Optimising caesarean section use 1

Global epidemiology of use of and disparities in caesarean sections

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In this Series paper, we describe the frequency of, trends in, determinants of, and inequalities in caesarean section (CS) use, globally, regionally, and in selected countries. On the basis of data from 169 countries that include 98·4% of the world's births, we estimate that 29·7 million (21·1%, 95% uncertainty interval 19·9–22·4) births occurred through CS in 2015, which was almost double the number of births by this method in 2000 (16·0 million [12·1%, 10·9–13·3] births). CS use in 2015 was up to ten times more frequent in the Latin America and Caribbean region, where it was used in 44·3% (41·3–47·4) of births, than in the west and central Africa region, where it was used in 4·1% (3·6–4·6) of births. The global and regional increases in CS use were driven both by an increasing proportion of births occurring in health facilities (accounting for 66·5% of the global increase) and increases in CS use within health facilities (33·5%), with considerable variation between regions. Based on the most recent data available for each country, 15% of births in 106 (63%) of 169 countries were by CS, whereas 47 (28%) countries showed CS use in less than 10% of births. National CS use varied from 0·6% in South Sudan to 58·1% in the Dominican Republic. Within-country disparities in CS use were also very large: CS use was almost five times more frequent in births in the richest versus the poorest quintiles in low-income and middle-income countries; markedly high CS use was observed among low obstetric risk births, especially among more educated women in, for example, Brazil and China; and CS use was 1·6 times more frequent in private facilities than in public facilities.

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This is the first in a Series of three papers on optimising caesarean section use

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Introduction

Caesarean section (CS) is a life-saving intervention for women and newborns when complications occur, such as antepartum haemorrhage, fetal distress, abnormal fetal presentation, and hypertensive disease. CS is the most common major surgical intervention in many countries.[1] CS use has increased during the past 30 years to a frequency in excess of the proportion of 10–15% of births that is thought to be optimal.[2–4] This increase in use has been driven by major increases in non-medically indicated CS in many middle-income and high-income countries.[2–4] However, use of CS in more than 20% of births has not been shown to improve perinatal or neonatal outcomes in a population.[4–6] By contrast, many low-income and middle-income countries still use CS for less than 10% of births in the overall population, which is considered to be indicative of inadequate access to medically indicated CS.[3,5,6] Additionally, large differences in CS use have been observed between births in the poorest and the richest wealth quintiles within many low-income and middle-income countries.[7]

This is the first in a three-part Series on Optimising Caesarean Section Use that focuses on the high frequency of CS use globally and regionally, while acknowledging the concurrent problem of low use in some regions. The two other Series papers[8,9] summarise the evidence of health effects of CS on women and children and provide an overview of potential interventions to reduce high CS use. We aimed to describe the frequency of, trends in, determinants of, and inequalities in CS use, globally, regionally, and in selected countries. We update the global and regional estimates of the frequency of and trends in CS per 100 livebirths during 2000–15, including the relative contributions of changes in the number of

Key messages

- Caesarean section (CS) can save women's and infants' lives and should be universally accessible. However, the large increase in CS use, often for non-medical indications, is of concern given the risks for both women and children.
- CS use is increasing in all regions and, in 2015, more than one in five live births were by CS. In most countries, CS use has reached a frequency well above what is expected on the basis of obstetric indications. Within-country CS use is often particularly high among wealthier women and in private facilities.
- By contrast, inadequate access to CS is still a major issue in most low-income and several middle-income countries, especially in sub-Saharan Africa and among the poorest women. The low use of CS implies that women and babies are at much higher risks of dying because they cannot access lifesaving surgery during childbirth.
- Optimisation of CS use is needed, underpinned by a better understanding of demand and supply factors that drive the overuse of CS and by greater efforts to ensure universal access to CS for all women.

