# What is an appropriate caesarean delivery rate for China: a multicentre survey

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**Objective** To assess the current status of caesarean delivery (CD) in China, propose reference CD rates for China overall, and by regions, investigate the main indications for CDs and identify possible areas for safe reduction.

**Design** A multicentre cross-sectional study.

**Setting** A total of 94 hospitals across 23 provinces in China.

**Population** A total of 73 977 randomly selected deliveries.

**Methods** We used a modified Robson classification to characterise CDs in subgroups and by regions, and the World Health Organization (WHO) C-Model to calculate reference CD rates.

**Main outcome measures** CD rates in China.

**Results** In 2015–2016, the overall CD rate in China was 38.9% (95% CI 38.6–39.3%). Considering the obstetric characteristics of the population, the multivariable model-based reference CD rate was estimated at 28.5% (95% CI 28.3–28.8%). Accordingly, an absolute reduction of 10.4 (or 26.7% relative reduction) may be considered. The CD rate varied substantially by region. Previous CD was the most common indication in all regions, accounting for 38.2% of all CDs, followed by maternal request (9.8%), labour dystocia (8.3%), fetal distress (7.7%) and malpresentation (7.6%). Overall, 12.7% of women had prelabour CDs, contributing to 32.8% of the total CDs.

**Conclusions** Nearly 39% of births were delivered by caesarean in China but a reduction of this rate by a quarter may be considered

attainable. Repeat CD contributed more than one-third of the total CDs. Given the large variation in maternal characteristics, region-specific or even hospital-specific reference CD rates are needed for precision management of CD.

**Keywords** Caesarean section, China, reference rate.

**Tweetable abstract** The caesarean rate in 2015–2016 in China was 38.9%, whereas the reference rate was 28.5%.

**Linked article** This article is commented on by M Varner, p. 148 in this issue. To view this mini commentary visit https://doi.org/10.1111/1471-0528.16953.

# Introduction

The caesarean delivery (CD) rate has risen dramatically worldwide over the past three decades.[1] In the World Health Organization (WHO) Global Survey on Maternal and Perinatal Health in 2007–2008, the CD rate in China was reported at 46.2%, which placed China among the countries with the highest CD rates in the world.[2] Much attention was drawn to China's CD rate from the government, society and media afterwards. More astonishing figures were revealed thereafter. For example, the CD rate in Shanghai, with about 20 million people, reached 68% in 2008.[3] CD on maternal request without medical indication (CDMR) accounted for half of all CDs at that time.[4] But such figures may not necessarily be representative of the whole country.[3] The vast countryside still had a low CD rate, but has caught up fast. The National Maternal and Child Health Statistics showed that the China national CD rate was 34.9% in 2014.[3] The CD rates in super cities, and in urban and rural areas were approximately 48, 42 and 31%, respectively. But detailed analyses on the epidemiology of the CD rate in China are still lacking, and what should constitute an appropriate CD rate has not been adequately addressed.

Furthermore, the economic development in China is uneven across regions, reflected in the still large disparity in maternal and child health measurements.[5] In addition, after the implementation of the universal two-child policy in 2015, the characteristics of pregnant women have changed,[6] and may change even further after implementation of the three-child policy.[7] Therefore, the aims of the current study are: (i) to assess the current status of CD in China; (ii) to propose reference CD rates for China overall, and by region, by applying the WHO multivariable C-Model; (iii) to investigate the main indications for CD; and (iv) to examine the clinical indications of the major CD contributors to identify possible areas for safe reduction.

# Methods

## Study design and sample

The China Labour and Delivery Survey (CLDS) was a multicentre, hospital-based cross-sectional study conducted between 1 March 2015 and 31 December 2016. Hospitals across China were invited to participate in this study and only those with at least 1000 deliveries per year were eligible. The data coordinating centre randomly selected 6 weeks within a calendar year for hospitals with at least 6000 births per year or 10 weeks for hospitals with fewer than 6000 births per year for data collection. Medical records for all births within the selected weeks were extracted by trained staff. Births at <24 weeks of gestation or with birthweights of <500 g were further excluded from the data collection to make our results comparable with other studies.

