

# BMJ Open Association between prelabour caesarean section and perinatal outcomes: analysis of demographic and health surveys from 26 low-income and middle-income countries

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**To cite:** Opiyo N, Bellizzi S, Torloni MR, *et al.* Association between prelabour caesarean section and perinatal outcomes: analysis of demographic and health surveys from 26 low-income and middle-income countries. *BMJ Open* 2022;**12**:e053049. doi:10.1136/bmjopen-2021-053049

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-053049>).

Received 04 May 2021

Accepted 30 December 2021



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## ABSTRACT

**Objectives** Caesarean section (CS) conducted before labour (prelabour CS (PLCS)), compared with vaginal birth, may pose additional maternal and perinatal risks. No multicountry analysis has examined PLCS in low-income and middle-income countries (LMICs). This study assessed rates, risk factors and associations of PLCS with perinatal outcomes in LMICs.

**Design** Population-based cross-sectional surveys.

**Setting** Demographic and Health Surveys conducted between 2015 and 2018 in 26 LMICs (13 countries in Africa, 11 in Asia and 2 in the Americas).

**Participants** Women aged 15–49 years with singleton term births.

**Outcome measures** Main outcomes were early neonatal mortality, neonatal mortality, early breastfeeding (within 1 hour of birth), skin-to-skin contact and duration of hospital stay.

**Results** 255 227 women were included in the main analysis. Average rates of primary PLCS ranged from 1.3% in Zambia to 19.5% in Maldives. Median PLCS rate was 1.8% in the poorest versus 5.8% in the richest subgroups.

Higher maternal age, education, economic status and BMI, lower parity, urban residence, delivery in private hospitals, larger baby size, having health insurance, more antenatal care (ANC) visits, ANC by a doctor and ANC in private hospitals were associated with increased primary PLCS.

Across the 26 countries, primary PLCS, compared with vaginal delivery, was associated with increased neonatal mortality (adjusted odds ratio, aOR 1.2, 95% CI 1.0 to 1.5), decreased early breastfeeding (aOR 0.4, 95% CI 0.3 to 0.5) and skin-to-skin contact (aOR 0.4, 95% CI 0.3 to 0.5) and longer hospital stay (aOR 6.6, 95% CI 5.9 to 7.4). No significant association was found for early neonatal mortality (aOR 1.2, 95% CI 0.9 to 1.5).

**Conclusion** Primary PLCS, compared with vaginal birth, is associated with adverse perinatal outcomes in singleton term pregnancies in LMICs. Caesarean births should be audited regularly to monitor trends, appropriateness and context-specific drivers of CS.

## Strengths and limitations of this study

- This is the first study assessing national rates, risk factors and associations of prelabour caesarean section (CS) with perinatal outcomes. The analysis is based on a large sample (n=255 227 women) from 26 low-income and middle-income countries (LMICs).
- Detailed clinical data including the indication of prelabour CS were not reported in the Demographic and Health Surveys (DHSs). It was, therefore, not possible to distinguish between medically indicated and non-indicated prelabour CS in the analysis.
- The DHS is a cross-sectional survey, which precludes causal inference for the observed associations between prelabour CS and perinatal outcomes.
- We could not control for confounding bias by indication of prelabour CS. Given this limitation, caution should be exercised when interpreting the study results.

## INTRODUCTION

Although the onset of labour is not a fully understood phenomenon, it is likely triggered by interactive, finely coordinated anatomical and neurohormonal processes.<sup>1 2</sup> The result is that spontaneous labour onset in healthy, pregnant women at term usually occurs when both the mother and baby are at peak biophysical, neurohormonal and psychological readiness for birth and maternal–newborn transitions.<sup>2 3</sup> These innate processes are intended to facilitate optimal postnatal adaptation of the mother and newborn.

Physiologic labour and birth benefits include optimising maternal–newborn transitions and postnatal adaptations, breastfeeding, mother–infant attachment and other short-term and long-term health outcomes.<sup>4</sup>

Many contemporary perinatal interventions conducted before labour onset disrupt inherent mechanisms of labour and parturition, reduce their benefits and expose mothers and newborns to additional risks.<sup>3</sup>

When medically justified, obstetric interventions (such as induction or augmentation of labour, caesarean section (CS)) can reduce maternal and perinatal mortality and morbidity.<sup>5 6</sup> However, for healthy women and babies who do not require them, these interventions can disrupt physiologic processes, deprive the dyad of benefits and increase maternal and neonatal morbidity,<sup>4</sup> inducing epigenetic transgenerational changes.<sup>7 8</sup>

In the global context of escalating medicalisation, birth by CS is rising to unprecedented levels while not necessarily reaching women who really need the procedure.<sup>9 10</sup> The rise in the use of CS extends to low-income and middle-income countries (LMICs), where overuse and underuse coexist, and where the rate of CS complications is higher.<sup>11</sup> A caesarean section before spontaneous or induced labour (ie, prelabour CS) may be necessary due to clinical or obstetric complications (eg, maternal cardiopathy, pre-eclampsia or placental anomalies). However, where no clear medical indication exists, prelabour CS, compared with vaginal birth, may be associated with additional increased risks. Prelabour CS exposes women to major surgery and the baby to the risks of birth before complete maturity, and it deprives both the benefits of spontaneous labour.

The question on the timing of the decision to conduct a CS (ie, whether it was made before or after the onset of labour pains) was first introduced in the Demographic and Health Surveys (DHS) in 2015. A previous single-country DHS analysis showed that prelabour CS, compared with vaginal birth, is associated with a higher risk of neonatal mortality (prevalence ratio 3.79, 95% CI 1.03 to 13.93, n=10 641 women).<sup>12</sup> However, to our knowledge, no multicountry analysis has examined prelabour CS using DHS data.

## OBJECTIVES

Using nationally representative data from the DHS programme,<sup>13</sup> our objectives were:

- ▶ To estimate the proportion of prelabour CS among singleton, term deliveries without previous CS (considered lower risk women).
- ▶ To compare the rate of prelabour CS among lower risk women across countries by sociodemographic (eg, economic status, place of residence), childbirth (eg, place of delivery, size of baby) and antenatal care (ANC) (eg, number of visits, type of provider) characteristics.
- ▶ To assess association of prelabour CS, compared with vaginal birth, with perinatal outcomes (neonatal mortality, breastfeeding initiation, early skin-to-skin contact, duration of hospital stay).

- ▶ To compare the association of different types of caesarean birth (prelabour vs intrapartum CS) with perinatal outcomes.

## METHODS

### Data source

We searched the DHS programme website<sup>13</sup> and retrieved data for LMICs with information on timing of CS, from DHSs conducted between 2015 and 2018. DHSs are large-scale, nationally representative cross-sectional household surveys that are routinely conducted in LMICs to facilitate between-country comparisons.<sup>13</sup> The surveys employ a two-stage, stratified cluster sampling design.<sup>14</sup> In the first stage, each country is divided into geographic regions and the populations within the subnational regions stratified into urban and rural areas. These primary sampling units or clusters are selected with probability proportional to the contribution of that cluster's population to the total population. In the second stage, all households within a cluster are listed and a sample of households randomly selected for interviews by equal-probability systematic sampling.<sup>14</sup> DHSs are considered the best available method of obtaining several types of health indicators in LMICs.<sup>15</sup>

### Study population

We examined two study populations comprising women aged 15–49 years who reported having a childbirth in the last 5 years of the survey. The first population, named 'lower risk women' comprised singleton pregnancies at term in women with no previous CS. This group is similar to groups 1 to 4 of the Robson classification<sup>16</sup>. The second population comprised singleton pregnancies at term in women with previous CS.

### Exposure

The DHS questionnaire asks women about pregnancy, antenatal and delivery care for live births in the past 5 years. The data on CS and other variables in the DHS are collected based on mothers' self-report. The self-reported data on timing of CS were collected by asking mothers, the question: 'When was the decision made to have the caesarean section? Was it before or after your labour pains started?'. For this study, the exposure group comprised women who had a primary caesarean section (ie, first time CS) before the onset of labour pains and delivered a singleton infant at term. The unexposed group were women who had singleton, spontaneous, term, vaginal births in hospitals. History of a caesarean section before onset of labour pains was used as a proxy for prelabour CS.

### Outcomes

The outcomes examined comprised early neonatal mortality (defined as reported death of a child within 7 days of delivery), neonatal mortality (death during the first 28 days of life),<sup>17</sup> initiation of exclusive breastfeeding within 1 hour of birth, early skin-to-skin contact with baby (ie, skin-to-skin contact with mother immediately

following birth for at least 1 hour<sup>18</sup>) and duration of hospital stay.

### Covariates

We examined association of prelabour CS with a diverse set of maternal factors for the index pregnancy during the survey period: sociodemographic characteristics (maternal age at birth of child, parity, body mass index (BMI), economic status, education, place of residence, health insurance status); characteristics of childbirth (place of delivery, size of baby) and characteristics of ANC (number of visits, type of provider, time of first visit, location where ANC received). These factors were selected a priori based on the existing literature<sup>19 20</sup> and preanalytical assumptions of plausible associations with prelabour CS.

### Analysis

Our statistical analysis is divided into three parts. First, we computed, for each study population (ie, singleton, term pregnancies with and without previous CS), average prelabour CS with 95% CI for each country. We further disaggregated the average prelabour CS by asset-based household wealth quintiles (poorest, poorer, middle, richer, richest) and by place of residence (urban and rural). We then computed difference and ratio measures between richest and poorest quintiles, and urban and rural areas, to quantify absolute and relative differences in prelabour CS. Disaggregated proportions of wealth quintiles were presented using Box plots together with medians (mid-point estimates) and interquartile range.

Second, differences in the proportions of maternal factors (sociodemographic, childbirth, ANC characteristics) across delivery types (prelabour CS, intrapartum CS, vaginal delivery) were examined using  $\chi^2$  tests. Association of delivery type with outcomes was estimated using odds ratios (ORs), calculated by multivariable logistic regression. ORs were adjusted for all sociodemographic, childbirth and ANC variables. Adjusted ORs (aORs) were estimated using variance-component (random intercept) multilevel logistic regression. The stratified multistage sampling design (women nested in clusters, nested in

countries) and the survey normalised weights were taken into account in the analyses using the survey commands in Stata V.14.2 (StataCorp, College Station, Texas, USA).

Last, for each of the two study populations examined, we carried out sensitivity analysis using all pregnancies (ie, including preterm pregnancies). All statistical tests were two tailed and p less than 0.05 was considered statistically significant. We used Stata V.14.2 (StataCorp) for all analyses.

### Missing data

There were missing data on eight variables: size of baby at birth (6.7% of the pooled sample), occupation (42.6%), BMI (30.0%), health insurance status (10.8%), number of antenatal visits (1.1%), ANC provider (7.2%), first ANC visit (7.5%) and ANC location (12.9%). Missing values were excluded from logistic regression analyses. Further information on missing data for each variable is provided in the result tables.

### Patient and public involvement

Patients and the public were not involved in the design and conduct of this research.

We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline<sup>21</sup> in reporting this study.

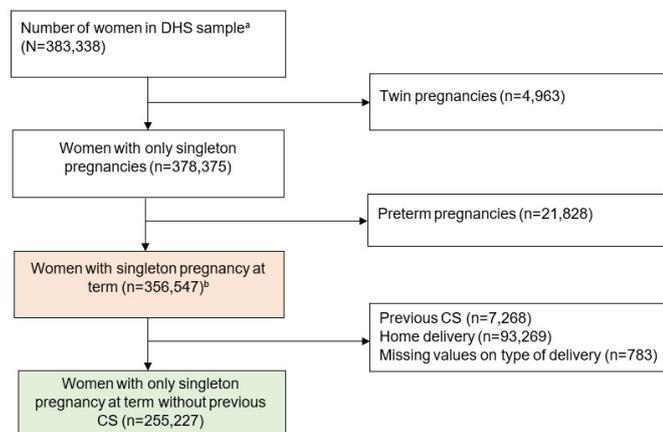
## RESULTS

We identified 26 LMICs that had DHSs with information on timing of CS (**figure 1**). Thirteen countries were from the African region (Angola, Benin, Burundi, Ethiopia, Guinea, Malawi, Mali, Nigeria, Senegal, Tanzania, Uganda, Zambia and Zimbabwe). Eleven countries were from the Asian region (Albania, Armenia, India, Indonesia, Jordan, Maldives, Nepal, Pakistan, Philippines, Tajikistan and Timor Leste). Two countries were from the American region (Colombia, Haiti).

**Figure 2** shows the study profile. A total of 255 227 women (singleton, term pregnancies, without previous CS) from



**Figure 1** Twenty-six low-income and middle-income countries included in the analysis.



**Figure 2** Flow diagram showing the selection of study participants. <sup>a</sup>Sample comprises 26 low-income and middle-income countries; <sup>b</sup>Including those with previous CS. CS, caesarean section; DHS, Demographic and Health Survey.

26 LMICs were included in the main analysis. The sample included 13 countries in Africa, 11 in Asia and 2 in America. The smallest sample ( $n=1334$  women) was from Armenia and the largest ( $n=1\,321\,03$  women) was from India (table 1). Average caesarean rates varied substantially, from 4.2% in Mali to 38.0% in Maldives. Average prelabour CS rates ranged from 1.3% in Zambia to 19.5% in Maldives.

Table 2 shows rates of primary prelabour CS by economic status across the 26 countries. Prelabour CS rates were lower in poorer women and tended to increase with rising economic status (figure 3). The median prelabour CS rate was 1.8% among women in the poorest quintile compared with 5.8% among women in the richest quintile. Substantial differences (exceeding 10 percentage points) in rates of prelabour CS between women in the richest and poorest quintiles were observed in seven countries (Albania, Indonesia, India, Colombia, Nepal, Pakistan and Philippines). Prelabour CS rate was higher among women in the poorest quintile compared with women in the richest quintile (4.6 percentage points difference) in one country (Maldives). In Africa, the largest difference was found in Burundi and Uganda (5.0 percentage points difference between the richest and poorest quintiles), while the largest ratio was in Nigeria, where prelabour CS was 37 times higher among women in the richest quintile compared with women in the poorest quintile (3.7% in the richest quintile vs 0.1% in the poorest quintile). In Asia, the largest difference was found in Pakistan (18.9 percentage points between the richest and poorest quintiles) while Nepal showed the largest ratio, with prelabour CS in the richest quintile, 17.5 times higher than in the poorest quintile.