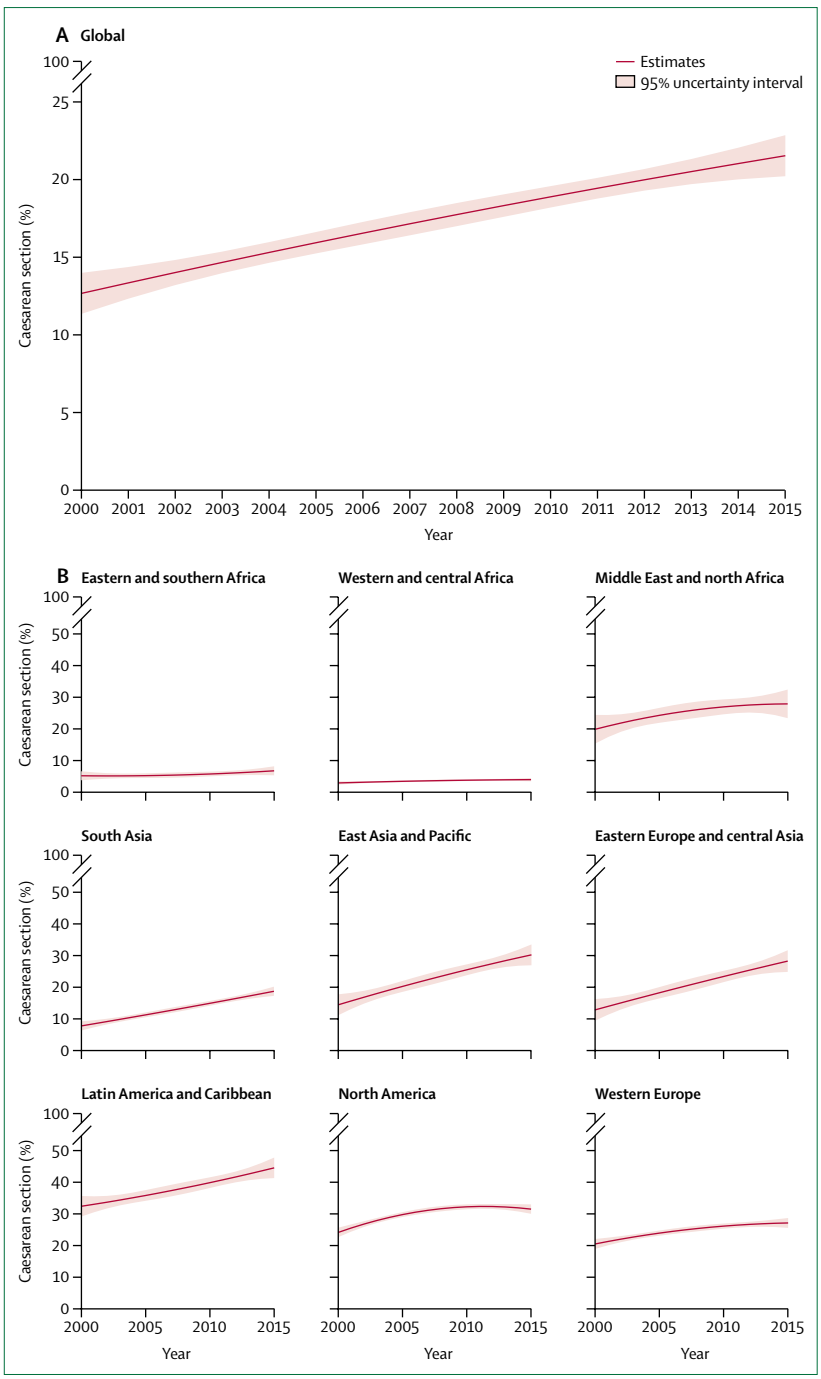

Figure 1: **Estimated frequency of and trends in caesarean section use, as a proportion of livebirths between 2000 and 2015**
(A) Global data and (B) regional data.

births in health institutions and in intra-institutional use of CS to the overall use of CS in the population. We assess the extent to which country-level CS use is associated with socioeconomic development, women's education, urbanisation, fertility, and availability of physicians. We analyse within-country socioeconomic and geographic disparities in CS use in the population and the differences in CS use between public and private health facilities. Finally, we use the Robson classification[10] to obtain further insights into the need for and use of CS as well as inequalities by women's education in Brazil and China.

Global and regional frequency and trends

We updated the WHO and UNICEF databases on population CS use and institutional delivery (ie, within health institutions) with data published before Jan 1, 2018, which were derived from household surveys, annual vital statistics, and routine statistical surveillance. For household surveys, information is collected retrospectively and statistics are computed for reference periods, typically for the 3 or 5 years preceding the survey. We located all survey data points in the calendar year that was in the middle of the reference periods.

Overall, 169 countries had at least one national data point on the use of CS and on the proportion of livebirths in health facilities since 2000, thereby including 98·4% of all births globally in 2015 (appendix). A mean of six data points were available per country, and 2013 was the mean year with the most recent data point. To obtain global and regional estimates, we weighted all data points by the number of livebirths for the reference year. We grouped countries into nine regions by use of the UNICEF region 2 classification (appendix). A penalised B-Spline regression model that used the Markov Chain Monte Carlo method of multiple imputations for missing data was used to estimate the frequency of CS use, trends, and uncertainty from 2000 to 2015 (appendix). We did not provide estimates beyond 2015 because only a few countries had data points after 2015. The model was used only for the global and regional frequency and trend estimates.