It should be noted that by regulation, few deliveries are performed in primary hospitals in China and most secondary and tertiary hospitals are in urban or suburban areas. To better represent the contemporary status and characteristics of CD in China, we assigned a weight for each delivery in the current study. The annual number of deliveries for each province was collected from the National Health and Family Planning Statistical Yearbook 2016 and 2017, and was then stratified by hospital level. The inverse probability weighting method was used to calculate the weighting, taking into account the annual number of deliveries for each province in the corresponding hospital level, the number of abstracted medical records for each hospital in the corresponding province, and the number of hospitals in the corresponding hospital level and province.

This project was approved by the Ethics Review Board of the Xinhua Hospital Affiliated to the Shanghai Jiao Tong University School of Medicine (XHEC-C-2015-006), the research project review panel (RP2) of the UNDP/UNFPA/

UNICEF/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction, at the Department of Sexual and Reproductive Health and Research, and the WHO Research Ethics Review Committee (ERC) of the World Health Organization (WHO Study A65899) and participating hospitals. Individual informed consent was not required because medical chart abstraction for deidentified information for research carried a minimal risk for patients.

## The modified Robson ten-group classification system

In 2001, Robson et al. first proposed a classification scheme that divided all pregnant women into ten groups based on five obstetric characteristics of each woman and her pregnancy.[8] These obstetric characteristics included parity, onset of labour, gestational age, fetal presentation/lie and number of fetuses. This classification system has been widely accepted in obstetrics and was recommended by the WHO for assessing, monitoring and comparing CS rates between facilities and over time.[9] To disentangle the contribution of induced labour and prelabour CD to the CD rate, we modified the Robson ten-group classification by separating induced labour and planned CD into two groups for both nulliparous and multiparous women. Furthermore, as the number of abnormal fetal presentations is small but the CD rate for these women is usually very high, we combined women with transverse or oblique fetal lie or breech presentations into one group. Thus, the number of

groups in the modified Robson classification system remains at ten, plus an unclassified group.[10] To make the 11 groups more easily recognisable, we labelled each group with a two-letter abbreviation (Table 1).

## C-Model

The C-Model is a mathematical model proposed by the WHO in 2015 to predict 'a reference CD rate' in health facilities based on the reference population, with relatively low CD rates and good perinatal outcomes among 22 countries.[11] It takes multiple obstetric factors of the population into account. A total of four versions of the C-Model were built based on the availability of predictor variables. Our study used the most complete model to estimate the probability of CD, which includes the following variables: parity, previous CD, presentation, onset of labour, preterm birth, multiple pregnancy, maternal age, organ dysfunction or admission to intensive care unit (ICU), placenta praevia, placental abruption, chronic hypertension, pre-eclampsia, renal disease and HIV infection. The calculation formula is as follows:

$\text{Logit} = -4.015252 - 0.77531*\text{parity} + 2.922222*\text{previous CD} + 1.834027*\text{multiple pregnancy} + 2.634921*\text{provider-initiated childbirth} + 2.985162*\text{fetal presentation} + 0.71104*\text{maternal age} + 0.661417*\text{organ dysfunction or ICU admission} + 3.796513*\text{placenta praevia} + 2.741255*\text{abruptio placentae} + 0.561991*\text{chronic hypertension} + 0.98718*\text{pre-eclampsia} + 1.301346*\text{renal disease} + 1.310211*\text{HIV}.$ $\text{Prob}(\text{CS}) = e^{\text{Logit}}/(1 + e^{\text{Logit}}).$

