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CLINICAL PRACTICE ARTICLE

Auditing cesarean section indications in women of Groups 1 to 4 of Robson's Ten-Group Classification System: A descriptive study at a university hospital in Thailand

[version 1; peer review: 2 approved with reservations]

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Abstract

Aim: To determine the appropriateness of indication for cesarean section in women at term with a single fetus in cephalic presentation without previous CS irrespective of parity and how labor started (Robson's Ten-Group Classification System [RTGCS] groups 1-4).
Methods: This was a descriptive study assessing medical records of 311 women in RTGCS groups 1- 4, between 1st January 2020 and 31st December 2020 who underwent a CS in Srinagarind Hospital, a university hospital, Khon Kaen, Thailand. Appropriateness of CS indications was assessed using criteria developed by our institute. Indications were classified into three categories: cephalopelvic disproportion (CPD), fetal indications, and other maternal indications.
Results: The overall appropriate rate of CS indications in RTGCS groups 1-4 was 32.5% (95% CI 26.8% – 38.7%). The appropriate rates of CS indications in RTCGS group 1, 2a, 2b, 3, 4a, and 4b were 43.0% (95% CI 35.2% - 51.2%), 10.6% (95% CI 0.0% - 24.9%), 11.7% (95% CI 0.0% - 25.0%), 50.0% (95% CI 32.1% - 68.6%), 0% (95% CI 0.0% - 100%), and 40.0% (95% CI 20.0% - 74.8%) respectively.
Conclusion: Low appropriateness in CS indications in RTGCS groups 1-4 leads to high CS rates. Increasing appropriateness of CS indications in this population will reduce unnecessary CS. Interventions focusing on increasing appropriateness in CS indications are urgently required to achieve appropriate use of CS.

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Keywords
Appropriate caesarean section, Audit, Robson's Ten-Group Classification System

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Abbreviations

WHO: World Health Organization

RTGCS: Robson's Ten-Group Classification System

CS: Cesarean section

MFM: Maternal fetal medicine

CPD: Cephalopelvic disproportion

EFHRM: Electronic fetal heart rate monitoring

Introduction

Cesarean section (CS) is a surgical procedure that can effectively prevent deaths and serious complications in mothers and babies when used for medically indicated reasons[1]. Worldwide, CS rates have increased from 12% in 2000 to about 21% in 2015[2]. However, it is not clear whether this is associated with significant maternal or perinatal health benefits or problems[3]. In addition, as a surgical procedure, a CS is not without risks. CS is associated with more blood loss and subsequent pregnancy risks such as placenta accreta spectrum, placenta previa, uterine rupture, and stillbirth, and long-term childhood outcomes such as asthma and obesity, compared to those delivered vaginally[3]. In Thailand, CS rates significantly increased from 23.2% in 2009 to 32.5% in 2017. If this trend continues without any implementation of effective interventions, the CS rate for Thailand could reach 59.1% in 2030[4].

Globally, reported reasons for rising CS rates from healthcare providers include differences in practice patterns, fear of malpractice suits and obstetricians' preferences[5]. Furthermore, private practices were reported to be one of the associated factors for high CS rate[6]. While increasing prevalence of maternal obesity, elderly pregnancies and multiple pregnancies, economic and sociocultural factors such as family responsibilities and fear of labor pain were the reasons for pregnant women[1,7,8].

Sustained increases in CS rates are a major public health concern worldwide[1]. Recognizing the growing importance of non-clinical factors in the increase, the World Health Organization (WHO) published recommendation for non-clinical interventions to reduce unnecessary CS targeted at women, healthcare professionals and organizations[9]. For interventions targeted at healthcare professionals, implementation of evidence-based clinical practice guidelines (CPGs) combined with mandatory second opinion for CS indication as well as audit and feedback to physicians and nurses involving in the decision-making process for deliveries is recommended to reduce unnecessary CS[1,9]. Health educational interventions targeted at women or families using decision-analysis tools (DAT) present evidence of an increased number of women choosing a trial of labor when eligible for vaginal birth[10–12]. Among other non-clinical interventions targeted at healthcare organizations, implementation of continuous support during labor and birth by companions has been recommended by the WHO to improve labor outcomes, increase spontaneous vaginal births and women's satisfaction with care services[13,14]. However, there are uncertainties regarding the feasibility and acceptability of these non-clinical interventions, and limited evidence relating to their effects in the context of implementation of complex, multi-faceted components, particularly in low- and middle-income countries.

The QUALI-DEC project

To respond to rising rates of CS, a consortium of researchers including WHO and research institutions from Europe and low- or middle-income countries (LMICs) designed and started in 2020 the QUALI-DEC study: "Appropriate use of cesarean section through QUALity Decision-making by women and providers". QUALI-DEC aims to design and evaluate a multi-faceted strategy to implement non-clinical interventions targeted at health professionals, women and health organizations to reduce unnecessary CS in the four participating countries: Argentina, Burkina Faso, Thailand and Viet Nam[15]. The multi-faceted QUALI-DEC strategy is designed to combine four key components: 1) opinion leaders to implement evidence-based clinical guidelines; 2) cesarean audits and feedback to help providers identify potentially avoidable CS; 3) a Decision Analysis Tool (DAT) to help women make an informed decision on mode of birth; and 4) implementation of WHO recommendations on companionship during labor and childbirth.

