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Original Article

Construction of a prediction model and a prevention control system for cesarean section rate based on the Robson classification system

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Abstract: Objective: To systematically explore the risk factors that influence cesarean section rate, and establish a prediction model to investigate a system effectively reducing cesarean section rates. Methods: This retrospective study was carried out in the medical institutions in Xingtai city, where cesarean section could be conducted. The data of parturients who gave birth to children in the past five years were collected using the hospital information system. Based on the Robson's ten group classification system, parturients were grouped. The difference of cesarean section rate in each group and its main influencing factors were then analyzed. The above factors and factors such as age, education background, and knowledge on childbirth were independent variables, while cesarean section was the dependent variable. A logistic regression model was constructed to determine the correlation between relevant influencing factors and cesarean section. Results: In the past 5 years, cesarean section rate in Xingtai city had been maintained at a relatively high level. Cesarean section rates in the R2 and R5 groups were the highest. Parity, fetal position, number of fetuses, and gestational weeks were all factors affecting cesarean section rate (all $P < 0.01$). After screening the above factors using logistic regression analysis, a regression equation was established: logistic (p) = -1.061 + 1.107 * parity + 0.196 * fetal position + 2.245 * number of fetuses - 0.070 * gestational week + 0.234 * age - 0.278 * education background + 0.623 * knowledge on childbirth. Conclusion: The Robson classification system plays an important role in evaluating and supervising parturients' conditions. Based on the Robson classification system, we find that parity, fetal position, number of fetuses, and gestational weeks are the main factors influencing cesarean section rate. Using logistic regression analysis, a prediction model, with guiding significance on the control of cesarean section rate, is established.

Keywords: Robson, cesarean section rate, influencing factors, model prediction

Introduction

Cesarean section rate is an essential evaluation indicator of obstetric services in countries, regions, and institutions. As an important intervention measure, cesarean section is used to prevent parturients and newborns from the threat of complications related to pregnancy and childbirth [1]. On Oct. 13, 2018, the International Federation of Gynecology and Obstetrics (FIGO) held in Brazil announced that the global cesarean section rate in 2015 had doubled when compared with that in 2000 [2]. To a certain extent, cesarean section can save the lives of mothers and babies. However, improper and excessive application of cesarean section may have a certain negative impact on the long-term health of mothers and babies [3, 4]. In other words, the increased cesarean section rate is a severe worldwide challenge [5]. In China, cesarean section rate in the city is more than 40%. What's worse, it is over 80% in some regions, which is far beyond the rate recommended by the World Health Organization (WHO) [6, 7]. In the Robson classification system, parturients are divided into 10 groups according to parity, fetal position, gestational week, number of fetuses, initiation of labor, and so on. The system has been unanimously promoted globally by clinical workers. In addition, the WHO and FIGO have recommended it as a global standard for the assessment, supervision, and comparison of cesarean section rate in medical institutions [5, 8]. In recent years,

Table 1. Robson's ten group classification system

Robson group	Characteristics
R1	primiparous, single birth, head position, gestational week ≥ 37 weeks, natural childbirth
R2	R2a: primiparous, single birth, head position, gestational week ≥ 37 weeks, induced labor
	R2b: primiparous, single birth, head position, gestational week ≥ 37 weeks, cesarean section before delivery
R3	perinatal, no history of cesarean section, single birth, head position, gestational week ≥ 37 weeks, natural childbirth
R4	R4a: perinatal, no history of cesarean section, single birth, head position, gestational week ≥ 37 weeks, induced labor
	R4b: perinatal, no history of cesarean section, single birth, head position, gestational week ≥ 37 weeks, cesarean section before delivery
R5	R5a: perinatal, once cesarean section, single birth, head position, gestational week ≥ 37 weeks
	R5b: perinatal, more than twice cesarean section, single birth, head position, gestational week ≥ 37 weeks
R6	primiparous, single birth, breech position
R7	perinatal, single birth, breech position, including parturients with history of cesarean section
R8	multiple births, including parturients with history of cesarean section
R9	single birth, oblique or horizontal position, including parturients with history of cesarean section
R10	single birth, gestational week < 37 weeks, including parturients with history of cesarean section

the cesarean section rate in Xingtai city has remained high. However, it has not been fully explored by researchers. In order to clarify the main factors contributing to the increased cesarean section rate in Xingtai city, we cooperated with related medical institutions, collected related data, and applied the Robson's ten group classification system to analyze the cesarean section rates.