**Table 1.** Comparison between the Robson ten-group classification and the modified classification

| Robson classification | | Modified classification | |
|---|---|---|---|
| **No.** | **Characteristics of the group** | **Label** | **Characteristics of the group** |
| 1 | Nulliparous, singleton, cephalic, term, spontaneous labour | NS (1) | The same |
| 2 | Nulliparous, singleton, cephalic, term, who had labour induced or prelabour CD | NI (2A) | Nulliparous, singleton, cephalic, term, induced labour |
| | | NC (2B) | Nulliparous, singleton, cephalic, term, prelabour CD |
| 3 | Multiparous without a previous CD, singleton, cephalic, term, spontaneous labour | MS (3) | The same |
| 4 | Multiparous without a previous CD, singleton, cephalic, term, who had labour induced or prelabour CD | MI (4A) | Multiparous without a previous CD, singleton, cephalic, term, induced labour |
| | | MC (4B) | Multiparous without a previous CD, singleton, cephalic, term, prelabour CD |
| 5 | Multiparous with previous CD, singleton, cephalic, term | PC (5) | The same |
| 6 | Nulliparous, singleton, breech | BR | All women, singleton, non-cephalic, including women with a previous CD |
| 7 | Multiparous, singleton, breech, including women with a previous CD | (6 + 7+9) | |
| 9 | All women, singleton, transverse or oblique lie, including women with a previous CD | | |
| 8 | Multiple pregnancies, including women with a previous CD | TW (8) | The same |
| 10 | Singleton, cephalic, preterm, including women with a previous CD | PT (10) | The same |
| | | UK | All women unclassified as a result of missing data |

This model is flexible and dynamic to fit the local obstetric population. If, for example, previous CD is common in a population, the reference CD rate is expected to be higher.

## Statistical analysis

Continuous variables were presented as means and standard deviations (SDs), whereas categorical variables were given as numbers and percentages. Within each subgroup of the ten-group classification, four indicators were calculated, including the proportion of deliveries (deliveries within each subgroup divided by total deliveries), the group-specific CD rate (the number of CDs within each subgroup divided by the total number of deliveries of that group), the absolute CD rate (the number of CDs within each subgroup divided by the total number of deliveries), as well as the relative CD rate (the number of CDs within each subgroup divided by the total number of CDs). For each indication, we calculated its proportion in all CDs by modified Robson groups and regions. The total population was divided into seven administrative regions (central, east, north, north-east, north-west, south and south-west). All analyses were conducted with sampling weight in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

## Results

A total of 73 977 deliveries in 94 hospitals across 23 provinces and autonomous regions in China were included in the current analysis; 69% were tertiary hospitals whereas 31% were secondary hospitals. The mean maternal age was $28.2 \pm 4.8$ years, 10.9% of the women were aged 35 years or older and 20.3% of the women had college or higher education. The mean body mass index (BMI) at delivery was $27.1 \pm 3.5$ kg/m$^2$. The overall CD rate was 38.9%; 1.3% were stillbirths. The mean birthweight was $3270 \pm 540$ g. The incidence of very low birthweight, low birthweight and macrosomia was 1.1, 4.6 and 6.8%, respectively. Table S1 also shows large variations in maternal education, BMI, CD rate and birthweight among geographic regions in China.

Table 2 presents the distribution of obstetric population by the ten modified Robson groups and the CD rate in each group. The overall CD rate was 38.9% (95% CI 38.6–39.3%). Nulliparas and multiparas with spontaneous onset of labour (NS and MS) were the largest two groups (27.6 and 21.5%, respectively), followed by women with uterine scar (PC, 14.1%). We found that 12.7% women had prelabour CDs (NC and MC combined), which contributed to 32.8% of the total CDs. Table 2 also shows that 3.3% had non-vertex presentation, 1.8% were multiple gestation and the incidence of preterm birth was 6.7%. We found that 1.4% of women could not be classified to any of the above groups as a result of missing information. Nearly 80–90% of women with previous CD (PC), non-vertex presentation (BR) or multiple gestation (TW) were delivered by CD. PC contributed one-third of all CDs followed by term nulliparous women with prelabour CD (NC, 23.0%). The

