



Trend Prediction for Cesarean Deliveries Based on Robson Classification System at a Tertiary Referral Unit of North India

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Abstract

Background World Health Organization proposed use of Robson Classification as a global standard for assessing, maintaining and comparing Cesarean section (CS) rates. This paper aimed to examine CS trend at a tertiary center according to Robson Ten-Group Classification System (TGCS) over three-year period (2015–2017) and to predict future Cesarean trends.

Methods This prospective observational study was conducted at a tertiary teaching institute and included 81,784 females who delivered at this hospital over three-year duration (2015–2017). The data compilation was done according to Robson TGCS. The main outcome measures were overall annual CS rates, Robson group-wise CS rates, future overall and Robson group-wise CS trend. These parameters were calculated, trend analysis was done and trend over future 3 years was predicted.

Results There were 81,784 deliveries (62,336 vaginal and 19,448 Cesarean deliveries) over the study period. The year-wise CS rate was 22.4%, 23.5% and 25.5%, respectively. The largest contribution was by group 5 followed by group 2 and group 1. Based on 3-year data, it was predicted that CS rate will increase by 0.905% annually over coming 3 years. In groups 3, 4, 6, 7 and 8, predicted trend value showed an annual increase by 0.65%, 0.05%, 0.05%, 0.05% and 0.10%, respectively; in groups 1, 2, 5, 9 and 10, it showed an annual decrease of 0.45%, 0.05%, 1.50%, 0.50% and 0.05%, respectively.

Conclusion Increasing CS rate trend was seen over last 3 years with a predicted rise of 0.905% per year. Robson groups 5, 2 and 1 were at present major contributors; however, the trend analysis predicted a decreasing trend. Trend analysis predicted annual increment in groups 3, 4, 6, 7 and 8 over next 3 years, thereby suggesting need to focus on these groups as well.

Keywords Cesarean section audit · Cesarean trend analysis · Future Cesarean trends · Maternal health policy formulation

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Introduction

Rising Cesarean section (CS) rates is a global concern. Most countries have exceeded the limit (10–15%) set by World Health Organization (WHO) in 1985.

In India, CS rate has increased from 10.6% (NFHS-3, 2005–2006) to 17.2% (NFHS-4, 2015–2016) [1]. In USA too, the figures have risen from 20 to 31.3% (National Vital Statistics, 1989–2011) [2]. National Health Statistics from England has shown an increase from 11 to 15.5% (2006–2007 to 2016–2017), though much less than in USA and India yet showing a rising trend [3]. These growing figures clearly point toward an urgent need to investigate this global upward shift. For this, an internationally accepted, standardized classification system was required to monitor and compare the CS rates in an action-oriented manner both locally and internationally.

After systematic reviews (2011 and 2014), WHO recommended Robson Ten-Group Classification System (TGCS)

as easily interpretable and implementable global standard for assessing, maintaining and comparing CS rates within and between healthcare facilities [4–6].

Till date very little attempt has been made to identify CS rates, the factors behind, trends in developing countries and to evaluate whether this TGCS can help in improving the existing system. The study was done at a tertiary teaching institute of northern India catering to a maximum number of deliveries in National Capital Territory (NCT) of Delhi. Thus, *the trend of this center will be reflective of the national trend and will thus be helpful in formulating a national strategy also*. This study was devised with this background

This paper aims to study the CS rates, its current as well as future trend at the department of Obstetrics and Gynecology at a tertiary teaching institute of northern India by applying Robson TGCS over 3-year duration. The data thus compiled and the information thus analyzed will help to formulate institution specific strategies to control the CS rate.

Materials and methods

This prospective observational study was carried over a period of 3 years from January 1, 2015, to December 31, 2017, at a tertiary teaching institute. The total number of births (both vaginal and Cesarean) and Cesarean deliveries were assessed. Relevant information pertaining to Obstetric history (e.g., parity, mode of previous delivery, previous Cesarean section, its indication, spontaneous or induced labor and gestational age) was collected. At our center, we have been using established methods of induction of labor as per our institutional protocol which include medical (prostaglandin E2, oxytocin) and surgical (artificial rupture of membranes) methods.

