



## Cesarean delivery rates using Robson classification system in Ireland: What can we learn?



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### ABSTRACT

**Objective:** It has been proposed that the Robson Ten-Group Classification System be used as a global standard for assessing, monitoring and comparing cesarean delivery (CD) rates within and between maternity services. Our objective was to compare the change of CD rates within the 10-Group Classification System in our institution over 10 years.

**Study design:** From 2005–2014 inclusive data was collected prospectively and all women were classified using the obstetric concepts and parameters described in the Ten-Group Classification System. Linear regression and weighted Least Squares regression analyses were used to analyze trends over time.

**Results:** During 2005–2014 inclusive, 88,004 mothers delivered 89,649 babies  $\geq 500$  g. Over the 10 year period there was an increase in CD rate from 18.3% to 23.5%, with a linear increase in CD rate by 0.6% annually (95% CI:0.52, 0.75;  $p < 0.001$ ). The main contribution to the increase in the CD rate was Group 2a (induced single cephalic nulliparous women at term), Group 2b (pre-labor single cephalic nulliparous women at term) and Group 5 (single cephalic multiparous women at term with a previous CD). No increase in CD rate was noted in Group 1 (single cephalic nulliparous women presenting in spontaneous labor at term). The percentage of women  $\geq 35$  years of age increased from 28.4% to 39.8% over the study period (0.98% per year; 95% CI:0.64, 1.33;  $p < 0.001$ ).

**Conclusion:** The driving force for the increase in CD in the National Maternity Hospital has been induction of labor and pre-labor CD in nulliparous women with a single cephalic pregnancy at term. This inevitably results in a larger population of women with a previous CD and therefore a secondary contribution to the increase in the overall CD rate.

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### Introduction

In many counties, rates of cesarean delivery (CD) have increased steadily during recent decades, particularly in middle- and high-income countries, and this has become a major and controversial public health concern [1–5]. Given the maternal morbidity and mortality associated with the procedure, reducing CD rates is a public health priority [3]. When medically justified, a CD can reduce maternal and perinatal mortality and morbidity [4].

In 1985, World Health Organization (WHO) stated that CD rates should not exceed 10–15% in any region of the world [1,6], however many countries in the western world have rates greater than 15%. By 2005, the national CD rate had exceeded 30% in the United

States [7], and in the National Maternity Hospital (NMH), it had risen to 23.5% in 2014 [8]. Potential explanations for the rise in CD rates internationally include maternal obesity, increasing maternal age, maternal request, medicolegal concerns, diabetes, and multiple pregnancy [9–13]. The rapid increase in CD rate over the past number of decades is associated with immediate and later risk of maternal and neonatal complications [14–16]. It is also associated with increased healthcare costs [17].

A 2011 systematic review and critical appraisal by Torloni et al. [18] of 27 classification systems for CD concluded that the women-based classifications in general and in particular, the Ten-Group Classification System proposed by Robson in 2001 [19] would be the most appropriate to compare CD rates. Individual groups are objectively defined, mutually exclusive, and totally inclusive. Each group classifies the CD based on the characteristics of each individual woman and their pregnancy rather than the indication for CD [19]. Indications are more usefully used within the groups.

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The classification is prospectively determined, clinically relevant, robust and withstands close scrutiny [20]. It provides a useful and easy tool for analyzing the clinical activity and philosophy of care of an individual care group, organization, region or country [21]. Users of the classification system may wish to further subdivide or amalgamate the 10 groups and analyze other relevant characteristics within each of the groups, according to their local needs and interests. A systematic review conducted by the WHO in 2014 found that users praised the simplicity, robustness, reproducibility and flexibility of the Ten-Group Classification System [22]. Our objective was to compare the change of CD rates within Ten-Group Classification System in our institution over a 10 year period.