**Table 2.** Characteristics of caesarean delivery by modified Robson ten-group classification in China

| Modified classification[a] | No. of total births | Percentage of total births (%)[b] | No. of CDs | CD rate within the group (%)[c] | Absolute CD rate (%)[d] | Proportion of total CDs (%)[e] |
|---|---|---|---|---|---|---|
| Total | 8 708 331 | – | 3 358 202 | – | 38.9 | 100 |
| NS (1) | 2 402 836 | 27.6 | 252 595 | 10.5 | 2.9 | 7.5 |
| NI (2A) | 669 636 | 7.7 | 154 286 | 23.0 | 1.8 | 4.6 |
| NC (2B) | 772 654 | 8.9 | 772 654 | 100 | 8.9 | 23.0 |
| MS (3) | 1 870 726 | 21.5 | 70 476 | 3.8 | 0.8 | 2.1 |
| MI (4A) | 277 502 | 3.2 | 14 998 | 5.4 | 0.2 | 0.4 |
| MC (4B) | 329 043 | 3.8 | 329 043 | 100 | 3.8 | 9.8 |
| PC (5) | 1 232 000 | 14.1 | 1 111 535 | 90.2 | 12.8 | 33.1 |
| BR (6,7,9) | 284 343 | 3.3 | 257 041 | 90.4 | 3.0 | 7.7 |
| TW (8) | 157 468 | 1.8 | 132 316 | 84.0 | 1.5 | 3.9 |
| PT (10) | 586 043 | 6.7 | 234 528 | 40.0 | 2.7 | 7.0 |
| UK | 126 080 | 1.4 | 28 730 | 22.8 | 0.3 | 0.9 |

[a]Please refer to the labels listed in Table 1: 1 = NS (nulliparous, spontaneous); 2A = NI (nulliparous, induced); 2B = NC (nulliparous, caesarean); 3 = MS (multiparous, spontaneous); 4A = MI (multiparous, induced); 4B = MC (multiparous, caesarean); 5 = PC (previous caesarean); 6,7,9 combined = BR (breech and other non-cephalic presentations); 8 = TW (twin and other multiple pregnancies); 10 = PT (preterm).
[b]Percentage of total births = (number of women in the group/total number of women in this area) × 100.
[c]CD rate within the group = (number of caesareans in the group/total number of women who gave birth in the setting) × 100.
[d]Absolute CD rate = (number of caesareans in the group/total number of women in this area) × 100.
[e]Proportion of total CDs = (number of caesareans in the group/total number of caesareans) × 100.
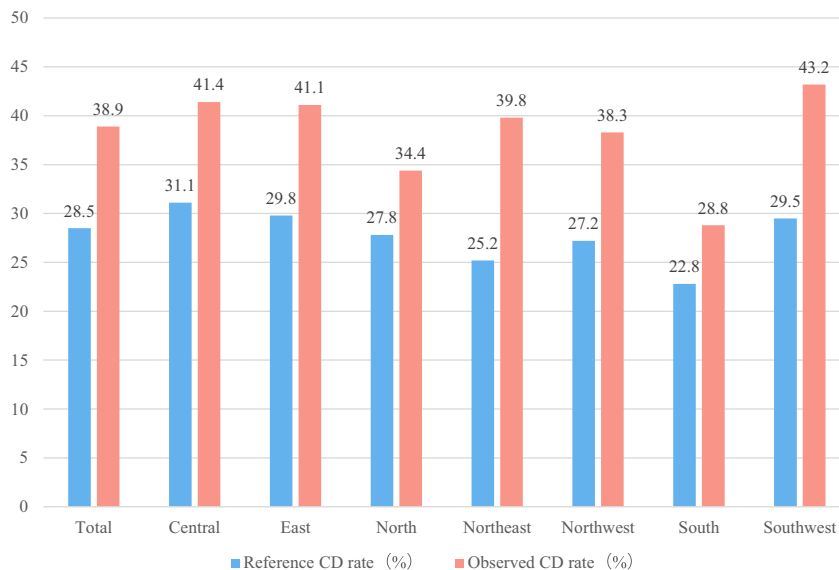
**Figure 1.** The reference and observed caesarean delivery rates across different geographical regions in China.

distribution of these ten groups also varied widely by region (Table S2).