In Thailand, a recent cross-sectional analysis from all 24 government hospitals in Khon Kaen Province showed an overall CS rate of 31.4%. About two-third of women giving birth were women at term with a singleton pregnancy in cephalic presentation without a previous CS entering labor spontaneously (Robson's Ten-Group Classification System (RTGCS) groups 1 and 3). Although these women can be considered low risk, they are large contributors to the overall CS rate in this province[16]. Given that a CS rate of 10% in RTGCS group 1 has been suggested by WHO as achievable[17], the 20.5% rate found in RTGCS group 1 in Khon Kaen may be considered medically unjustified[16]. In RTGCS groups 2, 3 and 4, the relative contributions of overall CS rates were 21.1%, 8.4% and 7.1%, respectively.

In the context of the QUALI-DEC project, the objective of this manuscript is to present the results of the cesarean audit conducted to evaluate the appropriateness of CS indications in low-risk women (RTGCS groups 1-4) using the data extracted from medical records of Srinagarind Hospital, a university hospital in Khon Kaen Province, which is one of the participating hospitals in QUALI-DEC project in Thailand. This study provided insights on the magnitude and causes of potentially avoidable CS before the implementation of the QUALI-DEC project.

Methods

Patient population and inclusion criteria

This is a descriptive study conducted in pregnant women who delivered their babies at Srinagarind Hospital, a university hospital, Khon Kaen, Thailand. We collected data from medical records of all women who gave birth between 1st January 2020 and 31stDecember 2020. We used Robson's Ten-Group Classification System (RTGCS) to monitor CS rates.

We focused only on women who underwent a CS in RTGCS groups 1-4 (Appendix I[18]). Women in these RTGCS groups 1-4 are low-risk groups for CS. Since there is no accepted international classification of CS indications, our Maternal and Fetal Medicine (MFM) unit developed the criteria for appropriateness of CS indications, which was adapted from WHO recommendations on intrapartum care for a positive childbirth experience[19] (Appendix II[20–23]). Medical records of these women were assessed for appropriateness of CS indications using an audit report form and our appropriateness criteria.

Indications. The indications for CS were classified into three categories: fetal indications (e.g. non- reassuring fetal status, fetal macrosomia, major fetal anomaly, head deflexion, and etc.), cephalo-pelvic disproportion (CPD) and other maternal indications (e.g. placenta previa, elderly nulliparous, COVID-19 infection, failed operative vaginal delivery, infertility, failed induction, and etc.). We also categorized CS as pre-labor CS (RTGCS groups 2b and 4b), and intrapartum CS (RTGCS groups 1, 2a, 3, and 4a) because in our context, the decision-making processes for these two groups are different.

We categorized each CS as appropriate, borderline appropriate and inappropriate indications. When CS was deemed the only appropriate route of delivery, we classified it as appropriateness. On the contrary, inappropriateness is classified when CS was performed without enough justification. Borderline appropriateness referred to the conditions that did not meet the appropriateness criteria but not clearly inappropriate. Assessment for appropriateness was conducted independently by two authors (WW and RK). Disagreement was resolved by the third author (PL). Women with missing or incomplete data were excluded.

This study was approved by the Khon Kaen University Ethics Committee on Human Research as per the Helsinki Declaration and Good Clinical Practice Guidelines (HE 651067) and the QUALI-DEC project was approved by the Research Project Review Panel (RP2) of the UNDP/UNFPA/UNICEF/WHO/World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP) at the Department of Sexual and Reproductive Health and Research of WHO and the WHO Research Ethics Review Committee (ERC), Geneva, Switzerland. Patient consent was waived by Khon Kaen University Ethics Committee.

Sample size calculation

Prior to the study, we piloted the audit using data from 30 pregnant women in RTGCS groups 1-4. We found 43% of CS with inappropriate indications. With an acceptable error of 6 %, at least 257 women are needed for this study[24] in order to determine the appropriateness of indication for CS.

Statistical analysis

Data analysis was performed using R Statistical Software (version 4.2.2). We reported baseline characteristics as mean and standard deviation, median and interquartile range for continuous data, and percentage for dichotomous data. The appropriate, borderline appropriate and inappropriate indications for CS of all women in RTGCS groups 1 to 4 were reported as percentage with 95% confidence intervals (CIs) calculated according to the method of Sison and Glaz[25]. We also reported all deliveries at Srinagarind Hospital in 2020 according to RTGCS using data from QUALI-DEC project. CSs were also categorized as; 1) pre-labor or 2) intrapartum to assess appropriateness in each group.

Results

In the study period there were 1,725 deliveries, 734 (42.6%) by CS. RTGCS group 1 was the largest (38.2%) and together groups 1 and 3 accounted for almost two-thirds of the obstetric population (61.5%). Although, RTGCS group 5 had the largest relative contribution (26.2%) to the overall CS rate. The CS rates in RTGCS groups 1 to 4 were 24.3%, 14.9%, 4.9% and 2.5%, respectively (Table 1).

