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## ORIGINAL RESEARCH ARTICLE

# Cesarean section rate changes after audit and feedback with the Ten Group Classification System in a French perinatal network: A retrospective pre-post study

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## Abstract

**Introduction:** The rise in the number of cesarean sections (CS) is a major health public problem which concerns nearly all countries. It is suggested that the Ten Group Classification System be adapted to a procedure of audit/feedback cycles, which could have an effect on CS practice. Therefore, we aimed to study changes in CS rates between maternity wards in a perinatal network after implementation of the Ten Group Classification System in an audit with feedback.

**Material and methods:** This was a retrospective pre-post study of all births from 1 January 2012 to 31 December 2018, in a French perinatal network of 10 maternity wards in the Yvelines district of France. All live births occurring at a gestational age  $\geq 24$  weeks in the network were included. During the pre-period (1 January 2012 to 31 December 2014), the audit and feedback provided only overall CS rates. During the post-period (1 January 2015 to 31 December 2018), CS rates for each Robson Ten Group Classification System group were provided. Regression models, adjusted for maternal characteristics and maternity ward, were used to compare CS rates globally and for each group of the system. Variability of CS rates between maternity wards was analyzed using the coefficients of variation.

**Results:** There were 51 082 women who delivered during the pre-period and 63 964 during the post-period. The overall CS rate did not decrease (24.5% during the pre-period vs 25.1% during the post-period). There were no significant differences in CS rates for any group of the Ten Group Classification System after adjustment for maternity, maternal age and sociodemographic characteristics, nor did audit implementation decrease CS rate variability between maternity wards or within groups of the system.

**Conclusions:** Implementation of an audit-and-feedback cycle using the Ten Group Classification System did not decrease either CS rates or variability between maternity wards.

**Abbreviations:** CS, cesarean section; CV, coefficient of variation; MYPA, French perinatal network *Réseau Maternités en Yvelines et périnatalité active*.

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## KEYWORDS

audit, cesarean delivery, feedback, Ten Group Classification System, variability

## 1 | INTRODUCTION

The rising cesarean section (CS) rate is a major concern in nearly all countries, especially when its overuse leads to avoidable maternal and neonatal morbidity.<sup>1</sup> In 2015, 29.7 million cesarean deliveries (21.1%) were performed globally, representing a near doubling since 2000 (12.1%).<sup>1</sup> The increase in CS rates has been highly variable between countries/regions over the last two decades. Some areas (eg South Asia, East Asia and Pacific, Eastern Europe and the USA) have had a significant increase in rates of CS, whereas rates in others (eg Western and Central Africa) have increased modestly.<sup>2,3</sup> In France, the national CS rate was 15.4% in 1995 and has remained around 20% for the last two decades.<sup>4</sup>

The reasons for such discrepancies in CS rate increases are complex, and many non-clinical interventions have been studied to reduce unnecessary CS.<sup>5,6</sup> Intervention targets have included women and families, as well as healthcare professionals, organizations and facilities. In a meta-analysis of the Cochrane Database, most of these interventions have shown little effect on the CS rates.<sup>7</sup> However, those targeting healthcare organizations seemed to have the greatest impact. Audit and feedback represents one such approach.<sup>8</sup> Although there is heterogeneity in how audits and feedback methods are performed, some authors have suggested that the Ten Group Classification System (which is also named the Robson Classification) is well adapted for this purpose because it is recognized as a prospective, objective and reliable system that is suitable for benchmarking CS rates within homogeneous groups of women.<sup>9,10</sup> Using the Ten Group Classification system, high variability in CS rates has been shown between maternity wards, even within groups. Explaining this variability is now a research focus.<sup>11-13</sup>

Thus, our purpose was to compare CS rates before and after an audit-and-feedback cycle using the Ten Group Classification System, and to identify groups in which CS rates changed. We also studied whether CS rate variability between maternity wards changed after the audit and feedback.

