)	1.36 (0.78-2.37)	3.78 (2.17-6.58)	3.25 (1.84-5.74)

* Adjusting for all explanatory variables

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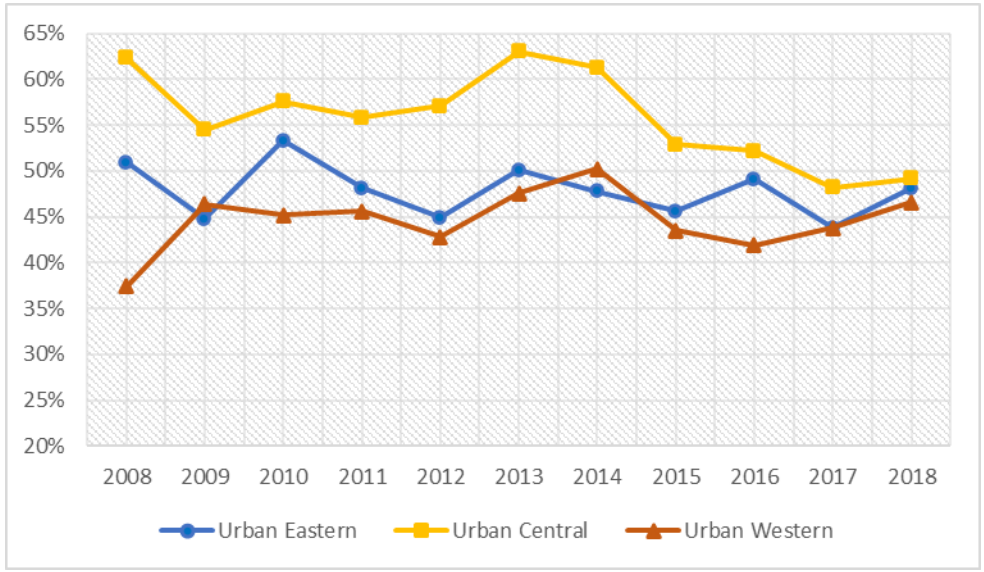
Figure S1 Proportion of women giving birth by caesarean section across regions by urban and rural, 2008-2018

a. Caesarean section rate in urban areas across regions



b. Caesarean section rate in rural areas across regions

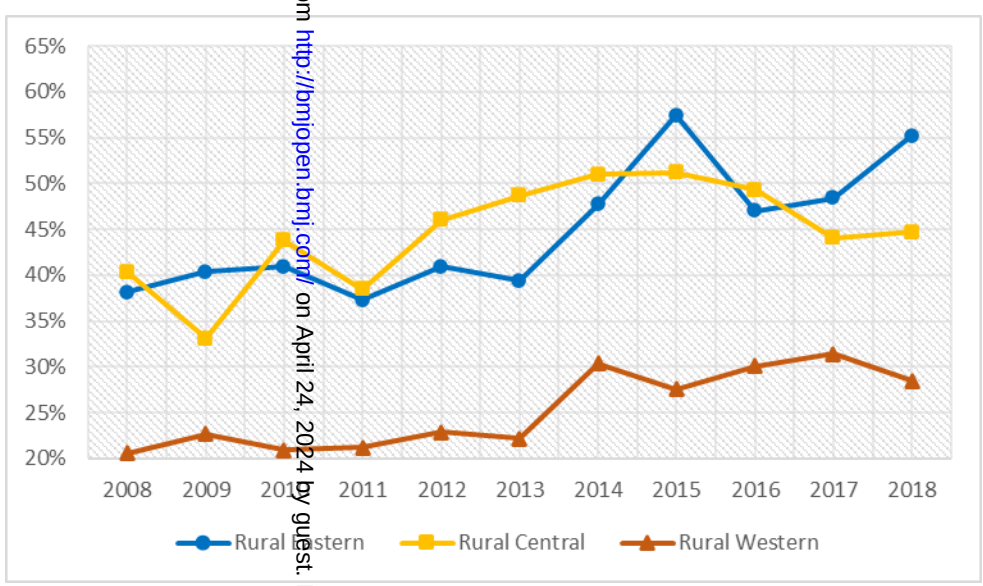


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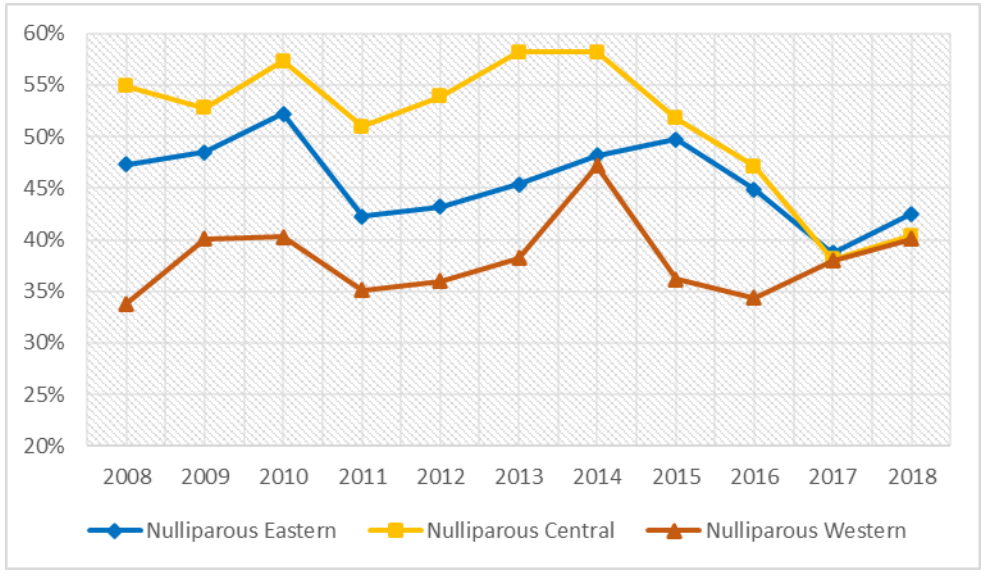
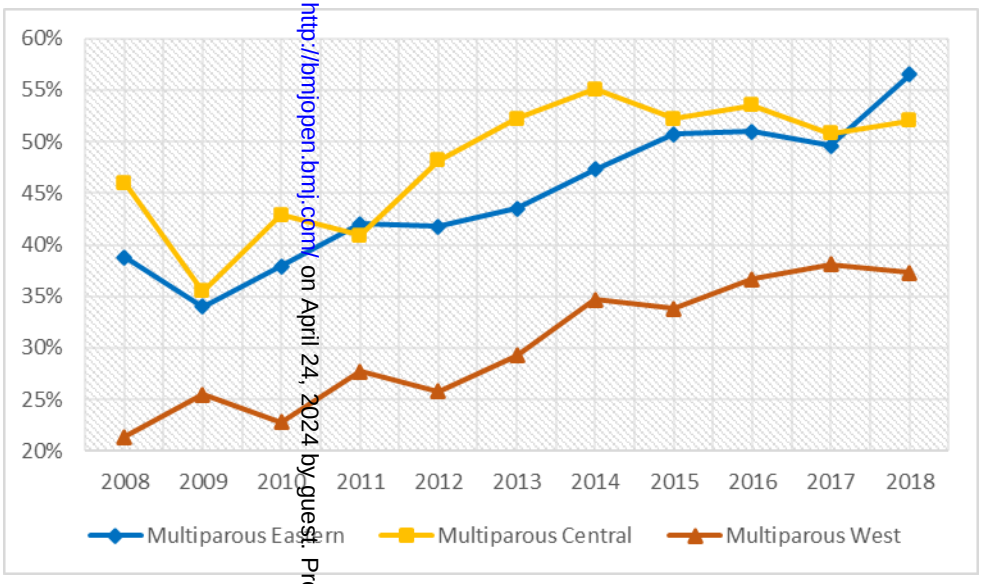
Figure S2 Proportion of women giving birth by caesarean section by parity across regions, 2008-2018

a. Caesarean section rate among nulliparous women across regions



b. Caesarean section rate among multiparous women across regions



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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	17 (Table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	7-8

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Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

The authors confirmed that the manuscript writing followed the STORBE checklist for cross-sectional studies.

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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Changes to caesarean section rates in China during the period of transition from the one-to-two child policy era: Cross-sectional National Household Health Services Surveys

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Abstract

Objectives: Since 2009, China has introduced policies, principally targeting health professionals, to reduce caesarean section (CS) overuse. In 2016, China endorsed a universal two-child policy. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS. This study investigated changes to CS rates in 2008-2018, and factors associated with CS use during the period of transition from the one-to-two child policy era.

Design: We used births data from cross-sectional National Household Health Services Surveys in 2013 and 2018.

Setting: Population-based national survey

Participants: Women who had the last live birth within the five years before the survey

Primary outcome measure: Caesarean section rate

Results: Overall CS use increased from 40.9% in 2008 to 47.2% in 2014 with significant increase in rural areas and the western region, and slightly decreased to 45.2% in 2018 with the greatest decrease among nulliparous women. Maternal request for CS by urban nulliparous women decreased from 36.8% in 2008-2009 to 22.2% in 2016-2018, but this change was not statistically significant in rural areas. Maternal age over 35 years old (OR 2.40, 95%CI 1.76-3.31) and births occurred at private hospital(OR 1.52, 95%CI 1.25-1.86) were associated with CS use among nulliparous women in 2016-2018. The CS rate among multiparous women increased over time. Individual socio-economic factors associated with CS use among multiparous women.