Of 342 women in RTGCS groups 1-4, thirty-one (9.1%) had incomplete data, hence only 311 were included. Of these, 70 underwent pre-labor CS, while 241 were intrapartum CS (Figure 1). Mean age of these women was 30.1 years (SD ± 5.2 years). Other baseline characteristics were shown in Table 2. Most women had gestational ages at delivery less than 41 weeks and received at least one antenatal care in this hospital. The most frequent complications during pregnancy were gestational diabetes and pregnancy induced hypertension. No perinatal death was observed in this study.

The overall appropriate rate of CS indications in RTGCS groups 1-4 was 32.5% (95% CI 26.8% – 38.7%). The appropriate rates of CS indications in RTCGS groups 1, 2a, 2b, 3, 4a, and 4b were 43.0% (95% CI 35.2% - 51.2%), 10.6% (95% CI 0.0% - 24.9%), 11.7% (95% CI 0.0% - 25.0%), 50.0% (95% CI 32.1% - 68.6%), 0% (95% CI 0.0% - 100%), and 40.0% (95% CI 20.0% - 74.8%) respectively (Table 3 and Figure 2). CS for fetal indications had the highest appropriate rate at 54.0% (95% CI 43.7% – 64.7%), while CS for other maternal indications had the lowest appropriate rate at 15.9% (95% CI 5.7% – 27.5%) (Table 3 and Figure 2).

For pre-labor CS, the highest appropriate rate was found in other maternal indication in group 4b (100%, 95% CI 100% - 100%), while the lowest appropriate rate was observed in CPD of group 2b (0%, 95% CI 0.0% - 10.1%). In intrapartum CS, we found the highest appropriate rate in fetal indication of group 2a (83.3%, 95% CI 66.7% - 100%). On the other hand, the lowest appropriate rates were other maternal indication in group 3 (0%, 95% CI 0.0% - 100%) and 4a (0%, 95% CI 0.0% - 100%) and CPD in group 2a (0%, 95% CI 0.0% - 23.4%) (Table 3 and Figure 2).

The overall appropriate, borderline appropriate and inappropriate indications for CS were 32.5%, 25.1 % and 42.4%, respectively. The three most common indications for CS were CPD, non-reassuring fetal status and failed induction. The main indication in appropriate group was non-reassuring

Table 1. Cesarean section rate in each RTGCS. Distribution of all cesarean procedures stratified by the Robson ten's-Group Classification System.

Setting: Srinagarind Hospital				Period: January 2020 to December 2020		
Group	**Number of CS in group**	**Number of women in group**	**Group size (%)**	**Group CS rate (%)**	**Absolute group contribution to overall CS rate (%)**	**Relative contribution of group to overall CS rate (%)**
1	178	659	38.2%	27.0%	10.3%	24.3%
2	110	132	7.7%	83.3%	6.4%	14.9%
3	36	403	23.3%	8.9%	2.1%	4.9%
4	18	34	2.0%	52.9%	1.0%	2.5%
5	192	192	11.1%	100%	11.1%	26.2%
6	29	31	1.8%	93.6%	1.7%	3.9%
7	25	27	1.6%	92.6%	1.5%	3.4%
8	51	53	3.1%	96.2%	3.0%	6.9%
9	5	5	0.3%	100%	0.3%	0.7%
10	90	189	10.9%	47.6%	5.2%	12.3%
Total	734	1725	100%	42.6%	42.6%	100%

1. Group size (%) = no. of women in the group / total no. of women delivered in the hospital x 100
2. Cesarean section rate (%) = no. of cesareans in group / no. of women in group x 100
3. Absolute contribution (%) = no. of cesareans in the group / total no. of women in the hospital x 100
4. Relative contribution (%) = no. of cesareans in the group / total no. of cesareans in hospital x100

Note: Of 342 women in RTGCS group 1-4, thirty-one (9.1%) had incomplete data, hence only 311 were included