## 2 | MATERIAL AND METHODS

### 2.1 | Study design

We conducted a pre-post study of all women who delivered their babies at the Réseau Maternités en Yvelines et périnatalité active (MYPA) perinatal network  $\geq 24$  weeks' gestation from 1 January 2010 to 31 December 2020. Combining all the region's maternity wards, the MYPA perinatal network was created in 2004 and is located just outside Paris. Since 2012, the MYPA network has included 10 maternity wards, five public and five private, of which

#### Key message

Ten group classification system implementation is feasible for an audit/feedback cycle, but this procedure did not decrease cesarean rate or variability in a French perinatal network.

one is a tertiary university hospital and another has a neonatal intensive care unit. This perinatal network remained unchanged and no maternity was removed or added during the study period. More than 16 000 live births per year occurred in this perinatal network.

### 2.2 | Research methods

In collaboration with local authorities (Conseil Départemental des Yvelines), the regional health authority agency (Agence Régionale de Santé Ile de France) and a research unit (Inserm Unit U953), the CoNaissance Program was established in 2008 to monitor maternal and perinatal morbidity and mortality in the MYPA network. For this purpose, data on all births (live and stillbirths)  $\geq 24$  weeks' gestation were continuously recorded from two health certificates:

- The first certificate of infants (PCS; premier certificate de santé) born in network maternity wards, which is completed during a nationally mandated medical examination performed within 8 days after birth, usually in the maternity ward.
- A complementary health certificate, specifically developed within the MYPA network which reports additional data (eg severe maternal morbidity, sociodemographic characteristics, fetal deaths and medical terminations of pregnancy at or after 22 weeks' gestation).

Women were excluded from the analyses if their delivery mode or one of the six items of the system were not recorded.

Maternal age ( $<35$  years, 35–39 years or  $>40$  years) and socio-demographic characteristics including educational level (categorized as college, high school or university) and employment (yes or no) were collected, as the variables necessary to classify women into one group of the Ten Group Classification System. Briefly, the Ten Group Classification System uses six pregnancy characteristics: single or multiple pregnancy, parity, previous CS, fetal presentation and gestational age at delivery, and onset of labor. These characteristics allow classification of all women admitted for delivery into one of 10 mutually exclusive groups (Table S1).<sup>14</sup> The 5-minute Apgar score was also collected as a neonatal outcome measure.

### 2.3 | Audit-and-feedback implementation

The CoNaissance Program data were audited by a team external to the perinatal network (Inserm Unit); the team was allowed to collect CS rates (at the perinatal network level and for each maternity), maternal outcomes (eg maternal deaths, postpartum hemorrhage) and neonatal outcomes (neonatal deaths, 5-minute Apgar, admission to neonatal intensive care unit). Feedback implementation was held to report these outcomes at annual medical staff meetings, to which all health providers from every maternity ward in the perinatal network were invited. The feedback was presented by a staff team including the MYPA co-ordinator (PiR), the Inserm unit statistician who analyzed the data, and the chief of the tertiary hospital, who is a key opinion leader in the perinatal network (PR). The outcomes were presented by the Inserm unit statistician.

The pre-period included all births from 1 January 2012 to 31 December 2014. During this period, the audit and feedback on CSs was based on the overall CS rate. The post-period included all births from 1 January 2015 to 31 December 2018, when an audit of the Ten Group Classification System and group-based audit were implemented using CoNaissance Program data beginning 1 January 2014. Although feedback on 2014 was provided during the second half of 2015, we kept 2015 within the post-period. Notably, the CS rates during the first half of 2015 could therefore not have been impacted by the new audit-and-feedback cycle. During the post-period, standardized audit and feedback were delivered, including a description of overall CS rates, CS rates within each group of the Ten Group Classification System, the contribution of each group to the overall population and the contribution of each group's CS rate to the overall rate. These data

were presented annually without identifying individual hospitals. The perinatal network co-ordinator also then met individually with each maternity leader and health provider team to report their specific CS rates compared with that of the perinatal network. The goals of these secondary meetings were to sensitize the maternity leaders to their CS rates in relation to the overall network and identify groups of this system with unexpectedly high CS rates or high intragroup variations between maternity wards. This feedback was expected to decrease CS rates and homogenize delivery practices.