Globally, 29·7 million (21·1%, 95% uncertainty interval 19·9–22·4%) of 140·6 million livebirths were estimated to be by CS in 2015, which was an increase from 16·0 million (12·1%, 10·9–13·3%) of 131·9 million livebirths in 2000 (figure 1; table 1). The average annual rate of increase in CS use globally was 3·7% during 2000–15. CS use in 2015 varied greatly between the nine regions, from 4·1% (3·6–4·6%) in the west and central Africa region to 44·3% (41·3–47·4%) in the Latin America and Caribbean region. Increases in CS use were observed in all regions during 2000–15, and this increase occurred most rapidly in the eastern Europe and central Asia (average annual rate of change 5·5%) and south Asia (6·1%) regions. In the south Asia, eastern Europe and central Asia, and east Asia and Pacific regions, population CS use more than doubled during 2000–15, with average annual rates of change exceeding 5%. Population CS use increased most slowly in west and central Africa (2·1%) and eastern and southern Africa (2·0%), and CS use in these regions was still less than 10% in 2015.

	Population CS use, % of livebirths			Institutional deliveries, % of total livebirths			Intra-institutional CS use, % of livebirths within institutions			Contribution to change in CS use, %	
	2000 (95% uncertainty interval)	2015 (95% uncertainty interval)	AARC	2000	2015	AARC	2000	2015	AARC	Institutional delivery	Institutional CS use
Global	12·1% (10·9–13·3)	21·1% (19·9–22·4)	3·7%	53·7%	77·8%	2·5%	22·5%	27·1%	1·2%	66·5%	33·5%
West and central Africa	3·0% (2·4–3·5)	4·1% (3·6–4·6)	2·1%	45·3%	57·3%	1·6%	6·6%	7·2%	0·5%	75·2%	24·8%
Eastern and southern Africa	4·6% (3·4–5·9)	6·2% (5·0–7·5)	2·0%	38·2%	55·8%	2·5%	12·0%	11·1%	–0·5%	127·3%	–27·3%
Middle East and north Africa	19·0% (14·9–23·0)	29·6% (25·5–33·7)	3·0%	65·8%	87·2%	1·9%	28·9%	33·9%	1·1%	63·4%	36·6%
South Asia	7·2% (5·8–8·5)	18·1% (16·7–19·4)	6·1%	29·6%	71·0%	5·8%	24·3%	25·5%	0·3%	94·6%	5·4%
East Asia and Pacific	13·4% (11·0–15·9)	28·8% (26·3–31·2)	5·1%	65·7%	92·2%	2·3%	20·4%	31·2%	2·8%	44·4%	55·6%
Latin America and Caribbean	32·3% (29·2–35·3)	44·3% (41·3–47·4)	2·1%	86·8%	94·2%	0·5%	37·2%	47·0%	1·6%	26·0%	74·0%
Eastern Europe and central Asia	11·9% (8·7–15·2)	27·3% (24·1–30·6)	5·5%	89·4%	99·4%	0·7%	13·3%	27·5%	4·8%	13·2%	86·8%
North America	24·3% (22·8–25·8)	32·0% (30·5–33·5)	1·8%	99·3%	98·1%	–0·1%	24·5%	32·6%	1·9%	–4·4%	104·4%
Western Europe	19·6% (18·1–21·2)	26·9% (25·4–28·5)	2·1%	97·3%	97·5%	0	20·1%	27·6%	2·1%	0·7%	99·3%

CS=caesarean section. AARC=average annual rate of change, calculated as ln(value in 2015/value in 2000)/15.

Table 1: **CS use as a proportion of livebirths, including annual rates of change between 2000 and 2015, and the contributions of changing frequency of delivery within institutions and changing use of CS in institutions, stratified by region**

Contributions of increasing institutional birth rates and intra-institutional CS rates

Population CS use, the proportion of all livebirths by CS, can also be expressed as the product of the proportion of all livebirths in the population that occurred in any health institution (institutional births) and the proportion of livebirths by CS within health institutions (intra-institutional CS use). The intra-institutional CS estimate provides additional insights into the epidemiology of CS in countries where a substantial proportion of births occur at home, since the proportion of institutional births vary over time and within countries. We derived the intra-institutional CS estimates (CS per 100 livebirths in health facilities) by dividing the proportion of livebirths by CS by the proportion of livebirths in health institutions. For each region and globally, we calculated the relative contribution of changes in institutional deliveries and intra-institutional CS use to the trends in population CS use.