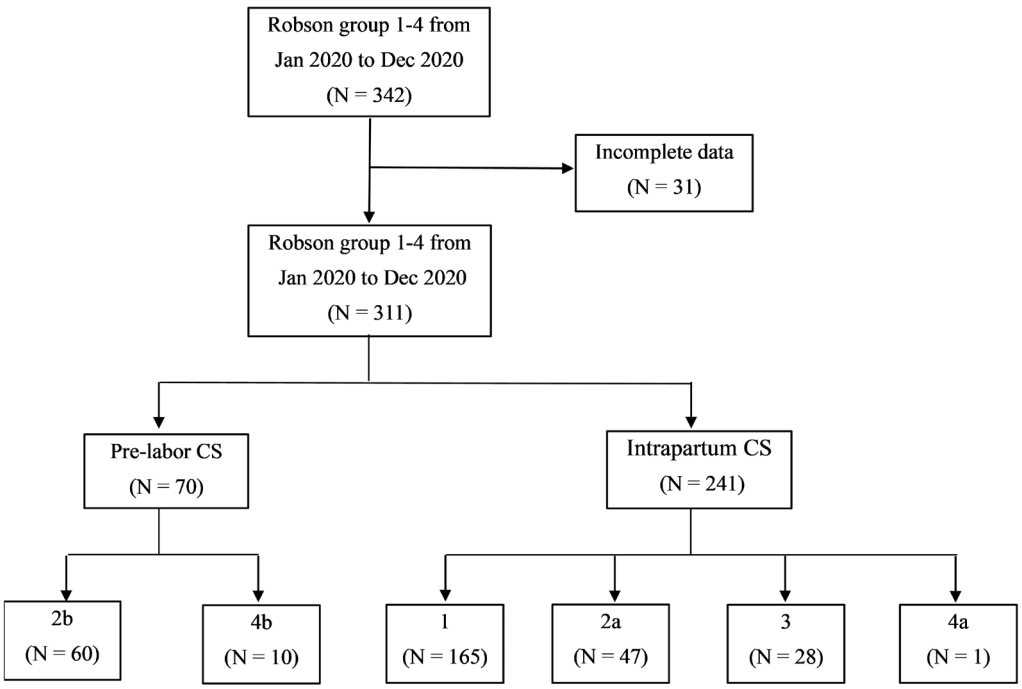

Figure 1. Flow chart of data process.

Table 2. Baseline characteristics of women in RTGCS group 1–4.

Characteristics	Pre-labor CS (group 2b, 4b) (n= 70)	Intrapartum CS (group 1, 2a, 3, 4a) (n= 241)	Total (n=311)
Information about pregnant women			
Age (years), mean ± SD[a]	32.4 ± 5.2	29.5 ± 5.0	30.1 ±5.2
Maternal age, n (%)			
< 35 years	44 (62.9)	201 (83.4)	245 (78.8)
≥ 35 years	26 (37.1)	40 (16.6)	66 (21.2)
BMI[b] before delivery (kg/m²), n (%)			
< 18.5	0	0	0
18.5 – 22.9	1 (1.4)	16 (6.6)	17 (5.5)
≥ 23	69 (98.6)	225 (93.4)	294 (94.5)
Parity, n (%)			
Nulliparous	60 (85.7)	212 (88.0)	272 (87.5)
Multiparous	10 (14.3)	29 (12.0)	39 (12.5)
Gestational age			
< 41 weeks	67 (95.7)	229 (95.0)	296 (95.2)
41 weeks	3 (4.3)	12 (5.0)	15 (4.8)
Information on the newborn			
Gender, n (%)			
Male	44 (62.9)	124 (51.5)	168 (54.0)
Female	26 (37.1)	117 (48.5)	143 (46.0)
Weight (g), mean ± SD	3,272.1 ± 498.7	3,268.7 ± 456.4	3,269.5 ± 465.4
Apgar at 1 minute	8 (8 – 8)	8 (8 – 8)	8 (8 – 8)
Apgar at 5 minutes	9 (9 – 9)	9 (9 – 9)	9 (9 – 9)
Neonatal outcome, n (%)			
Live birth	70 (100)	241 (100)	311 (100)
Perinatal death	0	0	0
Recorded complications during pregnancy, before labor, n (%)			
None	47 (67.1)	180 (74.6)	227 (66.6)
Severe maternal anemia (Hb[c] <7 g/L)	0	1 (0.4)	1 (0.3)
Chorioamnionitis	0	2 (0.8)	2 (0.6)
Placental abruption	0	1 (0.4)	1 (0.3)
Antepartum hemorrhage	1 (1.4)	2 (0.8)	3 (0.9)
Placenta previa	7 (10)	1 (0.4)	8 (2.6)
Gestational diabetes	8 (11.4)	22 (9.1)	30 (9.6)
Preeclampsia/eclampsia	4 (5.7)	13 (5.4)	17 (5.5)
Intrauterine growth retardation	1 (1.4)	7 (2.9)	8 (2.6)
Pre-labor rupture of membranes	0	7 (2.9)	7 (2.2)
Other	3 (4.3)	11 (4.6)	14 (4.5)

