Association between Robson classification groups and cesarean delivery: a longitudinal analysis in Mongolia

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BACKGROUND: The number of cesarean deliveries has increased sharply worldwide over the last 3 decades. The World Health Organization recommends using the Robson classification as the best tool for monitoring and auditing cesarean delivery rates and to safely reduce the rate of avoidable cesarean deliveries.

OBJECTIVE: This study aimed to identify the association between the Robson classification groups and cesarean delivery in 2008 and 2018 at the Urguu Maternity Hospital, Ulaanbaatar, Mongolia, and to examine the changes in this association over 10 years.

STUDY DESIGN: This cross-sectional study was conducted using 21,225 participants’ electronic birth records (9,544 in 2008 and 11,681 in 2018) from the Urguu Maternity Hospital. Birth records were categorized into 10 groups using the Robson classification report table. Multiple logistic regressions were conducted to examine the association between the Robson classification group and the cesarean delivery rate for 2008 and 2018. The same regression analysis was subsequently conducted using a pooled data set to capture the changes in the association among the Robson classification group, a birth-year dummy, and the cesarean delivery rate.

RESULTS: The odds of having a cesarean delivery when classified in group 1 in 2018 (adjusted odds ratio, 3.02; 95% confidence interval, 1.85–4.94; P<.001) was 3 times greater than that in 2008. Moreover, the odds of having a cesarean delivery when classified in group 2 (adjusted odds ratio, 0.66; 95% confidence interval, 0.51–0.85; P=.001), group 3 (adjusted odds ratio, 0.21; 95% confidence interval, 0.16–0.29; P<.001), or group 4 (adjusted odds ratio, 0.33; 95% confidence interval, 0.25–0.45; P<.001) declined in 2018 when compared with 2008. The odds of having a cesarean delivery were the lowest among mothers classified in group 3 and the highest among mothers in group 5 in both study years.

CONCLUSION: The high percentage of mothers classified as group 5 who gave birth via cesarean delivery suggests that healthcare providers should work with mothers in group 5 to increase their willingness to give birth vaginally after a previous cesarean delivery in an attempt to reduce the overall cesarean delivery rates. Further research is needed to better understand the factors that may influence the increasing rates of birth through cesarean delivery.

Key words: birth mode, cesarean delivery, longitudinal change, surgical birth, 10 group classification

Introduction
The annual number of cesarean deliveries (CDs) has increased sharply worldwide from 6.7% in 1990 to 21.1% in 2018. However, the reason for this increase is multifactorial and not fully understood. The increasing tendency toward having a CD is problematic for both maternal and neonatal health services owing to the short- and long-term consequences for mothers and their newborns. Among the most commonly cited issues are the increased risk for life-threatening maternal complications and the subsequent abnormal development of the newborn immune system. Moreover, the sharp rise in CDs performed worldwide suggests that it is performed more often than needed without clear evidence that practice improves the maternal and neonatal health.
To safely reduce the increasing prevalence of CDs, the World Health Organization recommended the Robson classification as a tool for monitoring and auditing CD rates in 2016. The classification uses 6 basic obstetrical variables (parity, previous CD, onset of labor, gestational age, number of fetuses, fetal lie, and presentation) to classify each woman into 1 of 10 groups. Moreover, this classification system allows for the comparison of differing geographic settings in a time series. Any differences in the CD outcomes among health facilities or in a time series that are the consequence of poor data quality, diversity of obstetrical populations, and differences in the clinical practice of a particular setting can be deduced from the Robson classification report table. To emphasize the common features across obstetrical populations, the classification is based on the following 3 main assessments: (1) quality of data, (2) type of obstetrical population, and (3) CD rates. Although it does not focus on the clinical indications for CD, it can be used to detect specific determinants of CDs in a clinically relevant and robust manner. Moreover, the implementation of the Robson classification has shown to be an effective intervention to reduce the number of unnecessary CDs.

The use of the Robson classification is diverse among countries with limited applicability in low-resource settings. According to a systematic review conducted by the WHO, >78% of the studies on this classification system were conducted in high- or upper-middle-income countries. However, to evaluate any intervention aimed at reducing unnecessary CDs globally, evidence generated using the Robson classification in low- and lower-middle-income countries is critical.