Figure 1 illustrates that the current CD rate varied from 28.8% in the south to 43.2% in the south-west. Based on the WHO C-Model, the overall reference rate would be 28.5% (95% CI 28.3–28.8%), i.e. there was a 10.4% difference in the absolute rate. The reference rate by region ranged from 22.8 to 31.1%, whereas the rate difference ranges from 6.0 to 14.6%.

Figure 2 presents the top five reasons for CD across geographic regions. These five reasons accounted for over 70% of all the CDs in all regions. Scarred uterus was far more common than any other indication in all regions, ranging from 27.5 to 44.6% of all CDs. CDMR was ranked no. 2 overall, accounting for nearly 10% of all CDs, followed by labour dystocia (8.3%), fetal distress (7.7%) and malpresentation (7.6%).

Table 3 details the top five reasons for CD in the ten Robson groups. Overall, scarred uterus was the biggest contributor to CD. Maternal request was also one of the major causes in several groups. Prelabor CD accounted for a high percentage of total CDs, particularly in nulliparas. Suspected macrosomia or cephalopelvic disproportion (CPD) were the second most common reasons for over 21% of
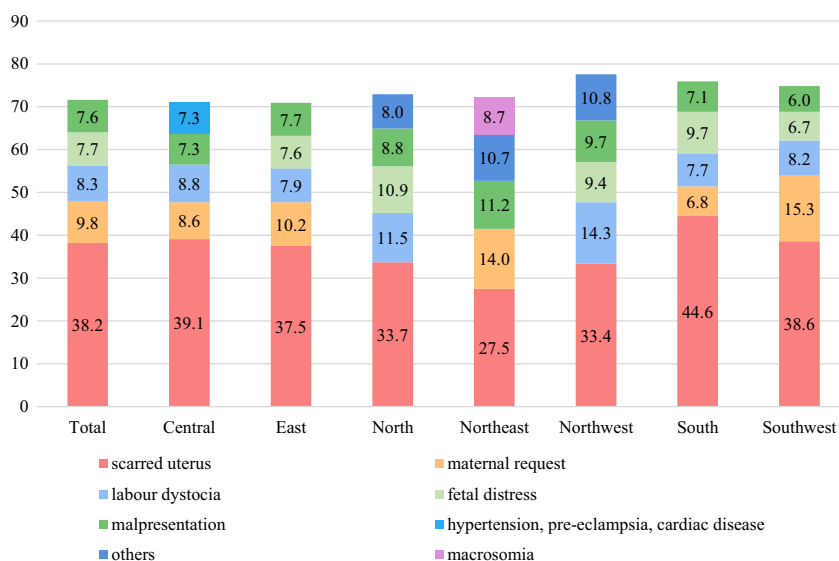


**Figure 2.** The top five reasons for caesarean delivery across geographic regions. For each indication, we calculated its proportion for all CDs by region.