[a] Standard deviation; [b] Body mass index; [c] Hemoglobin

Table 3. **Appropriateness of CS indications.**

Indication	No. of CS (%)	No. of appropriate CS (%)	No. of borderline appropriate CS (%)	No. of inappropriate CS (%)
Group 1: 165 (53.1%) women				
CPD[a]	99 (60.0%)	35 (35.4%) 95% CI 26.5% – 45.0%	0 (0.0%) 95% CI 0.0% - 9.6%	64 (64.7%) 95% CI 55.6% - 74.3%
Fetal	45 (27.3%)	31 (68.9%) 95% CI 57.8% - 83.7%	14 (31.1%) 95% CI 20.0% - 45.9%	0 (0.0%) 95% CI 0.0% - 14.8%
Other maternal	21 (12.7%)	5 (23.8%) 95% CI 4.8% - 47.9%	7 (33.3%) 95% CI 14.3% - 57.4%	9 (42.9%) 95% CI 23.8% -67.0%
Total	165 (100%)	71 (43.0%) 95% CI 35.2% - 51.2%	21 (12.7%) 95% CI 4.8% - 20.9%	73 (44.2%) 95% CI 36.4% - 52.4%
Group 2a: 47 (15.1%) women				
CPD[a]	7 (14.9%)	0 (0.0%) 95% CI 0.0% - 23.4%	0 (0.0%) 95% CI 0.0% - 23.4%	7 (100%) 95% CI 100% -100%
Fetal	6 (12.8%)	5 (83.3%) 95% CI 66.7% - 100%	1 (16.7%) 95% CI 0.0% - 44.5%	0 (0.0%) 95% CI 0.0% -27.8%
Other maternal	34 (72.3%)	0 (0.0%) 95% CI 0.0% - 16.0%	12 (35.3%) 95% CI 20.6% - 51.3%	22 (64.7%) 95% CI 50.0% - 80.7%
Total	47 (100%)	5 (10.6%) 95% CI 0.0% - 24.9%	13 (27.7%) 95% CI 14.9% - 42.0%	29 (61.7%) 95% CI 48.9% - 76.0%
Group 2b: 60 (19.3%) women				
CPD[a]	16 (26.7%)	0 (0.0%) 95% CI 0.0% - 10.1%	0 (0.0%) 95% CI 0.0% - 10.1%	16 (100%) 95% CI 100% - 100%
Fetal	16 (26.7%)	1 (6.3%) 95% CI 0.0% - 24.8%	14 (87.5%) 95% CI 81.3% - 100%	1 (6.3%) 95% CI 0.0% - 24.8%
Other maternal	28 (46.7%)	6 (21.4%) 95% CI 7.1% - 37.9%	20 (71.4%) 95% CI 57.1% - 87.9%	2 (7.1%) 95% CI 0.0% - 23.6%
Total	60 (100%)	7 (11.7%) 95% CI 0.0% - 25.0%	34 (56.7%) 95% CI 45.0% - 70.0%	19 (31.7%) 95% CI 20.0% - 45.0%
Group 3: 28 (9.0%) women				
CPD[a]	14 (50.0%)	5 (35.7%) 95% CI 14.3% - 59.6%	0 (0.0%) 95% CI 0.0% - 23.9%	9 (64.3%) 95% CI 42.9% - 88.2%
Fetal	13 (46.4%)	9 (69.2%) 95% CI 53.8% - 98.1%	4 (30.8%) 95% CI 15.4% - 59.6%	0 (0.0%) 95% CI 0.0% - 28.9%
Other maternal	1 (3.6%)	0 (0.0%) 95% CI 0.0% - 100%	0 (0.0%) 95% CI 0.0% - 100%	1 (100%) 95% CI 100% - 100%
Total	28 (100%)	14 (50.0%) 95% CI 32.1% - 68.6%	4 (14.3%) 95% CI 0.0% - 32.9%	10 (35.7%) 95% CI 17.9% - 54.3%
Group 4a: 1 (0.3%) woman				
Other maternal	1 (100%)	0 (0.0%) 95% CI 0.0% - 100%	0 (0.0%) 95% CI 0.0% - 100%	1 (100%) 95% CI 100% - 100%
Total	1 (100%)	0 (0.0%) 95% CI 0.0% - 100%	0 (0.0%) 95% CI 0.0% - 100%	1 (100%) 95% CI 100% - 100%
Group 4b: 10 (3.2%) women				
Fetal	7 (70.0%)	1 (14.3%) 95% CI 0.0% - 38.4%	6 (85.7%) 95% CI 71.4% - 100%	0 (0.0%) 95% CI 0.0% - 24.1%

Indication	No. of CS (%)	No. of appropriate CS (%)	No. of borderline appropriate CS (%)	No. of inappropriate CS (%)
Other maternal	3 (30.0%)	3 (100%) 95% CI 100% - 100%	0 (0.0%) 95% CI 0.0% - 56.4%	0 (0.0%) 95% CI 0.0% - 56.4%
Total	10 (100%)	4 (40.0%) 95% CI 20.0% - 74.8%	6 (60.0%) 95% CI 40.0% - 94.8%	0 (0.0%) 95% CI 0.0% - 34.8%
Pre-labor CS (group 2b, 4b): 70 (22.5%) women				
CPD[a]	15 (21.4%)	0 (0%) 95% CI 0% – 10.8%	0 (0%) 95% CI 0% – 10.8%	15 (100%) 95% CI 100% - 100%
Fetal	22 (31.4%)	1 (4.5%) 95% CI 0% – 18.2%	20 (90.9%) 95% CI 86.4% – 100%	1 (4.5%) 95% CI 0% – 18.2%
Other maternal	33 (47.1%)	10 (30.3%) 95% CI 15.2% – 47.3%	20 (60.6%) 95% CI 45.5% – 77.6%	3 (9.1%) 95% CI 0% – 26.1%
Total	70 (100%)	11 (15.7%) 95% CI 4.3% – 27.3%	40 (57.1%) 95% CI 45.7% – 68.8%	19 (27.1%) 95% CI 15.7% – 38.8%
Intrapartum CS (group 1, 2a, 3, 4a): 241 (77.5%) women				
CPD[a]	121 (50.2%)	40 (33.1%) 95% CI 24.8% – 41.4%	0 (0%) 95% CI 0% – 8.4%	81 (66.9%) 95% CI 58.7% – 75.3%
Fetal	65 (27.0%)	46 (70.8%) 95% CI 61.5% – 82.8%	19 (29.2%) 95% CI 20.0% – 41.3%	0 (0%) 95% CI 0% – 12.1%
Other maternal	55 (22.8%)	4 (7.3%) 95% CI 0% – 20.2%	19 (34.5%) 95% CI 21.8% – 47.5%	32 (58.2%) 95% CI 45.5% – 71.1%
Total	241(100%)	90 (37.3%) 95% CI 30.7% – 44.1%	38 (15.8%) 95% CI 9.1% – 22.5%	113 (46.9%) 95% CI 40.2% – 53.6%
Total: 311 women				
CPD[a]	136 (43.7%)	40 (29.4%) 95% CI 22.1% – 37.2%	0 (0%) 95% CI 0% – 7.8%	96 (70.6%) 95% CI 63.2% – 78.4%
Fetal	87 (28.0%)	47 (54.0%) 95% CI 43.7% – 64.7%	39 (44.8%) 95% CI 34.5% – 55.5%	1 (1.1%) 95% CI 0% – 11.9%
Other maternal	88 (28.3%)	14 (15.9) 95% CI 5.7% – 27.5%	39 (44.3%) 95% CI 34.1% – 55.9%	35 (39.8%) 95% CI 29.5% – 51.4%
Total	311 (100%)	101 (32.5%) 95% CI 26.8% – 38.7%	78 (25.1%) 95% CI 19.3% – 31.3%	132 (42.4%) 95% CI 36.7%– 48.7%