## Materials and methods

This was a prospective study. The National Maternity Hospital (NMH) in Dublin, Ireland is a tertiary referral hospital and one of the largest maternity hospitals in Europe. The philosophy of Active Management of Labor which was conceived in the NMH in 1963 includes strict diagnostic criteria for labour, early amniotomy, early but appropriate use of oxytocin, continuous one to one midwifery care with midwifery and obstetric review and audit of partograms [23]. The NMH has a meticulous clinical auditing system resulting in an annual clinical report each year that is available for external scrutiny. Data that was prospectively collected using the hospital's obstetric database over a ten year period from January 2005 to December 2014 was used for this study and all women were contemporaneously classified using the five obstetric concepts and their parameters described in the Ten-Group Classification System; Single/multiple, nulliparity/multiparity/multiparity with CD scar, cephalic/breech presentation, spontaneous/induced labor onset/pre-labor CD and gestation (>37 weeks) gestation [19]. Women were included if they delivered a liveborn baby at least 500 g or at a gestational age of at least 24 weeks. Overall CD rate, relative size of each group, CD rate in each group and absolute contribution of each group to the overall CD rate were calculated and plotted over the study period. The relative size of each of the 10 groups was calculated by dividing the number of deliveries in each group by the total number of deliveries in obstetric population and expressing it as a percentage. The CD rates were calculated by dividing the number of CD by the total number of deliveries in each group and expressing it as a percentage. Finally, the percentage contribution made by each group to the overall CD rate was calculated by dividing the number of CD in each group by the total number of deliveries in the obstetric population.

Linear regression was used to determine the form of the linear trend over time in the number of deliveries, and number of babies. Weighted Least Squares (WLS) regression was used to analyze the trends in CD over time, weighted for the total number of deliveries in each year, or the total number in each Ten-Group Classification System group in that year. Hospital ethical approval was not required for this study as this was an analysis of publicly available data.

## Results

### Overall

During 2005–2014, 88,004 mothers delivered 89,649 babies  $\geq 500$  g in the National Maternity Hospital, Dublin. The baseline characteristics are outlined in Table 1. There was an increase in CD rate from 18.3% to 23.5% over the study period by 0.6% (95% CI: 0.52, 0.75) annually ( $p < 0.001$ ) (Fig. 1).

There was a statistically significant increase in the total number of deliveries per year (+142 per year; 95% CI: 10.0, 274.8;  $p = 0.04$ ), and in the number of babies delivered (+153 per year; 95% CI: 17.6, 289.2;  $p = 0.03$ ) over the time period.

The percentage of women  $\geq 35$  years of age increased from 28.4% to 39.8% (0.98% per year; 95% CI: 0.64, 1.33;  $p < 0.001$ ). There was a significant trend for the percentage of obese mothers (BMI  $\geq 30$  kg/m [2]) to decrease (−0.43% per year; 95% CI: −0.52, −0.34;  $p < 0.001$ ).

Perinatal Mortality Rate (PMR) did not change (−0.12% per year; 95% CI: −0.43, 0.19;  $p = 0.39$ ), nor did the percentage of nulliparous women attending our institution (−0.08% per year; 95% CI: −0.55, 0.40;  $p = 0.72$ ).

### Ten-Group Classification System

Table 2 demonstrates the groups within the Ten-Group Classification System. Table 3 demonstrates the trends in the proportions of women in the 10 groups over time and the proportion of cesarean deliveries per group over time. Fig. 2 shows the CD rate per Ten-Group Classification System group over time. Fig. 3 shows the contribution of each group to the overall CD rate over time.

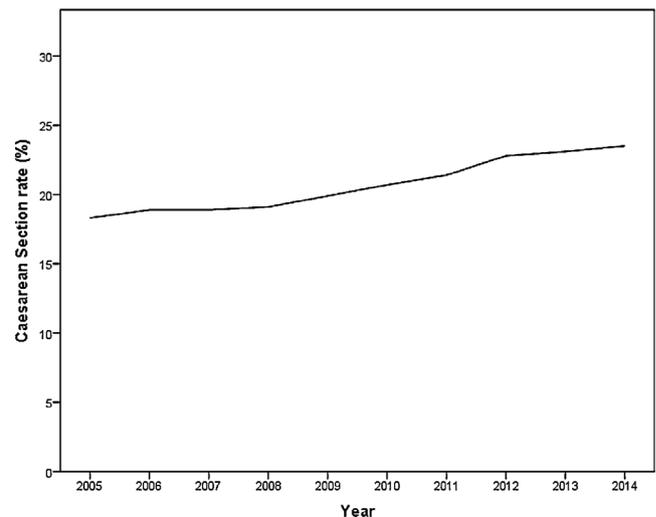


Fig. 1. Linear trend for the Caesarean Delivery rate from 2005 to 2014.