Materials and methods

Research subjects

Maternity and child health care hospitals and general hospitals in Xingtai city, where cesarean section could be performed, were our targeted hospitals for data retrieval. With the hospital information system (HIS), detailed information (like reproductive history and delivery method) of parturients who gave birth to children from January 2015 to December 2019 were collected. Among them, parturients with fetal death, stillbirth, and malformed fetuses were excluded. Incomplete information was supplemented with a "by hand" search. In total, 57,368 parturients were recruited in this study. The study has been reviewed and approved by the Medical Ethics Committee of the Xingtai People's Hospital.

Methods

We cleared the collection of parturient information. Here, we mainly explored the characteristics regarding 5 aspects, including delivery method, parity, fetal position, number of fetuses, and gestational weeks. The information collection personnel were trained, and data were respectively extracted and recorded into the Excel table by 2 personnel. Thereafter, these data were checked to make sure that the data were consistent. According to the original and improved Robson's ten group classification system and above 5 characteristics, parturients were allocated into 10 groups (**Table 1**) [9-12]. The composition ratio of parturients in each group, cesarean section rate in each group, and its ratio to that in the whole group were calculated. Cesarean section rate in each group refers to the number of parturients who underwent cesarean section in each group compared to the total number of parturients in the group. Ratio of total cesarean section rate is the number of parturients who underwent cesarean section in each group compared to the total number of parturients who underwent cesarean sections. In the end, the main factor that influences cesarean section rate was clarified.

Statistical methods

All data were analyzed using SPSS statistical software version 23.0. The enumeration data

Table 2. Overview of cesarean section in Xingtai city from 2015 to 2019

Year	Total number of parturients	Parturients received cesarean section	Parturients received vaginal delivery	Cesarean section rate (%)
2015	9929	4044	5885	40.73
2016	10574	4489	6085	42.45
2017	11802	5221	6581	44.24
2018	12737	5845	6892	45.89
2019	12326	5436	6890	44.10
χ^2				69.262
P				0.000

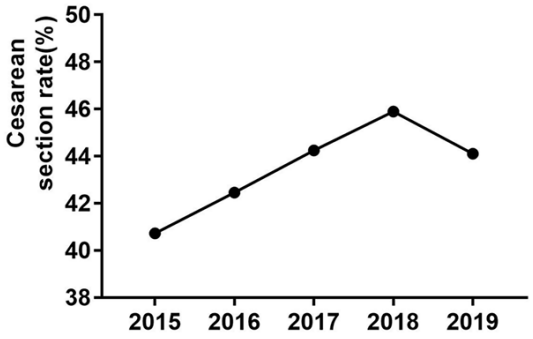

Figure 1. Overall overview of cesarean section in Xingtai City from 2015 to 2019.

(including composition ratio of parturients and cesarean section rate were expressed as percentage (%); comparison was conducted with chi-square test. What's more, logistic regression was used to analyze the main influencing factors of cesarean section rate. The difference was statistically significant when *P* value was less than 0.05.

Results

Overview of cesarean section in Xingtai city from 2015 to 2019

The number of parturients in Xingtai city has been increasing since 2015. It reached a peak in 2018, while being maintained at a relatively stable level in 2019. In the past 5 years, cesarean section rate in Xingtai city had been growing continuously. Cesarean section rate from 2015 to 2018 has increased each. Compared with that in 2018, cesarean section rate in 2019 displayed a slight downward trend. However, the overall cesarean section rate was still over 40%. Details are shown in **Table 2** and **Figure 1**.

Total cesarean section rate in each group during the past 5 years

In the past five years, total cesarean section rate in Xingtai city was still at a high level (43.64%). The composition ratios of parturients in R1, R2 (R2a and R2b), and R5 (R5a and R5b) groups were above 50%. Among them, the ratio of parturients in the R1 and R2 group reached 64.28%, where primiparas were still the main parturients. Based on Robson's ten group classification system, we found that cesarean section rates in R2b, R4b, R5a, R5b, R6, R8 and R9 group were all above 90%. In addition, fetal position, parity, and number of fetuses were the main factors affecting cesarean section rate. Moreover, cesarean section rate in the past five years in group R10 was close to that in the R1, R2, R5, and R6 groups. Total cesarean section rate of group R10 was 2.06%, suggesting that the number of gestational weeks has a certain influence on cesarean section rate. Details are displayed in **Table 3** and **Figure 2**.

Composition ratio and cesarean section rate between 2015 and 2019

Cesarean section rate in most groups such as R1, R3, R4b, R5b, R6, R7, R8, R9, and R10 group in the past 5 years remained basically the same, while it changed significantly in the R2a, R2b, R4a, and R5a groups (all $P < 0.01$). The change curve of cesarean section rate in each group in the past five years showed that cesarean section rate in most groups fluctuated significantly in 2016 and 2017. The change of cesarean section rate in each group in 2019 was not significant when compared with that in 2018. Details are shown in **Table 4** and **Figure 3**.