[a] CPD; Cephalopelvic disproportion

fetal status. All these fetuses were evaluated for their status using an intrapartum monitoring machine. Whereas fetal macrosomia was the main indication in borderline appropriate group. Cephalopelvic disproportion (CPD) was the most frequent indication in inappropriate group. When assessing cases which were pre-laborly diagnosed as CPD, one case was nearly short stature (148 cm.) and another one was suspected fetal macrosomia. For those diagnosed with fetal macrosomia, only 10.8% (3/28) had birth weight less than 3500 gm (Table 4).

Discussion

Our study confirms the high rate of CS in Srinagarind Hospital. Our audit of indications for CS shows that only one third of the CS in RTGCS groups 1–4 who represent 70% of the women giving birth in the hospital, complied with the criteria for appropriateness of CS indication. Overall, CS for fetal indications and other maternal indications had the highest and lowest appropriateness rate, respectively. Main appropriate indication in pre-labor group was other maternal indications (placenta previa and history of pelvic fracture S/P surgery), while fetal indications were the highest in intrapartum CS (non-reassuring fetal status).

Appropriate indication of CS was rarely evaluated in prior studies. About two decades ago, the multi-country WHO Global Survey found that only 1% of the CS were conducted

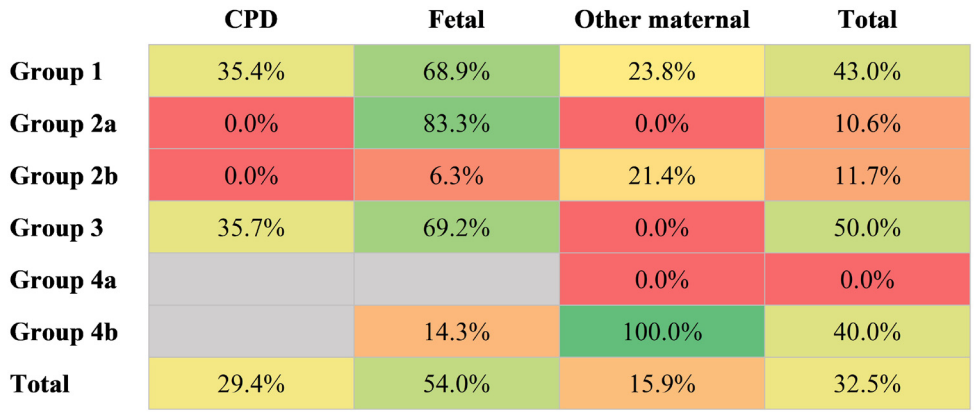

Figure 2. Heat map for appropriateness of CS indications. Other maternal indications include placenta previa, elderly nulliparous, COVID-19 infection, failed operative vaginal delivery, infertility or failed induction, etc. Green, yellow, orange and red indicate from more appropriateness to less appropriateness, respectively. Grey indicates no data.

Table 4. Assessment of the appropriateness of indications for CS.

Assessment	Percentage (N = 311)	Indications
Appropriate	32.5% (101) 95% CI 26.8 – 38.7	Non-reassuring fetal status (47) CPD[a] (40) Placenta previa (8) History of pelvic fracture s/p surgery (4) Failed operative vaginal delivery (1) Maternal heart disease (1)
Borderline appropriate	25.1% (78) 95% CI 19.3 – 31.3	Fetal macrosomia (28) Occiput posterior (4) Oligohydramnios (3) Major fetal anomaly (2) Head deflexion (1) Non-reassuring fetal status (1) Elderly primigravida (17) Failed induction (11) Preeclampsia with severe feature (4) Short stature (2) Narrow pubic outlet (2) Infertility with treatment (1) Placental abruption (1) Bad obstetric history (1)
Inappropriate	42.4% (132) 95% CI 36.7– 48.7	Borderline oligohydramnios (1) CPD (96) Failed induction (32) Preeclampsia without severe feature (2) Maternal short stature (1)

[a] Cephalopelvic disproportion

without medical indication[26]. The appropriateness rate in this study differs from that of WHO study due to the difference in definition used. The WHO study defined non-medical indication as maternal request or no recorded indication, while we included other indications as inappropriateness. Moreover, the indications in the WHO Global Survey were not audited and thus reflect the indications as recorded in the medical record. However, the observed appropriateness in this

study is closed to the recent study conducted in Saudi Arabia which focused on primary CS[27]. The appropriate indications of CS were 26.5% which is slightly lower than this study. This highlights that the criteria for appropriateness of CS indication might differ among countries due to the diverse contexts and clinical protocols used in each country or hospital. Comparisons must therefore be made with caution.