Table 3 shows rates of prelabour CS by place of residence across the 26 countries. Prelabour CS rates were higher in urban areas compared with rural areas in all countries, apart from Maldives, where rates were higher in rural areas (3.5 percentage point difference). The largest difference in urban–rural prelabour CS rates (exceeding

**Table 1** Caesareans in women with singleton, term pregnancies without previous caesareans in 26 low-income and middle-income countries

Country*	Total number of women	Intrapartum and prelabour CS	Average primary prelabour CS
	N	n (%)	n (%)
<b>Africa</b>			
Angola	3879	235 (6.1)	75 (1.9)
Benin	6506	351 (5.4)	118 (1.8)
Burundi	6783	410 (6.0)	155 (2.3)
Ethiopia	2548	199 (7.8)	80 (3.1)
Guinea	2737	148 (5.4)	72 (2.6)
Malawi	10897	712 (6.5)	145 (1.3)
Nigeria	8417	494 (5.9)	204 (2.4)
Senegal	6207	336 (5.4)	138 (2.2)
Mali	4076	171 (4.2)	64 (1.6)
Tanzania	4472	382 (8.5)	88 (2.0)
Uganda	6165	475 (7.7)	142 (2.3)
Zambia	5706	290 (5.1)	73 (1.3)
Zimbabwe	3752	245 (6.5)	87 (2.3)
<b>Asia</b>			
Tajikistan	3532	194 (5.5)	90 (2.5)
Indonesia	11 164	2342 (21.0)	879 (7.9)
Philippines	5910	808 (13.7)	471 (8.0)
Timor Leste	2183	168 (7.7)	96 (4.4)
India	132 103	22 738 (17.2)	12 167 (9.2)
Maldives	2116	805 (38.0)	413 (19.5)
Nepal	2219	300 (13.5)	158 (7.1)
Pakistan	4910	1094 (22.3)	724 (14.7)
Armenia	1334	208 (15.6)	174 (13.0)
Jordan	6165	1247 (20.2)	862 (14.0)
Albania	2208	598 (27.1)	424 (19.2)
<b>Americas</b>			
Colombia	7376	2710 (36.7)	1209 (16.4)
Haiti	1862	243 (13.0)	94 (5.0)
<b>All countries</b>			
Total	255 227	37 903 (14.9)	19 202 (7.5)

\*Categorised according to United Nations geographical grouping. CS, caesarean section.

five percentage points) was observed in five countries (Albania, Burundi, Colombia, India and Pakistan).

Table 4 shows characteristics of women with primary prelabour CS compared with primary intrapartum CS and vaginal deliveries. Overall, across the 26 countries, prelabour CS was higher among women aged more than 35 years, with higher education, residing in urban areas, with higher economic status, having health insurance, nulliparous women, with higher BMI, giving birth to very large

**Table 2** Primary prelabour caesarean sections by economic status in 26 low-income and middle-income countries\*

Country†	Average	Poorest	Poorer	Middle	Richer	Richest	Difference (richest–poorest)	Ratio (richest/poorest)
<b>Africa</b>								
Angola	1.9 (1.5–2.4)	0.3 (0.1–0.5)	0.5 (0.2–0.7)	0.7 (0.5–0.9)	1.0 (0.7–1.3)	3.4 (3.0–3.8)	3.1	11.3
Benin	1.8 (1.5–2.2)	0.3 (0.1–0.5)	0.6 (0.4–0.8)	0.9 (0.6–1.2)	1.9 (1.4–2.3)	4.5 (3.9–5.1)	4.2	15.0
Burundi	2.3 (1.9–2.7)	0.6 (0.3–0.9)	0.9 (0.6–1.2)	0.8 (0.5–1.3)	1.4 (1.1–1.8)	5.6 (5.9–6.2)	5.0	9.3
Ethiopia	3.1 (2.5–3.9)	0.2 (0.1–0.4)	0 (0)	0.3 (0.1–0.5)	0.2 (0.1–0.4)	4.6 (3.9–5.5)	4.4	23.0
Guinea	2.6 (2.1–3.3)	0.2 (0.1–0.4)	0.5 (0.2–0.8)	1.2 (0.8–1.6)	2.3 (1.8–2.7)	3.3 (2.6–4.1)	3.1	16.5
Malawi	1.3 (1.1–1.6)	0.4 (0.2–0.7)	0.7 (0.3–1.1)	1.1 (0.7–1.5)	1.5 (1.0–2.1)	2.7 (2.1–3.2)	2.3	6.7
Nigeria	2.4 (2.1–2.8)	0.1 (0.1–0.3)	0.1 (0.1–0.3)	0.6 (0.3–1.0)	1.4 (1.0–1.9)	3.7 (3.2–4.2)	3.6	37.0
Senegal	2.2 (1.9–2.6)	0.8 (0.3–1.2)	1.1 (0.9–1.4)	1.5 (1.2–1.8)	3.3 (2.9–3.7)	3.9 (3.5–4.4)	3.1	4.9
Mali	1.6 (1.2–2.0)	0.5 (0.2–0.9)	0.5 (0.2–0.9)	0.7 (0.3–1.0)	1.1 (0.8–1.4)	2.5 (2.0–3.0)	2.0	5.0
Tanzania	2.0 (1.6–2.4)	0.2 (0.1–0.4)	0.7 (0.3–1.0)	0.6 (0.3–0.9)	1.3 (1.0–1.6)	3.9 (3.4–4.4)	3.7	19.5
Uganda	2.3 (1.9–2.7)	0.5 (0.2–0.9)	0.6 (0.3–0.9)	1.0 (0.7–1.3)	1.3 (1.0–1.6)	5.5 (5.1–5.9)	5.0	11
Zambia	1.3 (1.0–1.6)	0.5 (0.2–0.9)	0.4 (0.2–0.6)	0.9 (0.6–1.2)	0.9 (0.6–1.2)	3.8 (3.4–4.3)	3.3	7.6
Zimbabwe	2.3 (1.9–2.8)	0.6 (0.2–1.0)	0.4 (0.2–0.6)	0.8 (0.4–1.2)	2.1 (1.7–2.6)	5.0 (4.2–5.8)	4.4	8.3
<b>Asia</b>								
Tajikistan	2.5 (2.1–3.1)	1.9 (1.4–2.3)	1.8 (1.4–2.2)	2.1 (1.5–2.6)	2.1 (1.5–2.6)	2.9 (2.5–3.4)	1.0	1.5
Indonesia	7.8 (7.4–8.4)	1.7 (1.3–2.1)	3.9 (3.3–4.5)	5.2 (4.6–5.8)	7.4 (6.7–8.1)	14.2 (13.6–14.9)	12.5	8.3
Philippines	8.0 (7.3–8.7)	2.1 (1.7–2.4)	3.8 (3.4–4.2)	7.3 (6.8–7.7)	11.0 (10.5–11.6)	16.1 (15.5–16.8)	14.0	7.7
Timor Leste	4.4 (3.6–5.3)	1.1 (0.5–1.6)	1.1 (0.5–1.6)	2.0 (1.4–2.5)	2.5 (1.8–3.2)	4.6 (3.7–5.5)	3.5	4.2
India	9.2 (9.0–9.4)	1.5 (1.3–1.8)	3.6 (3.4–3.8)	7.3 (7.1–7.5)	11.7 (11.5–11.9)	16.6 (16.4–16.8)	15.1	3.2
Maldives	19.3 (17.9–21.3)	18.1 (17.6–18.6)	17.2 (16.5–17.9)	19.7 (19.1–20.3)	21.3 (19.4–22.2)	13.9 (13.2–24.5)	–4.6	0.8
Nepal	7.1 (6.1–8.3)	0.9 (0.5–10.4)	2.3 (1.6–3.0)	3.4 (2.8–4.1)	4.1 (3.5–4.9)	15.8 (14.8–16.7)	14.9	17.5
Pakistan	14.7 (13.8–15.8)	2.7 (2.4–3.1)	4.7 (4.2–5.1)	8.7 (8.2–9.3)	14.2 (13.4–15.0)	21.6 (20.6–22.7)	18.9	8.0
Armenia	13.0 (11.3–15.0)	11.7 (11.0–12.8)	13.3 (12.9–14.1)	11.6 (10.6–12.5)	13.6 (12.7–14.5)	14.8 (13.9–15.7)	3.1	1.3
Jordan	13.5 (11.5–15.1)	10.3 (9.2–11.4)	13.8 (12.7–14.9)	14.1 (13.0–14.3)	17.1 (16.0–18.3)	17.2 (16.0–18.4)	6.9	1.7
Albania	19.2 (17.6–20.9)	14.5 (13.2–15.7)	14.7 (13.6–15.9)	20.5 (19.2–21.7)	24.1 (22.9–25.3)	31.0 (29.5–32.6)	12.1	2.1
<b>Americas</b>								
Colombia	16.4 (15.6–17.2)	9.0 (8.3–9.8)	17.7 (17.3–18.2)	17.9 (17.2–18.6)	19.5 (19.0–20.1)	23.6 (23.0–24.2)	14.6	2.6

Continued

Table 2 Continued

Country†	Average	Poorest	Poorer	Middle	Richer	Richest	Difference (richest–poorest)	Ratio (richest/poorest)
Haiti	5.0 (4.1–6.1)	0.2 (0.1–0.5)	0.3 (0.1–0.6)	1.5 (1.2–1.9)	2.8 (2.4–3.3)	7.8 (6.9–8.7)	7.6	39.0
<b>All countries</b>								
Median‡	–	1.8 (0.7–5.6)	1.5 (0.9–5.3)	2.4 (1.1–8.8)	3.3 (1.6–13.1)	5.8 (4.1–16.8)	–	–

\*Values are percentages (95% confidence intervals).

†Categorised according to United Nations geographical grouping.

‡Values in brackets indicate the interquartile range (middle 50% of estimates).

babies, in private facilities. Similar patterns of results were observed in stratified regional analyses, except for size of baby at birth (where higher rates were observed among women with very small babies in Africa) (online supplemental appendix 1: tables S1–S3).

Table 5 shows the characteristics of ANC in women with primary prelabour CS compared with primary intrapartum CS and vaginal deliveries. Overall, across the 26 countries, prelabour CS was higher among women who started ANC in the first trimester, had more than three ANC visits, where ANC was provided by a doctor, and in a private hospital. Similar patterns of results were observed in stratified regional analyses in Africa, Asia and America (online supplemental appendix 2: tables S4–S6).

Table 6 illustrates the results of adjusted multinomial logistic regression exploring association of maternal factors with primary prelabour CS. Factors significantly associated with increased odds of prelabour CS, compared with vaginal birth, were higher maternal age at birth, higher maternal education, urban residence, delivery in a private hospital, higher economic status, having health insurance, lower parity, higher BMI and larger size of baby. ANC factors significantly associated with increased odds of prelabour CS, compared with vaginal birth, were having more than three ANC visits, ANC by a doctor and receiving ANC from a private hospital. No

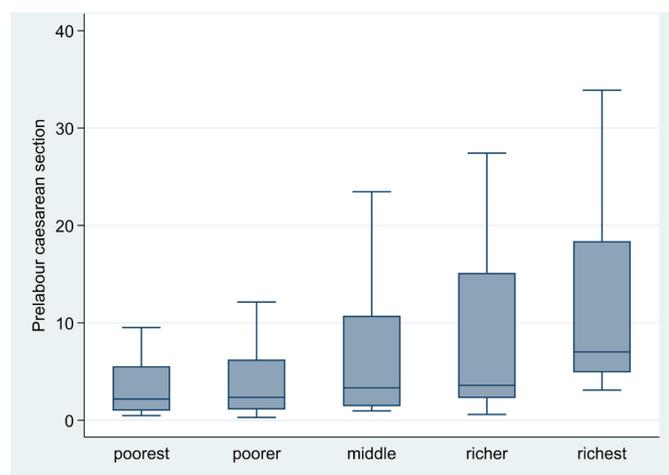
significant association was found for timing of first ANC visit (table 7).

### Perinatal outcomes

Table 8 shows association of primary prelabour CS with perinatal outcomes. Across the 26 countries, prelabour CS, compared with vaginal delivery, was associated with significantly increased odds of neonatal mortality, aOR 1.2, 95% CI 1.0 to 1.5. However, no significant association was found for early neonatal mortality (aOR 1.2, 95% CI 0.9 to 1.5). Compared with vaginal delivery, prelabour CS was associated with decreased odds of early skin-to-skin contact (aOR 0.4, 95% CI 0.3 to 0.5), decreased odds of initiation of breastfeeding within 1 hour of birth (aOR 0.4, 95% CI 0.3 to 0.5) and increased hospital stay more than 72 hours (aOR 6.6, 95% CI 5.9 to 7.4).

Region-specific associations of prelabour CS with perinatal outcomes are shown in online supplemental appendix 1: tables S7–S9. Across geographical regions, prelabour CS, compared with vaginal delivery, was associated with increased odds of neonatal mortality in Africa (aOR 2.2, 95% CI 1.3 to 3.7). However, no significant association was found in Asia (aOR 1.2, 95% CI 0.9 to 1.5) and Americas (aOR 2.4, 95% CI 0.5 to 11.2). Similarly, prelabour CS compared with vaginal delivery, was associated with increased odds of early neonatal mortality in Africa (aOR 2.3, 95% CI 1.3 to 4.1), but no significant association was found in Asia (aOR 1.2, 95% CI 0.9 to 1.5) and America (aOR 2.4, 95% CI 0.5 to 11.3). Compared with vaginal delivery, prelabour CS was associated with decreased odds of early skin-to-skin contact (aOR 0.2, 95% CI 0.1 to 0.3), decreased odds of initiation of breastfeeding within 1 hour of birth (aOR 0.2, 0.1 to 0.3) and increased hospital stay more than 72 hours (aOR 19.6, 95% CI 14.1 to 27.4) in Africa. Similar trend of associations was found in Asia and Americas.

Similar patterns of results were found for analyses comparing association of different types of caesarean birth (prelabour and intrapartum CS) with perinatal outcomes, except for early neonatal mortality (where a significant association was found between intrapartum CS and early neonatal mortality in pooled data from 26 countries, aOR 1.7, 95% CI 1.4 to 2.1) (table 8) and neonatal mortality (where a significant association was found between intrapartum CS and neonatal mortality



**Figure 3** Primary prelabour CS rates by economic status in 26 low-income and middle-income countries. CS, caesarean section.

**Table 3** Primary prelabour caesarean section by place of residence in 26 low-income and middle-income countries\*

Country†	Average	Urban		Rural		Difference (urban–rural)	Ratio (urban/rural)
<b>Africa</b>							
Angola	1.9 (1.5–2.4)	2.0	1.5–2.5	1.8	1.3–2.3	1.2	1.1
Benin	1.8 (1.5–2.2)	3.0	2.5–3.5	1.0	0.6–1.5	2.0	3.0
Burundi	2.3 (1.9–2.7)	6.5	6.1–6.9	1.3	0.9–1.6	5.2	5.0
Ethiopia	3.1 (2.5–3.9)	5.6	4.7–6.2	1.1	0.4–1.6	4.5	5.1
Guinea	2.6 (2.1–3.3)	3.8	3.3–5.2	1.5	1.0–2.1	2.3	2.5
Malawi	1.3 (1.1–1.6)	3.2	2.9–3.5	0.9	0.6–1.3	2.3	3.5
Nigeria	2.4 (2.1–2.8)	3.1	2.5–3.6	1.7	1.1–2.3	1.4	1.8
Senegal	2.2 (1.9–2.6)	3.2	2.7–3.8	1.5	0.9–2.1	1.7	2.1
Mali	1.6 (1.2–2.0)	2.1	1.7–2.5	1.3	0.7–1.9	0.8	1.6
Tanzania	2.0 (1.6–2.4)	3.3	2.7–3.8	1.2	0.5–2.2	2.1	2.7
Uganda	2.3 (1.9–2.7)	4.9	4.0–5.5	1.4	0.8–2.1	3.5	3.5
Zambia	1.3 (1.0–1.6)	2.2	1.8–2.6	0.8	0.5–1.0	1.4	2.7
Zimbabwe	2.3 (1.9–2.8)	4.2	3.7–4.9	0.9	0.5–1.4	3.3	4.7
<b>Asia</b>							
Tajikistan	2.5 (2.1–3.1)	2.7	2.4–3.0	2.4	1.8–2.9	0.3	1.1
Indonesia	7.8 (7.4–8.4)	9.5	9.1–10.0	5.6	5.2–6.1	3.9	1.7
Philippines	8.0 (7.3–8.7)	10.3	9.7–10.9	6.7	6.1–7.2	3.6	1.5
Timor Leste	4.4 (3.6–5.3)	5.2	4.5–5.8	3.6	2.9–4.4	1.6	1.4
India	9.2 (9.0–9.4)	14.5	14.3–14.7	7.1	6.9–7.3	7.4	1.9
Maldives	19.3 (17.9–21.3)	16.3	15.5–17.1	19.8	18.9–20.7	–3.5	0.8
Nepal	7.1 (6.1–8.3)	7.5	7.0–8.1	6.3	5.8–6.9	2.2	1.2
Pakistan	14.7 (13.8–15.8)	17.4	16.8–18.0	11.8	11.0–6.7	5.6	1.5
Armenia	13.0 (11.3–15.0)	13.9	13.3–14.5	11.9	11.4–12.4	2.0	1.2
Jordan	13.5 (11.5–15.1)	14.6	14.1–15.0	11.8	11.4–12.3	2.8	1.2
Albania	19.2 (17.6–20.9)	23.5	22.9–24.0	16.0	15.4–16.5	7.5	1.5

Continued



Table 3 Continued

Country†	Average	Urban		Rural		Difference (urban–rural)	Ratio (urban/rural)
<b>Americas</b>							
Colombia	16.4 (15.6–17.2)	18.2	17.7–18.8	11.6	10.6–11.7	6.6	1.6
Haiti	5.0 (4.1–6.1)	7.2	6.6–7.9	3.0	2.1–3.8	4.2	2.4

\*Values are percentages (95% confidence intervals).