Table 1

Trends in the baseline characteristics of women attending the National Maternity Hospital, Dublin over the period 2005–2014.

%	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	p-value
Nulliparous	43.6	44.8	45.4	47.2	43.6	48.2	46.2	43.6	43.5	44.3	0.72
Obese	NR*	8.6	15.1	15.1	14.3	13.9	14.0	13.2	12.4	12.3	<0.001
$\geq 35$ years	28.4	30.1	30.0	30.3	30.1	31.4	32.2	34.2	35.6	38.8	<0.001
Induction of labor	24.4	23.2	24.8	25.4	25.2	24.8	24.9	26.4	26.5	27.1	0.005
Cesarean Delivery	18.3	18.9	18.9	19.1	19.9	20.7	21.4	22.8	23.1	23.5	<0.001
Irish	80.8	78.2	75.3	72.9	71.7	71.6	72.9	73.2	58.2	60.7	<0.001
Birthweight $\geq 4$ kg	19.0	18.9	19.1	18.9	18.1	18.5	20.4	19.7	19.0	19.0	1.00
Neonatal intensive care unit admission	12.9	11.4	10.2	10.2	11.8	12.0	11.8	13.0	18.0	18.5	<0.001

\* NR = not recorded.

**Table 2**  
Robson Ten-Group Classification System.

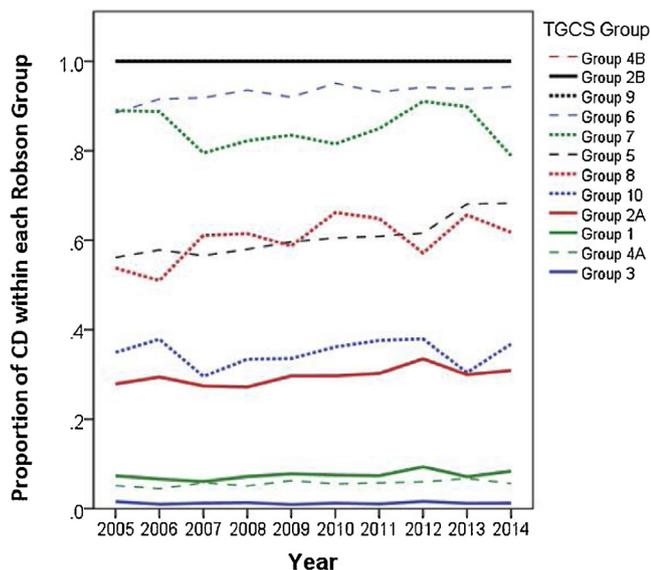
- 1 Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation in spontaneous labor
- 2 Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation who either had labor induced (Group 2a) or had a cesarean delivery before labor (Group 2b)
- 3 Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks in spontaneous labor
- 4 Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks who either had labor induced (Group 4a) or who had a cesarean delivery (Group 4b)
- 5 All multiparous women, with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation
- 6 All nulliparous women with a single breech pregnancy
- 7 All multiparous women with a single breech pregnancy including, women with previous uterine scars
- 8 All women with multiple pregnancies, including women with previous uterine scars
- 9 All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars
- 10 All women with a single cephalic pregnancy at less than or equal to 36 weeks gestation, including women with previous scars.

**Table 3**  
Trends in the proportions of women in the 10 groups and the cesarean delivery rate in each group over the period 2005–2014.

Group	Trends in the proportions of women in the 10 groups over time			Trends in the proportion of cesarean deliveries per group over time		
	Change in overall % per year	95% CI	p-value	Change in % CD rate per year	95% CI	p-value
1	<b>-0.48</b>	<b>-0.79, -0.16</b>	<b>0.009</b>	0.18	-0.01, 0.38	0.063
2A	<b>0.29</b>	<b>0.12, 0.47</b>	<b>0.005</b>	<b>0.44</b>	<b>0.07, 0.82</b>	<b>0.026</b>
2B	<b>0.05</b>	<b>0.01, 0.08</b>	<b>0.015</b>	constant		
3	<b>-0.21</b>	<b>-0.40, -0.03</b>	<b>0.030</b>	0.00	-0.06, 0.07	0.996
4A	0.00	-0.19, 0.19	0.997	<b>0.13</b>	<b>0.001, 0.26</b>	<b>0.049</b>
4B	0.02	-0.003, 0.04	0.080	constant		
5	<b>0.25</b>	<b>0.11, 0.39</b>	<b>0.004</b>	<b>1.35</b>	<b>0.87, 1.83</b>	<b>&lt;0.001</b>
6	0.04	-0.004, 0.08	0.072	0.46	0.14, 0.78	0.010
7	0.02	-0.01, 0.04	0.164	-0.06	-1.28, 1.16	0.909
8	<b>0.10</b>	<b>0.05, 0.14</b>	<b>0.001</b>	0.91	-0.17, 2.00	0.089
9	-0.002	-0.03, 0.02	0.854	constant		
10	<b>-0.07</b>	<b>-0.13, -0.01</b>	<b>0.033</b>	0.15	-0.68, 0.98	0.687