Conclusions: The CS rate rise in China in 2008-2018 is attributable to increased use in rural areas and the less developed Western region. The population policy shift, alongside facility policies for unnecessary CS reduction, are likely factors in CS reduction in urban areas. The challenge remains to reduce unnecessary CS, at the same time as providing safe, universal access to CSs for women in need.

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Strengths and limitations of this study

- This study used well-established population-based national survey data to examine the change of caesarean section rate in China by urban and rural areas, across regions and women's characteristics over the periods of population policy shift.
- This study could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China.
- We are not able to conduct more sub-groups analysis such as previous caesarean section or caesarean section with or without medical indications due to unavailable data.

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Introduction

Globally, Caesarean Section (CS) rates are rising in all regions with one of fifth of live births being by CS in 2015.[1] Complex social, cultural, economic, and medical factors are known drivers of CS use.[2] Overuse and underuse of CS represent simultaneous challenges for many health systems. Overuse of CS, where CS is performed without or on the basis of ambiguous medical indications has been associated with increased risk of maternal and newborn adverse outcomes and increased costs for health systems and individuals.[3, 4] Meanwhile, the low use of CS implies limited accessibility to this life-saving procedures for women in need during childbirth.[1] The World Health Organization (WHO) Statement on Caesarean Section Rates suggests that CS rates at population level higher than 10% are not associated with reductions in maternal and newborn mortality rates, while every effort should be made to provide CS to women in need.[5]

China has witnessed a rapid increase in the use of CS since 1990s.[6-9] According to the data from the National Household Health Services Surveys in China, the CS rate increased from 19.2% in 2003 to 36.3% in 2011.[7] Many CSs in China are not medically indicated.[10] There is evidence that individual, health system and socio-cultural factors are driving the use of CS.[11] Women may request CS because of fear of labor pain, fear of risk and adverse outcomes of vaginal delivery, perceived convenience of CS for birth plan and control and perceived CS as a safe option for childbirth.[11] In China, facility-based delivery is a national strategy to reduce risks of adverse outcomes for mothers and newborns. Almost all births occurred in health facilities by 2015. It has been argued that financial incentive and fear of malpractice may shape the preference of health professionals for performing CS in the hospital settings.[11, 12]

Since 2009, the Chinese government has increasingly introduced policies and strategies at national and local levels to restrict the use of unnecessary CS.[9] These strategies largely targeted health professionals. They include revising clinical guideline to strict control of CS indications, strengthening training of midwifery care and audit of CS without medical indications, setting facility CS rate targets and removing financial incentives for CS. China has gradually relaxed family planning policy since 2013, with all families being allowed and encouraged to have a second child in 2016. Advanced maternal age and previous CS may indicate changes in obstetric risks, which raise the concerns on the need for and safety of CS.[13, 14]

Recent studies that used data from the National Maternal Near Miss Surveillance System (NMNMSS) reported a moderate decrease of CS rate in some big cities, which coincided with the period of relaxation of the one-child policy between 2012-2016.[8, 9] This decrease in

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CS rate may be attributable to facility strategies to reduce the use of CS without medical indications. However, the authors also acknowledged the limitation of NMNMSS data in over-representing urban populations. Little is known about trends of CS use in rural areas, across regions at different stages of socio-economic development, nor how facility strategies to mitigate unnecessary CS and the population policy shift have affected the use of CS in these places.

This study used cross-sectional data from the National Household Health Services Survey conducted in 2013 and 2018, which achieved reliable representativeness of the general population by urban and rural areas and across socio-economic development regions. We investigated changes to CS rates between 2008 and 2018, by urban and rural location, and across socio-economic regions in China. It sought to examine maternal request for CS by the study periods and by parity, as well as demographic and socio-economic factors associated with use of CS during the period of transition from the one-to-two child policy era.

Methods

Data source

We obtained the permission to access to birth dataset from National Household Health Services Surveys conducted in 2013 and 2018. Each survey employed the same three-stage, stratified, cluster random sampling procedure. At the first stage, urban and rural location and socio-economic regions were used to classify cities and counties into six groups: eastern urban, eastern rural, central urban, central rural, western urban and western rural. Simple random sampling was used to select cities and counties from each group. The random sample process was repeated for three times to select the ones most close to the parameters (e.g. fertility rate, mortality rate and demographic structure etc.) representing the general. Then five sub-districts or townships were randomly selected from each city or county based on the rank of number of population. Finally, three communities or villages from each sub-district or township were randomly selected and all households in the selected sub-district or township were included in the survey. In total, 93,613 households were included in the survey of 2013 and 94,074 in the survey of 2018.

The trained primary health workers administered face-to-face survey to each family member in the sampled households using structured questionnaire. The questionnaires used in the two surveys had a same structure and involved similar questions, which included the general demographic and socio-economic characteristics of the sampled households and family members, the utilization of and expenditures on health services. There is one section on the childbirth that asked questions about the use of antenatal care, place of delivery, mode of

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delivery and caesarean delivery for maternal request. We included women who had the last live birth within the five years before the survey in this study to avoid overrepresentation of women who have one more child.

Measures

The outcome measure was CS rate, the percentage of births by CS. In the survey, the mode of delivery was asked with the following question: “How did the birth take place: a) vaginal delivery; b) caesarean section”. If the answer was “caesarean section”, the following question was “Who was the most important person of proposing CS: a) myself; b) husband; c) parent; d) doctor; e) others”. We considered CS as a woman request in the analysis if the woman choose the option “a (myself)”.

We examined demographic and socio-economic factors associated with the use of CS that included: maternal age (<25, 25-34, ≥35); maternal educational level (illiterate or primary school, secondary school, high school/professional school or higher); location of resident (urban, rural); living in different socio-economic region (developed Eastern, less developed Central, least developed Western); health insurance coverage; income quartile; parity, defined as the number of live births born by a woman; and place of delivery, defined as type of health facility where the live birth occurred (county or higher level hospital, maternal and child health hospital, township/community health center, private hospital). There are three basic health insurance schemes in China: Urban Employee Basic Health Insurance (UEBMI), Urban Residents Basic Health Insurance (URBMI) and rural New Cooperative Medical Scheme (NCMS). In recent years, URBMI was integrated with NCMS in some provinces renamed as Urban and Rural Residents Basic Medical Insurance (URRBMI). Overall, UEBMI provides better coverage for both inpatient and outpatient care compared to URRBMI. In the analysis, we grouped URBMI, NCMS and URRBMI into one category as “URRBMI”. Health insurance coverage was grouped into: none coverage, UEBMI, URRBMI and others (including free medical service scheme for special sectors or labor insurance). Annual household income in the calendar year that preceded the survey included savings and household expenditure on consumables during that year. We generated income quartile by dividing household income by the number of individuals in the household, which reflected lowest income group (quartile 1), low income group (quartile 2), middle income group (quartile 3) and high income group (quartile 4).

Data analysis

We investigated changes of CS rate in 2008-2018 by urban and rural areas and across different socio-economic regions. We also examined CS rate among nulliparous and

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multiparous women by location and region in the study periods. We studied change of women request for CS by parity that the time period 2008-2018 was divided into 2008-2009, 2010-2012, 2013-2015 and 2016-2018. Chi-square test was used to test the difference by the study period. We conducted bi-variate and multi-variate logistic regression analysis to study explanatory variables associated with the use of CS for all and in stratification of urban and rural areas and by socio-economic regions in 2008-2018. In addition, we stratified data in 2016-2018 to study demographic and socio-economic factors associated with the use of CS after universal two-child policy in China for all and by nulliparous and multiparous women, by location and regions. We applied Stata 13.0 for data analysis.

Ethical statement

This study is based on a secondary data analysis. The research team obtained the approval of the Center for Health Statistics and Information of the National Health Commission (NHC) of China (formerly the Ministry of Health) to access to de-identified birth dataset.

Patient and public involvement

No patient involved.

Results:

Total 23,053 women who had a live birth in the study period 2008-2018 were included in the analysis (Table 1). The distribution of maternal age was relatively similar by the study periods, and more than 60% of women were aged at 25-34 years. The proportion of women who received high school and professional school or higher and those who had two or more children increased over time. Few women had no health insurance coverage, and a vast majority of women had enrolled in URRBMI. In addition, there were more women in urban areas giving birth than women in rural areas observed in the period of 2016-2018. The distribution of women living region was relatively similar over time. The majority of women gave birth in general hospital (county or higher level hospital) and this proportion increased over time. The proportion of women giving birth in community and township health centers decreased in both urban and rural areas across different socio-economic regions (Supplementary files: Table 1). In the 2018 survey, fewer women reported choosing to give birth in a private hospital.

CS rate

Nationwide, the overall CS rate increased from 40.9% in 2008 to 47.2% in 2014. After the scale-up of the two-child policy, the CS rate slightly decreased; it was 45.2% in 2018.

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1) CS rate by urban and rural areas and across regions

In urban areas, the CS rate slightly increased from 50.4% in 2008 to 52.3% in 2014, and then slightly decreased to 47.8% in 2018. However, in rural areas the CS rate had significantly increased from 33.1% in 2008 to 43.8% in 2015. In rural areas there was also a slight decrease after the relaxation of the one-child policy. The CS rate in rural areas was 41.2% in 2018 (Figure 1a). A similar trend was found across different socio-economic regions (Figure 1b). We observed a significant increase in CS rate from 28.1% in 2008 to 38.6% in 2018 in the least developed western region. In the stratification of urban and rural areas by regions, in 2008 the CS rates in urban areas in the eastern, central and western regions were 50.9%, 62.3% and 37.4% respectively. The difference of CS rate in urban areas by region became very small in 2018 (48.1% in eastern, 49.2% in central and 46.6% in western region). The CS rates in rural areas across all regions increased between 2008 and 2018. The CS rates in the eastern and central rural areas were higher or close to the rate in urban areas in these two regions (Supplementary file: Figure 1).