Mongolia is a lower-middle-income country and is 1 of 9 countries that achieved the Millennium Development Goal (MDG) 5 to improve maternal health within the target period (2000–2015). According to a 2015 report by the Mongolian Ministry of Health, 98% of births occurred in the presence of skilled birth attendants, the maternal mortality ratio decreased by 75% from 2004, and 86% of mothers had more than 6 antenatal visits. However, the domestic CD rates surged from 5.1% in 1998 to 24.8% in 2015. Despite the improvements in perinatal care and birth outcomes, there is a lack of attention on the increasing rates of CD in Mongolia. Moreover, a search of official reports or guidelines from the Mongolian authority revealed that the Robson classification has not been implemented yet in Mongolia.

Although a few studies have investigated CD rates as they relate to the Robson classification in Lithuania, Australia, Ethiopia, and the United States, little is known about the longitudinal changes in the Robson classification groups and CD births. This study was conducted to identify the association between the Robson classification group and CD births in 2008 and 2018 and to examine the changes in this association over a period of 10 years at the largest maternity hospital in Mongolia. In addition, a better understanding of the increasing CD rates in Mongolia may serve as a lesson for other low- and lower-middle-income countries that are attempting to reduce the maternal mortality while maintaining low CD rates.

Materials and Methods

Study design and participants

This cross-sectional study was conducted using secondary data from the Urguu Maternity Hospital (UMH) in the Mongolian capital city of Ulaanbaatar. The UMH is the largest maternity hospital in Mongolia and covers approximately 15% of all annual deliveries in the country.

The study participants included all mothers who delivered (via a vaginal delivery or CD) at the UMH in 2008 and 2018. Demographic and clinical data of all the deliveries of both years were extracted from the medical records at the UMH. This time frame was chosen to showcase the transition between the MDG and Sustainable Development Goals era. The exclusion criteria included the records of mothers under 16 years of age or those with missing data.

Birth records were categorized into 10 groups according to the Robson classification report table. The categorization was based on 6 obstetrical variables, namely parity (nulliparous vs multiparous), gestational age (term [gestational age ≥ 37 weeks] vs preterm), onset of labor (spontaneous, induced labor, and prelabor CD), fetal presentation (cephalic, breech, and other malpresentations), number of fetuses (single pregnancy vs multiple pregnancy [twins or more]), and previous CD (Table 1).
TABLE 1
Robson classification system

| Groups           | Group description                                           |
|------------------|-------------------------------------------------------------|
| Group 1          | All nulliparous, single cephalic, ≥37 wk, in spontaneous labor |
| Group 2          | Nulliparous, single cephalic, ≥37 wk, induced or CD before labor |
| Group 3          | Multiparous (excluding previous CD), single cephalic, ≥37 wk, spontaneous labor |
| Group 4          | Multiparous (excluding previous CD), single cephalic, >37 wk, induced or CD before labor |
| Group 5          | Previous CD, single cephalic, ≥37 wk                        |
| Group 6          | All nulliparous breeches                                   |
| Group 7          | All multiparous breeches (including previous CD)           |
| Group 8          | All multiple pregnancies (including previous CD)            |
| Group 9          | All abnormal lies (including previous CD)                   |
| Group 10         | All single cephalic, <37 wk (including previous CD)        |

CD, cesarean delivery.

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Variables
The exposure variable was the Robson classification group and patients were categorized into groups 1 to 10.

The covariates were maternal sociodemographic characteristics (age, maternal higher education status, marital status, and employment status), clinical practices (successful attempts at instrumental delivery), and birthing year. Maternal age was a continuous variable, whereas all the other variables were dichotomized.

The outcome variable was CD and was dichotomized as “yes” for CD and “no” for vaginal delivery.

Data collection
All data were obtained from the UMH electronic medical record database in September 2019. Because the electronic birth records from the hospital contained a large number of missing values, the corresponding paper-based records were reviewed to locate any missing values.

Data analysis
The maternal sociodemographic characteristics, clinical practices, birth outcomes, and Robson classification groups corresponding to the years 2008 and 2018 were compared. Independent sample t tests and chi-square tests were used to test for differences in the mother’s sociodemographic characteristics and other variables between the study years.