Distribution of all Cesarean deliveries was then classified as per Robson TGCS as follows [5].

GROUP-1-Nulliparous, singleton, cephalic, term, spontaneous labor

GROUP-2-Nulliparous, singleton, cephalic, term, induced labor or CS before labor

GROUP-3-Multiparous, singleton, cephalic, term, without a previous CS, spontaneous labor

GROUP-4-Multiparous, singleton, cephalic, term, without a previous CS, induced labor or by CS before labor

GROUP-5-Multiparous, singleton, cephalic, term with a previous CS

GROUP-6-Nulliparous, singleton, breech

GROUP-7-Multiparous, singleton, breech

GROUP-8-Multiple pregnancy (twins or higher-order multiples)

GROUP-9-Singleton, transverse or oblique lie

GROUP-10-Singleton, cephalic, preterm

The CS rate was calculated as percentage of total deliveries and contribution of each group to overall CS rate. The trend of CS rate (overall and group-wise) over these 3 years was studied. *Trend Analysis* of current tendencies and prediction of future trend was done by “least square method”. With trend analysis, annual change in Cesarean rate was also calculated. The data were entered in MS Excel sheet and statistical analysis was done.

Results

There were total 81,784 deliveries (62,336 vaginal deliveries and 19,448 Cesarean deliveries) during study duration (Table 1). Year-wise CS rate was 22.4%, 23.5% and 25.5% from 2015 to 2017, respectively (Table 1).

The total deliveries have increased from 2015 to 2017 (Table 1). In totality over 3 years, group 5 had the maximum number of subjects (5711/19,448) and contributed 29.4% to overall CS rate and 6.98% to all deliveries (5711/81,874). From 2015 to 2017, group 5 contributed maximum, i.e., 31.8%, 27.6% and 28.8% to overall CS rate with 7.1%, 6.5% and 7.2% to all deliveries, respectively.

Of total 5711 women in group 5, 84.4% (4825/5711) had previous one Cesarean. Rest 15.6% (886/5711) who had history of previous classical CS, previous myomectomy (with opening of uterine cavity), uterus-rupture repair, previous-2 CS and previous-3 CS, history of previous preterm CS or hysterotomy were taken for CS as per institutional protocol (Table 2). Of these 4825 group 5 women, 28% (1351) had impending uterine rupture, 30.1% (1452) had non-reassuring feta-heart, 19.2% (926) had cephalopelvic disproportion, 9.9% (478) were not willing for vaginal birth after Cesarean and 12.8% (618) underwent CS for other indications like failed induction. Rupture uterus or scar dehiscence was found in 20% (270/1351) of women taken up for CS with indication of impending uterine rupture indicating need of careful selection in this particular group of women. Thus, the group which can actually be focused upon to curb overall contribution to CS in group 5 were these 84.4% (4825).

On analysis of data, it was seen that we received total 6944 antenatal women with previous scar (which can be classified under group 5). Of these 65.7% (4564/6944) were given TOLAC (trial of labor after Cesarean), 17.6% (1233/6944) has successful VBAC (vaginal birth after Cesarean) while 32.9% (2290/6944) comprised of cases who had indication for a repeat section (e.g., contracted pelvis, cephalopelvic disproportion, failed induction or not giving consent for TOLAC/VBAC).