The global increase in CS use between 2000 and 2015 was driven by increases in the proportion of births occurring in health institutions (accounting for 66·5% of the increase) and an increase in CS use within health institutions (accounting for 33·5% of the increase; table 1; appendix). In sub-Saharan Africa, the modest increase in population CS use was largely due to an increasing proportion of deliveries occurring within health institutions. In the eastern and southern Africa region, intra-institutional CS use decreased slightly in frequency, leading to negative contributions to the change in population CS use. These trends might suggest that the health facilities are not able to cope with the increased attendance and need for life-saving CSs. In south Asia, the doubling of the population CS use was driven by more women delivering in health facilities, although the intra-institutional CS use increased slightly from 24·3% in 2000 to 25·5% in 2015.

Disparities between countries

An analysis based on the most recent data point from each country showed that CS was used in more than 15% of births in 106 (63%) of the 169 countries assessed, whereas, in 48 (28%) countries, CS was used in less than 10% of births. There were large differences in intra-institutional CS use, even among countries with similar proportions of institutional births (figure 2). Among 85 countries with more than 95% of births occurring in health facilities, intra-institutional CS use varied from less than 10% in Turkmenistan (6·3%) and Kyrgyzstan (9·4%) to more than 50% in the Dominican Republic (59·3%) and Brazil (56·0%). Among 32 countries that reported 80–94% of births occurring within an institution, ten (31%) countries had intra-institutional CS use of less than 10%, whereas CS was used in 63·0% of births in Egypt. 17 (71%) of the 24 countries where less than 60% of births were institutional births reported intra-institutional CS use of less than 10%, but seven (29%) countries reported CS use in at least 15% of livebirths; of these 24 countries, the greatest intra-institutional CS use was reported in Bangladesh (65·2%) and Myanmar (46·3%).

We assessed the associations of the most recent data on national CS use with level of socioeconomic development (based on gross national income per capita) and women's education (the net enrolment in secondary education among girls), urbanisation (the proportion of the population living in urban areas), total fertility (the number of children that a woman aged 15 years would have by the end of her reproductive lifespan at current fertility rates), and physicians per 10 000 population, by use of linear regression models with the proportion of births by CS as the dependent variable. The proportion of births by CS was significantly higher in countries with higher levels of socioeconomic development, higher net female enrolment

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See **Online** for appendix

For **World Population Prospects data on livebirths from 2000–15** see http://esa.un.org/unpd/wpp/Download/Standard/Population

For **socioeconomic data and data on education globally from the World Bank** see http://data.worldbank.org/indicator

For **Global Health Observatory data on physician density** see http://www.who.int/gho

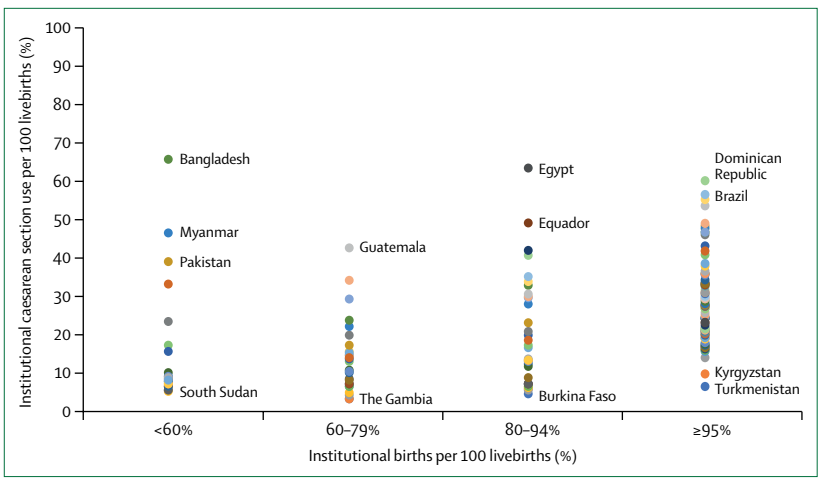

Figure 2: **Intra-institutional use of caesarean section as a proportion of livebirths, relative to the proportion of births occurring in health institutions, by country**
Dots each represent one of the 169 countries with available data. Countries were grouped into four categories, based on frequency of institutional delivery. Estimates are based on the most recent data point available from 2000 to 2015.

in secondary education, higher levels of urbanisation, greater density of physicians, and lower fertility (appendix; all p<0·0001). However, when restricting the analysis to countries with possible overuse of CS (use in 15% of births or more), none of the determinants was significantly associated with the frequency of CS use (p>0·05). Among countries with low access to CS (CS use in less than 10% of births), total fertility rate (p<0·0001), female enrolment in secondary education (p=0·002), and physician density (0·008) were significantly associated with CS use, but socioeconomic development (p=0·143) and urbanisation (p=0·974) had no significant association with CS use. In a multivariable regression model of CS use with all five independent variables, only total fertility remained significantly associated with the frequency of CS use (p=0·01).