Appropriateness in the pre-labor CS group was only half of that in the intrapartum CS group. This underlines the urgent need for intervention in this group, particularly in RTGCS group 2b which pre-labor diagnosis of CPD was predominate. According to WHO[19], CPD is diagnosed after women enter active phase of labor. For those antepartum diagnosis, however, we suspected that this would reflect that some providers exploited the term "CPD" in order to avoid using the term "maternal request" or for ease of managing providers' schedules. This warrants further studies to understand the underlying dynamics for decision-making in pre-labor CS. There are many motivations influencing mothers' preference for choosing CS such as fear of labor pains or misbelief that CS is safer than vaginal delivery[28]. In Thailand, the options and availability of pain relief during labor is very limited and, given the relevance of this factor, we recommend the serious consideration of interventions for this purpose. Therefore, implementing effective pain relief intervention is crucial. Furthermore, interventions to educate mothers regarding the risks associated with unnecessary CS and companionship to support women during labor maybe considered in order to amend this situation[29]. On the other hand, providers' factors underpinning the increase of CS are more challenging to address. Opinion leaders, a person in the institute who has influence on their colleagues' attitudes and views, may play a significant role to enhance adherence to the standard guideline[1]. Opinion leaders can take a variety of actions to reduce CS rate such as promoting evidence-based practices, providing guidance, educating healthcare professionals, and advocating for policy changes. A policy for mandatory second opinion before conducting a pre-labor CS may be an intervention with potential to reduce unnecessary use[1].

For intrapartum CS, in line with ours, fetal indications are the main appropriate indication reported by other studies[30]. This is probably because there is a clear standard definition of non-reassuring fetal status[31]. Among each group, the highest inappropriate rate was in CPD in RTGCS groups 1, 2a and 2b. Define the clear definitions for CPD and other maternal indications such as maternal short stature[32] or failed induction[33] may be beneficial to ameliorate the situation. Evidence-based clinical intrapartum care algorithms may also help healthcare providers decide a CS for women who need[34]. In order to enhance the adherence, audit and timely feedback to healthcare providers is crucial[1]. If we can increase the appropriateness by 50% more, the overall CS would be reduced from 25.3% to 16.4% in RTGCS 1–4 and 42.6% to 36.2% in all deliveries.

Our baseline evaluation of indications will serve to find specific interventions to reduce avoidable CS for the QUALI-DEC project. This is the first study proposing a category of borderline appropriate indications of CS which contributed to one-fourth of overall CS rate. This may be more practical and reflect the real-life situation since in some situations and circumstances, women may not meet the appropriate CS indication, but waiting for normal delivery may put them at higher risk.

The strength of our study includes the recruitment of all women in RTGCS groups 1–4 in the study period, hence no selection bias. However, the retrospective data collection might have some limitations pertaining to lacking some data including electronic fetal heart rate monitoring (EFHRM) records or evidence of maternal requesting for CS that was important to classify the appropriateness. Thirty-one (9.1%) of the selected CS could not be assessed due to missing information in the medical record. This is one of the very important issues that we should always emphasize for our trainees to complete all the information in the medical records. Analysis of women stratified by parity (nulliparous vs. multiparous) may yield more in-depth conclusions and recommendations in each group. Despite our attempt to stratify the data into various groups, our one-year data in 2020 from the QUALI-DEC project, we have very limited number of women in RTGCS groups 4a and 4b.

Low appropriate indications of women in RTGCS groups 1–4 lead to high CS rates. CS for maternal indications other than CPD had the lowest appropriateness rate. Increasing appropriateness of CS in women in RTGCS groups 1–4 will reduce unnecessary CS. Interventions focusing on reducing CS rate of women in RTGCS groups 1–4 by increasing appropriate indications are urgently required to achieve a rational and appropriate use of CS.

Data availability

Underlying data

Open Science Framework: Auditing cesarean section indications in women of Groups 1 to 4 of Robson's Ten-Group Classification System: A descriptive study at a university hospital in Thailand, https://doi.org/10.17605/OSF.IO/AMSFQ[18].

This project contains the following underlying data:

- Raw data.xlsx

Extended data

Open Science Framework: Auditing cesarean section indications in women of Groups 1 to 4 of Robson's Ten-Group Classification System: A descriptive study at a university hospital in Thailand, https://doi.org/10.17605/OSF.IO/AMSFQ[18].

This project contains the following extended data:

- Appendix.pdf
- Appendix I: Robson's Ten Group Classification System (RTGCS)
- Appendix II: Assessment of indications for CS

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgements

The authors would like to thank the QUALI-DEC project for allowing the access to the overall Robson Classification data in 2020.