Group 5 was followed by group 2. Overall, 22.2% contribution was made by this group with 5.2% CS of all deliveries. From 2015 to 2017, year-wise contribution of group 2 to

Table 1 Table showing year-wise and group-wise distribution of total number of Cesarean deliveries according to Robson TGCS, total number of deliveries and year-wise CS rate

Robson group	2015			2016			2017			Total		
	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	788	13.4	3	682	10.6	2.5	895	12.5	3.2	2365	12.2	2.9
2	1298	22.1	5	1443	22.5	5.3	1572	22	5.6	4313	22.2	5.2
3	268	4.6	1.02	370	5.7	1.4	428	5.9	1.5	1066	5.5	1.3
4	468	7.9	1.7	639	9.9	2.3	760	10.6	2.7	1867	9.6	2.3
5	1874	31.8	7.1	1774	27.6	6.5	2063	28.8	7.2	5711	29.4	6.98
6	278	4.7	1.1	325	5.1	1.2	344	4.8	1.2	947	4.9	1.2
7	126	2.1	0.5	197	3.1	0.73	210	2.9	0.7	533	2.7	0.7
8	101	1.7	0.4	145	2.3	0.53	133	1.9	0.5	379	1.8	0.5
9	123	2.1	0.5	138	2.1	0.51	77	1.1	0.3	338	1.7	0.4
10	562	9.5	2.14	696	10.9	2.6	671	9.4	2.4	1929	9.9	2.3
Total CS	5886	100	22.4	6409	100	23.5	7153	100	25.3	19,448	100	23.7
Total vaginal deliveries	20,327			20,850			21,159			62,336		
Total deliveries	26,213			27,259			28,312			81,784 ^a		
CS rate (%)	22.4			23.5			25.3			23.7		

Data is expressed in absolute numbers (N) and percentage (%); CS Cesarean section

X=Contribution of each group to total CS (%)= $N/\text{total CS} \times 100$

Y=Contribution of each group to total birth (%)= $N/\text{total deliveries} \times 100$

^a81,874 (total deliveries from 2015 to 2017) = 62,336 (vaginal deliveries) + 19,448 (CS)

Table 2 Table showing distribution of antenatal women in group 5

Group 5 distribution	2015 (N=1874)		2016 (N=1774)		2017 (N=2063)		Total (N=5711)	
	N	%	N	%	N	%	N	%
Previous 1 CS	1601	85.4	1510	85.1	1714	83.1	4825	84.4
Previous classical CS	5	0.3	3	0.2	3	0.14	11	0.2
Previous myomectomy/uterine rupture repair	9	0.5	11	0.6	12	0.6	32	0.6
Previous 2 CS	249	13.3	240	13.5	320	15.5	809	14.2
Previous 3 CS	10	0.53	10	0.56	14	0.67	34	0.6
Total	1874	100	1774	100	2063	100	5711	100
Overall contribution to total CS rate (%)	31.8%		27.6%		28.8%		29.4%	

overall annual CS rate was 22.1%, 22.5% and 22%, respectively, with CS of 5%, 5.3% and 5.6% of all deliveries.

The third contributor was group 1 with overall contribution of 12.2% of all CS and 3.2% (2365/81,874) CS of all deliveries. Year-wise contribution of this group to overall annual CS rate was 13.4%, 10.6% and 12.5%, respectively. Over these 3 years, 3%, 2.5% and 3.2%, respectively, of all deliveries were by CS (Table 1).

Thus groups 5, 2 and 1 had an overall contribution 63.8% to overall CS rate. Rest other groups contributed to 36.2% of overall CS rate.

Of the remaining groups, group 10 made the maximum contribution of 9.9% to the CS deliveries followed by group 4 with 9.6% (1066/19,448) to the CS. Similarly, over year 2015–2017, group 10 contribution to overall CS was 9.5%,

10.9% and 9.4%, respectively, and that of group 4 was 7.9%, 9.9% and 10.6%, respectively.

There was an upward-year-wise CS trend (Fig. 1). Prediction of future trends was not done on the basis of average percentage as there was an increasing tendency over these 3 years. It was done by trend analysis by least square method.

On computing future CS rates by doing the trend analysis based on 3-year data, *it was predicted that CS rate will increase by 0.905% annually over coming 3 years* (Fig. 1; Table 3).