Disparities within countries

For **Demographic and Health Surveys** see http://www.dhsprogram.com

For **UNICEF Multiple Indicator Cluster Surveys** see http://mics.unicef.org/surveys

We updated data from a previous study[7] with data from Demographic and Health Surveys or Multiple Indicator Cluster Surveys to examine the effects of household wealth on both population and intra-institutional CS use for 82 low-income and middle-income countries (table 2). There were large differences in population CS use between women in the poorest (median 4·1%, IQR 1·9–12·0) and the richest (19·1%, 10·6–33·8) wealth quintile in these countries. Two thirds (55 countries) of 82 low-income and middle-income countries reported population CS use in less than 10% of births among the poorest women and 35 (43%) countries reported CS use in less than 3% of births among these women. In 40 countries with a national population CS use of less than 10%, the median CS use was 1·7% (IQR 3·2–6·3) among the poorest quintile and 10·6% (8·0–14·0) among the richest quintile.

When the women have reached a health facility, there are no obstetric reasons to expect a lower use of CS among the poorest women compared with wealthier women. Yet women in the wealthiest quintile, on average, reported 2·4 times greater use of CS than women in the poorest quintile (8·9% *vs* 21·3%; appendix), which shows the major differences in access to CS even after women have reached a health facility. The possible reasons for this disparity could be a low overall capacity to provide CS, particularly in rural settings where most women in the poorest quintiles deliver, financial barriers to CS, and a role of the private sector in providing CS to wealthier women in mostly urban areas.

Subnational differences are also large. For example, subnational data for the ten countries with the highest number of births in 2010–15 showed large but variable differences within countries (appendix). The frequency of birth by CS in Ethiopia nationally was 2·0%, but Addis Ababa reported CS use in 21·4% of births. Nigeria also had CS use of 2·0% nationally, and the states with the most frequent use still reported use of less than 10%. Bangladesh, Brazil, and the USA all reported CS use in more than 25% of births nationally, but the use of CS differed by at least a factor of two between the administrative units with the most and least frequent CS use. Within-country differences in China and India were large, with provincial differences in China ranging from 4% to 62% and inter-state differences in India from 7% to 49%.

The median intra-institutional CS use was 1·6 times higher (IQR 1·2–2·2) in private facilities (18·3%, 19·1–36·4) than public facilities (11·0%, 6·9–19·9), according to survey data from 69 (84%) of the 82 low-income and middle-income countries. Intra-institutional CS use in private facilities exceeded 50% of births in 12 countries. Despite the more frequent use of CS in private facilities, the public sector still accounted for the largest proportion of births by CS: the median proportion of all CSs that took place in the public sector was 81·0% (64·6–92·0) across the 69 countries. More frequent use of CS in private institutions than in public health facilities has also been documented in high-income and upper middle-income countries,[11,12] and almost universal use of CS has been reported for the births of wealthier women in private health facilities in Brazil.[13] A systematic review and meta-analysis[14] of 11 studies in high-income and upper middle-income countries indicated that the odds of receiving a CS were, on average, 1·84 times higher (95% CI 1·49–2·27) in private, for-profit hospitals than in non-profit hospitals. Increasing privatisation of the obstetric services might, therefore, lead to further increases in use of CS.

CS according to need

The Robson classification provides further information on the need for and use of CS by possible medical indication.[10,15] The Robson system classifies women

	National average	Quintile 1 (poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (richest)
Low-income and middle-income countries (n=82)	10·1% (4·5–21·1)	4·1% (1·9–12·0)	6·9% (2·4–17·9)	9·4% (3·6–21·6)	11·9% (5·9–25·2)	19·1% (10·6–33·8)
Low CS use countries (<10% of births; n=40)	4·4% (3·2–6·3)	1·7% (0·9–2·5)	2·3% (1·2–3·5)	3·5% (2·1–4·7)	5·7% (3·4–7·0)	10·6% (8·0–14·0)
High CS use countries (≥15% of births; n=31)	26·2% (19·8–30·7)	14·8% (10·6–25·9)	19·9% (16·3–25·6)	26·8% (21·0–33·2)	28·6% (23·8–39·9)	39·4% (33·0–53·8)

Data are median % per 100 livebirths (IQR). Data are from Demographic and Health Surveys and Multiple Indicator Cluster Surveys from 2010 or later. CS=caesarean section.