†Categorised according to United Nations geographical grouping.

in the Asian region, aOR 1.7, 95% CI 1.4 to 2.1) (online supplemental appendix 2: table S8).

### Ancillary analyses

We conducted three sets of additional analyses. In the first set, we computed, for each country, average and disaggregated (by household wealth quintiles and place of residence) prelabour CS among women with previous CS (online supplemental appendix 2: tables S1–S3). Prelabour CS rates and differences between richest and poorest quintiles and urban and rural areas were generally larger, but followed similar patterns as those for women without previous CS.

In the second set of analysis, we explored associations of prelabour CS with various maternal characteristics restricted to women with previous CS (online supplemental appendix 2: tables S4–S11). We found similar pattern of results as those for women without previous CS, except for parity (where higher rates of prelabour CS was found among women of parity 1 to 2 with previous CS in Africa).

Findings for analyses comparing associations of prelabour CS with perinatal outcomes for women with previous CS were similar to those for women without previous CS, except for early neonatal mortality (where prelabour CS increased odds of early neonatal mortality among women with previous CS in pooled analyses across the 26 countries, aOR 1.6, 95% CI 1.4 to 1.9) and neonatal mortality (where prelabour CS increased odds of neonatal mortality among women with previous CS in Asia, aOR 1.3, 95% CI 1.1 to 1.6) (online supplemental appendix 2: tables S12–S15). Similar patterns of results were found for analyses comparing association of different types of caesarean birth (prelabour and intrapartum CS) with perinatal outcomes (online supplemental appendix 2: tables S12–S15).

In the third set of analysis of all pregnancies (term and preterm), prelabour CS was associated with increased neonatal mortality (aOR 1.2, 95% CI 1.0 to 1.5) and early mortality (aOR 1.3, 95% CI 1.0 to 1.4) among women without previous CS (online supplemental appendix 1: table S10–S11). Similarly, prelabour CS was associated with increased neonatal mortality (aOR 1.3, 95% CI 1.1 to 1.6) among women with previous CS (online supplemental appendix 2: tables S16 and S17). However, no

significant association with early neonatal mortality was observed.

## DISCUSSION

### Interpretation of results

We examined nationally representative primary prelabour CS rates, risk factors and the relationship between prelabour CS with perinatal outcomes in 255 227 lower risk pregnancies across 26 LMICs. Prelabour CS rates varied substantially across countries, ranging from 1.3% in Zambia to 19.5% in the Maldives. Differences across wealth subgroups were also significant, with the rate among women in the wealthiest subgroup about three times in the poorest subgroup. The highest prelabour CS rates and the most remarkable absolute differences between the richest and the poorest subgroups were observed in Asian countries. In contrast, countries from the African region had low prelabour CS rates and comparatively lower absolute differences between the richest and poorest subgroups. However, relatively large differences were also found in some African countries (eg, Angola, Benin, Ethiopia, Guinea, Nigeria, Tanzania, Uganda). The lack of a universal benchmark for optimal rate of prelabour CS, however, limits interpretation of our findings.

The low rates of prelabour CS in African countries and among women in poor and rural subgroups likely indicate inadequate access among women in need (underuse of CS). Conversely, higher rates of prelabour CS in some of the countries in Asia and the Americas and among women in wealthy and urban subgroups likely indicate overuse, possibly without medical indication.

Compared with vaginal births, babies born by CS prior to labour onset had a higher risk of dying during the neonatal period, reduced likelihood of early skin-to-skin contact with mother, delayed initiation of exclusive breastfeeding and increased duration of hospital stay. Associations of prelabour CS with perinatal outcomes were largely comparable to those for intrapartum CS. This suggests that unnecessary caesareans are likely concealed both among prelabour and intrapartum caesareans (strategies, to reduce unnecessary caesareans, should, therefore, focus on preventing both avoidable prelabour

**Table 4** Characteristics of women with primary prelabour CS in the index pregnancy compared with primary intrapartum CS and vaginal deliveries in 26 low-income and middle-income countries

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
<b>Maternal age (years)</b>					
<16	227	11 (4.8)	13 (5.7)	203 (89.4)	<0.001
16 to 35	222 743	16 091 (7.2)	16 482 (7.4)	190 170 (85.4)	
>35	32 257	3 100 (9.6)	2 206 (6.8)	43 997 (83.6)	
<b>Maternal education</b>					
No education	54 584	1 752 (3.2)	1 988 (3.6)	50 744 (93.2)	<0.001
Primary	53 029	2 172 (4.1)	2 668 (5.0)	48 187 (90.9)	
Secondary	114 541	9 915 (8.7)	9 555 (8.3)	95 059 (83.0)	
Higher	33 191	5 363 (16.3)	4 490 (13.4)	23 334 (70.3)	
<b>Place of residence</b>					
Urban	92 070	9 862 (10.7)	8 812 (9.6)	73 386 (79.7)	<0.001
Rural	163 176	9 340 (5.7)	9 889 (6.1)	143 938 (88.2)	
<b>Economic status</b>					
Poorest	47 867	1 621 (3.4)	2 123 (4.4)	44 121 (92.2)	<0.001
Poorer	53 704	2 764 (5.1)	3 045 (5.7)	47 890 (89.2)	
Middle	53 804	3 845 (7.1)	3 827 (7.1)	46 131 (85.8)	
Richer	51 371	4 827 (9.4)	4 440 (8.6)	42 098 (82.0)	
Richest	48 500	6 145 (12.7)	5 266 (10.9)	37 084 (76.4)	
<b>Health insurance cover</b>					
Yes	36 645	3 884 (10.6)	3 441 (9.4)	29 306 (80.0)	<0.001
No	191 173	13 156 (6.9)	12 906 (6.7)	165 106 (86.4)	
Missing	27 428	2 162	2 354	22 912	
<b>Parity</b>					
0	85 005	8 825 (10.4)	10 634 (12.5)	65 546 (77.1)	<0.001
1 to 2	113 608	8 481 (7.5)	6 190 (5.4)	98 928 (87.1)	
≥3	56 626	1 896 (3.3)	1 877 (3.3)	52 850 (93.4)	
<b>BMI (kg/m<sup>2</sup>)</b>					
Underweight (<18.5)	32 222	1 501 (4.7)	1 548 (4.8)	29 173 (90.5)	<0.001
Normal weight (18.5–24.9)	108 829	7 443 (6.8)	7 208 (6.6)	94 178 (86.6)	
Overweight (25–29.9)	27 849	3 796 (13.6)	2 980 (10.7)	21 073 (75.7)	
Obese (≥30)	9 693	1 791 (18.5)	1 213 (12.5)	6 689 (69.0)	
Missing	76 653	4 671	5 752	66 211	
<b>Place of delivery</b>					
Private hospital	60 976	9 383 (15.4)	8 727 (14.3)	42 854 (70.3)	<0.001
Public hospital	194 270	9 819 (5.0)	9 974 (5.1)	174 470 (89.9)	
<b>Size of baby at birth</b>					
Very large	16 892	1 284 (7.6)	1 335 (7.9)	14 273 (84.5)	<0.001
Larger than average	39 411	2 822 (7.2)	3 063 (7.8)	33 520 (85.0)	
Average	153 333	11 052 (7.2)	10 076 (6.6)	132 194 (86.2)	
Smaller than average	21 593	1 424 (6.6)	1 423 (6.6)	18 745 (86.6)	
Very small	6 984	452 (6.5)	483 (6.9)	6 048 (86.6)	
Missing	17 033	2 168	2 321	12 544	

BMI, body mass index; CS, caesarean section.

**Table 5** Characteristics of antenatal care in pregnancies with primary prelabour CS compared with primary intrapartum CS and vaginal deliveries in 26 low-income and middle-income countries

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
<b>Time of first ANC visit</b>					
First trimester	152 798	14 604 (9.6)	13 380 (8.8)	124 814 (81.6)	<0.001
Second trimester	72 587	2 997 (4.1)	3 929 (5.4)	65 661 (90.5)	
Third trimester	10 841	754 (7.0)	680 (6.3)	9 407 (86.7)	
Missing	19 001	847	712	17 442	
<b>Number of antenatal visits</b>					
0	18 205	794 (4.4)	677 (3.7)	16 734 (91.9)	<0.001
1 to 3	73 915	3 095 (4.2)	3 734 (5.0)	67 086 (90.8)	
>3	160 260	15 010 (9.4)	14 092 (8.8)	131 158 (81.8)	
Missing	2 847	303	198	2 346	
<b>ANC provider</b>					
Doctor	107 065	12 888 (12.0)	10 794 (10.1)	83 383 (77.9)	<0.001
Nurse/midwife	75 516	3 151 (4.2)	4 174 (5.5)	68 191 (90.3)	
Clinical officer	27 329	933 (3.4)	1 413 (5.2)	24 983 (91.4)	
Other (+TBA)	26 981	1 419 (5.3)	1 629 (6.0)	23 933 (88.7)	
Missing	18 336	811	691	16 834	
<b>ANC location</b>					
Public hospital	174 868	10 271 (5.9)	10 739 (6.1)	153 858 (88.0)	<0.001
Private hospital	47 498	7 146 (15.0)	6 082 (12.8)	34 270 (72.2)	
Missing	32 861	1 785	1 880	29 196	

Clinical officer refers to non-physician clinician.

ANC, antenatal care; CS, caesarean section; TBA, traditional birth attendant.

and intrapartum caesareans). The results of the main analyses (lower risk pregnancies) were comparable to those of ancillary analyses restricted to higher risk pregnancies (ie, preterm and term pregnancies with previous CS), indicating that the observed associations are robust. The observed patterns of inequalities (across wealth, urban and rural subgroups), maternal risk factors and associations of prelabour CS with perinatal outcomes are consistent with those for overall CS reported in previous research.<sup>9 10 22–28</sup>

A confluence of factors may contribute to the observed higher neonatal mortality with prelabour CS (compared with vaginal birth), including medical indications for the surgery (such as complications during pregnancy which may have been themselves the cause for conducting CS before labour), delay of a medically necessary CS or delayed breastfeeding initiation.<sup>29</sup> However, in the absence of information on the medical indications for the CSs, we cannot infer causality between prelabour CS and the increase in neonatal mortality. A possible explanation for the delayed early skin-to-skin contact and initiation of breastfeeding is that caesarean delivery is usually accompanied by postoperative care routines, which might delay the baby's immediate contact with the mother. Separation of the baby from the mother immediately after birth may also be necessitated by limited space in the delivery room,

particularly where delivery rooms are shared with other women, a common situation in many LMICs. Postsurgical pain experienced by mothers may result in discomfort, delaying initiation of breastfeeding. One previous cohort study found that women who had a caesarean delivery were three times more likely to have pain that affects breastfeeding than those who had a vaginal delivery.<sup>30</sup>

### Strengths and limitations

To our knowledge, this is the first study to investigate the association between prelabour CS and perinatal outcomes in lower risk pregnancies, using the latest available, large, nationally representative data sets from LMICs. Furthermore, this is the first DHS analysis to distinguish between association of types of caesarean birth (prelabour vs intrapartum CS) with perinatal outcomes. Additional strengths include the use of multivariable analysis, simultaneously adjusting for multiple risk factors and confounders; and disaggregation of results by lower risk and higher risk groups, exploring potential interaction across obstetric subgroups.

Our results should be interpreted in the context of some limitations. First, our data set does not include all LMICs (eg, only two countries from the Americas, a region with high CS rates,<sup>10</sup> were included in the analysis). Importantly, because of lack of recent national survey

**Table 6** Odds ratios calculated through multinomial logistic regression with vaginal delivery as the base outcome\*†

	Prelabour CS		Intrapartum CS	
	Odds ratio (95% CI)	P-value	Odds ratio (95% CI)	P-value
<b>Maternal age (years)</b>				
<35	1 (ref)		1 (ref)	
>35	2.07 (1.86 to 2.3)	<0.001	1.55 (1.37 to 1.75)	<0.001
<b>Maternal education</b>				
No education	1 (ref)		1 (ref)	
Primary	1.29 (1.15 to 1.45)	<0.001	1.13 (1.01 to 1.26)	0.038
Secondary	1.48 (1.35 to 1.63)	<0.001	1.28 (1.16 to 1.41)	<0.001
Higher	1.59 (1.41 to 1.79)	<0.001	1.38 (1.22 to 1.57)	<0.001
<b>Place of residence</b>				
Rural	1 (ref)		1 (ref)	
Urban	1.25 (1.17 to 1.34)	<0.001	1.2 (1.12 to 1.3)	<0.001
<b>Economic status</b>				
Poorest	1 (ref)		1 (ref)	
Poorer	1.44 (1.28 to 1.62)	<0.001	1.11 (1.00 to 1.23)	0.055
Middle	1.93 (1.73 to 2.16)	<0.001	1.34 (1.20 to 1.49)	<0.001
Richer	2.03 (1.81 to 2.28)	<0.001	1.37 (1.22 to 1.53)	<0.001
Richest	2.00 (1.76 to 2.28)	<0.001	1.27 (1.12 to 1.43)	0.001
<b>Health insurance coverage</b>				
No	1 (ref)		1 (ref)	
Yes	1.56 (1.45 to 1.68)	<0.001	1.39 (1.29 to 1.51)	<0.001
<b>Parity</b>				
0	4.28 (3.76 to 4.87)	<0.001	4.46 (3.97 to 5.01)	<0.001
1 to 2	2.32 (2.05 to 2.63)	<0.001	1.73 (1.54 to 1.94)	<0.001
≥3	1 (ref)		1 (ref)	
<b>BMI (kg/m<sup>2</sup>)</b>				
Underweight (<18.5)	0.76 (0.70 to 0.82)	<0.001	0.74 (0.68 to 0.80)	<0.001
Normal weight (18.5–24.9)	1 (ref)		1 (ref)	
Overweight (25–29.9)	1.85 (1.71 to 1.99)	<0.001	1.71 (1.58 to 1.85)	<0.001
Obese (≥30)	2.96 (2.64 to 3.32)	<0.001	2.48 (2.18 to 2.82)	<0.001
<b>Place of delivery</b>				
Public hospital	1 (ref)		1 (ref)	
Private hospital	3.25 (3.04 to 3.47)	<0.001	3.33 (3.11 to 3.55)	<0.001
<b>Size of baby at birth</b>				
Very large	1.60 (1.44 to 1.78)	<0.001	1.41 (1.26 to 1.57)	<0.001
Larger than average	1.29 (1.19 to 1.39)	<0.001	1.29 (1.18 to 1.4)	<0.001
Average	1 (ref)		1 (ref)	
Smaller than average	1.01 (0.91 to 1.12)	0.897	1.00 (0.90 to 1.11)	0.994
Very small	1.11 (0.92 to 1.33)	0.269	1.32 (1.12 to 1.55)	0.001

\*Adjusted for country of survey, complex survey design (clustering, weights and stratification) and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth).