2) CS rate by parity

Around half of nulliparous women in urban areas gave birth by CS between 2008 and 2014, and the proportion in rural areas grew significantly from 33.3% in 2008 to 49.6% in 2015. The CS rate among nulliparous women decreased rapidly in both urban (42.8% in 2018) and rural areas (37.5% in 2018) after the universal two-child policy (Figure 2a). The CS rate among multiparous women continued to increase from 35.3% in 2008 to 48.4% in 2018 with similar trends in both urban and rural areas (Figure 2b). We found similar finding in terms of the change of CS rate by parity across different socio-economic regions (Supplementary file: Figure 2).

Maternal request for CS

We examined maternal request for CS by the study periods (Table 2). According to women's self-report, the proportion of maternal request for CS among nulliparous women decreased from 35.8% in 2008-2009 to 24.4% in 2016-2018 (P<0.01). In the stratification of residents location, maternal request for CS significantly decreased in urban areas from 36.8% in 2008-2009 to 22.2% in 2016-2018 (p<0.01), however the change in rural areas was not statistically significant (from 33.5% in 2008-2009 to 29.4% in 2016-2018) (Supplementary files: Table 2). Among multiparous women, around one third of women reported maternal request for CS, and there was no significant change between 2008-2009 and 2016-2018.

In addition, the proportion of CS suggested by a doctor among nulliparous women increased from 63.3% in 2008-2009 to 72.7% in 2016-2018 (P<0.01), and there was no significant

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change of doctors' suggestion for CS among multiparous women by the study period. For both nulliparous and multiparous women, there were few CSs proposed by women's husband and others (Table 2).

Demographic and socio-economic factors associated with the use of CS

1) In the study period of 2008-2018

Table 3 shows factors associated with the use of CS in China by urban and rural areas over the study period of 2008-2018. After adjusting for all explanatory variables, the use of CS was less common in urban areas in the survey of 2018 (OR 0.85, 95%CI 0.78-0.92) compared to the survey of 2013, however, it was more common in rural areas (OR 1.30, 95%CI 1.19-1.41) in the survey of 2018. Advanced maternal age (≥35), having secondary education or higher and giving birth at high level hospital or private hospital were significantly associated with the use of CS in both urban and rural areas. In rural areas, women from the highest income quartile were more likely to have CS (OR 1.69, 95%CI 1.47-1.95) compared to women from the lowest quartile, and multiparous women were less likely to have CS (OR 0.80, 95%CI 0.73-0.88) than nulliparous women. While these differences were not statistically significant in urban areas.

Across different socio-economic regions, the use of CS increased in western region in the survey of 2018 (OR 1.10, 95% CI 1.00-1.22) than the survey of 2013, while this difference was not statistically significant in eastern and central regions (Supplementary files: Table 3). Advanced maternal age ((≥35) and giving birth at high level hospital or private hospital were associated with the use of CS in all regions. In central and western regions, women who lived in rural areas, were from low income quartile household and had more than one child were less likely to have CS.

2) In the study period of 2016-2018

Following the universal two-child policy in China (2016-2018), women in urban areas who were at advanced age ((≥35), multiparous and gave birth at county or high level hospital or private hospital were more likely to have CS (Supplementary files: Table 4). In rural areas, in addition to maternal age and place of delivery, maternal education attainment and household income were also positively associated with the use of CS. Factors associated with the use of CS in eastern and central regions at the same study period were found similar in urban areas and those in western region were found similar in rural areas (Supplementary files: Table 5).

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We examined the factors associated with the use of CS by parity in the era of two-child policy. We found that advanced maternal age (≥35) and births occurred at private hospital were significantly associated with the use of CS among nulliparous women after adjusting for all explanatory variables, while the association between the use of CS and other socio-economic factors was not statistically significant (Table 4). For multiparous women, women who were older, had higher education attainment, had health insurance coverage, were from wealthy household, lived in urban areas or eastern region and gave birth at higher level hospital or private hospital were more likely to have CS after adjusting for all explanatory variables (Table 4).

Discussion

Summary of key findings

In China, the CS rate increased between 2008 and 2015, which was, to a great extent, attributable to a rapid increase of the use of CS in rural areas and the least developed western region. After the scale-up of two-child policy, the CS rate slightly decreased in both urban and rural areas and across socio-economic regions, particularly among nulliparous women. The proportion of maternal request for CS decreased among nulliparous women in urban areas over time, however, this proportion decreased slightly in rural areas that 30% of women underwent CS due to maternal request for CS in 2016-2018. In the era of two-child policy, advanced maternal age and births occurred in a private hospital were associated with the use of CS among nulliparous women. The CS rate among multiparous women continued to increase over time, and demographic and socio-economic factors were positively associated with the use of CS among multiparous women.

Strengths and limitations

This study contributes to what is known about rates of CS in China, where most existing studies are limited to a few hospitals or regions. It is a strength of this paper that with the increase of population size and urbanization in China over the past two decades, the National Household Health Services Survey adapted its sampling method in 2013 and increased the sample size to achieve reliable representativeness of the general population by urban and rural areas and across different socio-economic regions. It provides unique insights into both mode of birth and whom households report proposed actual caesarean births. However, several limitations in terms of data and analysis remain. First, all information was based on women's reports, and the reasons for maternal request or doctor suggestion for CS were not asked. We were not able to distinguish in this study how many CSs performed were medically indicated. Second, women's history of pregnancy (e.g.

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previous CS or others) was not available. We could not make a sub-group analysis on the use of CS among women with or without uterine scar. Third, we could not separate the effects of strategies to reduce unnecessary CS and the shift of the population policy on the use of CS in China. That said, we did observe a slight decrease of CS rate in line with the period of the universal two-child policy and the CS rate in urban areas and regions with a high baseline rate had a moderate change over time (2008-2018). Thus the interpretation of a decrease in CS rate following relaxation of the one-child policy should be made with caution.

Interpretations

We observed a rapid decrease of CS rate among nulliparous women in both urban and rural areas and across all regions in line with the period of universal two-child policy, which is consistent with the findings in other studies.[9,15] However, any causal association remains speculative, not least because of the nuances within the one-child policy itself. In 1979, China announced its family planning policy to strictly control population size. The policy included rules of governing marriage, contraception, number of births and spacing where a second child was permitted.[16] The one child rule was strictest for urban residents and employees of the government agencies. In rural areas, a second child was generally allowed after five years, especially if the first born was a girl. Some ethnic minorities were permitted a third child. With socio-economic development and change of demographic structure, the Chinese government gradually relaxed the one-child policy over a decade with the entire population encouraged to have a second child since 2016.[17]

The CS rate decreased moderately in urban areas and the eastern and central regions, which had a relatively high baseline CS rate. One plausible explanation is that this may be attributable to the introduction of policies and strategies aiming to reverse the high CS rate through a national top-down approach in China. Although, results of introducing comprehensive interventions to mitigate unnecessary CSs are mixed in previous studies.[8,9,18]

We found that the CS rate increased dramatically in rural areas by all socio-economic regions between 2008-2015. This rise may be associated with a significant increase in the number of births occurring at secondary or higher-level (tertiary) hospitals, reflecting an increase in availability and accessibility of these services in these areas. The Chinese government had made strong commitment to reduce maternal and child mortality to achieve Millennium Development Goal (MDG) targets by 2015.[19] The main strategy was to promote hospital delivery, particularly in rural and poor areas with largely financial support from the central government and partly from the provincial government.[19] In the context of deepening China's health system reform, the national plan of further strengthening the hospital delivery

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for rural women in 2009 highlighted to provide the financial compensation for hospital delivery through rural health insurance (NCMS), the earmarked government fund and medical assistance program for the poor women in order to reduce financial burden placed on the households.[20] By 2014, hospital delivery in rural areas was almost universal. Across countries, the shift from community to hospital births is known to result in an increase in CS rates for medically indicated and non-medical reasons.[21] In China, cross-sectional research has shown that while tertiary hospitals have the highest rates of CS for ambiguous indications (i.e. Non-reassuring foetal heart tracing; failure to progress), secondary level hospitals report greater use of CS for maternal request.[22]

Implications for practice

Previous studies report maternal request for CS as a contributor to a rapid increase of CS rate in China,[22-25] despite the validity of the concept being widely debated internationally. For women who reportedly prefer CS, the most common reasons for their preference are fear of labor pain, safer for their baby and for themselves.[11] In this context, family members (e.g. husband or parent) also supported this choice to avoid an adverse event, especially in the context of one child in a family policy. Moreover, in our study around one third of nulliparous women reported self-request for CS in the era of one-child policy. This proportion significantly decreased in urban areas over time, which may be associated with the shift from strict one child in a family in urban areas to universal two children, and promotion of vaginal births in hospital settings. This change did not occur in rural areas, which indicate the needs of strengthening quality of maternity care including services delivery and women's experience in rural areas.