Table 2: **Median proportion of births by CS in low-income and middle-income countries and among countries with low and high CS use, overall and by quintile, stratified by wealth quintile**

giving birth in health facilities into ten groups on the basis of their obstetric characteristics (parity, previous CS, gestational age, onset of labour, fetal presentation, and number of fetuses). Groups 1 and 2 comprise nulliparous women who begin labour at or after 37 weeks with singleton, cephalic, fetuses; groups 3 and 4 comprise multiparous women without a uterine scar who begin labour at or after 37 weeks, with singleton, cephalic, fetuses; group 5 comprises women with a uterine scar, who begin labour at or after 37 weeks, with singleton, cephalic, fetuses; group 6 comprises all nulliparous women with singleton breech; group 7 comprises all multiparous women with singleton breech, including those with uterine scar; group 8 comprises all multiple pregnancies with other abnormalities, including women with a uterine scar; group 9 comprises all women with a singleton pregnancy with other abnormalities, including women with a uterine scar; and group 10 comprises all women who begin labour at or before 36 weeks (preterm births), including those with a uterine scar, with singleton, cephalic fetuses. The size of each group and the frequency of CS use within each group correspond to an expected range. Monitoring CS use within the Robson groups therefore allows an assessment of clinical practice, including the extent to which the frequency of CS use can be justified.

We examined CS use by the groups of the Robson classification in China and Brazil, which both have very high national CS use. These countries were also selected because they have available data on large numbers of births that are disaggregated by maternal education. We used two sources of nationally representative data: individual-level data[16] collected through China's National Maternal Near Miss Surveillance System, including all births in 438 hospitals in 2012 and 2016; and individual-level data collected through the Livebirths Information System of the Brazilian Ministry of Health, including all livebirths in health facilities in Brazil in 2015. We adapted the Robson classification to create only eight mutually exclusive categories because data from China did not include information on induction of labour (appendix).

CS use as a proportion of births in hospitals was more common in Brazil (55·6% in 2015) than in China (45·7% in 2012 and 41·3% in 2016). In both countries, a large proportion of livebirths were among women with a uterine scar (classified as Robson groups 5, and 7–10): 17·8% in China (2016) and 27·0% in Brazil (2015). Non-cephalic positions (breech or other abnormalities) and multiple pregnancies accounted for about 5% of births in both countries, whereas the percentage of births that were singleton, cephalic, and preterm (36 weeks or earlier) was 5·5% in China and 9·2% in Brazil. The Robson groups that made the largest contribution to overall CS frequency in both countries were single, cephalic births to nulliparous women with a gestational duration of at least 37 weeks (groups 1 and 2; 39·9% in China and 35·4% in Brazil) and single, cephalic births with a gestational duration of at least 37 weeks to women with a uterine scar (group 5; 33·9% in China and 32·7% in Brazil).

Educational disparity in intra-institutional CS use was much more pronounced in Brazil than in China, particularly among the Robson groups with the lowest need for CS (single, cephalic births to nulliparous or multiparous women with a gestational duration of at least 37 weeks; groups 1 to 4; appendix). For example, among women in Robson groups 3–4 (in whom CS use is expected to be low) in Brazil in 2015, those with less than 8 years of education used CS in 19·4% of births, compared with 54·4% of births among women in these groups with the highest educational duration (figure 3). In China in 2016,