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Daphne Rattner
Universidade de Brasília, Brasília, Brazil

This is a very interesting and innovative paper, since the authors used the Robson Classification of cesarean section indications, which classifies performance of c-sections according to the epidemiological risk of a surgical procedure, and checked the clinical, obstetrical, and fetal indications to verify the appropriateness of its indications.
Besides, they classified the indications by fetal, cephalopelvic disproportion and other maternal conditions; the c-sections as prior to labor or intrapartum, and then verified the appropriateness, by two different evaluators. In the case of discordant assessments, a third evaluator contributed to the decision. They classified the indications of surgical procedures for birth as appropriate, borderline, and inappropriate. Also, they performed a pilot test to estimate the sample size. Hence, methodologically, it is very sound research, and it rendered many interesting results. Furthermore, Table 3 and the heat map are the core of the results, and they display very interesting data, I really appreciated reading it.

However, I have a few comments to share with the authors.

1. The authors chose to collect the data between January 1st, 2020, and December 31st, 2020. This was the first year of the Covid-19 pandemic. We have anecdotal reports that, in many services, professionals decided to perform more cesarean sections in order to shorten the period of hospitalization, so women would stay for less time and more beds would become available; because of need of more beds for the Covid-19 cases, less beds were available for usual practice. Could it be that it also happened in this hospital? If yes, it might have increased artificially the c-section rate in this period.
2. The data is very interesting. I suggest adding a last column to Table 1, that will display the recommended c-section rate for each group by WHO (2017). It is available in your reference 20, The Robson Implementation manual, starting at page 45. This will help the reader to identify the deviation of the recommendations just looking at the table, although these are commented in the text.
3. Teaching hospitals should display a ‘golden standard’ practice, so that future professionals learn best procedures for each case. At least in my country, teaching hospitals privilege training future professionals in surgical techniques over appropriateness of indications. This

fact is exemplified in this paper, on training to perform episiotomies. [1] I wonder whether this might happen elsewhere. Maybe the authors could comment on this?

4. This research was performed in a teaching hospital. Group 5 was the greatest contributor to the c-section rate, suggesting that “once a c-section, always a c-section” might be the prevalent philosophy. Maybe the authors could comment on the lost opportunities to teach future practitioners on how to perform vaginal births after cesarean sections (VBAC)?
5. The authors reported that 9.1% of the records had incomplete data. The authors recommend adequately that this lack of data should be dealt in the future, since almost 10% of missing data may bias the results and hence the interpretation. Besides, future professionals should learn about the importance of adequately registering clinical and obstetric information. The authors also dealt well with the impressive rate of CPD (136 alleged cases). As a whole, only about one third of the indications were found to be appropriate, one fourth were borderline and about 40% were inappropriate. These are baseline data. I suggest planning and implementing an intervention and, in the future, to publish the results repeating this methodology, in order to assess changes in appropriateness of indications.
6. The BMI which is used currently is: below 18.5 = underweight; 18.5 to 24.9 = healthy weight; 25.0 to 29.9 = overweight; above 30 = obesity.
However, the authors used as cutting points: 18.5 and 22.9. Please explain this choice.
Besides, it is not explained if the BMI was measured at the beginning of pregnancy or when. As pregnant womem gain weight, this result/ classification might be misleading. Or there is a different classification for Thailandese women?

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Is the background of the cases’ history and progression described in sufficient detail?

Yes

Are enough details provided of any physical examination and diagnostic tests, treatment given and outcomes?

Yes

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?

Yes

Is the conclusion balanced and justified on the basis of the findings?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology; Quality of care; Public Health; Perinatal care; Women's Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 16 October 2023

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Sulaiman Muhammad Daneji
Obstetrics and Gynaecology, Bayero University, Kano, Kano, Nigeria

I will mention the comments based on sections as follows:
:

Abstract:

- The abstract was written well and has captured the study.
- The abbreviation "CS" should have been introduced in the first sentence like "cesarean section (CS)".
- This is a retrospective study not only a descriptive study and this should be added to the methodology aspect of the abstract.
- In the conclusion aspect we can revise the first sentence from "low appropriateness in CS indications" to "low appropriateness of CS indications".

Introduction:

- The introduction was written well and has highlighted the need for the audit.
- The last paragraph did not mention the objective of the study in full i.e. single fetus in cephalic presentation without previous CS irrespective of parity and how labor started.

Methods:

- The retrospective nature of this audit should be mentioned in the methodology.
- In the fourth paragraph the criteria for appropriateness should be explained and elaborated on.
- In the sample size calculation, I would like clarification on why an error of 6% was chosen which was not discussed in the results.

Results:

- The results section addressed the main objective of the audit, the standard deviation should be written in the format "Mean age of these women was 30.1± 5.2 years".
- The audit should have captured the percentage of patients that had antenatal care in the hospital.
- The neonatal outcomes should have included other outcomes like requirement for resuscitation, admission to neonatal intensive care unit APGAR score etc.

Discussion:

- The discussion was adequate and explanatory. A paragraph could have been added on recommendations.

Generally, the article is educative.

Is the background of the cases' history and progression described in sufficient detail?
Yes

Are enough details provided of any physical examination and diagnostic tests, treatment given and outcomes?
No

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?
Yes

Is the conclusion balanced and justified on the basis of the findings?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: General obstetrics and Gynaecology, social obstetrics, urogynaecology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.