**Table 3.** Top five reasons for caesarean deliveries in the Robson ten-group classification*

| Total (100%)** | 1: NS (7.5%)** | 2A: NI (4.6%)** | 2B: NC (23.0%)** | 3: MS (2.1%)** | 4A: MI (0.4%)** |
|---|---|---|---|---|---|
| Scarred uterus (38.2%) | Labour dystocia (36.5%) | Labour dystocia (42.2%) | Maternal request (25.4%) | Labour dystocia (29.7%) | Maternal request (48.0%) |
| Maternal request (9.8%) | Fetal distress (27.3%) | Fetal distress (24.7%) | Others (15.0%) | Fetal distress (16.7%) | Labour dystocia (17.4%) |
| Labour dystocia (8.3%) | Maternal request (11.3%) | Maternal request (10.7%) | Macrosomia (12.5%) | Maternal request (16.6%) | Fetal distress (16.4%) |
| Fetal distress (7.7%) | Meconium staining (4.6%) | Meconium staining (6.4%) | Fetal distress (10.5%) | Malpresentation (8.4%) | Others (5.3%) |
| Malpresentation (7.6%) | Others (4.0%) | Failed induction of labour (5.2%) | Cephalopelvic disproportion (8.9%) | Scarred uterus (7.3%) | Other fetal abnormalities (3.0%) |
| | **4B: MC (9.8%)**** | **5: PC (33.1%)**** | **6,7,9: BR (7.7%)**** | **8: TW (3.9%)**** | **10: PT (7.0%)**** |
| | Scarred uterus (33.5%) | Scarred uterus (92.1%) | Malpresentation (78.3%) | Multiple pregnancy (60.1%) | Scarred uterus (25.2%) |
| | Maternal request (13.1%) | HBP, PE, cardiac disease (2.2%) | Scarred uterus (9.4%) | HBP, PE, cardiac disease (9.0%) | HBP, PE, cardiac disease (19.7%) |
| | Others (12.8%) | Others (1.5%) | HBP, PE, cardiac disease (3.3%) | Others (8.2%) | Placenta praevia (9.9%) |
| | Fetal distress (8.2%) | Maternal request (0.8%) | Other fetal abnormalities (2.4%) | Scarred uterus (7.1%) | Fetal distress (8.8%) |
| | HBP, PE, cardiac disease (7.6%) | Placenta praevia (0.6%) | Placenta praevia (1.7%) | Emergency situations (3.7%) | Others (5.9%) |

*For each indication, we calculated its proportion in all CDs by modified Robson groups.
**(Number of caesareans in the group/total number of caesarean) × 100. Please refer to the labels listed in Table 1: 1 = NS (nulliparous, spontaneous); 2A = NI (nulliparous, induced); 2B = NC (nulliparous, caesarean); 3 = MS (multiparous, spontaneous); 4A = MI (multiparous, induced); 4B = MC (multiparous, caesarean); 5 = PC (previous caesarean); 6, 7, 9 combined = BR (breech and other non-cephalic presentation); 8 = TW (twin and other multiple pregnancies); 10 = PT (preterm). HBP, high blood pressure; PE, pre-eclampsia.

prelabor CDs in nulliparas. The mean birthweight for suspected macrosomia was 4095 g and 45.2% were above 4000 g, whereas the mean birthweight for suspected CPD cases was 3568 g and 14.9% were above 400 g.

## Main findings

Our study found that the CD rate in China was 38.9% in 2015–2016. Based on the WHO C-Model and characteristics of Chinese pregnant women, the overall reference CS rate was 28.5%, indicating that a reduction of 10% in the absolute rate or a reduction of a quarter in the relative rate may be considered attainable. We found that 14.1% of women had a previous CD and a scarred uterus contributed up to 38.2% of all CDs. Maternal request was the second most common reason for CD, accounting for nearly 10% of all CDs. Over 80% of multiple gestations and 90% of women with uterine scar or non-cephalic fetal presentation were delivered by caesarean.

## Strengths and limitations

Our study has several strengths. First, our results were based on 94 hospitals in 23 provinces in China. The study has a good representation across the country. Second, the detailed information that our study collected allowed us to

make an in-depth analysis of the causes of CD and reveal possible areas for a reduction of unnecessary CDs. This has never been achieved in a large-scale study in China.

Our study also has some limitations, however. First, the study population was not a random sample of the total obstetric population in China. Hospitals with fewer than 1000 deliveries a year were not included in our study. Our study population may, therefore, be unable to totally represent the general population. However, the basic characteristics of our study population were very similar to those in China's National Maternal Near Miss Surveillance System, which covers 438 hospitals across the country (Table S3).[6] The overall CD rate in our study (38.9%) was comparable with that in a previous national study.[3] Second, our study was a large cross-sectional survey. Thus, we cannot evaluate the temporal trends of CD and its indications. Third, the indications for CDs were extracted from medical records, which were not standardised and may be influenced by the preferences of physicians.