<sup>†</sup>CD = Cesarean Delivery.

Values in bold represent statistically significant trends ( $p < 0.05$ ).



\*TGCS = Ten Group Classification System

\*\*Groups 2B, 4b and 9 had a CD of 100%.

**Fig. 2.** Cesarean Delivery rate per Ten Group Classification System group.

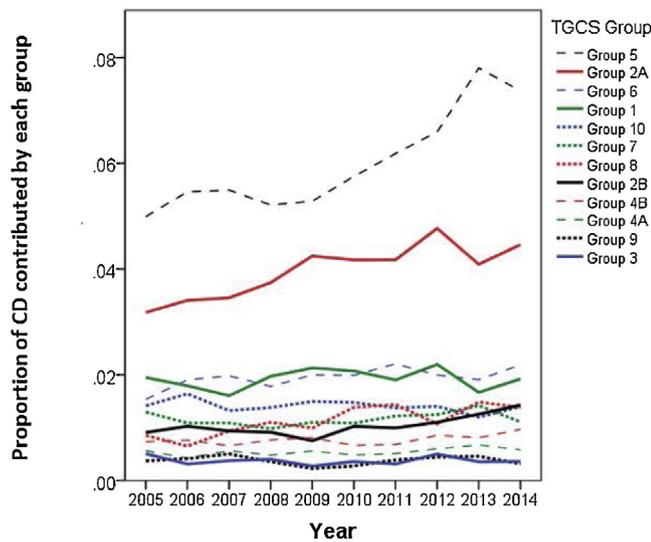
\*TGCS = Ten Group Classification System.

\*\*Groups 2B, 4b and 9 had a CD rate of 100%.

### Term Singleton cephalic nullipara

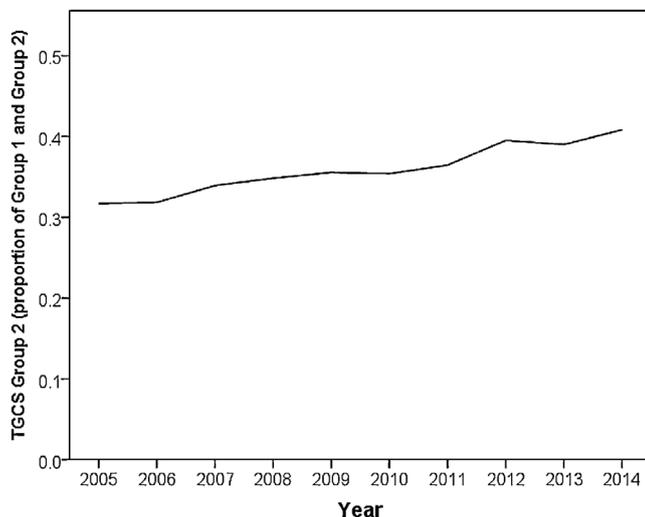
Groups 1 (spontaneously laboring term nullipara) and 2 (pre-labor CD and induced term nullipara) were combined as a composite variable, Term Singleton Cephalic Nullipara. There was no change in the overall size of Term Singleton Cephalic Nullipara over the study period (38.8% in 2005 and 38.8% in 2014). However, the overall contribution of group 1 declined over the study period from 26.5% to 23.0% at a rate of  $-0.48\%$  per year, while the overall contribution of group 2 increased from 12.3% to 16.8% at a rate of  $+0.34\%$  per year. The ratio of groups 1 and 2 is generally 2:1 or greater unless there is a practice resulting in greater intervention towards the end of pregnancy. In 2005, it was 2.15:1 and in 2014 it was 1.45:1. The number of induced term nullipara and pre-labor CD (Group 2) significantly increased as a proportion of all Term Singleton Cephalic Nullipara, with at a rate of  $1.0\%$  per year (95% CI: 0.8, 1.2;  $p < 0.001$ ) (Fig. 4). This may have been clinically indicated or related to other non-clinical factors. The proportion of women who were induced (group 2a) and the proportion of women who had pre-labor CD (group 2b) increased by  $+0.29\%$  ( $p = 0.005$ ) and  $+0.05\%$  ( $p = 0.015$ ) respectively per year over the study period.