†The results are based on 176 069 participants with complete data for all covariates. 79 158 (31%) of 255, 227 participants had missing data and were excluded.

BMI, body mass index; CS, caesarean section.

data, the data set does not include some of the LMICs with the highest CS in the world, for example, Brazil with a national CS rate of 55.6% (in 2015) and China with a national CS rate of 41.3% (in 2016).<sup>10</sup> This may limit the

representativeness of our findings. Second, data from the DHS are self-reported based on a recall period of 5 years. We cannot, therefore, exclude the likelihood of measurement error for some of the factors analysed (eg, ANC

**Table 7** Odds ratios calculated through multinomial logistic regression with vaginal delivery as the base outcome\*†

	Prelabour CS		Intrapartum CS	
	Odds ratio (95% CI)	P-value	Odds ratio (95% CI)	P-value
<b>Time of first ANC visit</b>				
First trimester	1 (ref)		1 (ref)	
Second trimester	0.92 (0.86 to 0.99)	0.027	0.98 (0.92 to 1.05)	0.648
Third trimester	1.09 (0.94 to 1.25)	0.244	0.92 (0.8 to 1.06)	0.228
<b>Number of antenatal visits</b>				
0	–		–	
1 to 3	1 (ref)		1 (ref)	
>3	1.57 (1.46 to 1.68)	<0.001	1.41 (1.32 to 1.51)	<0.001
<b>ANC provider</b>				
Doctor	1.61 (1.47 to 1.77)	<0.001	1.42 (1.32 to 1.52)	<0.001
Nurse/midwife	1 (ref)		1 (ref)	
Clinical officer	0.75 (0.65 to 0.87)	<0.001	0.95 (0.84 to 1.08)	0.442
Other (+TBA)	1.26 (1.11 to 1.42)	<0.001	1.06 (0.96 to 1.17)	0.273
<b>ANC location</b>				
Public hospital	1 (ref)		1 (ref)	
Private hospital	1.60 (1.51 to 1.69)	<0.001	1.59 (1.50 to 1.69)	<0.001

Clinical officer refers to non-physician clinician.

\*Adjusted for country of survey, complex survey design (clustering, weights and stratification) and confounders (maternal age at birth, parity, education, place of residence, economic status).

†The results are based on 212, 584 participants with complete data for all covariates. 42, 643 (16.7%) of 255, 227 participants had missing data and were excluded.

ANC, antenatal care; CS, caesarean section; TBA, traditional birth attendant.

received, breastfeeding history). However, validation and reliability studies in several countries have shown that recall of CS is good in most settings.<sup>26 31 32</sup>

Third, we could not adjust for all possible confounders due to a lack of detailed clinical information in the DHSs. For instance, the indication of prelabour CS, an important confounder, is not reported in the DHSs. Since prelabour CSs include both necessary and unnecessary caesareans, it is likely that a proportion of the ‘lower risk women’ needed a CS because of clinical or obstetric disorders (such as hypertension, pre-eclampsia or placenta previa) identified during pregnancy. In this subset of women, where prelabour CS was performed because of a medical complication, the adverse outcomes could be linked to the complication rather than the CS. We suspect this is particularly the case in the African region, where primary CS rates were generally low, suggesting that most women probably receive this procedure in response to obstetric complications, possibly the same underlying cause behind the observed increased odds of neonatal deaths. Since we could not assess the size of this subgroup of women with necessary prelabour CSs, caution should be exercised when interpreting the results to avoid the bias of reverse causality.

Fourth, the analysis relied on self-reported ‘timing of decision to conduct caesarean section’ as a proxy to the types of caesarean birth (prelabour and intrapartum CS). Although reasonable, the extent to which this proxy

accurately measures actual types of caesarean births remain unclear. Fifth, large amount of missing data for some of the variables (eg, occupation (42%), BMI (30.0%)) were excluded from the regression analyses. This reduced the precision of observed estimates. Finally, the population-level data analysed have the attendant limitations of observational studies, which preclude drawing any causal inferences for the relationship between prelabour CS and studied outcomes.

### Future research

Prospective longitudinal studies are needed to understand better the determinants and the relationship between prelabour CS and perinatal outcomes, to provide a more solid basis for interventions aimed at optimising caesarean use. Future studies should collect and report data on indications of prelabour CS and explore the decision-making process for planned and emergency prelabour CS in LMICs. Further research into biologically plausible mechanisms by which prelabour CS may put an infant at higher risk for neonatal mortality are also needed. Directed acyclic graphs<sup>33</sup> may aid these investigations. Long-term multisite studies of epigenetic consequences of prelabour CS and other modes of delivery are also warranted.

### Implications for policy and practice

What can be done to mitigate the identified adverse effects of prelabour CS? Ideally, the adverse effects could be reduced

**Table 8** Association of primary prelabour CS with various outcomes in 26 low-income and middle-income countries

Outcome	Total number (N)	n (%)	OR (95% CI)*	P-value	Adjusted OR (95% CI)	P-value
<b>Neonatal mortality</b>						
Vaginal delivery	217 324	2735 (1.3)	1		1	
Prelabour CS	19 202	257 (1.3)	0.9 (0.8 to 1.2)	0.8	1.2 (1.0 to 1.5)	0.04
Intrapartum CS	18 701	336 (1.8)	1.3 (1.1 to 1.5)	<0.001	1.7 (1.4 to 2.0)	<0.001
<b>Early neonatal mortality</b>						
Vaginal delivery	217 324	2357 (1.1)	1		1	
Prelabour CS	19 202	215 (1.1)	1.0 (0.8 to 1.2)	0.7	1.2 (0.9 to 1.5)	0.1
Intrapartum CS	18 701	299 (1.6)	1.4 (1.2 to 1.6)	<0.001	1.7 (1.4 to 2.1)	<0.001
<b>Early skin-to-skin contact</b>						
Vaginal delivery	203 648	112 897 (55.4)	1		1	
Prelabour CS	16 738	6097 (36.4)	0.5 (0.4 to 0.6)	<0.001	0.4 (0.3 to 0.5)	<0.001
Intrapartum CS	16 098	5402 (33.6)	0.4 (0.3 to 0.5)	<0.001	0.4 (0.3 to 0.5)	<0.001
<b>Breastfeeding initiated within 1 hour of birth</b>						
Vaginal delivery	203 648	152 859 (75.1)	1		1	
Prelabour CS	16 738	8981 (53.7)	0.4 (0.3 to 0.5)	<0.001	0.4 (0.3 to 0.5)	<0.001
Intrapartum CS	16 098	7961 (49.4)	0.3 (0.2 to 0.4)	<0.001	0.4 (0.3 to 0.5)	<0.001
<b>Hospital stay &gt;72 hours</b>						
Vaginal delivery	212 557	147 749 (69.5)	1		1	
Prelabour CS	17 992	17 119 (95.2)	8.6 (7.6 to 9.7)	<0.001	6.6 (5.9 to 7.4)	<0.001
Intrapartum CS	17 200	16 482 (95.8)	9.9 (8.8 to 11.1)	<0.001	7.9 (7.0 to 8.9)	<0.001

\*Adjusted for country of survey and complex survey design (clustering, weights and stratification).

†Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [219 566 observations].  
CS, caesarean section.

by promoting normal physiologic labour and birth in a safe and dignified environment for women with no indications for prelabour delivery. Proven evidence-based approaches to achieve this include prenatal birth preparation classes,<sup>34</sup> psychoeducation for women with fear of pain,<sup>34</sup> midwife-led continuity of care,<sup>35</sup> encouraging free movement during labour<sup>36</sup> and continuous support during labour.<sup>37</sup> Health-care providers should be supported (eg, through in-service training and coaching) to develop and maintain skills to manage labour (including induction where appropriate and timely recognition and referral in remote facilities when prelabour CS is indicated) and to provide early breastfeeding and skin-to-skin support for women who have had CS.<sup>5 18</sup> Along with improvement in quality of intrapartum care, financial incentives for use of prelabour CS should be removed.

Maternity care managers should explore new care routines to minimise the time of separation following caesarean birth. Father skin-to-skin care of the newborn is safe and effective<sup>38</sup> and should be supported where separation of mother and newborn is medically indicated. Ensuring that the mother is as physically and emotionally comfortable as possible may help promote early initiation of breastfeeding. Facility coverage of early exclusive breastfeeding and skin-to-skin care of the newborn following caesarean birth should be routinely monitored and evaluated as quality of care indicators. These efforts should be accompanied with improvement in quality of care for small and sick newborns (who are the highest risk

of mortality) and infrastructure and supplies to support early breastfeeding and skin-to-skin care (eg, adequate accommodation to allow rooming-in on a 24-hour basis).<sup>39</sup>

Evidence about risk factors and adverse outcomes associated with prelabour CS should help inform discussions about the choice of mode of delivery and may facilitate appropriate personalised birth planning and case management to mitigate the adverse effects of prelabour CS. The reasons for the observed variations in the frequency of prelabour CS across countries are context specific (underpinned by a complex interplay of factors at individual, societal and organisational levels).<sup>40</sup> An understanding of country health systems, local norms and cultural practices and specific barriers and facilitators of concurrent overuse and underuse is crucial to developing country-appropriate strategies to optimise caesarean section use.

## CONCLUSIONS

Primary caesarean section conducted before onset of labour, compared with vaginal birth, is associated with adverse perinatal outcomes in lower risk pregnancies in LMICs. Caesarean births should be monitored and audited regularly to determine appropriateness, provide opportunities for identifying context-specific factors and practices contributing to prelabour CS and promote optimal antenatal and perinatal care.

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**Acknowledgements** We acknowledge the support of the Demographic and Health Survey Program (<https://www.dhsprogram.com>) for providing access to the data.

**Contributors** APB conceptualised the analysis with input from NO, SB, MRT and JPS. SB acquired the data and ran the analysis. NO prepared the first draft of the manuscript. NO, SB, MRT, JPS and APB participated in the interpretation of results, critical revision of the manuscript and approved the final version. NO is the guarantor.

**Funding** UNDP/UNFPA/UNICEF/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), Department of Sexual and Reproductive Health and Research, World Health Organization, Geneva, Switzerland. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Map disclaimer** The inclusion of any map (including the depiction of any boundaries therein), or of any geographic or locational reference, does not imply the expression of any opinion whatsoever on the part of BMJ concerning the legal status of any country, territory, jurisdiction or area or of its authorities. Any such expression remains solely that of the relevant source and is not endorsed by BMJ. Maps are provided without any warranty of any kind, either express or implied.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** This study does not involve human participants; ethical approval was not required for this study. We used publicly available, non-identifiable secondary survey data. The DHS receives government permission and follows ethical practices including informed consent and assurance of confidentiality. Written consent to participate was obtained from respondents at the time of data collection by the DHS enumerators.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available in a public, open access repository. All data relevant to the study are included in the article or uploaded as supplementary information. Source data are available in a public, open access repository (<https://dhsprogram.com/data/available-datasets.cfm>). Data are accessible free of charge upon registration with the DHS Program. All data generated or analysed during this study are included in this manuscript and its additional files.

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## Online supplementary appendix 1

This file includes the following analyses for singleton pregnancies at term without previous CS and ancillary analyses cited in the full text manuscript.

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Table S1. Characteristics of women with primary prelabour CS in the index pregnancy in Africa

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	144	2 (1.4)	5 (3.5)	137 (95.1)	<0.001
16 to 35	58102	1036 (1.8)	2438 (4.2)	54628 (94.9)	
>35	13899	403 (2.9)	564 (4.1)	12932 (93.0)	
Maternal education					
No education	20590	293 (1.4)	585 (2.8)	19712 (95.8)	<0.001
Primary	27306	381 (1.4)	1075 (3.9)	25850 (94.7)	
Secondary	20623	510 (2.5)	1018 (4.9)	19095 (92.6)	
Higher	3625	258 (7.1)	329 (9.1)	3039 (83.8)	
Parity					
0	17325	428 (2.5)	1323 (7.6)	15574 (89.9)	<0.001
1 to 2	25805	587 (2.3)	853 (3.3)	24365 (94.4)	
≥ 3	29015	426 (1.5)	831 (2.9)	27758 (95.6)	
Place of residence					
Urban	26872	899 (3.3)	1478 (5.5)	24495 (91.2)	<0.001
Rural	45273	542 (1.2)	1529 (3.4)	43202 (95.4)	
Place of delivery					
Private hospital	9857	356 (3.6)	589 (6.0)	8912 (90.4)	<0.001
Public hospital	62288	1085 (1.7)	2418 (3.9)	58785 (94.4)	
Economic status					
Poorest	11663	89 (0.8)	310 (2.7)	11264 (96.6)	<0.001
Poorer	13296	125 (0.9)	366 (2.7)	12805 (96.4)	
Middle	14843	189 (1.3)	493 (3.3)	14161 (95.4)	
Richer	15849	303 (1.9)	683 (4.3)	14863 (93.8)	
Richest	16494	735 (4.5)	1155 (7.0)	14604 (88.5)	
Size of baby at birth					
Very large	7985	204 (2.5)	471 (5.9)	7310 (91.6)	<0.001
Larger than average	15891	333 (2.1)	796 (5.0)	14762 (92.9)	
Average	37559	638 (1.7)	1346 (3.6)	35575 (94.7)	
Smaller than average	7162	161 (2.2)	248 (3.5)	6753 (94.3)	
Very small	2931	86 (2.9)	108 (3.7)	2737 (93.4)	
Missing	617	19	38	560	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	2315	28 (1.2)	54 (2.3)	2233 (94.5)	<0.001
Normal weight	19175	294 (1.5)	713 (3.7)	18168 (94.8)	

(18·5-24·9)					
Overweight (25-29·9)	5652	142 (2.5)	321 (5.7)	5189 (91.8)	
Obese (≥30)	2739	173 (6.3)	219 (8.0)	2347 (85.7)	
Missing	42264	804	1700	39760	
Health insurance cover					
Yes	3970	184 (4.6)	259 (6.5)	3527 (88.9)	<0.001
No	61968	1119 (1.8)	2550 (4.1)	58299 (94.1)	
Missing	6207				

Table S2. Characteristics of women with primary prelabour CS in the index pregnancy in Asia