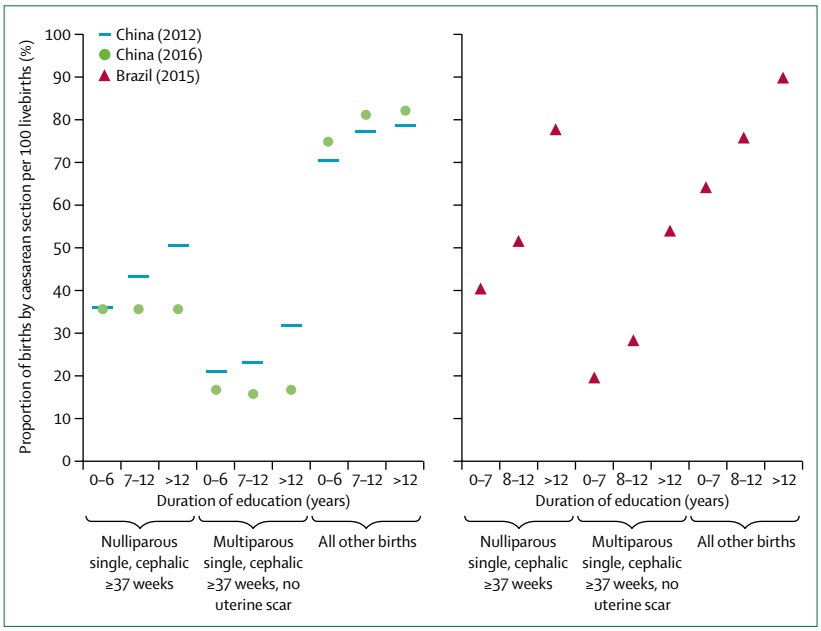

Figure 3: **Proportion of births by caesarean section among single, cephalic births at term and all other livebirths in China and Brazil, by the level of women's education**
Data are from 438 hospitals in China in 2012 and 2016, and all hospital data from Brazil in 2015.

For the **Livebirths Information System of the Brazilian Ministry of Health** see http://sinasc.saude.gov.br/default.asp

CS use in groups 3–4 was around 16%, regardless of educational achievement. Notably, although the overall use of CS in China decreased between 2012 and 2016, the substantial disparity in CS use between women educated for different durations nearly disappeared in 2012.

Previous CS is a major indication for CS. The proportion of livebirths to women with a previous CS in China increased from 10% to 18% between 2012 and 2016; this change is attributed to the relaxation of the one-child policy. In Brazil in 2015, the proportion of births to women who had previously had a CS was 27%. The WHO multi-country studies[15] also reported high proportions of women with a previous CS. Previous CSs are therefore a major factor in increasing CS use, and accentuate socioeconomic and other differences. Also, this factor means that future reductions in CS use are likely to be slower than increases, because of the relatively large proportion of births in women with previous CS and the trend to opt for elective CS by women with a previous CS. There is now evidence from a few countries of a stabilisation or decrease in the frequency of CS use, including in China,[16] the USA,[17,18] and western European countries.

For **CS data from WHO Regional Office for Europe** see https://gateway.euro.who.int/en/hfa-explorer/

Poor access versus overuse

In 2015, an estimated 29·7 million (21·1%) births globally were by CS, which represented almost a doubling in the proportion since 2000, when 16·0 million (12·1%) births were by CS. The differences in the frequency of CS use between regions were striking, with a high of 44·3% in the Latin America and Caribbean region and a low of 4·1% in the west and central Africa region. CS use more than doubled in frequency in the south Asia region and the eastern Europe and central Asia region during 2000–15. The contribution of the proportion of births that occurred in health facilities and intra-institutional CS use varied by region. Differences between countries were also very large. CS was used in more than 15% of births in 106 (63%) of the 169 countries, whereas 48 (28%) countries reported use of CS in less than 10% of births. CS use in the Dominican Republic (58%), was 14 times higher than the mean of countries in the west and central Africa region.

Countries with CS use of 15% or more were more likely to have higher levels of socioeconomic development, women's education, urbanisation, density of physicians, and lower fertility rate than countries with CS use in less than 10% of births. Within the group of countries with CS use in 15% of births or more, none of the societal determinants was associated with the frequency of CS use. Among countries with a low frequency of CS use (10% or lower), only fertility was a significant determinant: higher total fertility rate was associated with a lower frequency of CS use. Differences within countries were also large. In low-income and middle-income countries, births in households in the wealthiest quintile had almost five times more frequent CS use than those in the poorest quintile. Within large-population countries, CS use between regions and provinces often differed by a factor of at least five. The median intra-institutional use of CS was 1·6 times higher (IQR 1·2–2·2) in private facilities compared with public facilities.

Conclusions

There are several limitations to our analysis. First, we were unable to obtain recent data for all countries and, for a small proportion of countries (26 [15·4%] of 169 countries), we only had one data point during 2000–15, so we used additional data points in the 1990s to obtain better information on trends. We did, however, have data for mode of delivery that represented 98·4% of the world's births in 2015. Second, we relied heavily on survey data for low-income and middle-income countries. The recall of CS use in surveys might be biased, but validation and reliability studies in several countries have shown that recall of CS is good in most settings.[19–21] All CS use data were expressed per 100 livebirths, in accordance with the standard definition; a better measure would be CS use as a proportion of all births, including stillbirths, but such data were not available.