At the same time, future trends in individual groups over next 3 years showed a varied picture. In groups 3, 4, 6, 7 and 8, predicted trend value showed an annual increase by 0.65%, 0.05%, 0.05%, 0.05% and 0.10%, respectively, while

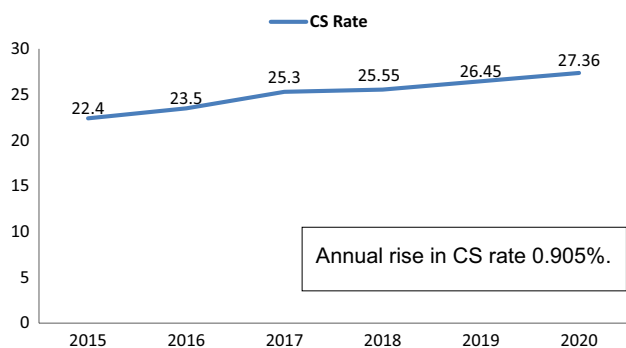


Fig. 1 Figure showing current CS rate and future trend of CS rate. An annual rise of 0.905% in CS rate has been predicted over next 3 years (2018–2020)

predicted trend value in group 1,2,5,9 and 10 showed an annual decrease of 0.45%, 0.05%, 1.50%, 0.50% and 0.05%, respectively, over next 3 years (Table 3; Fig. 2).

Discussion

There was an increasing trend of CS rate over last 3 years. Robson TGCS was successfully applied to a large dataset of 81,874 women. It clearly showed the need to focus particularly on women in groups 5, 2 and 1.

Globally, CS rates are increasing but with wide variation from center to center. The year-wise CS rate over last 3 years was 22.4%, 23.5% and 25.5%, respectively. This was much

less than rates obtained from studies from other parts of the country where it came out to be 37.65%, 40% and 25.7%, respectively, by Koteshwara et al. [7], Patel et al. [8] and Katke et al. [9].

The analysis showed an increasing trend (Fig. 2), but the figures were much less than that at other centers of the country. Ours is a tertiary teaching center with a recently added Obstetrics Critical Care Unit (started in 2016). Due to this, the number of referrals of complicated antenatal cases has become too high, explaining these rising figures. According to the NFHS-4(2015–2016), the CS rate of country is 17.2% in comparison with 10.6 according to NFHS-3 (2005–2006) [2]. The CS Rate in National Capital Territory (NCT) of Delhi according to NFHS-4 (2015–2016) has also risen from 12 (according to NFHS-3) to 23.7% [2]. The overall figures of National Capital Territory of Delhi (23.7%) thus matched with our institutional CS rate (23.5% in 2016), as ours is the center catering to the maximum number of antenatal women of NCT of Delhi.

Maximum contribution to CS rate was from the nulliparous group (groups 1 and 2) with 34.2% contribution. Le Ray et al. [10] conducted a study in France in 2015 and found that nulliparous women with cephalic, singleton, fetuses contributed for almost one-third of all CS performed.

It was seen that those who had spontaneous labor had lower CS rate (group 1 and group 3: 2.9% and 1.3%, respectively). Overall groups 1, 2 and 5 contributed to more than half (63.8%) of all CS rate. In other worldwide studies also, these three groups have contributed to majority of CS [11–13].

Table 3 Predicted trend value of Cesarean rate % of Robson groups over future 3 years