Multiple logistic regression models were created to examine the association between the exposure variables and outcomes. First, regression analyses were conducted separately for the years 2008 and 2018. A multiple logistic regression was then conducted using a pooled data set for 2008 and 2018 to capture the changes in the association between the Robson classification group, interacted with a birth-year dummy, and CD. Covariates were excluded from the multiple regression model if they demonstrated a power of less than 80% to detect a 0.05 significance level in a simple logistic regression model. STATA version 15.1 (StataCorp LLC, College Station, TX) was used to process and analyze the data. Results were displayed as adjusted odds ratios (aORs), 95% confidence intervals (CIs), and P values, with group 1 representing the Robson classification reference group.

Ethics
Ethical approval was obtained from the Research Ethics Committee of the Graduate School of Medicine, The University of Tokyo, Japan (2019126NI), and the Research Ethics Committee of the Department of Medical Research, Ministry of Health, Mongolia (No. 120). Confidentiality of study participants and data was strictly maintained.

Results
The Figure 1 depicts a flowchart detailing the selection of the study population. A total of 21,325 electronic birth records were identified, of which 4415 had missing values. Most of the missing values (98%) were verified by reviewing the corresponding paper-based records, whereas attempts to locate the missing values in 86 electronic birth records failed because the corresponding non-identifiable, paper-based records in the hospital archive could not be retrieved.

A total of 100 electronic birth records were excluded from the overall data set: 14 records were excluded because the mothers were under the age of 16 years and 86 records were excluded because of missing values, which were mainly related to the onset of labor and fetal lie. Finally, 9544 birth records from 2008 and 11,681 birth records from 2018 were included in the analysis (21,225 in total).

Birth characteristics of mothers in 2008 and 2018
Table 2 shows the birth characteristics of the mothers who delivered in 2008 and 2018. The CD rates increased from 26.7% to 35.1% between the 2 years studied (P < .001). The mean maternal age, the proportion of mothers who had a college degree or higher level of education, and the number of employed mothers increased over time.

The proportions of stillbirths, early neonatal deaths, and maternal mortality remained almost unchanged in the 2 years studied.

Robson classification of mothers in 2008 and 2018
Table 3 depicts the Robson classification report table for 2008 and 2018, compiled in accordance with the WHO Robson classification implementation manual. By 2018, the CD rates for the nulliparous (single, cephalic, and term) population had increased, whereas the CD rates for the multiparous (single, cephalic, and term) population had decreased. The contribution to the overall CD rates of group 5 (women with a previous CD) sharply increased between 2008 and 2018. The contributions of
group 2 (nulliparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD) and group 4 (multiparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD) to the overall CD rates remained high in both years studied.

Association between the Robson classification group and cesarean delivery

Table 4 shows the association between the Robson classification groups and CD based on multiple logistic regression analyses for 2008 and 2018 separately, while adjusting for the obstetrical population by sociodemographic characteristics. Factors including the maternal marital status and successful instrumental delivery attempts were excluded from the final model because of the low statistical power (16% in both cases). In addition, the data from patients categorized in group 9 was excluded from the analysis because of a CD rate of 100%.

According to the multiple logistic regression analysis, the odds of having a CD when classified in group 1 (nulliparous women with single, cephalic, and term pregnancies in spontaneous labor) increased 3-fold between 2008 and 2018. However, the odds of having a CD declined during the same period among women classified in group 2 (nulliparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD), group 3 (multiparous women with single, cephalic, and term pregnancies in spontaneous labor), and group 4 (multiparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD). Second, no changes were found in the rank ordering likelihood of having a CD across the Robson classification group between the years 2008 and 2018. In both years, the odds of having a CD were the highest in group 5 (women with a previous CD) and the lowest in group 3.