We used the modified Ten Group Classification System by adding subcategories of women initially classified into groups 2, 4 and 5, by adding a subgroup within each, for those with planned vaginal deliveries (labor induction in subgroups 2A and 4A; women having a planned vaginal delivery regardless of labor onset mode in subgroup 5A) and women having a prelabor CS (subgroups 2B, 4B and 5B). The Ten Group Classification System, as it was presented in the 2015 World Health Organization (WHO) framework, and the modified Robson classification, are presented in Figure 2.

### 2.4 | Statistical analyses

The demographic and clinical characteristics for the two periods are described as means and standard deviations for continuous variables and absolute number and proportions (%) for categorical variables. We used a chi-square test to compare categorical variables and Student t-tests to compare continuous variables.

Statistics were performed at a population level (ie overall perinatal network) and at the maternity level. We calculated CS rates

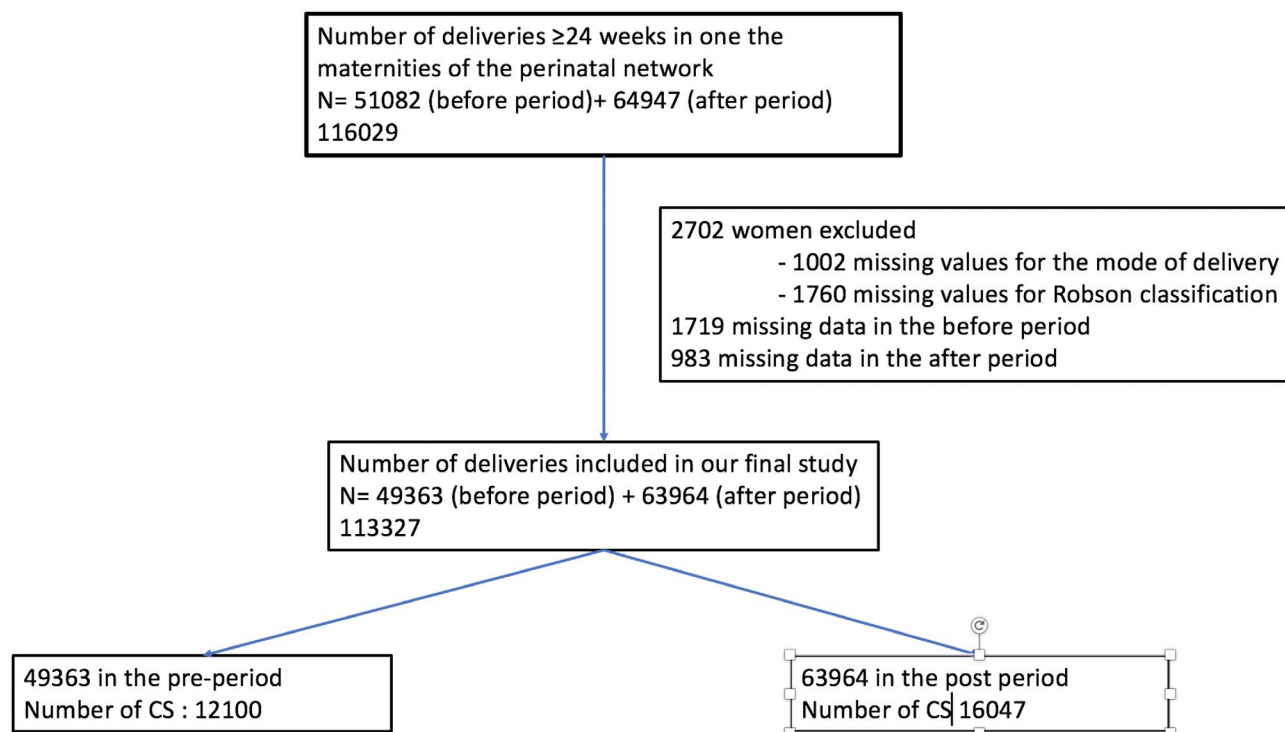


FIGURE 1 Study flow chart. CS, cesarean section

**TABLE 1** Characteristics of women delivering in the French perinatal network Réseau Maternités en Yvelines et périnatalité active (MYPA) network since 2012