Robson group	Trend value (%) ^c $Y = a + bx$	Annual change (%)	2018	2019	2020
1	$12.17 - 0.45x$	- 0.45	11.27	10.82	9.92
2	$22.20 - 0.05x$	- 0.05	22.10	22.05	22.00
3	$5.40 + 0.65x$	+ 0.65	6.7	7.35	8.00
4	$9.47 + 0.05x$	+ 0.05	12.17	13.52	14.87
5	$29.40 - 1.50x$	- 1.50	26.40	24.90	23.40
6	$4.87 + 0.05x$	+ 0.05	4.97	5.02	5.07
7	$2.70 + 0.05x$	+ 0.05	3.50	3.90	4.30
8	$1.97 + 0.10x$	+ 0.10	2.17	2.27	2.37
9	$1.77 - 0.50x$	- 0.50	0.77	0.27	- 0.23
10	$9.93 - 0.05x$	- 0.05	9.83	9.78	9.73
Total	$23.74 + 0.905x$	+ 0.905 ^d	25.55	26.45	27.36

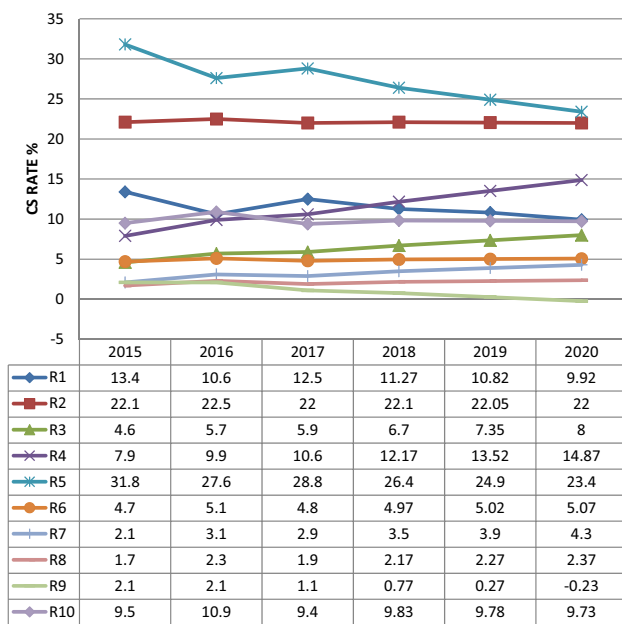
Y =trend value (%), a =origin=average percentage in individual group over 3 years of study, b =slope (annual increase/decrease), x =time lag = 1 (year)

^cTrend (%), i.e., the annual change in CS rate as calculated by least square method. “Negative” sign shows decrease; “Positive” sign shows increase

^dAnnual increase of overall Cesarean rate predicted for future 3 years: 0.905% per year

Annual increase predicted in group 3, 4, 6, 7 and 8 over future 3 years (indicated by positive sign)

Annual decrease predicted in group 1, 2, 5, 9 and 10 over future 3 years (indicated by negative sign)



Groupwise current and predicted future trend of CS rate .

Fig. 2 Figure showing Robson group wise current and predicted future trend of CS rate. It shows an increasing trend in group 3, 4, 6, 7 and 8 while decreasing trend in group 1, 2, 5, 9 and 10

However, in other study, group 4 replaces group 1 [14]. This difference in the contributor population group across different centers clearly exhibits the importance of implementation of Robson TGCS. The results of its application across various centers of the country and across the globe can help the different centers and countries to develop their center-specific strategies and target-specific goals to control the rising Cesarean rate.

Over 2015–2017, year-wise figures showed an upward trend of CS rate at our institution. The analysis based on 3-year data (2015–2017) showed an annual increase in CS rate by 0.905% per year over coming 3 years (2018–2020).

At the same time, future trends in individual Robson groups over next 3 years showed a varied picture. In groups 3, 4, 6, 7 and 8, predicted trend value showed an annual increase by 0.65%, 0.05%, 0.05%, 0.05% and 0.10%, respectively, while predicted trend value in groups 1, 2, 5, 9 and 10 showed an annual decrease of 0.45%, 0.05%, 1.50%, 0.50% and 0.05%, respectively, over next 3 years (Table 3; Fig. 2). The groups 5, 2, 1 and 10 which were the leading causes of CS over last 3 years were predicted to show decrement over coming years. After recognizing these groups as major contributor groups (in this order), appropriate institutional measures have been and will continue to be taken during the ongoing years to control the rising contributory percentage of these groups, which explains this future trend. This

again emphasizes the significance of applying and analyzing Cesarean trends by TGCS system.