## Interpretation

The most common indication for CD in China used to be CDMR, responsible for nearly half of all CDs in some studies.[4] The two-child policy has had a significant impact on

women and families who may want to have a second child.[12] They may think twice before requesting a CD. Furthermore, the recent effort to reduce unnecessary CD may also have made an important contribution.[13] For example, the National Health Commission issued prenatal and intrapartum care guidelines, encouraging vaginal birth and avoiding caesarean section without clinical indications.[14] On the other hand, it is possible that some physicians may feel pressured and report a different indication for CD instead of maternal request, so that CDMR appeared to have had a larger decrease than in reality.[15] Nonetheless, CDMR still accounts for a higher proportion of total CDs in China than in many other countries.[16] A number of factors continue to play a role. Women's fear of labour pain, which was reflected in the intrapartum CDMR and prelabour CDs, is a major contributor in several groups. Misperceptions of CD being safer than natural birth and financial incentives for physicians to perform CDs remain prevalent, along with the evolution of women's views and preferences in China.[15] To further reduce CDMR, labour companionship and pain relief during vaginal birth need to be further developed and strengthened. A clearer message of the benefits of physiological birth and potential long-term effects of CD on child health may help women in decision making. At the organisational level adjustments of the financial compensation may be useful, although their effectiveness must be investigated further.[17]

In contrast, scarred uterus is now far more common than any other CD indication in all regions, a result of the combination of a high primary CD rate in nulliparas and repeat CD rate in multiparas. This was a particular issue when the two-child policy was newly implemented. One study showed that the repeat CD rate doubled at that time.[13] In our study, 90% of women with previous CD eventually gave birth by CD, contributing the most to the total CD rate. Although obstetric guidelines in China also recommend trial of labour after previous caesarean (TOLAC) for women with scarred uterus,[18,19] the VBAC rate in China was only 2–3% in a previous study,[16] well below that of some European countries, such as Finland (51%), Norway (51%) and the Netherlands (55%).[20] Several factors may be attributable to the low rate of vaginal birth after caesarean (VBAC). First, a comprehensive health assessment of pregnant women would be required before TOLAC. A high level of emergency care is also necessary in case of clinical risk. Both requirements might pose challenges to many lower-level hospitals in China and require commitment to training and resources. Previous studies have shown that although policies can temporarily improve the rate of TOLAC, hospital conditions remain the biggest obstacle for the promotion of TOLAC.[21,22] Second, the high incidence of placenta praevia may also lead to the low rate of TOLAC.[19] Finally, in China, where indications for CD are still relatively liberal and a few women want to have more than two children, women and physicians have less incentive for TOLAC. Substantial efforts and training are needed in order to improve the rate of TOLAC.

We used the WHO multivariable C-Model to estimate a reference CD rate for China. The C-Model generated a locally 'appropriate' CD rate based on the obstetric characteristics of the population under study. The development of the C-Model showed good discriminatory capacity, ranging from 0.832 to 0.844. It was built using data from 22 countries and tested with data from 43 countries and previous research found that the WHO C-Model fits well in both high-risk and low-risk populations.[23] For our population, the reference rate was about 10% lower than the current rate: 28.5 versus 38.9%. However, our study also shows that the CD rates varied substantially by region. The CD rate is affected by the composition of the obstetric population (e.g. parity and maternal age) and practice pattern. Thus, for a country like China, a one-size-fits-all reference CD rate may not be an appropriate policy to achieve optimal obstetric and perinatal outcomes. We applied the WHO C-Model by region and believe that a regional or even a hospital-specific rate and corresponding policy will be in the best interest of the region and the hospital. Each region needs to carefully examine the characteristics of its obstetric population, practice and indications for CD, along with the reference CD rate, to set up a policy that suits the local situation to eventually reduce unnecessary CD. The Robson classification system is extremely useful to monitor CD rate and identify targets for safe reduction. In the long run, a large-scale study with an appropriate obstetric population in China will be ideal to establish its own multivariable caesarean model like the WHO C-Model.