	Period 2012–2014, n = 49 363	Period 2015–2018, n = 63 964
Maternal age		
<35 years old	76.3% (37 648)	73.4% (46 969)
35–39 years old	18.9% (9262)	21.1% (13 471)
>40 years old	4.8% (2374)	5.4% (3416)
Educational level		
High school	61.2% (23 222)	60.3% (28 348)
College	22.6% (8577)	23.9% (11 239)
Primary	16.2% (6156)	15.8% (7434)
Employed (Yes)	69.2% (28 067)	68.7% (35 365)
Nulliparous	42.2% (20 830)	39.5% (25 246)
History of CS	11.1% (5485)	11.9% (7604)
Multiple pregnancy	1.7% (1128)	1.7% (1116)
Labor induction	21.1% (10 425)	22.7% (14 575)
Pre-labor CS	13.3% (6565)	13.6% (8686)
Preterm birth	5.6% (2785)	6.1% (3891)
Prolonged pregnancy	17.6% (8695)	17.3% (11 063)
Public maternity	66.0% (32 586)	68.9% (44 120)

Abbreviation: CS, cesarean section.

for each period within the MYPA network and each maternity ward using the modified Robson classification to determine the following outcomes: CS rate within each Robson classification group; contribution of each group to the overall CS rate within each maternity; and the proportion of each group within each CS cohort. CS rates within each period were compared with a chi-square test, and logistic regression was used to adjust these comparisons for the maternity ward, maternal age and sociodemographic characteristics that are not considered in the Ten Group Classification System. Moreover, as we assessed large time periods, we graphed curves to illustrate the CS rate evolutions across years. The latter was performed to unmask potential early effects of the audit implementation, which might otherwise have been hidden within the pre-post study.

Variability in group of CS rates among maternity wards was calculated using the coefficient of variation (CV). Direct comparisons between CVs for each group of the Ten Group Classification System between the two periods would have been inappropriate because the CV is also affected by variation in CS rates within maternity wards across years. Therefore, we studied CV between maternity wards and over the years within each group using the R package “cvequality” to test for the equality of variance.<sup>15</sup>

## 2.5 | ETHICAL APPROVAL

The National Committee for Data Protection (Commission Nationale de l'Informatique et des Libertés, registration number

**TABLE 2** Cesarean delivery (CD) rate according to study period and Robson group

	CD rate for overall MYPA network deliveries		P	P <sup>a</sup>
	2012–2014	2015–2018		
Overall	24.5% (49 363)	25.1% (63 964)	0.03	0.03
Group 1	12.5% (1613/12 907)	12.8% (1947/15 228)	0.47	0.24
Group 2	42.3% (2381/5631)	42.5% (3169/7449)	0.78	0.61
Group 2A	34.9% (1743/4993)	35.0% (2288/6566)	0.95	0.18
Group 2B	100% (638/638)	100% (881/881)		
Group 3	3.4% (536/15 549)	3.6% (739/20 315)	0.35	0.53
Group 4	24.6% (416/5751)	23.4% (1895/8092)	0.10	0.07
Group 4A	10.1% (488/4823)	11.8% (829/7026)	0.004	0.18
Group 4B	100% (928/928)	100% (1066/1066)		
Group 5	67.8% (3341/4925)	67.7% (4532/6694)	0.89	0.68
Group 5A	37.0% (932/2516)	38.9% (1374/3536)	0.15	0.42
Group 5B	100% (2409/2409)	100% (3158/3158)		
Group 6	92.1% (821/891)	92.2% (954/1035)	1	0.32
Group 7	82.1% (579/705)	85.5% (807/944)	0.007	0.52
Group 8	67.1% (576/858)	66.6% (728/1093)	0.84	0.66
Group 9	92.6% (113/122)	97.4% (186/191)	0.25	0.45
Group 10	35.7% (724/2024)	37.3% (1090/2923)	0.29	0.39

Note: MYPA, French perinatal network Réseau Maternités en Yvelines et périnatalité active.