Table 3. Cesarean section rate in each group during the past 5 years

Group	Number of parturients	Composition ratio of parturient (%)	Parturients received cesarean section	Cesarean section rate in each group (%)	Total cesarean section rate (%)
R1	9835	17.14	1543	15.69	2.69
R2a	17702	30.86	3699	20.90	6.45
R2b	9340	16.28	9167	98.15	15.98
R3	4694	8.18	72	1.53	0.13
R4a	3147	5.49	179	5.69	0.31
R4b	341	0.59	328	96.19	0.57
R5a	5043	8.79	4624	91.69	8.06
R5b	679	1.18	661	97.35	1.15
R6	1855	3.23	1736	93.58	3.03
R7	1044	1.82	903	86.49	1.57
R8	960	1.67	871	90.73	1.52
R9	69	0.12	68	98.55	0.12
R10	2659	4.63	1184	44.53	2.06
Total	57368		25035		43.64

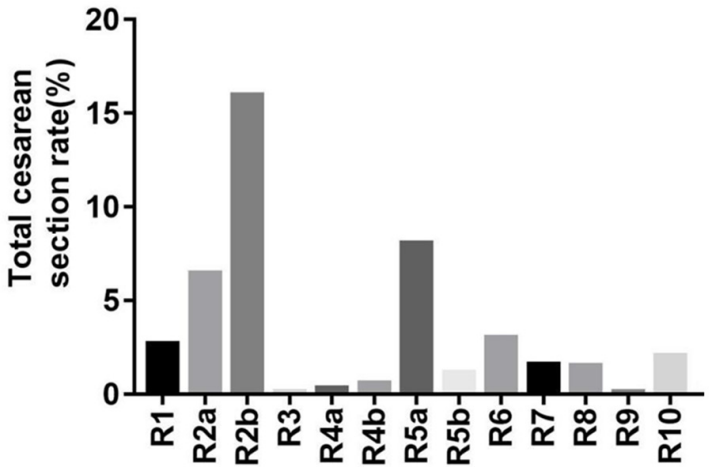

Figure 2. Robson classification system results of ten groups of total cesarean section rate.

Logistic regression analysis of factors related to cesarean section rate

According to the Robson classification system, cesarean section rate may be correlated with factors like parity, fetal position, number of fetuses, and gestational weeks. What's more, age, education background, and knowledge on childbirth are also factors influencing cesarean section rate [13]. In our study, a logistics regression analysis was performed with the above factors as independent variables of the multifactor analysis and cesarean section as the dependent variable. Results displayed that parity, fetal position, number of fetuses, gestational weeks, age, education background, and knowledge on childbirth were all related to cesarean section rate (all $P < 0.01$). Among them, parity, number of fetuses, non-cephalic delivery, and the increase of maternal age were factors increasing the incidence of cesarean section. Meanwhile, the increase of gestational weeks, improvement of education background, and enrichment of knowledge on childbirth were protective factors of cesarean section. Accuracy of the prediction model of parturients' cesarean section rate was 84.40%, with a logistic regression equation described below: W = -1.061 + 1.107 * parity + 0.196 * fetal position + 2.245 * number of fetuses - 0.070 * gestational weeks + 0.234 * age - 0.278 * education background + 0.623 * knowledge on childbirth (parity: primiparous 0, perinatal 1; fetal position: head position = 0, non-head position = 1; number of fetuses: single birth = 0, multiple births = 1; gestational week: ≥ 37 weeks = 0, < 37 weeks = 1; age: < 25 years old = 1, 25 to 30 years old = 2, 31 to 35 years old = 3, > 35 years old = 4; education background: high school and below = 0, junior college and undergraduate = 1, graduate and above = 2; knowledge on childbirth: learned knowledge on childbirth before childbirth = 0, not learned knowledge on childbirth before childbirth = 1). Details are shown in **Table 5**.