Simultaneously, the predicted future trend in groups 3, 4, 6, 7 and 8 showed increasing pattern. The future rise in groups 3 and 4 is especially a matter of concern. It is thus recommended that proper selection of CS cases in these groups can control the predicted rise in these groups. The rise in groups 6 and 7 can also be handled by appropriate selection of cases for conducting breech delivery. But as far as group 8 is concerned, the number is likely to soar, with the increasing conception by artificial reproductive techniques (ART). There is always a lower inclination for a convenient delivery option (both for patient and obstetrician) in these cases.

Therefore, there is a need to focus on three population groups in our population. First is nulliparous group. Unsuccessful/failed “induction of labor” plays a major role in increasing CS rate. There must be a clear cut evidence-based indication for induction as well as for elective CS. All centers must have critical review and appraisal of induction protocols from time to time [15]. If we focus on cutting down the number of primary CS, it would automatically result in lowering a repeat Cesarean delivery rate (i.e., group 5) which contributed maximum to the overall CS rate in our population with 29.4% contribution to the total CS and 6.98% of total births. Similar results with group 5 as main contributor group were seen by Roberge et al. [16] with 35% contribution of overall 22.9% CS rate and Tanaka et al. [17] with 10.9% of overall 23.5% CS rate. But in small maternity homes, group 1 was the main contributor group with 37.62% contribution followed by group 5 with 17.06% contribution [18]. This difference can be explained as ours being a referral tertiary center, receives all complicated cases which include array of antenatal cases with high-risk medical conditions like, NYHA Grade 4 heart disease in pregnancy, acute respiratory distress syndrome (ARDS), sepsis, severe acidosis, previous scar on uterus, etc., which can be confounding reasons for high number in group 5. This also highlights that small maternity homes and hospitals should focus on making policies to decrease the primary CS rate. This will automatically cut down the number of CS rate in group 5. Therefore, the key issue in group 1 is decreasing the incidence of dystocia by achieving efficient and adequate uterine contractions and in group 2 is limiting the number of unjustified inductions and pre-labor CS.

On further analyzing group 5 (Table 3), 84.4% were found to have previous-one CS. Thus, promoting and offering vaginal birth after Cesarean (VBACs) and judicious fetal heart monitoring in large figure of 84.4% is definitely going to work to some extent in controlling CS in this group [19]. As only 20% of women taken for CS for impending rupture actually had uterine rupture or scar dehiscence, it calls for careful selection of women with previous CS being taken up

for this indication. This can be done by use of electronic fetal monitoring to pick up fetal heart changes along with clinical signs to avoid over-diagnosis leading to injudicious CS.

In yet another study by Wang et al. in Chinese population, though the CS rate has decreased from 66.9 to 44.7%, it was still higher compared to our rate. In contrast to our population, they found nulligravida with singleton term cephalic pregnancy (group 1), multiparous with previous CS (group 5) and preterm CS (group 10) as key population to focus upon [20]. The difference in the results once again highlights the utility of application of TGCS system across different health systems across different communities with common aim to achieve reduction in overall CS rates globally.

The most common indications for primary Cesarean delivery include labor dystocia, abnormal FHR, malpresentations, multiple gestation and suspected fetal macrosomia [21]. As suggested by ACOG and SMFM (American College of Obstetricians and Gynecologists and Society Of Maternal and Fetal Medicine), it is high time to revisit the definition of labor dystocia. Moreover, improved fetal heart rate (FHR) interpretation and management must be stressed upon. External Cephalic Version (ECV) for breech presentation and trial of labor for females with twin gestation with first in cephalic presentation can also contribute to safe lowering of primary CS. All these steps can help in controlling the CS rate contributed by minor contribution groups. If CS rates in individuals are controlled, it will reflect in lowering of overall rates.