Efforts to promote vaginal birth in China included midwifery care training (e.g. training more professional midwives, establishment of standardized evaluation scheme of midwifery practice etc.), pain relief for vaginal birth and informing women about benefits and risks of different mode of delivery.[26] Other studies, largely in big cities and tertiary hospitals report woman-centered pregnancy and childbirth care which includes provision of antenatal classes to shape women's beliefs and confidence to childbirth, build connection and trust between doctors, midwives and women as well as provide continuous supports during labor and birth.[15, 23, 27] At the same time, pharmacological and non-pharmacological options for labor pain management have become available. However, the midwifery workforce in China is insufficient. Quality of midwifery care can vary by hospitals, and urban-rural disparity in midwife numbers and training is anecdotally reported. Lack of support during labor, lack of pain relief and sub-optimal birth environment were reported as the main reasons that rural women requested for CS.[28] Hence, strengthening midwifery care to improve women's

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experience on childbirth, particularly in rural areas will be critical to optimize the use of CS in China.

Implications for further research

In the era of two-child policy, only advanced maternal age and giving birth in a private hospital were positively associated with the use of CS by nulliparous women. Since 2013 onward, the latest health-care delivery reform in China encouraged competition between public and private hospitals, and set out the target of private hospitals sharing 20% of market by 2015. The burgeoning of private hospital provision in China is driven by market forces, with providers charges unregulated unless contracted by the basic health insurance schemes.[29] Studies in other countries report much higher CSs rate in private hospitals due to profit driven behavior.[30-32] It needs further study to have a better understanding on the use of CS in private hospitals in China in order to propose evidence-based recommendations for relevant policy development. In addition, we found that CS rate among multiparous women continued to increase over time, especially in urban areas, which may be associated with the increase of women who underwent repeat CS. Based on the NMNMSS data, Liang and colleagues reported a high CS rate among multiparous women with a uterine scar and it was unchanged over time.[9] In China, repeat CS is often suggested and accepted for women with a previous CS to mitigate the risk of uterine rupture or other adverse event, despite repeat CS share similar risks. We can only speculate that there may be increasing referrals of women with a previous CS to high level or specialty hospitals. The accessibility, functional referral and affordability of such services as well as health outcomes, particularly for socio-economic vulnerable women should be rigorous assessed in further research.

Conclusion

A rapid increase of CS rate in rural areas and less developed western region contributed to the increase of CS rate in China over the past decade. The population policy shift, alongside facility policies to limit the use of unnecessary CS, are likely factors contributing to the reduction of CS in urban areas. Strategies at system, organization and individual levels to mitigate unnecessary CSs should be continually strengthened, especially in rural areas and western region. Improving midwifery care will be fundamental to ensure safety and positive childbirth experience in the era of two-child in a family in China.

Research Ethics Approval Statement

We obtained the permission to access to de-identified birth dataset. No patient was involved, and thus an approval from an ethics committee was not required.

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Contributors

QL conceived and led the overall analysis and wrote the first manuscript draft. YGZ conducted the data analysis and commented on the manuscript. XJT and JZ contributed to the analysis and commented on the manuscript. CK contributed to the study concept and overall analysis and participated in the manuscript writing.

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Conflicts of Interest

The authors declared no conflicts of interest.

Data availability statement

No data are available

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Table 1 Demographic and socioeconomic characteristics of women giving birth in China, 2008-2018

Characteristics	2008-2009 (n=2638)	2010-2012 (n=7015)	2013-2015 (n=6151)	2016-2018 (n=7249)	Total (n=23053)
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Age					
<25	146 (5.5)	1395 (19.9)	785 (12.8)	961 (13.3)	3287 (14.3)
25-34	1708 (64.7)	4514 (64.3)	3836 (62.4)	4775 (65.9)	14833 (64.3)
≥35	784 (29.7)	1106 (15.8)	1530 (24.9)	1513 (20.9)	4933 (21.4)
Educational level [a]					
Illiterate or primary school	493 (18.7)	1091 (15.6)	869 (14.1)	671 (9.3)	3124 (13.5)
Secondary school	128 (48.7)	337 (48.0)	250 (40.8)	250 (34.5)	9662 (41.9)
High school/ professional school or higher	861 (32.6)	2554 (36.4)	2773 (45.1)	4078 (56.3)	10266 (44.5)
Parity [b]					
1	1424 (54.0)	4068 (58.0)	2965 (48.2)	2937 (40.5)	11394 (49.4)
≥2	1213 (46.0)	2947 (42.0)	3184 (51.8)	4312 (59.5)	11656 (50.6)
Health insurance coverage [*]					
None	115(4.4)	366 (5.2)	334 (5.4)	386 (5.3)	1201 (5.2)
UEBMI	470 (17.8)	1112 (15.9)	1343 (21.8)	1953 (26.9)	4878 (21.2)
URRBMI	2007 (76.1)	5440 (77.5)	4270 (69.4)	4589 (63.3)	16306 (70.7)
Others	46 (1.7)	97 (1.4)	204 (3.3)	321 (4.4)	668 (2.9)
Location					
Urban	1234 (46.8)	3261 (46.5)	3133 (50.9)	4166 (57.5)	11794 (51.2)
Rural	1404 (53.2)	3754 (53.5)	3018 (49.1)	3083 (42.5)	11259 (48.8)
Region					
Eastern	878 (33.3)	2238 (31.9)	2133 (34.7)	2741 (37.8)	7990 (34.7)
Central	875 (33.2)	2309 (32.9)	1822 (29.6)	1957 (27.0)	6963 (30.2)

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Western	885 (33.5)	2468 (35.2)	2196 (35.7)	2551 (35.2)	8100 (35.1)
Place of delivery #					
County or higher level hospital	1416 (53.7)	4163 (59.3)	3755 (61.0)	4746 (65.5)	14080 (61.1)
Maternal and child health hospital	670 (25.4)	1743 (24.8)	1482 (24.1)	1678 (23.1)	5573 (24.2)
Township/community health center	552 (20.9)	1109 (15.8)	633 (10.3)	391 (5.4)	2685 (11.6)
Private hospital	--	--	281 (4.6)	434 (6.0)	715 (3.1)

* UEBMI: Urban Employee Basic Medical Insurance

URRBMI: Urban and Rural Resident Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

The private hospital was not included in the survey in 2013.

[a] Data were missing for one woman in 2013-2015

[b] Data were missing for one woman in 2008-2009, and two in 2013-2015

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Table 2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by parity in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Parity 1					
Women request	35.8	30.2	27.9	24.4	<0.001
Husband	0	0	1.3	1.6	<0.001
Doctor	63.3	68.8	69.5	72.7	<0.001
Others	0.9	1.0	1.3	1.3	0.877
Parity ≥2					
Women request	31.7	30.0	32.6	30.9	0.445
Husband	0	0	1.8	1.2	<0.001
Doctor	66.3	69.1	64.4	67.1	0.094
Others	2.0	0.9	1.2	0.8	0.243

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Table 3 Factors associated with use of caesarean section in China by location, 2008-2018

	All		Urban		Rural	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Year of the survey						
2013	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.16 (1.10-1.22)	1.03 (0.97-1.09)	0.92 (0.86-0.99)	0.85 (0.78-0.92)	1.38 (1.27-1.49)	1.30 (1.19-1.41)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.44 (1.33-1.55)	1.32 (1.21-1.43)	1.29 (1.14-1.46)	1.29 (1.13-1.47)	1.36 (1.23-1.51)	1.35 (1.20-1.52)
⩾35	2.03 (1.85-2.22)	2.02 (1.82-2.25)	1.93 (1.68-2.21)	2.05 (1.75-2.39)	1.78 (1.57-2.02)	2.00 (1.72-2.32)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.32 (1.21-1.43)	1.21 (1.10-1.32)	1.10 (0.94-1.29)	1.16 (0.98-1.36)	1.32 (1.19-1.46)	1.14 (1.02-1.27)
High school or higher	1.76 (1.62-1.92)	1.21 (1.10-1.34)	1.21 (1.05-1.41)	1.22 (1.03-1.44)	1.66 (1.48-1.86)	1.10 (0.96-1.26)
Residence						
Urban			--	--	--	--
Rural	0.61 (0.58-0.65)	0.75 (0.70-0.80)	--	--	--	--
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.18 (1.11-1.26)	1.25 (1.17-1.34)	1.38 (1.26-1.51)	1.35 (1.23-1.48)	1.01 (0.92-1.11)	1.12 (1.01-1.23)
Western	0.62 (0.58-0.66)	0.69 (0.64-0.73)	0.91 (0.83-0.99)	0.92 (0.84-1.01)	0.43 (0.39-0.47)	0.48 (0.43-0.53)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.52 (1.42-1.62)	0.98 (0.91-1.07)	1.11 (1.03-1.20)	1.01 (0.92-1.11)	1.91 (1.63-2.24)	1.13 (0.94-1.35)
None	1.25 (1.11-1.40)	0.96 (0.85-1.09)	0.94 (0.82-1.08)	0.91 (0.79-1.05)	1.42 (1.13-1.79)	1.27 (1.00-1.61)
Others	1.34 (1.15-1.57)	1.05 (0.90-1.24)	1.18 (0.97-1.43)	1.12 (0.92-1.36)	1.12 (0.84-1.47)	1.06 (0.79-1.42)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.39 (1.29-1.50)	1.24 (1.15-1.34)	1.43 (1.30-1.58)	1.10 (0.97-1.24)	1.43 (1.30-1.58)	1.28 (1.15-1.41)
Quartile 3	1.62 (1.50-1.74)	1.30 (1.21-1.41)	1.63 (1.47-1.80)	1.14 (1.02-1.29)	1.63 (1.47-1.80)	1.36 (1.22-1.52)
Quartile 4	1.76 (1.63-1.89)	1.26 (1.16-1.38)	2.04 (1.79-2.32)	1.07 (0.95-1.21)	2.04 (1.79-2.32)	1.69 (1.47-1.95)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	0.87 (0.83-0.92)	0.87 (0.82-0.93)	1.02 (0.95-1.10)	0.94 (0.86-1.02)	0.89 (0.83-0.96)	0.80 (0.73-0.88)
Place of delivery						