We used the population CS use thresholds of 10% as an indicator of poor access and 15% as an indicator of overuse of CS. The optimal threshold of CS use is difficult to determine. A 2014 systematic review[2] of the evidence of the association between CS use and mortality concluded that CS use improved maternal, neonate, and infant survival until a threshold ranging from 9% to 16%, but that socioeconomic factors could be the main explanation for the association between CS use and mortality. Another study[22] in six countries showed that a minimum CS use of 9% was needed to meet the prevalence of six potentially life-saving indicators, such as major antepartum haemorrhage or obstructed labour. We have found that in Brazil and China, which both report very frequent CS use and a high proportion of births within health facilities, there were only small differences in the prevalence of obstetric problems (namely, complications such as breech and other abnormal presentations) between the three groups of women with different educational duration (about 5–6%) and multiple pregnancies (1·5–2·2%) and modest differences in the prevalence of preterm birth (5–10%). WHO multi-country studies[15,16] in 2004–08 and 2010–11 showed similar frequencies of breech and other abnormal fetal presentations, multiple pregnancies, and preterm birth to those that we present in Brazil and China. Within these high-risk categories, CS is an important and leading intervention, but not the only intervention. Optimal CS frequency will vary depending on the prevalence of the obstetric problems and the capacity of the health facility to implement high-quality obstetric interventions.

The current high frequency of CS use is of concern for medical education: young medics have become experts in CS but are losing the wider art of obstetrics and vaginal assisted deliveries. Staff must be supported to develop the

skills to provide quality support for both uncomplicated birth and emergency care.

CS use is a health service indicator that has one of the largest disparities between the rich and the poor. However, our analysis shows that many women in low-income and middle-income countries still do not have adequate access to CS. CS use is increasing, mainly driven by increases in the proportion of deliveries occurring in health institutions, but the frequency of birth by CS is still less than 10% in many countries. In several countries, the proportion of births by CS in poor and vulnerable women is close to 0%, implying that some women die because they cannot access life-saving surgery during childbirth. Almost all countries with low frequencies of CS use have inadequate health systems, where surgical facilities and health workforce shortages are persistent obstacles to reaching all women with emergency CS, especially in rural areas and in vulnerable populations. Wealthier women, who often live in urban areas, generally have much better access to CS services than poor women.

By contrast, there is strong evidence of overuse of CS (ie, beyond what is medically necessary) in all parts of the world. There are few common medical interventions with such great differences between and within countries and regions. Our analysis did not identify factors that could explain why some countries have very common CS use and others have not.

The third paper in the Series,[9] however, identifies that the drivers of high and increasing use of CS include factors related to women's agency, families, communities, and the broader society; factors related to health professionals; and health-care system characteristics, financing, and culture. The reasons for women to demand CSs without a medical indication include fear of labour pain, or of labour effects such as pelvic floor damage, urinary incontinence, or reduced quality of sexual functioning. Cultural perceptions and myths also have a role in women choosing birth by CS, as do perception of care quality, logistics, costs, and agency. Previous negative experiences of vaginal birth and of care are also influences. Most women who prefer a CS perceive it to be safer for themselves or for their baby.[9] Further, the physician or obstetrician is often central to the choice of delivery mode in most countries. Logistical and financial incentives, fear of litigation, and the demands of women are factors with which health-care providers contend. Society in general, particularly the legal profession, might believe that CSs are protective, contrary to scientific evidence. Consequently, practitioners could be more likely to be sued for complications during vaginal delivery than for unnecessary CS.

All these driving factors are analysed in detail in the third paper of this Series,[9] whereas the second paper[8] explores the short-term and long-term effects of CS.[23] Further work is needed to understand why CS use is so frequent in many upper middle-income and high-income countries, and why CS is increasingly used among wealthier and urban women in low-income and lower middle-income countries. The Robson classification provides useful data to assess and monitor the use of CS among different groups of women but it does not identify the reasons for the CS nor assess the full array of medical conditions and obstetric complications.[8] More research is needed to understand the high frequency of CS use and its determinants in some countries and the very low use of CS in other countries, to provide a more solid basis for interventions towards an optimal frequency of CS use for mothers and children.

Contributors

TB, CR, and MT conceptualised the paper. TB wrote the first draft and all authors contributed to revisions. DYM led the estimation work. TB, AJDB, and ARH ran the survey data analyses by wealth quintile and private sector. CR, FCB, LJ, MY, and DdLRN did the Brazil and China analyses by use of the Robson classification. All authors reviewed and approved the final manuscript.

Declaration of interests

We declare no competing interests.

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