The CD rate in group 1 has been stable over the time period, however, the CD rate in group 2a (Induced term nullipara) has increased from 27.9% in 2005 to 30.9% at a rate of  $+0.44\%$  per year. Therefore, the absolute contribution to the CD rate in group 1 has been consistent at 1.9% over the study period with a rise in absolute contribution to the CD rate in group 2a from 3.2 to 4.5%.



\*TGCS = Ten Group Classification System

**Fig. 3.** Absolute Contribution of each group to the overall Cesarean Delivery rate.  
\*TGCS = Ten Group Classification System.



**Fig. 4.** Group 2 as a proportion of groups 1 and 2.

#### Term Singleton cephalic multipara

The contribution of groups 3 and 4 has declined from 43.1% in 2005 to 40.3% in 2014. The ratio between the sizes of groups 3 (Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks in spontaneous labor) and 4 (Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks who either had labor induced [Group 4a] or were delivered by a CD [Group 4b]) is classically always higher than the ratio between groups 1 and 2 in every population [24]. However, there was no significant change over time in the Group 4 delivery rate, as a proportion of all Group 3 and Group 4 deliveries, with only 0.2% increase per year (95% CI: -0.1, 0.5;  $p=0.25$ ). CD rate in induced multipara (Group 4a) increased over time from 5.2% to 5.7% but this is not clinically significant.

#### Previous CD, single cephalic, $\geq 37$ weeks

The overall size of group 5 (All multiparous women, with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation) increased by +0.25% per year ( $p=0.004$ ) over the study period from 8.9% in 2005 to 10.8% in 2014. Furthermore, the CD rate in group 5 increased by +1.35% per year ( $p < 0.001$ ) from 56.2% in 2005 to 68.3% in 2014. Group 5 contributed 5.0% to the overall CD rate in 2005 and 7.4% in 2014 (the largest contributor).

#### All nulliparous breeches and all multiparous breeches (including previous CD)

There was an increase in the CD rate in group 6 (nulliparous breeches) over the study period by 0.46% per year ( $p=0.01$ ) from 88.5% to 94.3% but this had no significance on the contribution to the overall CD rate. There were no changes over time in the proportion of women or CD rate in group 7 (All multiparous women with a single breech pregnancy including, women with previous uterine scars).

#### All multiple pregnancies (including previous CD)

There was a significant increase in the number of women in group 8 of 0.1% per year ( $p=0.001$ ) from 1.6% in 2005 to 2.2% in 2014, with a non-significant increase in the CD rate from 53.8% to 61.8%.

#### All transverse/oblique lies (including previous CD)

The CD rate in group 9 was 100% in 2005 and 2014, as expected. There was no significant change in the contribution of women to this group.

#### All preterm single cephalic, $< 37$ weeks, including previous CD

There was a small reduction in the contribution to group 10 by -0.07% over the study period ( $p=0.03$ ) from 4.0% to 3.8%, however there were no differences in CD rate in the group and contribution to the overall CD rate.

#### Effects of maternal age on term Singleton cephalic nullipara

In group 1 deliveries, the mean parturient age significantly increased over this period from 28.5 years (SD 5.5) in 2005 to 31.6 years (SD 4.6) in 2014 (+0.27 years per year;  $p < 0.001$ ). Similarly, the group 2a and 2b mothers increased from a mean age from 30.0 years (SD 5.4) in 2005 to 32.7 years (SD 5.1) in 2014 (+0.23 years, per year;  $p < 0.001$ ). The median gestational age at delivery marginally decreased in the groups 2a and 2b mothers, by 0.22 days per year between 2005 and 2014 ( $p < 0.001$ ).