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	41	5 (12.2)	0 (0)	36 (87.8)	<0.001
16 to 35	156821	14035 (8.9)	12599 (8.0)	130174 (83.0)	
>35	17001	2418 (14.2)	1445 (8.5)	13132 (77.3)	
Maternal education					
No education	33635	1445 (4.3)	1378 (4.1)	30812 (91.6)	<0.001
Primary	23860	1618 (6.8)	1366 (5.7)	20876 (87.5)	
Secondary	89053	8764 (9.8)	7706 (8.6)	72583 (81.6)	
Higher	27296	4631 (17.0)	3594 (13.2)	19071 (69.8)	
Parity					
0	63624	7913 (12.4)	8301 (13.1)	47410 (74.5)	<0.001
1 to 2	83852	7174 (8.6)	4816 (5.7)	71862 (85.7)	
≥ 3	26368	1371 (5.2)	927 (3.5)	24070 (91.3)	
Place of residence					
Urban	58929	7924 (13.4)	6108 (10.4)	44897 (76.2)	<0.001
Rural	114915	8534 (7.4)	7936 (6.9)	98445 (85.7)	
Place of delivery					
Private hospital	48463	8454 (17.4)	7523 (15.5)	32486 (67.1)	<0.001
Public hospital	125381	8004 (6.4)	6521 (5.2)	110856 (88.4)	
Economic status					
Poorest	33853	1298 (3.8)	1437 (4.2)	31118 (91.0)	<0.001
Poorer	37686	2198 (5.8)	2146 (5.7)	33342 (88.5)	
Middle	37036	3371 (9.1)	2953 (8.0)	30712 (82.9)	
Richer	34197	4336 (12.7)	3546 (10.4)	26315 (76.9)	
Richest	31072	5255 (16.9)	3962 (12.7)	21855 (70.4)	
Size of baby at birth					
Very large	8737	1070 (12.2)	850 (9.7)	6817 (78.1)	<0.001
Larger than average	23267	2473 (10.6)	2241 (9.6)	18553 (79.8)	
Average	114790	10364 (9.0)	8663 (7.5)	95763 (83.5)	
Smaller than average	14132	1253 (8.9)	1155 (8.2)	11724 (82.9)	
Very small	3878	358 (9.2)	353 (9.1)	3167 (81.7)	
Missing	9040	940	782	7318	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	29846	1473 (4.9)	1491 (5.0)	26882 (90.1)	<0.001
Normal weight	89031	7130 (8.1)	6454 (7.2)	75447 (84.7)	

(18·5-24·9)					
Overweight (25-29·9)	21851	3634 (16.6)	2621 (12.0)	15596 (71.4)	
Obese (≥30)	6744	1594 (23.6)	968 (14.3)	4182 (62.1)	
Missing	26372	2627	2510	21235	
Health insurance cover					
Yes	32576	3688 (11.3)	3163 (9.7)	25725 (79.0)	<0.001
No	127423	11955 (9.4)	10226 (8.0)	105242 (82.6)	
Missing	13845	815	655	12375	

Table S3. Characteristics of women with primary prelabour CS in the index pregnancy in Americas

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	42	4 (9.5)	8 (19.0)	30 (71.5)	<0.001
16 to 35	7833	1020 (13.0)	1445 (18.4)	5368 (68.6)	
>35	1363	279 (20.5)	197 (14.4)	887 (65.1)	
Maternal education					
No education	259	14 (5.4)	25 (9.6)	220 (85.0)	<0.001
Primary	1860	173 (9.3)	227 (12.2)	1460 (78.5)	
Secondary	4853	641 (13.2)	831 (17.1)	3381 (69.7)	
Higher	2266	475 (21.0)	567 (25.0)	1224 (54.0)	
Parity					
0	4056	484 (11.9)	1010 (24.9)	2562 (63.2)	<0.001
1 to 2	3942	720 (18.3)	521 (13.2)	2701 (68.5)	
≥ 3	1240	99 (8.0)	119 (9.6)	1022 (82.4)	
Place of residence					
Urban	6259	1039 (16.6)	1226 (19.6)	3994 (63.8)	<0.001
Rural	2979	264 (8.9)	424 (14.2)	2291 (76.9)	
Place of delivery					
Private hospital	2644	573 (21.7)	615 (23.3)	1456 (55.0)	<0.001
Public hospital	6594	730 (11.1)	1035 (15.7)	4829 (73.2)	
Economic status					
Poorest	2349	234 (10.0)	376 (16.0)	1739 (74.0)	<0.001
Poorer	2717	441 (16.2)	533 (19.6)	1743 (64.2)	
Middle	1924	285 (14.8)	381 (19.8)	1258 (65.4)	
Richer	1319	188 (14.2)	211 (16.0)	920 (69.8)	
Richest	929	155 (16.7)	149 (16.0)	625 (67.3)	
Size of baby at birth					
Very large	170	10 (5.9)	14 (8.2)	146 (85.9)	0.1
Larger than average	247	16 (6.5)	26 (10.5)	205 (83.0)	
Average	973	50 (5.1)	67 (6.9)	856 (88.0)	
Smaller than average	298	10 (3.4)	20 (6.7)	268 (89.9)	
Very small	174	8 (4.6)	22 (12.6)	144 (82.8)	
Missing	7376	1209	1501	4666	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	61	0 (0)	3 (4.9)	58 (95.1)	<0.001
Normal weight	623	19 (3.0)	41 (6.6)	563 (90.4)	

(18·5-24·9)					
Overweight (25-29·9)	346	20 (5.8)	38 (11.0)	288 (83.2)	
Obese (≥30)	210	24 (11.4)	26 (12.4)	160 (86.2)	
Missing	7998	1240	1542	5261	
Health insurance cover					
Yes	85	12 (14.1)	19 (22.3)	54 (63.6)	<0.001
No	1777	82 (4.6)	130 (7.3)	1565 (88.1)	
Missing	7376	1209	1501	4666	

Table S4. Characteristics of antenatal care in pregnancies with primary prelabour CS in Africa

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	1697	25 (1.5)	60 (3.5)	1612 (95.0)	<0.001
1 to 3	24370	344 (1.4)	828 (3.4)	23198 (95.2)	
>3	45142	1038 (2.3)	2081 (4.6)	42013 (93.1)	
Missing	936	24	38	874	
ANC provider					
Doctor	9221	462 (5.0)	585 (6.3)	8174 (88.7)	<0.001
Nurse / midwife	39513	624 (1.6)	1504 (3.8)	37385 (94.6)	
Clinical officer	15666	230 (1.5)	496 (3.2)	14940 (95.3)	
Other (+ TBA)	5996	92 (1.5)	356 (5.9)	5548 (92.6)	
Missing	1749	33	66	1650	
ANC first visit					
First trimester	28829	773 (2.7)	1337 (4.6)	26719 (92.7)	<0.001
Second trimester	37360	587 (1.6)	1491 (4.0)	35282 (94.4)	
Third trimester	3913	48 (1.2)	109 (2.8)	3756 (96.0)	
Missing	2043	33	70	1940	
ANC location					
Public hospital	62037	1090 (1.8)	2464 (4.0)	58483 (94.2)	<0.001
Private hospital	6624	296 (4.5)	374 (5.6)	5954 (89.9)	
Missing	3484	55	169	3260	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer refers to non-physician clinician.					

Table S5. Characteristics of antenatal care in pregnancies with primary prelabour CS in Asia

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	16383	767 (4.7)	601 (3.7)	15015 (91.6)	<0.001
1 to 3	48826	2704 (5.5)	2812 (5.8)	43310 (88.7)	
>3	106811	12720 (11.9)	10489 (9.8)	83602 (78.3)	
Missing	1824	267	142	1415	
ANC provider					
Doctor	89725	11183 (12.5)	8689 (9.7)	69853 (77.8)	<0.001
Nurse / midwife	35078	2475 (7.1)	2569 (7.3)	30034 (85.6)	
Clinical officer	11632	699 (6.0)	910 (7.8)	10023 (86.2)	
Other (+TBA)	20948	1325 (6.3)	1267 (6.0)	18356 (87.7)	
Missing	16461	776	609	15076	
Time of first ANC visit					
First trimester	116849	12720 (10.9)	10724 (9.2)	93405 (79.9)	<0.001
Second trimester	33451	2239 (6.7)	2150 (6.4)	29062 (86.9)	
Third trimester	6725	688 (10.2)	544 (8.1)	5493 (81.7)	
Missing	16819	811	626	15382	
ANC location					
Public hospital	106910	8475 (7.9)	7320 (6.8)	91115 (85.3)	<0.001
Private hospital	37856	6264 (16.5)	5050 (13.3)	26542 (70.2)	
Missing	29078	1719	1674	25685	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer – non-physician clinician.					

Table S6. Characteristics of antenatal care in pregnancies with primary prelabour CS in Americas

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	125	2 (1.6)	16 (12.8)	107 (85.6)	<0.001
1 to 3	719	47 (6.5)	94 (13.1)	578 (80.4)	
>3	8307	1242 (14.9)	1522 (18.3)	5543 (66.8)	
Missing	87	12	18	57	
ANC provider					
Doctor	8119	1243 (15.3)	1520 (18.7)	5356 (66.0)	<0.001
Nurse / midwife	925	52 (5.6)	101 (10.9)	772 (83.5)	
Clinical officer	31	4 (12.9)	7 (22.6)	20 (64.5)	
Other (+TBA)	37	2 (5.4)	6 (16.2)	29 (78.4)	
Missing	126	2	16	108	
Time of first ANC visit					
First trimester	7120	1111 (15.6)	1319 (18.5)	4690 (65.9)	<0.001
Second trimester	1776	171 (9.6)	288 (16.2)	1317 (74.2)	
Third trimester	203	18 (8.9)	27 (13.3)	158 (77.8)	
Missing	139	3	16	120	
ANC location					
Public hospital	5921	586 (19.4)	658 (21.8)	1774 (58.8)	<0.001
Private hospital	3018	706 (11.9)	955 (16.1)	4260 (72.0)	
Missing	299	11	37	251	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer – non-physician clinician.					

Table S7. Association of primary prelabour CS with various outcomes in Africa

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	67697	899 (1.3)	1		1	
Prelabour CS	1441	41 (2.8)	2.5 (1.6-3.9)	<0.001	2.2 (1.3-3.7)	0.005
Intrapartum CS	3007	117 (3.9)	3.0 (2.4-3.8)	<0.001	3.3 (2.6-4.2)	<0.001
Early neonatal mortality						
Vaginal delivery	67697	777 (1.1)	1		1	
Prelabour CS	1441	40 (2.8)	2.7 (1.7-4.2)	<0.001	2.3 (1.3-4.1)	0.03
Intrapartum CS	3007	110 (3.7)	3.3 (2.6-4.2)	<0.001	3.6 (2.8-4.7)	<0.001
Early skin-to-skin contact						
Vaginal delivery	65960	41297 (62.6)	1		1	
Prelabour CS	1367	410 (30.0)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Intrapartum CS	2862	815 (28.5)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	65690	49433 (74.9)	1		1	
Prelabour CS	1367	570 (41.7)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Intrapartum CS	2862	1152 (40.2)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	67696	37500 (55.5)	1		1	
Prelabour CS	1441	1378 (95.6)	19.3 (13.9-26.7)	<0.001	19.6 (14.1-27.4)	<0.001
Intrapartum CS	3007	2904 (96.6)	25.0 (19.4-32.1)	<0.001	25.3 (19.5-32.8)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [69138 observations].						

Table S8. Association of primary prelabour CS with various outcomes in Asia

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	143342	1797 (1.2)	1		1	
Prelabour CS	16458	209 (1.3)	1.0 (0.8-1.2)	0.7	1.2 (0.9-1.5)	0.1
Intrapartum CS	14044	212 (1.5)	1.4 (1.2-1.6)	<0.001	1.7 (1.4-2.1)	<0.001
Early neonatal mortality						
Vaginal delivery	143342	1555 (1.1)	1		1	
Prelabour CS	16458	171 (1.0)	1.0 (0.8-1.2)	0.7	1.2 (0.9-1.5)	0.1
Intrapartum CS	14044	185 (1.3)	1.1 (0.9-1.4)	0.3	1.3 (0.9-1.6)	0.1
Early skin-to-skin contact						
Vaginal delivery	136147	70970 (52.1)	1		1	
Prelabour CS	15293	5675 (37.1)	0.5 (0.4-0.6)	<0.001	0.5 (0.4-0.6)	<0.001
Intrapartum CS	13103	4573 (34.9)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	136147	102156 (75.3)	1		1	
Prelabour CS	15293	8394 (54.9)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Intrapartum CS	13103	6779 (51.7)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	143242	109117 (76.2)	1		1	
Prelabour CS	16457	15651 (95.1)	3.4 (3.1-3.6)	<0.001	2.9 (2.7-3.1)	<0.001
Intrapartum CS	14044	13435 (95.7)	6.5 (5.8-7.4)	<0.001	5.4 (4.8-6.2)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [173844 observations].						

Table S9. Association of primary prelabour CS with various outcomes in Americas

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	6285	39 (0.6)	1		1	
Prelabour CS	1303	7 (0.5)	0.5 (0.2-1.5)	0.2	2.4 (0.5-11.2)	0.3
Intrapartum CS	1650	7 (0.4)	0.5 (0.1-2.1)	0.4	1.9 (0.4-9.0)	<0.001
Early neonatal mortality						
Vaginal delivery	6285	25 (0.4)	1		1	
Prelabour CS	1303	4 (0.3)	0.3 (0.1-1.2)	0.09	2.4 (0.5-11.3)	0.3
Intrapartum CS	1650	4 (0.2)	0.2 (0.1-0.8)	0.02	0.8 (0.2-3.2)	0.8
Early skin-to-skin contact						
Vaginal delivery	1541	639 (40.9)	1		1	
Prelabour CS	78	12 (15.4)	0.3 (0.1-0.6)	<0.001	0.3 (0.1-0.6)	<0.001
Intrapartum CS	133	14 (10.5)	0.2 (0.1-0.4)	<0.001	0.2 (0.1-0.4)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	1541	870 (56.5)	1		1	
Prelabour CS	78	17 (21.8)	0.2 (0.1-0.4)	<0.001	0.3 (0.1-0.6)	<0.001
Intrapartum CS	133	30 (22.6)	0.3 (0.2-0.4)	<0.001	0.3 (0.2-0.4)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	1619	1132 (69.9)	1		1	
Prelabour CS	94	90 (95.7)	11.6 (3.3-40.9)	<0.001	12.5 (3.5-45.2)	<0.001
Intrapartum CS	149	143 (95.9)	12.5 (4.9-31.7)	<0.001	12.4 (4.8-32.5)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [9238 observations].						

Table S10. Association of primary prelabour and intrapartum CS with various outcomes among all singleton pregnancies without previous CS<sup>a</sup>

Outcome	Total number (N)	n (%)	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality				
Vaginal delivery	235734	4008 (1.7)	1	
Prelabour CS	20828	324 (1.6)	1.2 (1.0-1.5)	0.05
Intrapartum CS	20493	431 (2.1)	1.6 (1.3-1.8)	<0.001
Early neonatal mortality				
Vaginal delivery	235734	3300 (1.4)	1	
Prelabour CS	20828	274 (1.3)	1.3 (1.0-1.4)	0.03
Intrapartum CS	20493	376 (1.8)	1.4 (1.2-1.6)	<0.001
Early skin-to-skin contact				
Vaginal delivery	230687	120649 (52.3)	1	
Prelabour CS	17971	6497 (36.1)	0.4 (0.3-0.5)	<0.001
Intrapartum CS	17134	5725 (33.4)	0.4 (0.3-0.5)	<0.001
Breastfeeding initiated within 1h				
Vaginal delivery	230687	165172 (71.6)	1	
Prelabour CS	17971	9573 (53.3)	0.3 (0.2-0.5)	<0.001
Intrapartum CS	17134	8434 (49.2)	0.4 (0.3-0.5)	<0.001
Duration stay hospital > 72 hours				
Vaginal delivery	224363	156924 (69.7)	1	
Prelabour CS	19371	18442 (95.2)	6.7 (6.0-7.5)	<0.001
Intrapartum CS	18358	17580 (95.8)	7.9 (7.1-8.9)	<0.001
OR – odds ratio; CI – confidence interval.				
<sup>a</sup> All singleton pregnancies (term and preterm) across 26 low-income and middle-income countries.				
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (economic status, maternal age, education, antenatal care, size of baby at birth) [228879 observations].				