Results and clinical implications

The odds of having a CD among mothers in group 1 in Mongolia increased 3-fold in 2018 when compared with that in 2008. Because no previous studies have investigated this change in Mongolia, we looked at studies conducted in other countries for a possible

Discussion

Principal findings

This study had 2 major findings regarding the likelihood of having a CD among the different Robson classification groups from 2008 to 2018. First, the following changes were detected: the odds of having a CD in group 1 (nulliparous women with single, cephalic, and term pregnancies in spontaneous labor) increased 3-fold between 2008 and 2018. However, the odds of having a CD declined during the same period among women classified in group 2 (nulliparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD), group 3 (multiparous women with single, cephalic, and term pregnancies in spontaneous labor), and group 4 (multiparous women with single, cephalic, and term pregnancies in induced labor or prelabor CD). Second, no changes were found in the rank ordering likelihood of having a CD across the Robson classification group between the years 2008 and 2018. In both years, the odds of having a CD were the highest in group 5 (women with a previous CD) and the lowest in group 3.
explanation. The most relevant material factors associated with the rising CD rates are changes in maternal characteristics, overdiagnosis of fetal distress, fear of sexual dysfunction, urinary and anal incontinence, and changing indications for CDs such as an increase in CDs on maternal request. Fear of litigation, financial reimbursement, and clinicians’ personal beliefs are common reasons for the increasing CD rates among health service providers; some of these factors may be applicable in the Mongolian context.

The odds of having a CD among mothers categorized in groups 2, 3, or 4 in Mongolia decreased significantly by 2018. The overall increase in the CD rate seems to be stabilizing gradually in the study setting. Similar evidence has been found in the United States and China, where the CD rates among low-risk pregnancies have increased less sharply since 2010 than in earlier time periods. Moreover, this study reflected the Mongolian implementation of the 2007 update of the WHO Guidelines on Managing Complications in Pregnancy and Childbirth. Implementing updated guidelines in practice may be effective in reducing CD rates in multiparous populations.

When compared with group 1, the odds of having a CD were the highest among women categorized in group 5, followed by those in groups 6 and 7 (breeches) in both years studied. Almost the entire study population in group 5 delivered via CD, which mirrors the phenomenon coined by American obstetrician Edwin Cragin: “Once cesarean always cesarean.” This concept has been identified as the main cause of the tripling CD rates in the United States in the 1980s. A high aOR was observed in group 6 and 7, which could present another possible mantra, “if breech, more likely cesarean.” According to the American College of Obstetricians and Gynecologists, delivery via CD in cases in which the fetus is in breech presentation is already a common trend in the United States. Unjustifiable CDs for breech pregnancies might increase if proper interventions are not taken immediately and might lead to an increase in the number of CDs in the future in Mongolia and worldwide.

Strengths and limitations
This study has some limitations. First, it includes data for only 2 discrete years of birth (2008 and 2018); annual changes between 2009 and 2017 were not reported. Second, this study could not include all potential confounders, such as postnatal characteristics (Apgar score and umbilical cord arterial pH) because these data were not systematically recorded in Mongolia. Third, we could only obtain data from the UMH, which represents approximately 15% of the total annual births in Mongolia. However, because this hospital was not randomly selected, it is not necessarily representative of the data of the country. Finally, the values in the medical records could not be independently verified, and incorrect data inputs were possible. For example, group 9 births
might have been recorded as group 6 or 7 (breech presentations) births owing to their clinical similarity. Despite these limitations, this study has several strengths. This study identified an association between the Robson classification groups and CD. By using the Robson classification, 6 commonly recorded obstetrical variables are combined into a single grouping that is directly related to the odds of undergoing a CD. This makes it easier for clinicians to determine a mother’s odds of having a CD at a glance. Moreover, this study provided a numeric hierarchy for the odds of having a CD among the Robson classification groups in comparison with group 1.

### Conclusion and research implications

Over the course of the study period, the odds of having a CD increased 3-fold for those classified as group 1, whereas the odds of having a CD decreased for those in groups 2, 3, and 4 in 2018 when compared with data from 2008. The odds of having a CD were highest in group 5 and lowest in group 3 in both years. A large proportion of mothers who gave birth via CD in group 5 suggests that in an attempt to reduce the overall CD rates, healthcare providers should work with mothers who had had a CD