<sup>a</sup>After adjustment for maternity unit, maternal age, educational level and employment (reference: pre-period).

1295794) approved the study, which was conducted in accordance with French legislation. Under French law, the study was exempt from informed consent requirements because patients received standard care and the dataset contained no identifiable information. Similarly, ethics committee approval was not required because the study used an anonymized database and did not influence patient care.

### 3 | RESULTS

There were 116029 women who delivered in the MYPA network from 1 January 2012 to 31 December 2018. Among these, 2702 (2.3%) were excluded with missing data required for group classification. Implementation of the audit in 2014 was associated with a decrease in missing data, mainly for variables of the Ten Group Classification System (3.3% [1719/51 082] vs 1.5% [983/64 947] in the pre- and post-periods, respectively). The final sample was

comprised of 113 327 women: 49 363 during the pre-period and 63 964 during the post-period (Figure 1).

A slight difference in sociodemographic and maternal clinical characteristics was noted between the two periods. During the post-period, there were more older women, more multipara women and more women with a CS history. There were also more deliveries in the public maternity wards. Labor induction was more common during the post-period, whereas the rate of prelabor CS remained unchanged between the two periods (Table 1). This translated to a significant change in the relative size of each modified Robson classification group, with notably fewer nulliparous women with a term, singleton, cephalic fetus and spontaneous labor, and an increase in multiparous women with a cephalic presentation across labor onset mode and CS history (Table S2). The relative sizes of groups 2A, 4A and 5A (prelabor CS for nulliparous women with a term singleton cephalic presentation; multiparous women with a term singleton cephalic presentation with or without a history of CS, respectively) remained unchanged from the pre- to post-period.