Table S11. Summary of association of primary prelabour CS with perinatal outcomes in term pregnancies and all pregnancies among women without previous CS<sup>a</sup>

	Adjusted OR (95% CI) <sup>b</sup>				
	Neonatal mortality	Early neonatal mortality	Early skin-to-skin contact	Breastfeeding initiated within 1h of birth	Duration stay hospital > 72 hours
Singleton pregnancies at term without previous CS	1.2 (1.0-1.5)	1.2 (0.9-1.5)	0.4 (0.3-0.5)	0.4 (0.3-0.5)	6.6 (5.9-7.4)
Singleton pregnancies (term and preterm) without previous CS	1.2 (1.0-1.5)	1.3 (1.0-1.4)	0.4 (0.3-0.5)	0.3 (0.2-0.5)	6.7 (6.0-7.5)

OR – odds ratio; CI – confidence interval.

<sup>a</sup>Pooled analysis of all pregnancies (term and preterm) in 26 low-income and middle-income countries.

<sup>b</sup>Adjusted for country of survey, complex survey design and confounders (economic status, maternal age, education, antenatal care, size of baby at birth).

## Online supplementary appendix 2

This file includes the following analyses for singleton pregnancies at term with previous CS and ancillary analyses cited in the full text manuscript.

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Table S1. Caesareans in women with singleton, term pregnancies with previous caesareans in 26 low-income and middle-income countries

Country <sup>a</sup>	Total number of women	Intrapartum and prelabour CS	Average prelabour CS
	N	n (%)	n (%)
<b>Africa</b>			
Angola	3939	273 (6.9)	87 (2.2)
Benin	6605	413 (6.2)	155 (2.3)
Burundi	6946	532 (7.7)	244 (3.5)
Ethiopia	2581	227 (8.8)	96 (3.7)
Guinea	2768	166 (6.0)	85 (3.1)
Malawi	11012	786 (7.1)	167 (1.5)
Nigeria	8568	592 (6.9)	260 (3.0)
Senegal	6244	357 (5.7)	152 (2.4)
Mali	4108	190 (4.6)	76 (1.8)
Tanzania	4538	427 (9.4)	118 (2.6)
Uganda	6293	567 (9.0)	187 (3.0)
Zambia	5751	320 (5.6)	88 (1.5)
Zimbabwe	3795	274 (7.2)	107 (2.8)
<b>Asia</b>			
Tajikistan	3597	243 (6.8)	119 (3.3)
Indonesia	11404	2557 (22.4)	1050 (9.2)
Philippines	6005	890 (14.8)	539 (9.0)
Timor Leste	2197	177 (8.1)	102 (4.6)
India	136729	26727 (19.5)	14711 (10.8)
Maldives	2219	898 (40.5)	472 (21.3)
Nepal	2245	321 (14.3)	169 (7.5)
Pakistan	5441	1589 (29.2)	1118 (20.5)
Armenia	1372	243 (17.7)	207 (15.1)
Jordan	6713	1718 (25.6)	1268 (18.9)
Albania	2288	676 (29.5)	496 (21.7)
<b>Americas</b>			
Colombia	7706	3024 (39.2)	1420 (18.4)
Haiti	1887	262 (13.9)	111 (5.9)
<b>All countries</b>			
Total	262951	44449 (16.9)	23604 (9.0)
<sup>a</sup> Categorized according to United Nations geographical grouping.			

Table S2. Prelabour caesarean sections by economic status in 26 low-income and middle-income countries<sup>a</sup>

Country <sup>b</sup>	Average	Poorest	Poorer	Middle	Richer	Richest	Difference (Richest/Poorest)	Ratio (Richest/Poorest)
<b>Africa</b>								
Angola	2.2 (1.8-2.7)	1.9 (1.1-2.4)	1.9 (1.2-2.3)	1.4 (0.9-1.9)	1.5 (1.0-2.0)	4.7 (3.9-5.4)	2.8	2.5
Benin	2.3 (2.0-2.7)	0.6 (0.2-1.4)	1.1 (0.6-1.8)	1.4 (0.9-2.0)	2.6 (1.9-3.2)	5.8 (5.0-6.7)	5.2	9.7
Burundi	3.5 (3.1-4.0)	1.2 (0.7-1.9)	1.5 (0.9-1.8)	1.5 (0.9-1.8)	2.9 (2.3-3.5)	9.0 (6.1-12.4)	7.8	7.5
Ethiopia	3.7 (3.0-4.5)	1.2 (0.8-1.6)	0.3 (0.1-0.5)	1.0 (0.5-1.5)	0.6 (0.3-0.9)	6.8 (5.2-9.1)	5.6	5.7
Guinea	3.1 (2.5-3.8)	0.7 (0.3-1.1)	1.6 (1.2-2.2)	3.1 (2.6-3.7)	3.4 (2.9-4.0)	4.4 (3.8-5.1)	3.7	6.3
Malawi	1.5 (1.3-1.8)	0.5 (0.2-0.8)	0.9 (0.5-1.3)	1.2 (0.8-1.6)	1.8 (1.3-2.4)	3.1 (2.5-3.6)	2.6	6.2
Nigeria	3.0 (2.7-3.4)	0.7 (0.4-1.0)	0.6 (0.3-0.9)	1.9 (1.5-2.4)	2.5 (2.0-2.9)	6.2 (5.6-6.8)	5.5	8.8
Senegal	2.4 (2.1-2.8)	1.4 (1.1-1.7)	1.7 (1.4-2.0)	1.8 (1.4-2.2)	3.9 (3.5-4.4)	4.9 (4.5-5.5)	3.5	3.5
Mali	1.8 (1.5-2.3)	1.2 (0.8-1.6)	1.1 (0.8-1.5)	1.5 (1.1-1.9)	1.5 (1.1-1.9)	3.1 (2.6-3.7)	1.9	2.6
Tanzania	2.6 (2.2-3.1)	0.5 (0.3-0.8)	1.7 (1.4-2.0)	1.3 (1.0-1.7)	2.0 (1.6-2.4)	5.8 (5.4-6.3)	5.3	11.6
Uganda	3.0 (2.6-3.4)	1.0 (0.6-1.3)	1.5 (1.2-1.9)	1.8 (1.4-2.2)	2.3 (1.9-2.8)	7.3 (6.8-7.9)	6.3	7.3
Zambia	1.5 (1.2-1.9)	0.8 (0.6-1.0)	0.5 (0.3-0.7)	1.0 (0.7-1.3)	1.3 (1.0-1.6)	4.8 (4.4-5.2)	4.0	6.0
Zimbabwe	2.8 (2.3-3.4)	1.0 (0.7-1.3)	1.0 (0.7-1.3)	1.4 (1.0-1.8)	2.7 (2.2-3.2)	6.1 (5.5-6.6)	5.1	5.1
<b>Asia</b>								
Tajikistan	3.3 (2.8-3.9)	2.9 (2.4-3.4)	3.2 (2.7-3.8)	3.5 (3.0-4.0)	3.0 (2.6-3.5)	3.7 (3.1-4.2)	0.8	1.3
Indonesia	9.2 (8.7-9.7)	3.8 (3.4-4.1)	6.2 (5.8-6.6)	7.2 (6.8-7.7)	10.0 (9.6-10.5)	17.7 (17.1-18.3)	13.9	4.6

Philippines	9.0 (8.3-9.7)	3.9 (3.4-4.4)	5.3 (4.8-5.9)	9.2 (8.5-9.9)	13.5 (12.5-14.7)	19.5 (18.2-20.7)	15.6	5.0
Timor Leste	4.6 (3.8-5.6)	5.6 (5.1-6.2)	3.2 (2.8-3.6)	4.5 (4.1-4.9)	3.7 (3.2-4.2)	6.0 (5.5-6.6)	0.4	1.1
India	10.8 (10.7-10.9)	3.0 (2.8-3.2)	6.0 (5.8-6.2)	10.7 (10.4-10.9)	15.1 (14.8-15.3)	19.5 (19.2-19.8)	16.5	6.5
Maldives	21.3 (19.6-23.0)	20.8 (19.4-22.8)	19.4 (18.2-20.6)	23.5 (22.2-24.9)	23.8 (22.3-24.9)	16.1 (15.0-17.4)	-4.7	0.8
Nepal	7.5 (6.5-8.7)	2.5 (2.0-3.1)	4.5 (2.9-5.1)	5.4 (4.8-6.0)	6.2 (5.7-6.7)	18.4 (17.3-19.5)	15.9	7.4
Pakistan	20.5 (19.5-21.6)	9.5 (8.6-10.6)	12.1 (11.2-13.0)	18.2 (17.2-19.2)	23.8 (22.6-24.9)	32.3 (31.1-33.5)	22.8	3.4
Armenia	15.1 (13.3-17.1)	14.0 (11.4-17.6)	14.8 (12.6-17.2)	13.2 (11.0-15.7)	16.2 (13.1-19.5)	17.8 (14.5-20.3)	3.8	1.3
Jordan	18.9 (18.0-19.8)	17.6 (16.9-18.1)	18.5 (17.8-19.2)	19.0 (18.0-20.1)	21.0 (19.9-22.0)	22.1 (21.0-23.2)	2.5	1.2
Albania	21.7 (20.0-23.4)	17.9 (12.4-23.1)	17.3 (12.6-22.9)	21.9 (17.1-24.5)	27.4 (23.0-30.9)	33.9 (28.8-39.0)	16.0	1.9
<b>Americas</b>								
Colombia	18.4 (17.6-19.3)	12.6 (10.3-15.0)	19.9 (17.1-22.3)	20.4 (17.9-22.8)	21.6 (19.0-23.0)	25.6 (23.5-27.9)	13.0	2.0
Haiti	5.9 (4.9-7.0)	2.6 (1.8-3.4)	2.8 (1.9-3.6)	3.7 (3.0-4.5)	5.9 (5.1-6.7)	10.9 (9.8-11.7)	8.3	4.2
<b>All countries</b>								
Median <sup>c</sup>	-	3.3 (1.4-10.7)	2.4 (1.1-6.2)	3.3 (1.4-10.7)	3.6 (2.3-15.1)	7.1 (4.9-18.4)	-	-
<sup>a</sup> Values are percentages (95% confidence intervals). <sup>b</sup> Categorized according to United Nations geographical grouping. <sup>c</sup> Values in brackets indicate the interquartile range (middle 50% of estimates).								

Figure S1. Prelabour CS rates by economic status in 26 low-income and middle-income countries

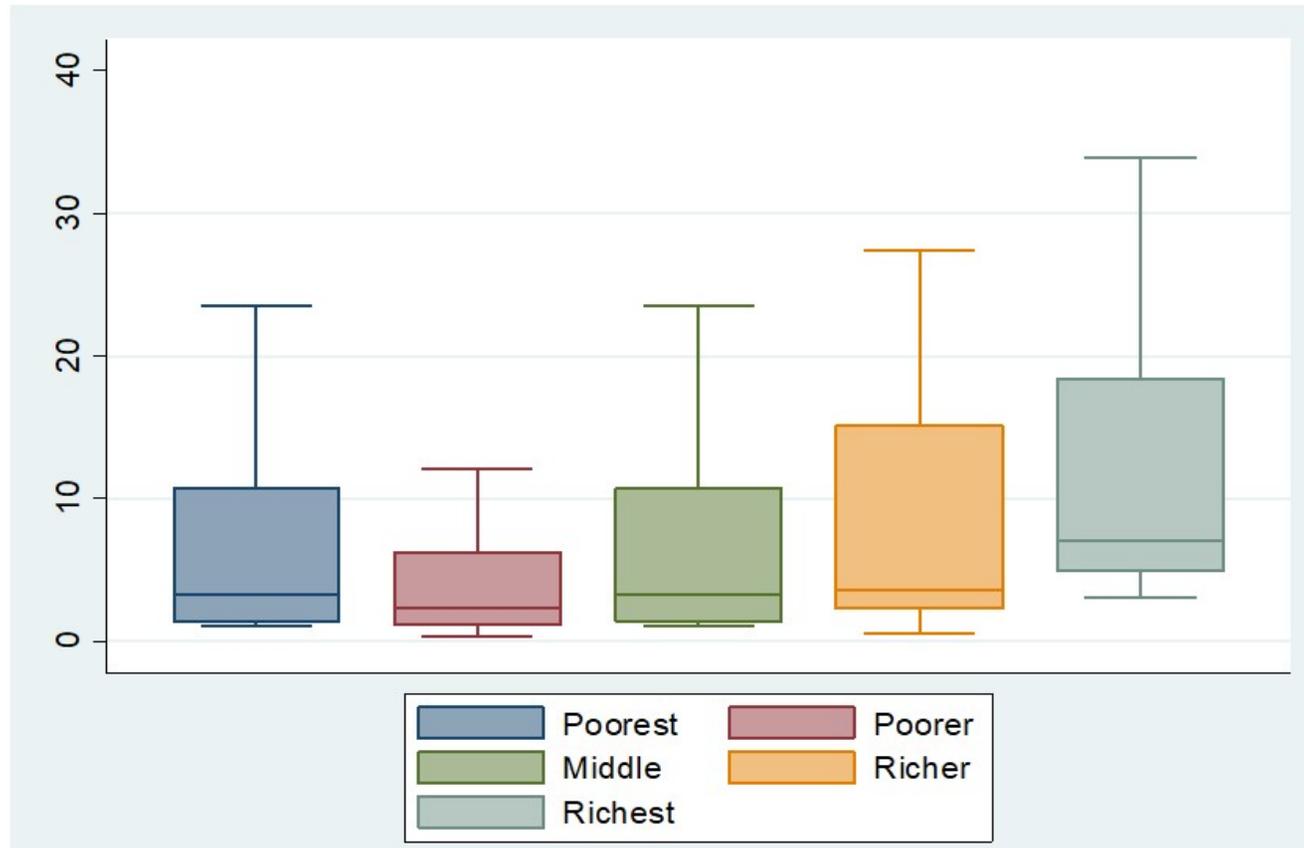


Table S3. Prelabour caesarean section by place of residence in 26 low-income and middle-income countries<sup>a</sup>