To bring about a modification in the local obstetricians' attitude in decreasing CS rates, remains a big challenge. However, some studies have shown that using systemic interventions across different communities and indication can help. A review in 2007 by Chaillet et al. found that CS rate decreased by 13% when audit and feedback were used; however, it reduced by 27% when these audit and feedback were used along with interventions like second opinion and culture change.

The environment, where obstetricians practice, is mostly vulnerable to medico-legal strains and stresses. Thus "tort reforms" seem to be important part of such culture change. Malpractice insurance has promoted the practice of "defensive medicine" on healthy women with normal pregnancies thus increased CS rates [22, 23]. With the growing violence incidences against doctors from all over the country [24] and fear of litigations, the boldness of obstetricians' practice is definitely affected and they are in a way bound to interfere too soon especially in cases of previous Cesarean section. American College of Obstetricians and Gynecologists Survey on professional liability done in 2012–2014 reflects a negative liability environment. It was observed that 50% of obstetricians made one or more changes to their practice as a result of the risk of fear of professional liability claims or litigation. It was

seen that 17% reported increase in Cesarean deliveries while 13.4% stopped performing or offering VBACs as a result of risk of fear or professional liability claims or litigations [25]. Thus, it is the need of the hour to give a fearless working environment to the practicing obstetricians so that their bold decision making approach is not afflicted.

Our data should encourage other obstetric units for impeccable adoption and implementation of this simple classification into the routine perinatal data-collection system. This can then provide a significant means of comparison between different obstetrics units. Moreover, identification of the group with maximum contribution can help in focusing on that particular group. There was an increasing trend of Cesarean rate, with average increase of 0.905 per year, if this trend continues. Though decreasing the number of deliveries at our tertiary referral center is beyond control, attention can be focused on main contributor population and so that center-specific protocols to curb the number of primary CS can be formulated. Training residents for conducting operative vaginal delivery, assisted breech delivery and procedures like External Cephalic Version will definitely help. Precision in deciding about selection of subjects and indications for induction of labor should be stressed upon. New recommendations and guidelines regarding definition of the labor must be incorporated in our current practice. The government authorities should look forward to give doctors a fearless environment and safety against violence in case of untoward happenings.

Strengths

The biggest strength of this study is the robust sample size. Most studies done till date have been in smaller facilities where delivery rates are lower. This data along with other studies at national level can help in formulating strategies and policies to decrease the rapidly rocketing CS rates in our country.

Although this was an observational study, but being prospective, during the course of the study period, it was seen that regular auditing of the CS by senior faculty led to a modest decrease in CS rates in some groups.

Limitations of the Study

This was a single-center study at a tertiary teaching institute with Obstetric Critical Care Unit and High Dependency Unit availability. This center caters the high risk and complicated antenatal population referred from other centers. Thus, there was a referral bias reflecting in the results.

Conclusion

Robson TGCS has been successfully applied to our dataset of population over last 3 years and showed an increasing trend of Cesarean rate with annual growth rate of 0.905%. The predicted future trends in various Robson groups emphasized to work upon specific groups to control the predicted rise. Main contributing obstetric population was identified which enabled us to plan appropriate actions. Decreasing primary CS deliveries will automatically decrease the population of previous CS, which is the chief contributor. It is further suggested that residents must be well trained in procedures like operative vaginal delivery, External Cephalic Version and Assisted breech delivery. Providing a fearless working environment to the obstetricians can help in bold decision making thereby curbing the overall CS rates. Robson TGCS can be easily implemented and applied across all the centers in the country and globe to enable the inter-units, inter-state, inter-facility and inter-country comparisons. This will enable to identify the starting point and help in developing population oriented goals and protocols to decrease the overall rates.

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Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Permission The data were gathered from the individual case sheets of the antenatal females delivering at the institute. The institutional review body approved the study.

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