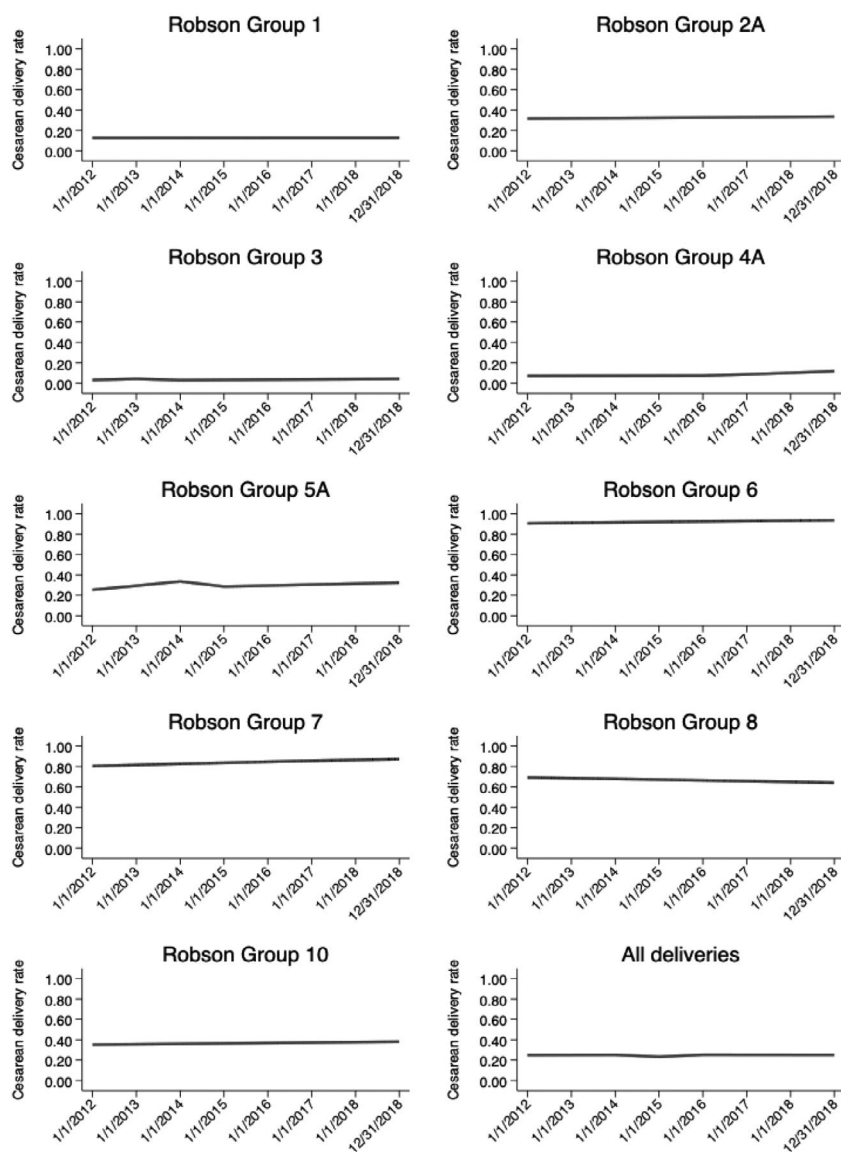


FIGURE 2 Cesarean delivery rate evolutions within each Robson group



The overall CS rate did not decrease in the post-period, and actually increased slightly from 24.5% during 2012–2014 to 25.1% during 2015–2018. An increase in CS rates was found in nearly every group but was significant only within groups 4A (multiparous women with induced labor and a singleton, cephalic fetus) and 7 (multiparous women with a breech fetus) (Table 2). There was no statistically significant association between the time period and CS rate after adjusting for maternity ward, maternal age and sociodemographic characteristics, regardless of group of the Ten Group Classification System or maternity ward. Year-to-year evolution in CS rates within each group are shown in Figure 2, illustrating a lack of impact of the audit over time. These global pre- vs post-results were confirmed by the year-to-year evolution within groups, which also showed no trends or marked change after 2014 (Figure 2). There was also no difference in the 5-minute Apgar score between the two periods on either global or within-group analyses (Table S3).

The CS rate variability between maternity wards was analyzed for each year using the CV. The CVs were highest for groups 1, 2, 2A, 3, 4 and 4A, which had the largest relative sizes (Table 3). Although around half of each group showed significant CV variation over the years, there were no trends or change in 2015, and no clear link to the audit and feedback (Figure 3).

## 4 | DISCUSSION

Regardless of the group of the Ten Group Classification System, CS rates did not decrease within the perinatal network following implementation of a Ten Group Classification System-based audit and feedback. CS variability was highest among nulliparous and multiparous women with a singleton, term, cephalic presentation, regardless of labor onset mode. This variability did not decrease following the audit and feedback.

This study, which was based on two relatively long study periods with more than 50 000 deliveries during each, was designed to assess whether an audit and feedback using a WHO-recommended classification system was associated with CS rate changes. The large study period, which was supplemented by an annual CS rate analysis, was valuable for developing an overview of how CS rates evolve and ensured that changes were not masked within time periods. These results were consistent at both the perinatal network and individual maternity levels.

The CoNaissance program was built into the MYPA network to provide information on major maternal and perinatal outcomes, and CS variability between network maternity wards was identified as a major study item. Thus, considerable effort was made to record all items from the first certificate to allow groupings within the Ten Group Classification System. These items were recorded in the database by two research midwives, and we found a decrease in missing data after the implementation of this classification. Moreover, the relative size of group 9 and its CS rate are valuable markers of data quality. Herein, the relative size of group 9 was <1% of the overall population. The high CS in this group suggests few patient misclassifications and overall good data quality.