Some common themes for reduction can be found. First and foremost is the need to reduce CDMR, which, as discussed above, and based on Chinese women's views,[24] would require the improved availability of labour analgesia and better counselling for women on the pros and cons of CD. Emerging evidence shows that child cognitive development, emotional attachment, sociability or microbiota, particularly in dyads who underwent prelabour CD (and were not exposed to the neurohormonal mechanism at work during labour, and its effects), are affected by CD.[25,26] Long-term child health (e.g. allergic disorders and obesity) and maternal health (e.g. adhesion and even infertility) should be incorporated into the equation.[27,28] Second, health policies, especially insurance policies, may need to be reformed to temper CDMR. For example, a previous study showed that policy interventions such as strictly controlling the indications for CD and enhancing health education in Wenzhou, China, achieved great success in reducing the rates of CD.[13] Third, studies have demonstrated that midwifery-led care has been related to safer

outcomes, lower CD rates and lower costs.[29] But, currently, midwifery-led care barely exists in China. The availability of midwifery-led care and labour companionship need to be further improved. Finally, creating role models and successful examples of positive experiences with vaginal birth seem to motivate women to seek vaginal delivery.[30] Women who experienced a previous successful vaginal birth were far more willing to undergo TOLAC.

Our study also showed that prelabour CD was quite common in China, and suspected macrosomia and CPD were among the main indications for primary CD. It is well recognised that fetal weight estimation is inaccurate in late gestation,[31] and true CPD is rare and has to be diagnosed at an advanced stage of labour. Thus, prelabour CDs for such indications are hardly justified and can be considered as potential areas for reduction.

In addition, 90.4% of women with non-cephalic fetal presentation (group BR) and 84.0% of women with multiple gestation (group TW) had a CD, whereas the corresponding CD rates in the Netherlands were 78.6 and 43.1%, respectively.[10] In a previous meta-analysis, external cephalic version had a success rate of 43% in avoiding CD.[32] Even in women with fetal breech presentation and a scarred uterus, external cephalic version could bring about a vaginal delivery rate of 83% in a recent meta-analysis.[33] Numerous studies further suggest that compared with vaginal delivery, CD cannot significantly decrease adverse maternal and perinatal outcomes for singleton pregnancy with non-cephalic presentation or multiple pregnancies.[34] Therefore, vaginal delivery should be encouraged first, particularly for a normal term twin gestation with a cephalic presentation of the first twin.[35]

## Conclusion

Nearly 39% of births were delivered by CD in China but a 10% reduction in the absolute rate (or a quarter reduction in the relative rate) may be considered. Repeat CD contributed one-third of the total CDs. Given the variations in maternal and obstetric characteristics by region, region-specific, and even hospital-specific, reference CD rates are needed for the precision management of the CD rate. Maternal request, suspected macrosomia and suspected CPD in prelabour CD among nulliparas are areas for potential reduction.

## Disclosure of interests

None declared. Completed disclosure of interests form available to view online as supporting information.

## Contribution to authorship

Jun Zhang conceived and designed the study and provided overall guidance. DL, NY, LS, WL, ST, Lanlan Wang, XW, TZ, Yuan Zhang, Zongjie Lu, Lingzhi Zheng, CG, JF, Zongyin Liu, LM, Zhenyu Cai, XY, HL, Hongyu Zhang, XZ, LY, Lina Wang, XS, QL, LL, Juanying Zhu, WQ, QY, SD, YY, Zhanrong Cui, YH, XF, LH, Huixin Zhang and XPW collected data. Yuqing Zhang analysed the data. Yuqing Zhang, APB and Jun Zhang drafted the article, and all authors contributed to the interpretation of the results and the development of the report. All authors reviewed and approved the final version.

## Details of ethics approval

This study was approved by the Ethics Review Board of the Xinhua Hospital Affiliated to the Shanghai Jiao Tong University School of Medicine (XHEC-C-2015-006), the WHO Research Ethics Review Committee (HRP Study A65899) and the participating hospitals.

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### Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available, in accordance with privacy or ethical restrictions.

## Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Characteristics of the study population by geographic region in China.

Table S2. Characteristics of caesarean deliveries by modified Robson ten-group classification across geographic regions in China.

Table S3. Comparison between the current study and a previous national survey on demographic characteristics of pregnant women in 2015–2016. ∎

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