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Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.23 (2.03-2.44)	2.03 (1.85-2.24)	1.57 (1.36-1.81)	1.48 (1.27-1.72)	2.49 (2.21-2.81)	2.45 (2.16-2.78)
Maternal and child health hospital	2.02 (1.83-2.23)	1.76 (1.59-1.96)	1.41 (1.21-1.64)	1.34 (1.14-1.57)	2.02 (1.75-2.32)	1.98 (1.71-2.29)
Private hospital	2.55 (2.15-3.02)	2.31 (1.93-2.76)	1.94 (1.53-2.47)	1.91 (1.49-2.46)	2.46 (1.92-3.17)	2.44 (1.87-3.18)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table 4 Factors associated with use of caesarean section after relaxation of the one child policy in China by parity, 2016-2018

	All		Parity 1		Parity ≥2	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.78 (1.53-2.06)	1.62 (1.38-1.90)	1.52 (1.27-1.83)	1.52 (1.25-1.86)	2.37 (1.79-3.14)	2.06 (1.54-2.75)
≥35	2.89 (2.44-3.43)	2.58 (2.12-3.13)	2.41 (1.76-3.31)	2.40 (1.72-3.35)	3.73 (2.78-5.00)	3.19 (2.34-4.33)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.40 (1.18-1.67)	1.42 (1.18-1.71)	0.96 (0.65-1.41)	1.02 (0.69-1.51)	1.58 (1.30-1.93)	1.49 (1.21-1.84)
High school or higher	1.38 (1.17-1.64)	1.24 (1.02-1.51)	0.97 (0.67-1.39)	0.85 (0.58-1.25)	1.74 (1.43-2.12)	1.35 (1.08-1.70)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	0.78 (0.71-0.86)	0.84 (0.75-0.95)	0.81 (0.69-0.95)	0.85 (0.70-1.02)	0.72 (0.63-0.81)	0.84 (0.73-0.97)
Region						
Eastern	1.00	1.00	1.00	1.00	1.00	1.00
Central	1.01 (0.90-1.13)	1.01 (0.90-1.14)	0.99 (0.82-1.19)	1.03 (0.84-1.25)	1.01 (0.87-1.17)	1.00 (0.86,1.17)
Western	0.65 (0.58-0.73)	0.70 (0.62-0.78)	0.83 (0.69-0.98)	0.87 (0.72-1.04)	0.55 (0.48-0.64)	0.61 (0.52-0.71)
Health insurance coverage [a]						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	1.19 (1.07-1.32)	0.95 (0.83-1.09)	1.17 (1.00-1.37)	1.05 (0.86-1.28)	1.34 (1.15-1.55)	0.91 (0.76-1.10)
None	0.92 (0.75-1.14)	0.81 (0.64-1.01)	1.07 (0.77-1.49)	0.99 (0.70-1.38)	0.85 (0.65-1.13)	0.69 (0.51-0.93)
Others	1.14 (0.91-1.44)	0.97 (0.76-1.23)	0.81 (0.54-1.22)	0.76 (0.50-1.14)	1.36 (1.03-1.81)	1.08 (0.80-1.47)
Income quartile						
Quartile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	1.22 (1.07-1.39)	1.12 (0.97-1.28)	1.12 (0.89-1.41)	1.07 (0.84-1.35)	1.28 (1.09-1.51)	1.12 (0.95-1.33)
Quartile 3	1.44 (1.27-1.64)	1.24 (1.07-1.43)	1.10 (0.89-1.37)	0.99 (0.79-1.25)	1.78 (1.51-2.10]	1.40 (1.17-1.68)
Quartile 4	1.28 (1.13-1.46)	1.04 (0.89-1.21)	1.13 (0.92-1.39)	0.94 (0.73-1.19)	1.51 (1.27-1.79)	1.10 (0.90-1.35)
Parity						
1	1.00	1.00	--	--	--	--
≥2	1.29 (1.18-1.42)	1.12 (1.01-1.25)	--	--	--	--
Place of delivery						
Township/community health center	1.00	1.00	1.00	1.00	1.00	1.00
County or higher level hospital	2.03 (1.62-2.54)	2.09 (1.66-2.64)	1.36 (0.85-2.19)	1.27 (0.78-2.06)	2.45 (1.89-3.16)	2.34 (1.80-3.05)
Maternal and child health hospital	1.67 (1.32-2.12)	1.68 (1.32-2.15)	1.15 (0.70-1.88)	1.03 (0.62-1.70)	1.99 (1.51-2.62)	1.88 (1.42-2.51)

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Private hospital	2.16 (1.62-2.88)	2.26 (1.68-3.04)	1.45 (0.83-2.54)	1.52 (1.25-1.86)	2.56 (1.81-3.61)	2.55 (1.79-3.64)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

Caesarean section rate in urban areas slightly decreased between 2008 and 2018, while it had increased in rural areas. Across regions, a large increase occurred in less developed Western region.

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Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

Caesarean section rate among nulliparous women decreased around 2016 in both urban and rural areas, while there was a large increase in the number of multiparous women delivering by caesarean section.

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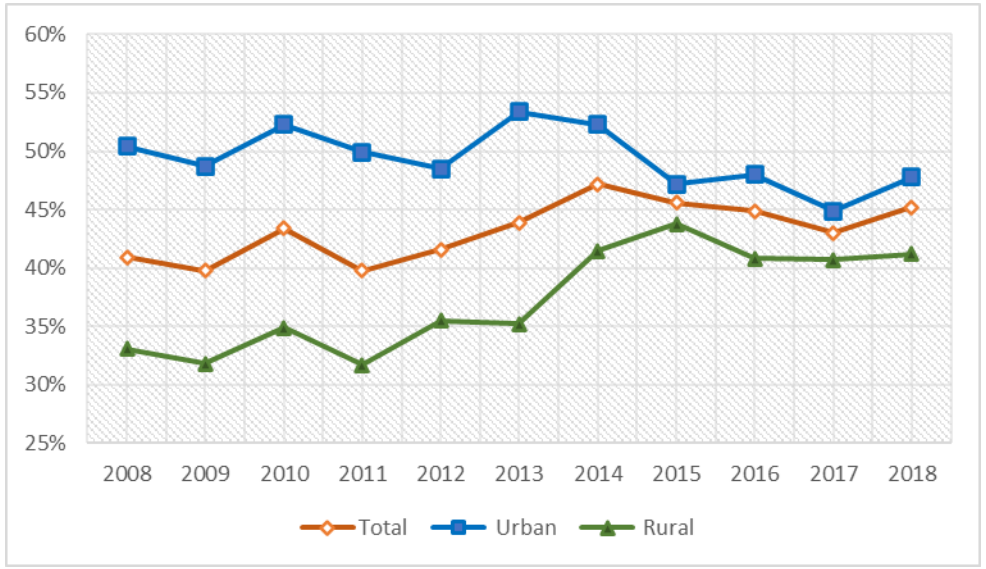
Figure 1 Proportion of women giving birth by caesarean section by urban and rural and across regions, 2008-2018