## Discussion

Our study shows that over a decade in our institution, 88,004 mothers delivered 89,649 babies weighing  $\geq 500$  g. There was an increase in the number of mothers delivering over the time period. There was an increase in CD rate of 0.63% per year from 18.3% to 23.5% and an increase in women  $\geq 35$  years of age from 28.4% to 39.8%. Analysis of trends over time using the Ten-Group Classification System allows identification of changes in particular groups, which may account for rising CD rates.

Group 5 (Previous CD, single cephalic,  $\geq 37$  weeks) makes the biggest absolute contribution to the overall CD rate (7.4% in 2014), and this has been previously reported by Robson and other authors

[19,20,25,26]. Not only did the size of this group increase significantly over the time period by 0.25% per year to 10.8% in 2014, the CD rate in this group increased by 1.4% per year to 68.3% in 2014. These rates of CD in this group are relatively high and similar rates have been previously reported in studies examining CD rates in Canada and the USA using the Ten-Group Classification System of up to 90% [25,26].

Although the size of Term Singleton Cephalic Nullipara was similar over the study period, there were significant changes within groups 1 and 2. The size of group 1 decreased over the study period, while the size of group 2 increased. Robson has described previously that a ratio of less than 2:1 between the sizes of groups 1 and 2 may reflect a high incidence of induction and pre-labor CD in this cohort [24]. In 2005, the ratio was between groups 1 and 2 was 2.15:1 and in 2014, it was 1.45:1. Furthermore, within group 2a (Induced term nullipara), the CD rate over the time period increased, thereby contributing significantly to the overall increased CD rate. The increase in Term Singleton Cephalic Nullipara CD rate has been described in our institution previously over a 35-year period [27].

Once the main contributors to CD rates are identified, the next steps should be to focus on potential interventions to prevent further rise [25]. It is important, through audit and analysis using the Ten-Group Classification System, that we identify the main contributors to the increasing CD rate. A prospective cohort study by Scarella et al. [28] in Chile showed that by implementing the Ten-Group Classification System over a 21 month period, the CD rate of 36.8% was reduced to 26.5%. Following cessation of the implementation, the CD rate increased to 31.8%.

A recent FIGO position paper concluded that health care professions in collaboration with government bodies, the health insurance industry and women's groups are urgently needed to reduce unnecessary CD [29]. The Robson classification can be useful at facility and population levels to identify which specific groups to target and to help develop policy options to reduce unnecessary CD [30]. Our data and data from other institutions suggest that the best way to reduce the overall rate of CD in this group is to prevent the first procedure [31], and to address the declining vaginal birth after caesarean delivery (VBAC) rate.

### Strengths and limitations

This study has strengths. This was a prospective study over a ten year period of 88,004 women in a large tertiary referral practicing a consistent management of labor protocol, Active Management of Labor [23]. A limitation to this study is that we have not analyzed indications for induction of labor, pre-labor CD and CD in women with one prior CD. This may provide further insight and explanation into the reasons for the increasing number of women, increasing CD rate and the decreasing gestational age at delivery in group 2, and the increasing number of women opting for elective repeat CD in group 5.

### Future direction

Future work should analyse indications for induction of labor in term nulliparas. Additionally, further work should address the reasons for the declining VBAC rate in women with one CD.

### Conclusion

Robust data collection and analysis using the Robson Ten-Group Classification System can illustrate potential contributors to a rising CD rate within an institution. Over the past decade, there has been a steady increase in the CD rate in our institution with an

increased contribution from induction of labor and pre-labor CD in term nulliparas. Furthermore, the proportion of women in these groups has increased over time. This inevitably results in a larger population of women with a previous CD and therefore a secondary contribution to the increase in the overall CD rate. Whether the increase in pre-labor intervention in nulliparous women with a single cephalic pregnancy at term is clinically justified remains a topic of debate.

### Author contributions

DC collected data, analysed data and wrote the manuscript, MM collected data and reviewed the manuscript, RS analyzed the data for the manuscript, FB collected and stored the collected data, RM, MR and FM co-authored the manuscript and edited the final draft.

### Conflicts of interest

The authors report no conflict of interest.

### Acknowledgement

Not Applicable.

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