However, our study also has several limitations. CS is a complex procedure in which many factors interact. Data on many potential confounders were unavailable, including those related to both maternal and fetal status and organizational status. Moreover, although standardized feedback was provided about indicators of this classification, no actions were identified to decrease CS rates or avoid unnecessary CSs. Indeed, since resources and maternal and perinatal care differ across maternity wards, the annual meeting would not have been an appropriate venue for elaborating on such procedures. Therefore, providing information, comparing maternity wards and discussing CS rates within each Robson group was considered the

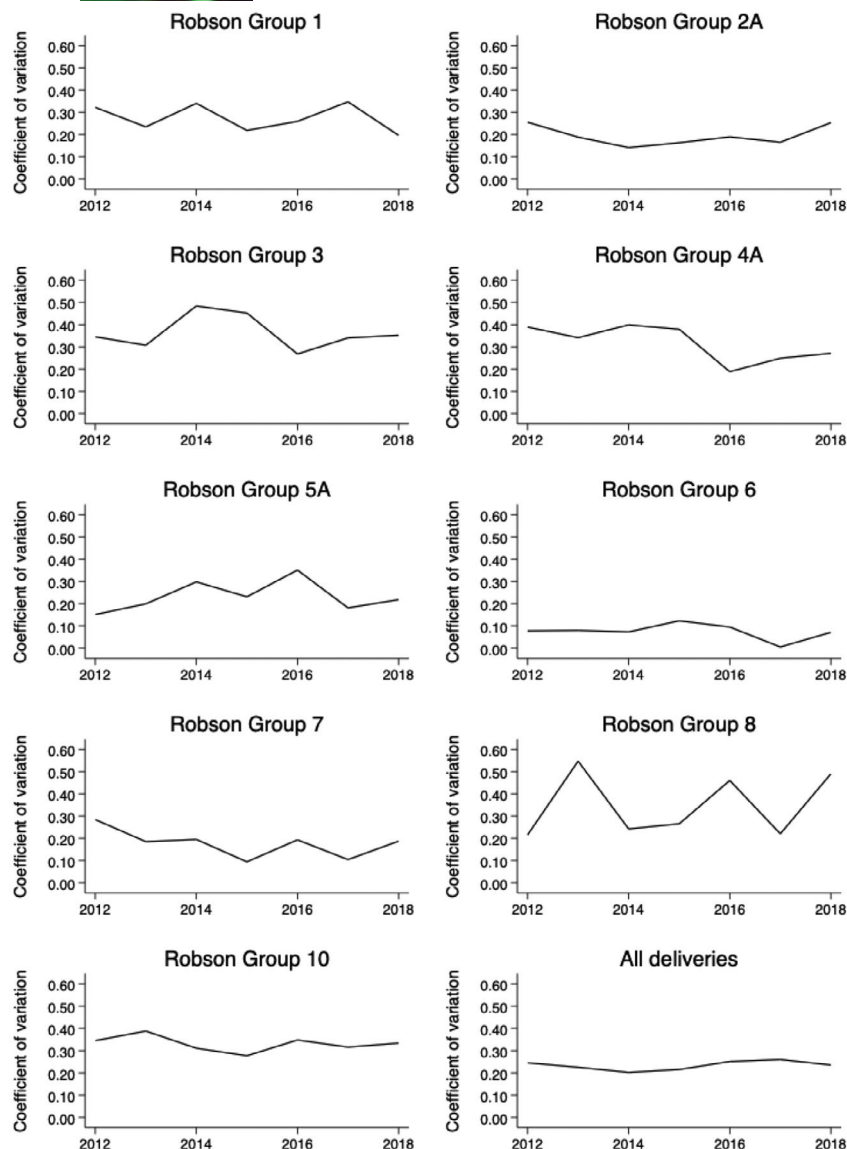
**TABLE 3** Coefficient of variation according to study year and Robson group