a. Caesarean section rate by urban and rural



b. Caesarean section rate across regions

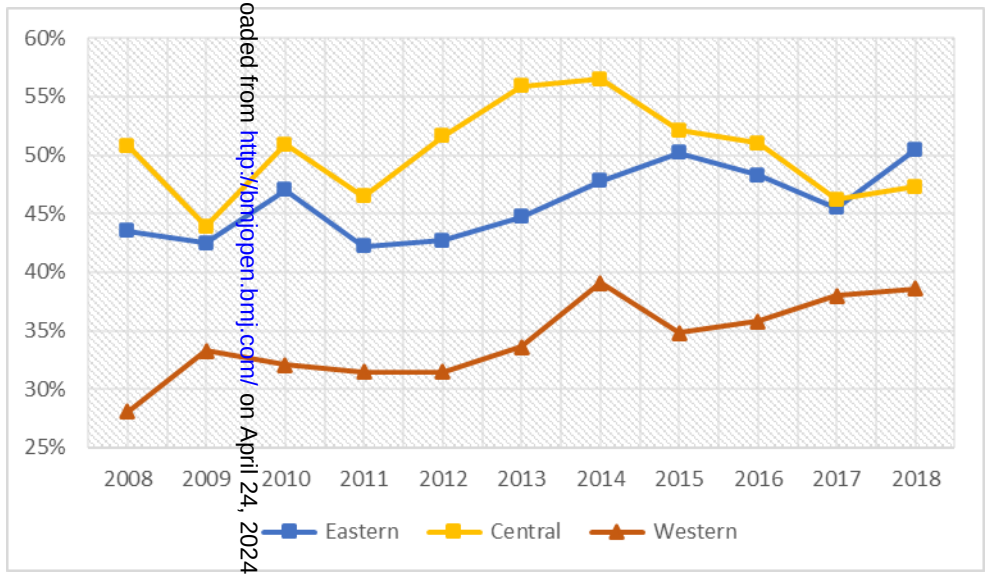


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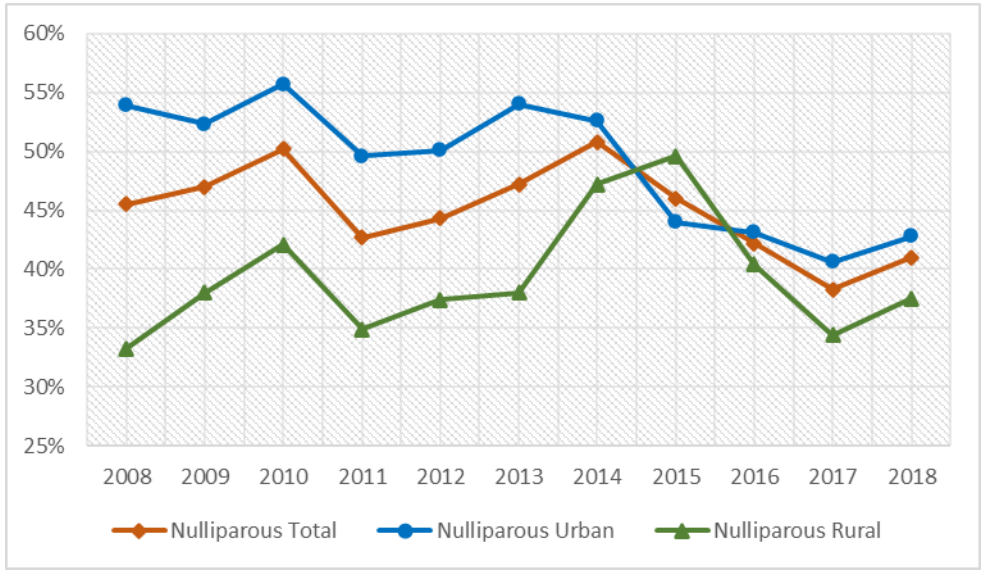
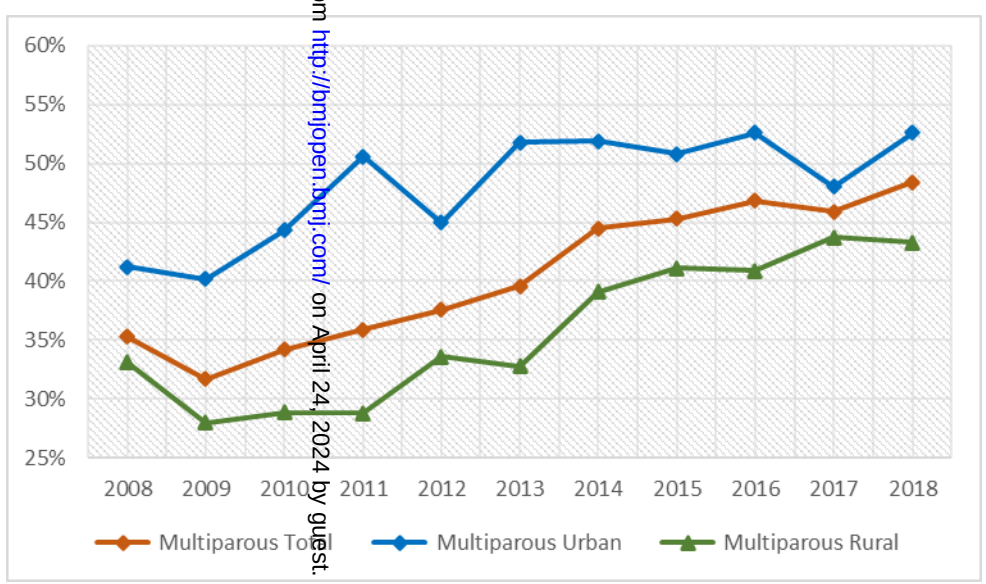
Figure 2 Proportion of women giving birth by caesarean section by parity by urban and rural areas, 2008-2018

a. Caesarean section rate among nulliparous women by urban and rural



b. Caesarean section rate among multiparous women by urban and rural



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Supplementary files:

Table S1 Place of women giving birth by urban and rural and by region, 2008-2018 (%)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of births	786	1852	1981	2219	2815	2462	1921	1768	2430	2819	2000
Rural											
County or higher level hospital	50.7	52.1	57.2	59.3	61.8	60.6	64.1	65.8	69.3	70.6	68.0
Maternal and child health hospital	21.8	19.8	18.1	21.6	18.3	20.0	17.9	16.7	15.5	17.2	20.6
Township/community health center	27.5	28.2	24.6	19.1	19.9	18.0	11.9	10.3	8.8	5.9	6.7
Private hospital	0	0	0	0	0	1.4	6.1	7.1	6.4	6.3	4.7
Urban											
County or higher level hospital	52.0	57.6	56.1	58.7	61.0	61.0	57.7	58.2	60.4	63.4	63.8
Maternal and child health hospital	34.7	29.7	31.8	31.4	30.6	29.6	29.5	29.3	28.0	26.7	27.3
Township/community health center	13.3	12.7	12.1	9.8	8.4	7.4	6.5	5.9	5.2	4.1	3.0
Private hospital	0	0	0	0	0	2.0	6.2	6.6	6.4	5.8	5.9
East											
County or higher level hospital	50.9	55.5	58.2	61.4	64.7	58.9	65.3	64.9	66.2	67.4	67.3
Maternal and child health hospital	27.3	23.2	22.2	24.5	20.4	24.9	23.0	21.3	21.7	22.0	22.5
Township/community health center	21.8	21.3	19.6	14.1	14.9	15.6	8.5	9.7	7.6	7.1	6.1
Private hospital	0	0	0	0	0	0.6	3.2	4.1	4.5	3.6	4.1
Central											
County or higher level hospital	50.8	52.4	55.0	55.6	58.3	63.3	57.8	58.8	60.3	66.4	64.7

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Maternal and child health hospital	29.1	25.4	26.0	28.3	26.3	22.5	26.5	25.5	24.4	22.0	22.9
Township/community health center	20.2	22.2	19.1	16.1	15.4	11.5	7.7	5.2	5.9	2.5	3.8
Private hospital	0	0	0	0	0	2.6	8.1	10.5	9.4	9.0	8.6
West											
County or higher level hospital	52.1	56.2	56.9	60.1	61.5	60.3	58.2	61.0	64.8	65.8	64.4
Maternal and child health hospital	26.5	24.7	26.2	25.1	25.1	26.1	23.3	23.9	22.6	23.4	27.8
Township/community health center	21.4	19.1	16.9	14.8	13.4	11.8	10.7	8.6	6.3	4.4	3.5
Private hospital	0	0	0	0	0	1.8	7.8	6.6	6.3	6.4	4.3

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Table S2 Proportion of women who had caesarean section (CS) reporting recommendation by others and own request for CS by location and regions in China, 2008-2018 (%)

Characteristics	2008-2009	2010-2012	2013-2015	2016-2018	P value
	n=1059	n=2912	n=2794	n=3208	
Urban					
Parity 1					
Women request	36.8	29.0	27.9	22.2	<0.001
Husband	0	0	1.6	14.7	<0.001
Doctor	62.3	70.1	69.9	75.5	<0.001
Others	0.9	0.86	0.6	0.86	0.899
Parity ≥2					
Women request	31.7	28.6	30.1	30.5	0.858
Husband	0	0	1.4	1.3	0.032
Doctor	65.5	70.7	67.0	67.4	0.564
Others	2.8	0.6	1.5	0.8	0.182
Rural					
Parity 1					
Women request	33.5	32.3	28.0	29.4	0.256
Husband	0	0	0.8	1.9	0.002
Doctor	65.5	66.6	68.7	66.6	0.725
Others	1.0	1.2	2.5	2.2	0.429
Parity ≥2					
Women request	31.8	31.1	35.0	31.4	0.279
Husband	0	0	2.1	1.0	0.001
Doctor	66.7	67.7	61.9	66.7	0.079
Others	1.6	1.2	1.0	0.9	0.743
Eastern					

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Parity 1					
Women request	34.8	31.7	27.7	23.6	0.002
Husband	0	0	1.5	1.3	0.006
Doctor	63.9	67.2	69.5	72.8	0.045
Others	1.2	1.1	1.3	2.32	0.494
Parity ≥2					
Women request	37.2	30.5	36.3	33.0	0.316
Husband	0	0	1.1	1.1	0.156
Doctor	60.6	68.9	61.6	65.4	0.142
Others	2.3	0.6	1.1	0.5	0.158
Central					
Parity 1					
Women request	37.6	30.3	30.7	27.0	0.020
Husband	0	0	1.0	1.6	0.005
Doctor	62.0	68.4	67.1	70.9	0.072
Others	0.4	1.3	1.2	0.6	0.502
Parity ≥2					
Women request	30.9	33.2	31.4	33.4	0.912
Husband	0	0	2.1	1.8	0.008
Doctor	67.9	65.7	65.0	64.2	0.776
Others	1.2	1.1	1.6	0.6	0.487
Western					
Parity 1					
Women request	34.8	28.2	24.3	23.3	0.029
Husband	0	0	1.6	2.0	0.005
Doctor	64.1	71.4	72.7	74.2	0.103
Others	1.1	0.4	1.3	0.5	0.383
Parity ≥2					

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Women request	26.0	24.7	29.9	24.9	0.302
Husband	0	0	2.2	0.7	0.012
Doctor	71.0	74.3	66.9	72.8	0.163
Others	3.0	1.0	1.0	1.6	0.515