Country <sup>b</sup>	Average	Urban		Rural		Difference (Urban - Rural)	Ratio (Urban / Rural)
<b>Africa</b>							
Angola	2.2 (1.8-2.7)	2.3	1.7-2.8	1.8	1.3-2.3	1.5	1.3
Benin	2.3 (2.0-2.7)	3.8	2.8-4.9	1.3	0.9-1.8	2.5	2.9
Burundi	3.5 (3.1-4.0)	9.6	8.7-10.5	2.0	1.5-2.5	7.6	4.8
Ethiopia	3.7 (3.0-4.5)	6.7	5.9-7.5	1.1	0.4-1.6	5.6	6.1
Guinea	3.1 (2.5-3.8)	4.2	3.6-4.8	2.0	1.5-2.4	2.2	2.1
Malawi	1.5 (1.3-1.8)	3.5	3.2-3.8	1.1	0.8-1.4	2.4	3.2
Nigeria	3.0 (2.7-3.4)	4.0	3.6-4.4	2.0	1.7-2.3	2.0	2.0
Senegal	2.4 (2.1-2.8)	3.6	2.9-4.5	1.5	0.9-2.1	2.1	2.4
Mali	1.8 (1.5-2.3)	2.5	2.1-2.9	1.5	1.2-1.9	1.0	1.7
Tanzania	2.6 (2.2-3.1)	4.4	3.6-5.2	1.6	1.1-2.1	2.8	2.7
Uganda	3.0 (2.6-3.4)	5.7	5.1-6.3	2.1	0.7-2.4	3.6	2.7
Zambia	1.5 (1.2-1.9)	2.7	2.1-3.4	0.8	0.5-1.0	1.9	3.4
Zimbabwe	2.8 (2.3-3.4)	4.8	3.8-5.9	1.2	0.7-1.6	3.6	4.0
<b>Asia</b>							
Tajikistan	3.3 (2.8-3.9)	3.4	2.8-3.9	3.3	2.7-3.9	0.1	1.1
Indonesia	9.2 (8.7-9.7)	11.1	10.8-11.4	6.6	6.3-6.9	4.5	1.7
Philippines	9.0 (8.3-9.7)	11.5	10.8-12.2	7.5	6.8-8.2	4.0	1.5
Timor Leste	4.6 (3.8-5.6)	5.7	4.7-6.2	3.7	2.9-4.5	2.0	1.5
India	10.8 (10.7-10.9)	16.4	16.2-16.6	8.5	8.3-8.7	7.4	1.9
Maldives	21.3 (19.6-23.0)	18.2	17.5-18.8	21.6	20.7-22.5	-3.4	0.8
Nepal	7.5 (6.5-8.7)	7.9	7.3-8.5	6.7	6.2-7.2	1.2	1.2
Pakistan	20.5 (19.5-21.6)	23.8	22.8-24.9	16.9	16.0-17.9	6.9	1.4

Armenia	15.1 (13.3-17.1)	16.5	14.7-18.3	13.2	11.7-15.1	3.3	1.2
Jordan	18.9 (18.0-19.8)	19.2	18.2-20.3	17.7	16.8-18.6	1.5	1.1
Albania	21.7 (20.0-23.4)	25.8	23.7-27.7	18.6	16.5-20.4	7.2	1.4
<b>Americas</b>							
Colombia	18.4 (17.6-19.3)	20.2	19.4-21.0	13.6	12.1-14.1	6.6	1.5
Haiti	5.9 (4.9-7.0)	7.9	7.1-8.4	3.9	3.0-4.7	4.0	2.0
<sup>a</sup> Values are percentages (95% confidence intervals).							
<sup>b</sup> Categorized according to United Nations geographical grouping.							

Table S4. Characteristics of women with prelabour CS in the index pregnancy in 26 low-income and middle-income countries

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	227	11 (4.8)	13 (5.7)	203 (89.5)	<0.001
16 to 35	229914	20125 (8.7)	18518 (8.0)	191271 (83.3)	
>35	32810	3468 (10.6)	2314 (7.0)	27028 (82.4)	
Maternal education					
No education	55471	2219 (4.0)	2274 (4.1)	50978 (91.9)	<0.001
Primary	54114	2681 (4.9)	3015 (5.6)	48418 (89.5)	
Secondary	118495	12182 (10.3)	10699 (9.0)	95614 (80.7)	
Higher	34870	6522 (18.7)	4857 (13.9)	23491 (67.4)	
Parity					
0	85005	8825 (10.4)	10634 (12.5)	65546 (77.1)	<0.001
1 to 2	120468	12387 (10.3)	8164 (6.8)	99917 (82.9)	
≥ 3	57478	2392 (4.2)	2047 (3.6)	53039 (92.2)	
Place of residence					
Urban	95558	12011 (12.6)	9714 (10.2)	73833 (77.3)	<0.001
Rural	167393	11593 (6.9)	11131 (6.6)	144669 (86.5)	
Place of delivery					
Private hospital	64354	11426 (17.7)	9765 (15.2)	43163 (67.1)	<0.001
Public hospital	198597	12178 (6.1)	11080 (5.6)	175339 (89.3)	
Economic status					
Poorest	48803	2070 (4.2)	2402 (4.9)	44331 (90.9)	<0.001
Poorer	54983	3442 (6.3)	3404 (6.2)	48137 (87.5)	
Middle	55553	4841 (8.7)	4315 (7.8)	46397 (83.5)	
Richer	53132	5865 (11.0)	4939 (9.3)	42328 (79.7)	
Richest	50480	7386 (14.6)	5785 (11.5)	37309 (73.9)	
Size of baby at birth					
Very large	17362	1541 (8.9)	1473 (8.5)	14348 (82.6)	<0.001
Larger than average	40412	3378 (8.4)	3346 (8.3)	33688 (83.4)	
Average	158123	13786 (8.7)	11405 (7.2)	132932 (84.1)	
Smaller than average	22272	1814 (8.1)	1613 (7.2)	18845 (84.7)	
Very small	7193	562 (7.8)	532 (7.4)	6099 (84.8)	
Missing	17589	2523	2476	12590	
BMI (kg/m <sup>2</sup> )					

Underweight (<18.5)	33004	1871 (5.7)	1802 (5.5)	29331 (88.9)	<0.001
Normal weight (18.5-24.9)	111952	9079 (8.1)	8160 (7.3)	94713 (84.6)	
Overweight (25-29.9)	29132	4617 (15.8)	3313 (11.4)	21202 (72.8)	
Obese (≥30)	10306	2216 (21.5)	1358 (13.2)	6732 (65.3)	
Missing	78557	5821	6112	66524	
Health insurance cover					
Yes	38240	4935 (12.9)	3799 (9.9)	29506 (77.2)	<0.001
No	196715	16167 (8.2)	14535 (7.4)	166013 (84.4)	
Missing	27996	2502	2511	22983	

Table S5. Characteristics of women with prelabour CS in the index pregnancy in Africa

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	144	2 (1.4)	5 (3.5)	137 (95.1)	<0.001
16 to 35	58975	1357 (2.3)	2704 (4.6)	54914 (93.1)	
>35	14029	463 (3.3)	593 (4.2)	12973 (92.5)	
Maternal education					
No education	20760	353 (1.7)	639 (3.1)	19768 (95.2)	<0.001
Primary	27629	472 (1.7)	1190 (4.3)	25967 (94.0)	
Secondary	20975	654 (3.1)	1109 (5.3)	19212 (91.6)	
Higher	3783	343 (9.1)	364 (9.6)	3076 (81.3)	
Parity					
0	17325	428 (2.5)	1323 (7.6)	15574 (89.9)	<0.001
1 to 2	26536	853 (3.2)	1082 (4.1)	24601 (92.7)	
≥ 3	29287	541 (1.8)	897 (3.1)	27849 (95.1)	
Place of residence					
Urban	27395	1126 (4.1)	1605 (5.9)	24664 (90.0)	<0.001
Rural	45753	696 (1.5)	1697 (3.7)	43360 (94.8)	
Place of delivery					
Private hospital	10093	462 (4.6)	649 (6.4)	8982 (89.0)	<0.001
Public hospital	63055	1360 (2.2)	2653 (4.2)	59042 (93.6)	
Economic status					
Poorest	11763	106 (0.9)	359 (3.0)	11298 (96.1)	<0.001
Poorer	13413	157 (1.2)	402 (3.0)	12854 (95.8)	
Middle	14999	233 (1.5)	545 (3.6)	14221 (94.9)	
Richer	16041	371 (2.3)	732 (4.6)	14938 (93.1)	
Richest	16932	955 (5.6)	1264 (7.5)	14713 (86.9)	
Size of baby at birth					
Very large	8101	256 (3.2)	510 (6.3)	7335 (90.5)	<0.001
Larger than average	16106	415 (2.6)	856 (5.3)	14835 (92.2)	
Average	38086	834 (2.2)	1494 (3.9)	35758 (93.9)	
Smaller than average	7265	194 (2.7)	289 (4.0)	6782 (93.3)	
Very small	2968	100 (3.4)	115 (3.9)	2753 (92.7)	
Missing	622	23	38	561	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	2329	33 (1.4)	56 (2.4)	2240 (96.2)	<0.001
Normal weight	19425	383 (2.0)	787 (4.0)	18255 (94.0)	

(18·5-24·9)					
Overweight (25-29·9)	5762	197 (3.4)	349 (6.1)	5216 (90.5)	
Obese (≥30)	2832	227 (8.0)	240 (8.5)	2365 (83.5)	
Missing	42800	982	1870	39948	
Health insurance cover					
Yes	4129	275 (6.7)	292 (7.1)	3562 (86.3)	<0.001
No	62775	1395 (2.2)	2805 (4.5)	58575 (93.3)	
Missing	6244	152	205	5887	

Table S6. Characteristics of women with prelabour CS in the index pregnancy in Asia

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	41	5 (12.2)	0 (0)	36 (87.8)	<0.001
16 to 35	162770	17535 (10.8)	14267 (8.8)	130968 (80.4)	
>35	17399	2711 (15.6)	1521 (8.7)	13167 (75.7)	
Maternal education					
No education	34446	1851 (5.4)	1605 (4.7)	30990 (89.9)	<0.001
Primary	24576	2006 (8.2)	1585 (6.4)	20985 (85.4)	
Secondary	92465	10766 (11.6)	8691 (9.4)	73008 (79.0)	
Higher	28723	5628 (19.6)	3907 (13.6)	19188 (66.8)	
Parity					
0	63624	7913 (12.4)	8301 (13.1)	47410 (74.5)	<0.001
1 to 2	89654	10599 (11.8)	6459 (7.2)	72596 (81.0)	
≥ 3	26932	1739 (6.5)	1028 (3.8)	24165 (89.7)	
Place of residence					
Urban	61647	9679 (15.7)	6807 (11.0)	45161 (73.3)	<0.001
Rural	118563	10572 (8.9)	8981 (7.6)	99010 (83.5)	
Place of delivery					
Private hospital	51498	10309 (20.0)	8468 (16.4)	32721 (63.6)	<0.001
Public hospital	128712	9942 (7.7)	7320 (5.7)	111450 (86.0)	
Economic status					
Poorest	34593	1675 (4.8)	1630 (4.7)	31288 (90.5)	<0.001
Poorer	38731	2768 (7.1)	2431 (6.3)	33532 (86.6)	
Middle	38560	4273 (11.1)	3374 (8.7)	30913 (80.2)	
Richer	35732	5277 (14.8)	3987 (11.2)	26468 (74.0)	
Richest	32594	6258 (19.2)	4366 (13.4)	21970 (67.4)	
Size of baby at birth					
Very large	9089	1273 (14.0)	949 (10.4)	6867 (75.5)	<0.001
Larger than average	24052	2941 (12.2)	2464 (10.2)	18647 (77.6)	
Average	119053	12896 (10.8)	9842 (8.3)	96315 (80.8)	
Smaller than average	14706	1609 (8.9)	1304 (8.9)	11793 (82.2)	
Very small	4049	452 (11.2)	395 (9.8)	3202 (80.0)	
Missing	9261	1080	834	7347	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	30612	1836 (6.0)	1743 (5.7)	27033 (88.3)	<0.001
Normal weight	91896	8672 (9.4)	7331 (8.0)	75893 (82.6)	

(18·5-24·9)					
Overweight (25-29·9)	23019	4397 (19.1)	2926 (12.7)	15696 (68.2)	
Obese (≥30)	7260	1963 (27.0)	1092 (15.0)	4205 (58.0)	
Missing	27423	3383	2696	21344	
Health insurance cover					
Yes	34022	4645 (13.6)	3488 (10.2)	25889 (76.2)	<0.001
No	132142	14676 (11.1)	11598 (8.9)	105868 (80.0)	
Missing	14046	930	702	12414	

Table S7. Characteristics of women with prelabour CS in the index pregnancy in Americas

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Maternal age (years)					
<16	42	4 (9.5)	8 (19.0)	30 (71.5)	<0.001
16 to 35	8169	1233 (15.1)	1547 (18.9)	5389 (66.0)	
>35	1382	294 (21.3)	200 (14.5)	888 (64.2)	
Maternal education					
No education	265	15 (5.7)	30 (11.3)	220 (83.0)	<0.001
Primary	1909	203 (10.6)	240 (12.6)	1466 (76.8)	
Secondary	5055	762 (15.1)	899 (17.8)	3394 (67.1)	
Higher	2364	551 (23.3)	586 (24.8)	1227 (51.9)	
Parity					
0	4056	484 (11.9)	1010 (24.9)	2562 (63.2)	<0.001
1 to 2	4278	935 (21.9)	623 (14.6)	2720 (63.5)	
≥ 3	1259	112 (8.9)	122 (9.7)	1025 (81.4)	
Place of residence					
Urban	6516	1206 (18.5)	1302 (20.0)	4008 (61.5)	<0.001
Rural	3077	325 (10.6)	453 (14.7)	2299 (74.7)	
Place of delivery					
Private hospital	2763	655 (23.7)	648 (23.4)	1460 (52.9)	<0.001
Public hospital	6830	876 (12.8)	1107 (16.2)	4847 (71.0)	
Economic status					
Poorest	2447	289 (11.8)	413 (16.9)	1745 (71.3)	<0.001
Poorer	2839	517 (18.2)	571 (20.1)	1751 (61.7)	
Middle	1994	335 (16.8)	396 (19.9)	1263 (65.3)	
Richer	1359	217 (16.0)	220 (16.2)	922 (67.8)	
Richest	954	173 (18.1)	155 (16.2)	626 (67.7)	
Size of baby at birth					
Very large	172	12 (7.0)	14 (8.1)	146 (84.9)	0.04
Larger than average	254	22 (8.7)	26 (10.1)	206 (81.2)	
Average	984	56 (5.7)	69 (7.0)	859 (83.3)	
Smaller than average	301	11 (3.6)	20 (6.6)	270 (89.8)	
Very small	176	10 (5.7)	22 (12.5)	144 (81.8)	
Missing	7706	1420	1604	4682	
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	63	2 (3.2)	3 (4.8)	58 (92.0)	<0.001
Normal weight	631	24 (3.8)	42 (6.7)	565 (89.5)	

(18·5-24·9)					
Overweight (25-29·9)	351	23 (6.5)	38 (10.8)	290 (82.7)	
Obese (≥30)	214	26 (12.1)	26 (12.1)	162 (75.8)	
Missing	8334	1456	1646	5232	
Health insurance cover					
Yes	89	15 (16.8)	19 (21.3)	55 (61.9)	<0.001
No	1798	96 (5.3)	132 (7.3)	1570 (87.4)	
Missing	7706	1420	1604	4682	

Table S8. Characteristics of antenatal care in pregnancies with prelabour CS in 26 low-income and middle-income countries

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	18578	957 (5.1)	799 (4.3)	16822 (90.5)	<0.001
1 to 3	75640	3882 (5.1)	4287 (5.7)	67471 (89.2)	
>3	165801	18408 (11.1)	15543 (9.4)	131850 (79.5)	
Missing	2932	357	216	2359	
ANC provider					
Doctor	111971	15930 (14.2)	12087 (10.8)	83954 (75.0)	<0.001
Nurse / midwife	76938	3807 (4.9)	4633 (6.0)	68498 (89.1)	
Clinical officer	27700	1124 (4.1)	1497 (5.4)	25079 (90.5)	
Other (+TBA)	27631	1769 (6.4)	1814 (6.6)	24048 (87.0)	
Missing	18711	974	814	16923	
ANC first visit					
First trimester	158125	17841 (11.3)	14802 (9.4)	125482 (79.3)	<0.001
Second trimester	74242	3790 (5.1)	4436 (6.0)	66016 (88.9)	
Third trimester	11200	957 (8.5)	770 (6.9)	9473 (84.6)	
Missing	19384	847	712	17442	
ANC location					
Public hospital	179173	12625 (7.0)	11927 (6.7)	154621 (86.3)	<0.001
Private hospital	50182	8833 (17.6)	6815 (13.6)	34534 (68.8)	
Missing	33596	2146	2103	29347	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer refers to non-physician clinician.					