	2012	2013	2014	2015	2016	2017	2018	P <sup>a</sup>
Robson 1	0.322	0.234	0.340	0.218	0.259	0.347	0.196	0.37
Robson 2	0.266	0.258	0.206	0.199	<b>0.275</b>	0.268	0.234	0.98
Robson 2a	0.255	0.188	0.141	0.163	0.189	0.165	0.253	0.40
Robson 3	0.345	0.307	0.484	0.452	0.268	0.340	0.352	0.003
Robson 4	0.28	0.346	0.294	0.346	0.221	0.289	0.261	0.007
Robson 4a	0.389	0.341	0.399	0.379	0.188	0.249	0.271	0.37
Robson 5	0.163	0.15	0.157	0.176	0.206	0.176	0.143	0.006
Robson 5a	0.151	0.199	0.298	0.231	0.351	0.181	0.218	0.27
Robson 6	0.078	0.08	0.073	0.123	0.095	0.005	0.071	<0.001
Robson 7	0.284	0.185	0.195	0.094	0.193	0.104	0.187	<0.001
Robson 8	0.215	0.547	0.242	0.265	0.460	0.2202	0.490	0.01
Robson 10	0.345	0.388	0.311	0.277	0.348	0.316	0.334	0.47

Note: Coefficient of variation (%) was calculated as: (standard deviation/mean) × 100, where the mean and standard deviation were calculated from proportion of each maternity ward CS rate.

<sup>a</sup> The asymptotic test was performed for the equality of CV between years.

Bold values indicate statistical significance of  $p < 0.05$ .



**FIGURE 3** Evolution of coefficient of variation within each Robson group

only pragmatic procedure that could be used to modify the network's or maternity wards' CS rates.

Finally, we used the 5-minute Apgar score alone as a neonatal outcome that might be affected by CS rate change. Evolution in CS rates should be reviewed with more extensive perinatal outcomes to ensure maternal and neonatal safety. Herein, 5-minute Apgar scores remained unchanged after feedbacks based on this classification, leading to the conclusion that our novel audit system did not modify CS practice and other outcomes were also likely to be unchanged.

Despite historic WHO recommendations to stabilize CS rates under 15%, the global rate has risen, with potential adverse maternal and perinatal outcomes.<sup>16,17</sup> Many classification systems have emerged to understand these increased rates; however, most suffer from a lack of reproducibility, particularly regarding the operational definitions of their items.<sup>18</sup> The woman-based Ten Group Classification System has emerged as the best to facilitate auditing, analyzing and comparing CSs across settings. Many articles based on this classification have been published, describing regional and national CS practices, revealing marked variability.<sup>11,13,19</sup> In 2016,

WHO updated its statement, asking healthcare providers to monitor their CS rates and implement this classification during their next audit cycle. Despite this, few articles have reported the impacts of this recommendation.<sup>10,20-23</sup> A recent literature review considered six articles on Ten Group Classification System audit and feedback, most of which were considered "weak" according to the Effective Public Health Practice Project framework.<sup>24</sup> Although most of these studies appeared promising because all of them reported a CS rate decrease in their target population (mostly nulliparous women), they had a common limitation, ie the long-term effects were poorly investigated. Indeed, Scarella et al. found a CS rate decrease during the first 7 months following the WHO classification implementation but an increase following the study period, suggesting that the benefit may have been related to observation for the study itself.<sup>10</sup> Our findings contradict previous studies, suggesting that the audit-and-feedback cycle with this classification alone is insufficient to modify or homogenize CS rates within a perinatal network. This is also supported by a meta-analysis by Chaillet & Dumont, who studied non-clinical interventions in which audit and feedback had



moderate effects on CS rate decreases, especially without supplementation by other procedures.<sup>6</sup> We agree that the Ten Group Classification System is quite useful for understanding how CS risks vary according to relevant obstetrical factors, but it is yet to be determined how it can be used to identify and decrease unnecessary CSs or to understand why CS practices may differ markedly among maternity wards.

## 5 | CONCLUSION

The Ten Group Classification System is appropriate for monitoring CS practices and is suitable for use in audit-and-feedback cycles. However, audit-and-feedback cycles based on this classification may be insufficient to change current CS practices.

## CONFLICT OF INTEREST

None.

## AUTHOR CONTRIBUTION

TQ developed the research question, facilitated analysis of the samples, designed the study and analytic plan, analyzed and interpreted the data, and drafted the manuscript. MC participated in analysis of the data collected. CB participated in collection of all data. PR contributed to writing the manuscript. All authors edited, read and approved the final manuscript.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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