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Table S3 Factors associated with use of caesarean section (CS) in China by region, 2008-2018

	Eastern		Central		Western	
	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)	CS rate (%)	Adjusted* OR (95%CI)
Year of the survey						
2013	43.5	1.00	49.7	1.00	31.7	1.00
2018	48.1	1.07 (0.97-1.18)	50.7	0.93 (0.84-1.04)	37.4	1.10 (1.00-1.22)
Age						
<25	36.5	1.00	43.2	1.00	26.4	1.00
25-34	44.5	1.36 (1.16-1.59)	49.7	1.27 (1.09-1.47)	34.4	1.30 (1.13-1.50)
⩾35	55.4	2.15 (1.78-2.59)	55.9	1.74 (1.45-2.09)	42.4	2.02 (1.69-2.41)
Educational level						
Illiterate or primary school	46.2	1.00	48.5	1.00	23.6	1.00
Secondary school	44.8	0.99 (0.83-1.19)	46.9	0.92 (0.78-1.09)	31.9	1.43 (1.24-1.64)
High school or higher	46.8	0.94 (0.78-1.14)	54.0	0.95 (0.79-1.14)	44.0	1.50 (1.27-1.76)
Residence						
Urban	47.4	1.00	55.5	1.00	45.0	1.00
Rural	44.2	0.95 (0.85-1.06)	44.5	0.78 (0.70-0.87)	25.4	0.56 (0.51-0.63)
Region						
Eastern	46.0	--	--	--	--	--
Central	--	--	50.2	--	--	--
Western	--	--	--	--	34.6	--
Health insurance coverage [a]						
URRBMI	44.6	1.00	47.8	1.00	31.8	1.00
UEBMI	48.5	1.01 (0.89-1.15)	57.5	1.07 (0.92-1.25)	49.2	0.96 (0.82-1.13)
None	43.6	0.88 (0.73-1.06)	56.7	1.24 (0.99-1.55)	37.2	0.91 (0.70-1.18)
Others	52.2	1.20 (0.93-1.55)	56.3	1.18 (0.87-1.60)	35.2	0.88 (0.65-1.19)
Income quartile						
Quartile 1	43.6	1.00	45.3	1.00	24.9	1.00
Quartile 2	44.9	1.04 (0.90-1.21)	49.6	1.16 (1.01-1.32)	35.5	1.38 (1.21-1.57)
Quartile 3	47.2	1.12 (0.97-1.28)	52.5	1.21 (1.07-1.38)	40.0	1.44 (1.25-1.65)
Quartile 4	47.0	1.06 (0.91-1.23)	54.9	1.19 (1.02-1.39)	47.3	1.60 (1.37-1.87)
Parity						
1	45.4	1.00	51.9	1.00	38.0	1.00
≥2	46.7	0.91 (0.81-1.01)	48.5	0.87 (0.78-0.97)	31.6	0.84 (0.75-0.94)
Place of delivery						
Township/community health center	32.0	1.00	34.4	1.00	16.4	1.00
County or higher level hospital	49.1	1.98 (1.71-2.30)	52.6	1.90 (1.61-2.24)	37.2	2.37 (1.95-2.87)

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Maternal and child health hospital	44.2	1.62 (1.37-1.91)	51.9	1.77 (1.48-2.12)	34.5	2.02 (1.64-2.48)
Private hospital	55.8	2.57 (1.82-3.62)	52.7	1.97 (1.48-2.62)	40.9	2.82 (2.04-3.90)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S4 Factors associated with use of caesarean section (CS) after relaxation of the one child policy by urban and rural, 2016-2018

	Urban		Rural	
	Unadjusted	Adjusted*	Unadjusted	Adjusted*
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age				
<25	1.00	1.00	1.00	1.00
25-34	1.57 (1.25-1.98)	1.51 (1.19-1.92)	1.87 (1.53-2.28)	1.74 (1.40-2.17)
≥35	2.73 (2.12-3.51)	2.50 (1.90-3.29)	2.60 (2.02-3.35)	2.46 (1.84-3.28)
Educational level				
Illiterate or primary school	1.00	1.00	1.00	1.00
Secondary school	1.25 (0.90-1.74)	1.39 (0.99-1.94)	1.40 (1.13-1.73)	1.34 (1.07-1.67)
High school or higher	1.12 (0.82-1.53)	1.25 (0.90-1.75)	1.29 (1.04-1.61)	1.09 (0.85-1.40)
Residence				
Urban	--	--	--	--
Rural	--	--	--	--
Region				
Eastern	1.00	1.00	1.00	1.00
Central	1.13 (0.97-1.32)	1.08 (0.92-1.26)	0.86 (0.71-1.03)	0.89 (0.74-1.08)
Western	0.89 (0.77-1.03)	0.89 (0.77-1.04)	0.43 (0.36-0.52)	0.49 (0.41-0.59)
Health insurance coverage [a]				
URRBMI	1.00	1.00	1.00	1.00
UEBMI	1.03 (0.90-1.18)	0.98 (0.84-1.15)	1.29 (1.00-1.66)	0.96 (0.72-1.28)
None	0.76 (0.59-0.97)	0.78 (0.60-1.01)	1.25 (0.79-1.99)	1.14 (0.71-1.84)
Others	1.20 (0.91-1.59)	1.08 (0.81-1.45)	0.80 (0.53-1.23)	0.85 (0.54-1.31)
Income quartile				
Quartile 1	1.00	1.00	1.00	1.00
Quartile 2	1.06 (0.86-1.31)	1.03 (0.83-1.27)	1.24 (1.04-1.48)	1.11 (0.92-1.33)
Quartile 3	1.15 (0.95-1.40)	1.10 (0.89-1.35)	1.56 (1.29-1.89)	1.33 (1.08-1.64)
Quartile 4	1.00 (0.83-1.21)	0.95 (0.77-1.17)	1.41 (1.09-1.83)	1.20 (0.91-1.59)
Parity				
1	1.00	1.00	1.00	1.00
≥2	1.41 (1.25-1.60)	1.17 (1.02-1.34)	1.25 (1.07-1.46)	1.03 (0.86-1.23)
Place of delivery				

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Township/community health center	1.00	1.00	1.00	1.00
County or higher level hospital	1.54 (1.12-2.12)	1.62 (1.17-2.25)	2.53 (1.83-3.51)	2.60 (1.86-3.63)
Maternal and child health hospital	1.30 (0.93-1.80)	1.37 (0.98-1.93)	1.85 (1.29-2.65)	1.84 (1.27-2.67)
Private hospital	1.72 (1.16-2.56)	1.84 (1.22-2.76)	2.48 (1.61-3.81)	2.62 (1.68-4.07)

* Adjusting for all explanatory variables

[a] URRBMI: Urban and Rural Residents Basic Medical Insurance

UEBMI: Urban Employee Basic Medical Insurance

Others include free medical service scheme for special sectors or labor insurance

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Table S5 Factors associated with use of C-section after relaxation of the one child policy across regions, 2016-2018

	Eastern		Central		Western	
	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Age						
<25	1.00	1.00	1.00	1.00	1.00	1.00
25-34	1.62 (1.22-2.16)	1.58 (1.17-2.14)	1.96 (1.47-2.60)	1.77 (1.31-2.39)	1.60 (1.27-2.00)	1.48 (1.16-1.88)
≥35	2.88 (2.11-3.95)	2.76 (1.94-3.91)	3.03 (2.18-4.21)	2.49 (1.72-3.61)	2.37 (1.80-3.11)	2.20 (1.60-3.01)
Educational level						
Illiterate or primary school	1.00	1.00	1.00	1.00	1.00	1.00
Secondary school	1.05 (0.74-1.49)	1.20 (0.84-1.72)	0.92 (0.65-1.31)	1.04 (0.72-1.51)	1.67 (1.28-2.19)	1.62 (1.22-2.14)
High school or higher	0.79 (0.57-1.10)	0.98 (0.68-1.41)	0.91 (0.65-1.28)	0.90 (0.61-1.32)	2.04 (1.57-2.64)	1.51 (1.12-2.05)
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.11 (0.95-1.30)	0.98 (0.81-1.17)	0.84 (0.70-1.01)	0.91 (0.73-1.13)	0.54 (0.46-0.64)	0.69 (0.57-0.84)
Region						
Eastern	--	--	--	--	--	--
Central	--	--	--	--	--	--
Western	--	--	--	--	--	--
Health insurance coverage						
URRBMI	1.00	1.00	1.00	1.00	1.00	1.00
UEBMI	0.85 (0.72-1.00)	0.92 (0.75-1.14)	1.26 (1.01-1.56)	1.12 (0.86-1.44)	1.50 (1.22-1.83)	0.95 (0.74-1.22)
None	0.62 (0.47-0.82)	0.65 (0.48-0.88)	1.23 (0.75-2.01)	1.36 (0.82-2.27)	1.24 (0.76-2.02)	1.05 (0.64-1.73)
Others	1.10 (0.77-1.58)	1.15 (0.79-1.69)	1.23 (0.81-1.85)	1.03 (0.67-1.57)	0.84 (0.53-1.32)	0.77 (0.48-1.24)
Income quintiles						
Quintile 1	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 2	0.90 (0.70-1.14)	0.97 (0.79-1.21)	0.93 (0.73-1.19)	0.94 (0.73-1.21)	1.62 (1.31-2.01)	1.37 (1.09-1.71)
Quintile 3	0.93 (0.74-1.17)	0.85 (0.68-1.06)	1.16 (0.91-1.48)	1.12 (0.87-1.45)	2.00 (1.60-2.50)	1.54 (1.21-1.98)
Quintile 4	0.77 (0.62-0.96)	1.16 (0.97-1.38)	1.09 (0.84-1.41)	1.01 (0.75-1.36)	1.93 (1.53-2.42)	1.33 (1.01-1.75)
Parity						
1	1.00	1.00	1.00	1.00	1.00	1.00
≥2	1.47	2.26	1.50	1.28	0.98	0.99