Table S9. Characteristics of antenatal care in pregnancies with prelabour CS in Africa

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	1707	28 (1.6)	62 (3.6)	1617 (94.8)	<0.001
1 to 3	24675	450 (1.8)	920 (3.7)	23305 (94.5)	
>3	45811	1312 (2.9)	2278 (5.0)	42221 (92.1)	
Missing	955	32	42	881	
ANC provider					
Doctor	9503	600 (6.3)	652 (6.9)	8251 (86.8)	<0.001
Nurse / midwife	39933	744 (1.9)	1655 (4.1)	37534 (94.0)	
Clinical officer	15878	319 (2.0)	551 (3.5)	15008 (94.5)	
Other (+TBA)	6074	123 (2.0)	376 (6.2)	5575 (91.8)	
Missing	1760	36	68	1656	
ANC first visit					
First trimester	29277	967 (3.3)	1461 (5.0)	26849 (91.7)	<0.001
Second trimester	37856	754 (2.0)	1649 (4.4)	35453 (93.6)	
Third trimester	3961	65 (1.6)	120 (3.0)	3776 (95.4)	
Missing	2054	36	72	1946	
ANC location					
Public hospital	62830	1375 (2.2)	2704 (4.3)	58751 (93.5)	<0.001
Private hospital	6798	377 (5.5)	420 (6.2)	6001 (88.3)	
Missing	3520	70	178	3272	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer refers to non-physician clinician.					

Table S10. Characteristics of antenatal care in pregnancies with prelabour CS in Asia

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	16734	926 (5.5)	710 (4.2)	15098 (90.3)	<0.001
1 to 3	50225	3378 (6.7)	3263 (6.5)	43584 (86.8)	
>3	111364	15636 (14.0)	11660 (10.5)	84068 (75.5)	
Missing	1887	311	155	1421	
ANC provider					
Doctor	94021	13869 (14.7)	9825 (10.4)	70327 (74.9)	<0.001
Nurse / midwife	36066	3003 (8.3)	2873 (8.0)	30190 (83.7)	
Clinical officer	11790	800 (6.8)	939 (8.0)	10051 (85.2)	
Other (+TBA)	21520	1644 (7.6)	1432 (6.6)	18444 (85.8)	
Missing	16813	935	719	15159	
Time of first ANC visit					
First trimester	121467	15582 (12.8)	11954 (9.8)	93931 (77.4)	<0.001
Second trimester	34536	2822 (8.2)	2478 (7.2)	29236 (84.6)	
Third trimester	7028	871 (12.4)	618 (8.8)	5539 (78.8)	
Missing	17179	976	738	15465	
ANC location					
Public hospital	110211	10418 (9.4)	8199 (7.4)	91594 (83.2)	<0.001
Private hospital	40241	7774 (19.3)	5713 (14.2)	26754 (66.5)	
Missing	29758	2059	1876	25823	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer refers to non-physician clinician.					

Table S11. Characteristics of antenatal care in pregnancies with prelabour CS in Americas

Variable	Number of women	Prelabour CS	Intrapartum CS	Vaginal delivery	P-value
	N	n (%)	n (%)	n (%)	
Number of antenatal visits					
0	137	3 (2.2)	27 (19.7)	107 (78.1)	<0.001
1 to 3	740	54 (7.3)	104 (14.0)	582 (78.7)	
>3	8626	1460 (16.9)	1605 (18.6)	5561 (64.5)	
Missing	90	14	19	57	
ANC provider					
Doctor	8447	1461 (17.3)	1610 (19.1)	5376 (63.6)	<0.001
Nurse / midwife	939	60 (6.4)	105 (11.2)	774 (82.4)	
Clinical officer	32	5 (15.6)	7 (21.9)	20 (62.5)	
Other (+TBA)	37	2 (5.4)	6 (16.2)	29 (78.4)	
Missing	138	3	27	108	
Time of first ANC visit					
First trimester	7381	1292 (17.5)	1387 (18.8)	4702 (63.7)	<0.001
Second trimester	1850	214 (11.6)	309 (16.7)	1327 (71.7)	
Third trimester	211	21 (9.9)	32 (15.2)	158 (74.9)	
Missing	151	4	27	120	
ANC location					
Public hospital	6132	832 (13.6)	1024 (16.7)	4276 (69.7)	<0.001
Private hospital	3143	682 (21.7)	682 (21.7)	1779 (56.6)	
Missing	318	17	49	252	
ANC – antenatal care; TBA – traditional birth attendant; Clinical officer refers to non-physician clinician.					

Table S12. Association of prelabour CS with various outcomes in 26 low-income and middle-income countries

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	218502	2764 (1.3)	1		1	
Prelabour CS	23604	319 (1.3)	1.0 (0.9-1.2)	0.9	1.3 (1.1-1.5)	0.004
Intrapartum CS	20845	366 (1.8)	1.3 (1.1-1.5)	0.001	1.6 (1.4-1.9)	<0.001
Early neonatal mortality						
Vaginal delivery	218502	2385 (1.1)	1		1	
Prelabour CS	23604	268 (1.1)	1.0 (0.8-1.2)	0.9	1.6 (1.4-1.9)	<0.001
Intrapartum CS	20845	321 (1.5)	1.3 (1.1-1.5)	0.001	1.7 (1.4-2.1)	<0.001
Early skin-to-skin contact						
Vaginal delivery	204736	113475 (55.4)	1		1	
Prelabour CS	20718	7496 (36.2)	0.5 (0.4-0.6)	<0.001	0.4 (0.3-0.5)	<0.001
Intrapartum CS	18043	6034 (33.4)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	204736	153650 (75.0)	1		1	
Prelabour CS	20718	11043 (53.3)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Intrapartum CS	18043	8959 (49.6)	0.3 (0.2-0.4)	<0.001	0.3 (0.2-0.4)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	213718	148587 (69.5)	1		1	
Prelabour CS	22183	21140 (95.3)	9.1 (8.3-10.1)	<0.001	7.2 (6.5-8.0)	<0.001
Intrapartum CS	19241	18439 (95.8)	10.1 (9.0-11.2)	<0.001	8.2 (7.3-9.1)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [221983 observations].						

Table S13. Association of prelabour CS with various outcomes in Africa

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	68024	908 (1.3)	1		1	
Prelabour CS	1822	46 (2.5)	2.1 (1.4-3.2)	<0.001	2.1 (1.2-3.5)	0.008
Intrapartum CS	3302	125 (3.8)	2.9 (2.3-3.6)	<0.001	3.4 (2.6-4.4)	<0.001
Early neonatal mortality						
Vaginal delivery	68024	786 (1.2)	1		1	
Prelabour CS	1822	45 (2.5)	2.3 (1.5-3.5)	<0.001	2.0 (1.1-3.4)	0.007
Intrapartum CS	3302	117 (3.5)	3.1 (2.5-4.0)	<0.001	3.4 (2.6-4.4)	<0.001
Early skin-to-skin contact						
Vaginal delivery	66276	41495 (62.6)	1		1	
Prelabour CS	1737	527 (30.3)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Intrapartum CS	3149	896 (28.4)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	66276	49658 (74.9)	1		1	
Prelabour CS	1737	744 (42.8)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Intrapartum CS	3149	1282 (40.7)	0.2 (0.1-0.3)	<0.001	0.2 (0.1-0.3)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	68023	37711 (55.4)	1		1	
Prelabour CS	1882	1748 (95.9)	21.1 (15.6-28.4)	<0.001	21.3 (15.7-28.9)	<0.001
Intrapartum CS	3302	3189 (96.6)	24.9 (19.4-31.9)	<0.001	25.2 (19.5-32.4)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [69138 observations].						

Table S14. Association of prelabour CS with various outcomes in Asia

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	144171	1817 (1.3)	1		1	
Prelabour CS	20251	265 (1.3)	1.0 (0.8-1.2)	0.9	1.3 (1.1-1.6)	0.008
Intrapartum CS	15788	234 (1.5)	1.1 (0.9-1.3)	0.4	1.2 (1.0-1.5)	0.04
Early neonatal mortality						
Vaginal delivery	144171	1574 (1.1)	1		1	
Prelabour CS	20251	218 (1.1)	1.0 (0.7-1.2)	0.7	1.2 (0.9-1.5)	0.06
Intrapartum CS	15788	200 (1.3)	1.1 (0.9-1.3)	0.5	1.2 (0.9-1.5)	0.09
Early skin-to-skin contact						
Vaginal delivery	136913	71349 (52.1)	1		1	
Prelabour CS	18887	6953 (36.8)	0.5 (0.4-0.6)	<0.001	0.8 (0.7-0.9)	<0.001
Intrapartum CS	14759	5124 (34.7)	0.5 (0.4-0.6)	<0.001	0.4 (0.3-0.5)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	136913	103119 (75.3)	1		1	
Prelabour CS	18887	10278 (54.4)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Intrapartum CS	14759	7646 (51.8)	0.4 (0.3-0.5)	<0.001	0.4 (0.3-0.5)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	144070	109741 (76.2)	1		1	
Prelabour CS	20250	19285 (95.2)	6.2 (5.6-6.9)	<0.001	5.2 (4.6-5.8)	<0.001
Intrapartum CS	15788	15105 (95.7)	6.7 (5.9-7.5)	<0.001	5.7 (5.0-6.4)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [150389 observations].						

Table S15. Association of prelabour CS with various outcomes in Americas

Outcome	Total number (N)	n (%)	OR (95% CI) <sup>a</sup>	P-value	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality						
Vaginal delivery	6307	39 (0.6)	1		1	
Prelabour CS	1531	8 (0.5)	0.6 (0.2-1.6)	0.2	3.3 (0.8-13.3)	0.3
Intrapartum CS	1755	7 (0.4)	0.5 (0.1-2.0)	0.4	1.9 (0.4-8.9)	0.4
Early neonatal mortality						
Vaginal delivery	6307	25 (0.4)	1		1	
Prelabour CS	1531	5 (0.3)	0.5 (0.2-1.8)	0.3	3.3 (0.8-13.3)	0.08
Intrapartum CS	1755	4 (0.2)	0.2 (0.1-0.8)	0.02	0.8 (0.2-3.2)	0.8
Early skin-to-skin contact						
Vaginal delivery	1547	631 (40.8)	1		1	
Prelabour CS	94	16 (17.0)	0.3 (0.1-0.6)	<0.001	0.3 (0.1-0.6)	<0.001
Intrapartum CS	135	14 (10.4)	0.2 (0.1-0.4)	<0.001	0.2 (0.1-0.4)	<0.001
Breastfeeding initiated within 1h of birth						
Vaginal delivery	1547	873 (56.4)	1		1	
Prelabour CS	94	21 (22.3)	0.2 (0.1-0.4)	<0.001	0.2 (0.1-0.4)	<0.001
Intrapartum CS	135	31 (23.0)	0.3 (0.2-0.4)	<0.001	0.3 (0.2-0.5)	<0.001
Duration stay hospital > 72 hours						
Vaginal delivery	1625	1135 (69.8)	1		1	
Prelabour CS	111	107 (96.4)	13.7 (3.9-48.0)	<0.001	15.2 (4.2-54.6)	<0.001
Intrapartum CS	151	145 (96.0)	12.5 (4.9-32.0)	<0.001	12.5 (4.8-32.6)	<0.001
OR – odds ratio; CI – confidence interval.						
<sup>a</sup> Adjusted for country of survey and complex survey design (clustering, weights and stratification).						
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (maternal age at birth, parity, education, antenatal care, place of residence, place of delivery, economic status, size of baby at birth) [9501 observations].						

Table S16. Association of prelabour and intrapartum CS with various outcomes among all singleton pregnancies with previous CS<sup>a</sup>

Outcome	Total number (N)	n (%)	Adjusted OR (95% CI) <sup>b</sup>	P-value
Neonatal mortality				
Vaginal delivery	237041	4029 (1.7)	1	
Prelabour CS	24782	421 (1.7)	1.3 (1.1-1.6)	0.04
Intrapartum CS	22956	482 (2.1)	1.5 (1.2-1.7)	<0.001
Early neonatal mortality				
Vaginal delivery	237041	3319 (1.4)	1	
Prelabour CS	24782	361 (1.4)	1.2 (0.9-1.3)	0.08
Intrapartum CS	22956	390 (1.7)	1.5 (1.2-1.7)	<0.001
Early skin-to-skin contact				
Vaginal delivery	231992	121332 (52.3)	1	
Prelabour CS	21976	7977 (36.3)	0.4 (0.2-0.5)	<0.001
Intrapartum CS	20008	6703 (33.5)	0.4 (0.2-0.5)	<0.001
Breastfeeding initiated within 1h				
Vaginal delivery	231992	166357 (71.8)	1	
Prelabour CS	21976	11735 (53.4)	0.3 (0.2-0.6)	<0.001
Intrapartum CS	20008	9904 (49.5)	0.3 (0.2-0.5)	<0.001
Duration stay hospital > 72 hours				
Vaginal delivery	227256	158625 (69.8)	1	
Prelabour CS	23043	21937 (95.2)	6.5 (5.9-7.3)	<0.001
Intrapartum CS	21823	22083 (95.6)	7.4 (6.7-8.6)	<0.001
OR – odds ratio; CI – confidence interval.				
<sup>a</sup> All singleton pregnancies (term and preterm) across 26 low-income and middle-income countries.				
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (economic status, maternal age, education, antenatal care, size of baby at birth) [234008 observations]				

Table S17. Summary of association of primary prelabour CS with perinatal outcomes in term pregnancies and all pregnancies among women with previous CS<sup>a</sup>

	Adjusted OR (95% CI) <sup>b</sup>				
	Neonatal mortality	Early neonatal mortality	Early skin-to-skin contact	Breastfeeding initiated within 1h of birth	Duration stay hospital > 72 hours
Singleton pregnancies at term with previous CS	1.3 (1.1-1.5)	1.6 (1.4-1.9)	0.4 (0.3-0.5)	0.4 (0.3-0.5)	7.2 (6.5-8.0)
Singleton pregnancies (term and preterm) with previous CS	1.3 (1.1-1.6)	1.2 (0.9-1.3)	0.4 (0.2-0.5)	0.3 (0.2-0.6)	6.5 (5.9-7.3)
OR – odds ratio; CI – confidence interval.					
<sup>a</sup> Pooled analysis of all pregnancies (term and preterm) in 26 low-income and middle-income countries.					
<sup>b</sup> Adjusted for country of survey, complex survey design and confounders (economic status, maternal age, education, antenatal care, size of baby at birth).					