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**TABLE 3**

| Groups | Number of women in a group | Group size (%)<sup>a</sup> | Group CD rates (%)<sup>b</sup> | Absolute contribution to overall CD rates (%)<sup>c</sup> |
|--------|-----------------------------|-----------------------------|-----------------------------|----------------------------------|
| 1      | 2941                        | 30.7                        | 9.1                         | 2.8                              |
| 2      | 1221                        | 12.8                        | 8.8                         | 65.2                             |
| 3      | 3584                        | 37.4                        | 12.5                        | 4.3                              |
| 4      | 759                         | 7.9                         | 47.2                        | 33.0                             |
| 5      | 438                         | 4.6                         | 99.3                        | 480                              |
| 6      | 139                         | 1.7                         | 90.7                        | 1.3                              |
| 7      | 176                         | 1.8                         | 90.3                        | 1.4                              |
| 8      | 93                          | 0.9                         | 62.4                        | 0.6                              |
| 9      | 0                            | 0.4                         | N/A                         | 0.4                              |
| 10     | 193                         | 2.0                         | 38.9                        | 2.9                              |
| Total  | 9544                        | 100                         | 100                         | 26.7                             |

<sup>a</sup> Number of women in group/total number of women who gave birth in the hospital in given year × 100; <sup>b</sup> Number of CDs in group/total number of women in the group in given year × 100; <sup>c</sup> Number of CDs in group/total number of women who gave birth in the hospital in given year × 1.

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**TABLE 4**

| Cesarean delivery | 2008 (n=9544) | 2018 (n=11,681) |
|-------------------|---------------|-----------------|
|                   | aOR 95% CI    | P value | aOR 95% CI    | P value |
| Maternal age      | 1.16 1.14−1.18 | <.001    | 1.14 1.13−1.16 | <.001 |
| Higher education  | 1.04 0.91−1.17 | .550     | 0.72 0.62−0.82 | <.001 |
| Employed          | 1.11 0.97−1.26 | .100     | 1.13 1.00−1.29 | .055  |
| Group 1           | Ref.          | Ref.     | Ref.           | Ref. |
| Group 2           | 9.36 7.86−11.16 | <.001    | 6.15 5.10−7.42 | <.001 |
| Group 3           | 0.48 0.39−0.58 | <.001    | 0.10 0.08−0.12 | <.001 |
| Group 4           | 2.96 2.38−3.67 | <.001    | 0.98 0.79−1.20 | .858  |
| Group 5           | 663.52 211.08−2085.07 | <.001 | 246.76 155.08−392.62 | <.001 |
| Group 6           | 106.18 58.68−192.13 | <.001 | 102.13 41.78−249.68 | <.001 |
| Group 7           | 32.73 19.19−55.80 | <.001 | 35.99 20.36−63.65 | <.001 |
| Group 8           | 8.49 5.32−13.53 | <.001    | 4.73 3.01−7.42 | <.001 |
| Group 10          | 3.56 2.51−5.05  | <.001    | 3.43 2.71−4.33 | <.001 |

aOR, adjusted odds ratio; CI, confidence interval.

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previously to increase their willingness to give birth vaginally for the next delivery. However, not all of them might agree.

The situation might improve if they give birth vaginally for the next delivery. However, not all of them might agree. More mothers should be informed that the risks of TOLAC are the same as for a repeat CD, whereas the vaginal delivery could be safer than CD.4,5 More mothers should be informed that the risks of TOLAC are the same as for a repeat CD, whereas the vaginal delivery could be safer than CD.4,5

| Cesarean delivery | Change over 10-year perioda |
|-------------------|-------------------------------|
|                   | aOR  | 95% CI | P value |
| 2018 #maternal age | 0.98 | 0.96–1.00 | .981 |
| 2018 #higher education | 0.69 | 0.57–0.83 | <.001 |
| 2018 #employed   | 1.02 | 0.85–1.23 | .807 |
| 2018 #group 1    | 3.02 | 1.85–4.94 | <.001 |
| 2018 #group 2    | 0.66 | 0.51–0.85 | .001 |
| 2018 #group 3    | 0.21 | 0.16–0.28 | <.001 |
| 2018 #group 4    | 0.33 | 0.24–0.46 | <.001 |
| 2018 #group 5    | 0.37 | 0.10–1.28 | .117 |
| 2018 #group 6    | 0.96 | 0.32–2.86 | .940 |
| 2018 #group 7    | 1.10 | 0.51–2.37 | .810 |
| 2018 #group 8    | 0.56 | 0.29–1.06 | .076 |
| 2018 #group 10   | 0.96 | 0.63–1.46 | .861 |

a Multiple logistic regression results using a pooled data set with dummy variables (birth year) in the interaction term. The reference category was Group 1.

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