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	(1.26-1.72)	(1.63-3.14)	(1.25-1.81)	(1.04-1.57)	(0.84-1.16)	(0.82-1.20)
Place of delivery						
Township/community health center (ref.)						
County or higher level hospital	2.08 (1.52-2.85)	1.66 (1.16-2.36)	1.71 (1.06-2.74)	1.79 (1.11-2.90)	2.51 (1.58-3.97)	2.06 (1.28-3.29)
Maternal and child health hospital	1.55 (1.10-2.18)	2.64 (1.61-4.31)	1.55 (0.95-2.54)	1.61 (0.96-2.67)	2.19 (1.36-3.53)	1.70 (1.04-2.78)
Private hospital	2.49 (1.54-4.03)	2.55 (1.79-3.64)	1.26 (0.73-2.18)	1.36 (0.78-2.37)	3.78 (2.17-6.58)	3.25 (1.84-5.74)

* Adjusting for all explanatory variables

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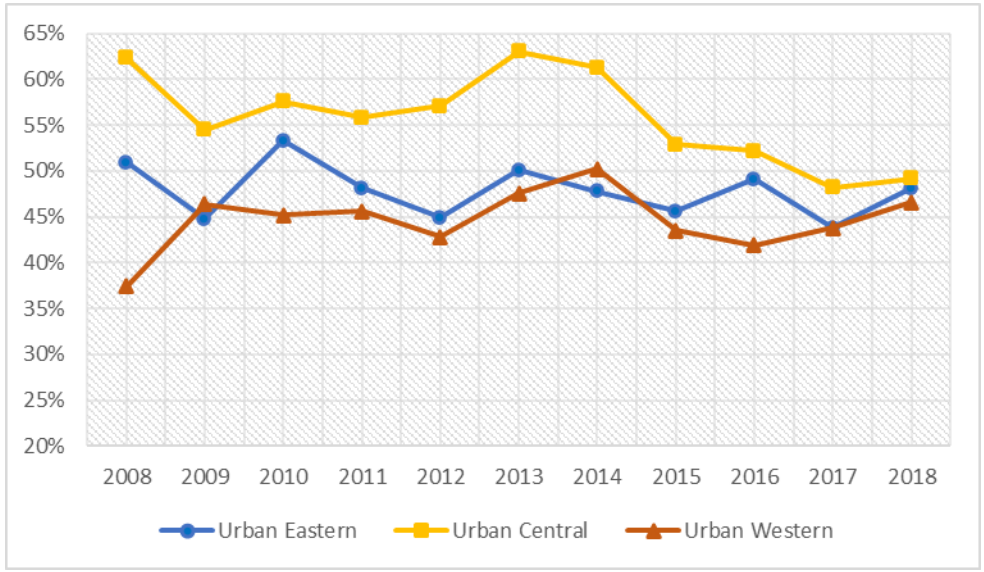
Figure S1 Proportion of women giving birth by caesarean section across regions by urban and rural, 2008-2018

a. Caesarean section rate in urban areas across regions



b. Caesarean section rate in rural areas across regions

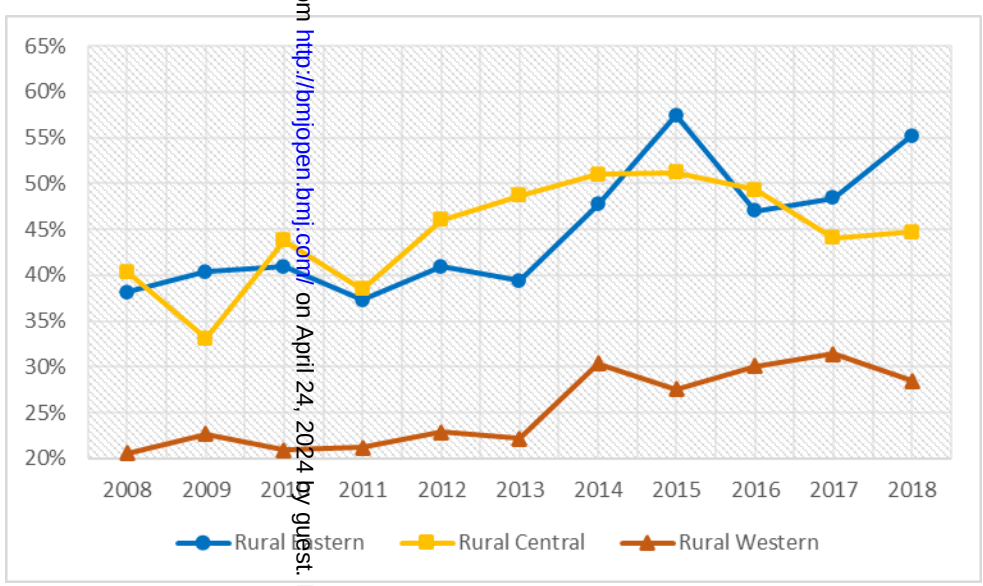


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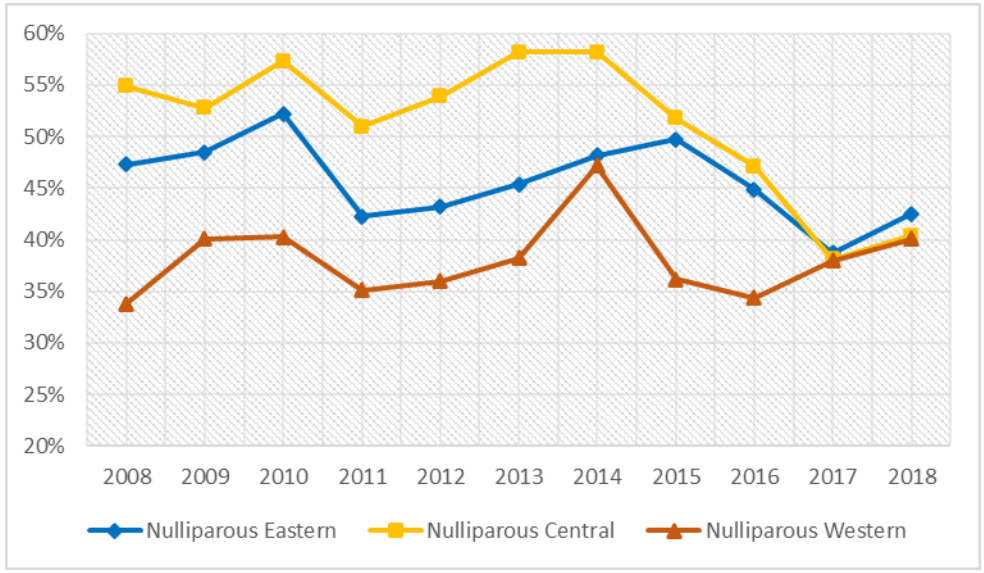
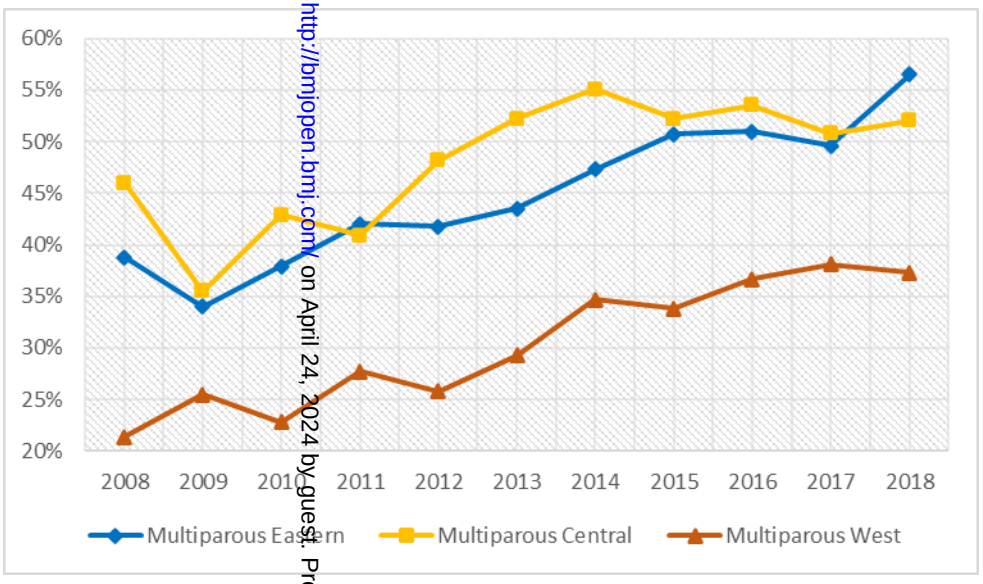
Figure S2 Proportion of women giving birth by caesarean section by parity across regions, 2008-2018

a. Caesarean section rate among nulliparous women across regions



b. Caesarean section rate among multiparous women across regions



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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	17 (Table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	7-8

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Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

The authors confirmed that the manuscript writing followed the STORBE checklist for cross-sectional studies.

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