Table 4. Composition ratio and cesarean section rate between 2015 and 2019

Robson group	2015		2016		2017		2018		2019		χ^2	P
	Cesarean section cases/ total cases in the group	Cesarean section rate in the group (%)	Cesarean section cases/ total cases in the group	Cesarean section rate in the group (%)	Cesarean section cases/ total cases in the group	Cesarean section rate in the group (%)	Cesarean section cases/ total cases in the group	Cesarean section rate in the group (%)	Cesarean section cases/ total cases in the group	Cesarean section rate in the group (%)		
R1	210/1455	14.43	294/1829	16.07	349/2275	15.34	341/2063	16.53	349/2213	15.77	3.262	0.515
R2a	685/3375	20.30	603/3038	19.85	805/3367	23.91	715/3883	18.41	891/4039	22.06	39.023	0.000
R2b	1518/1519	99.93	1641/1673	98.09	1900/1930	98.45	2298/2386	96.31	1810/1832	98.80	88.426	0.000
R3	12/984	1.22	15/1057	1.42	14/937	1.49	17/906	1.88	14/810	1.73	1.652	0.799
R4a	22/528	4.17	26/676	3.85	39/752	5.19	49/536	9.14	43/655	6.56	19.764	0.001
R4b	51/52	98.08	68/70	97.14	64/68	94.12	72/74	97.30	73/77	94.81	1.957	0.777
R5a	637/730	87.26	889/948	93.78	984/1062	92.66	1062/1152	92.19	1052/1151	91.40	26.021	0.000
R5b	82/88	93.18	115/116	99.14	136/138	98.55	187/194	96.39	141/143	98.60	7.937	0.071
R6	310/336	92.26	343/364	94.23	329/347	94.81	366/390	93.85	388/418	92.82	2.552	0.635
R7	122/137	89.05	129/141	91.49	184/214	85.98	245/296	82.77	223/256	87.11	7.423	0.115
R8	151/165	91.52	164/178	92.13	168/188	89.36	199/225	88.44	189/204	92.65	3.246	0.518
R9	14/14	100.00	11/11	100.00	14/15	93.33	15/15	100.00	14/14	100.00	3.837	1.000
R10	230/546	42.12	191/473	40.38	235/509	46.17	279/617	45.22	249/514	48.44	8.435	0.077

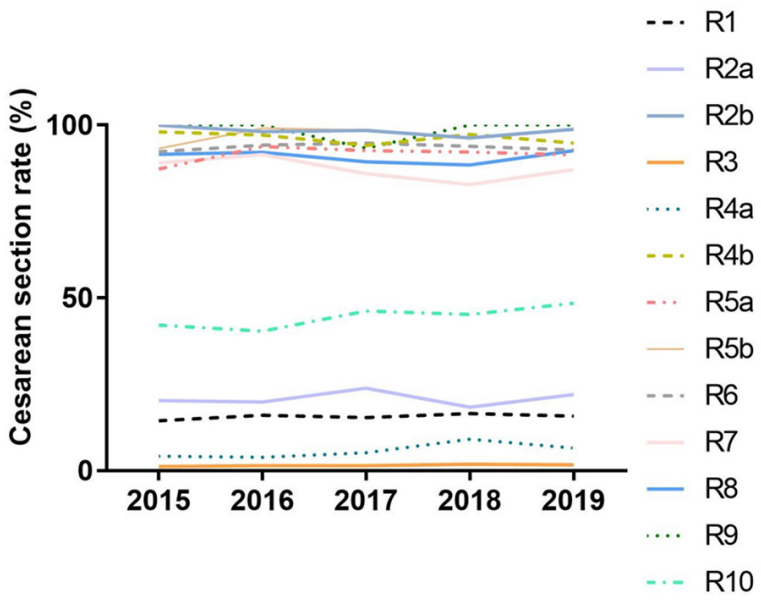

Figure 3. Variation trend of cesarean section rate in Robson sub-groups from 2015 to 2019.

Discussion

Cesarean section rate had been increasing from 2000 to 2015. The global cesarean section rate in 2015 has doubled when compared with that in 2000 [2, 14]. At present, however, there is no clear evidence showing that cesarean section could reduce the incidence and mortality of parturients and newborns [15]. For low-risk parturients, cesarean section may even pose a greater threat when compared with vaginal delivery. Therefore, the impact of cesarean section on parturients and newborns has attracted more and more researchers' attention. Recently, researchers have been focused on the reduction of cesarean section rate [16, 17].

In this retrospective study, cesarean section rate in Xingtai city was calculated in accordance with the Robson classification system. From an overall view, the number of parturients has been growing in the three years after 2015, which might be related to the full implementation of the two-childbirth policy in China. After 2015, both the number of parturients and cesarean section rate in R5 (R5a and R5b) group had been rising, which were consistent with the results reported previously [18, 19]. In recent years, more and more clinicians have realized the benefits of natural childbirth for both parturients and newborns. Accordingly, education and propaganda of natural childbirth has been strengthened [20]. In our study, the total number of primiparas in the R1 and R2 (R2a and R2b) groups has been increasing continuously between 2015 and 2019. Cesarean section rate in 2019 had slightly decreased when compared with that in 2015 (37.73% vs. 38.01%). These were consistent with results reported by Wu et al. and Xu et al. [21, 22].

If parturients have prenatal diseases like pregnancy-induced hypertension and diabetes and conditions including macrosomia and umbilical cord around the neck, they will have to receive cesarean section [23]. According to the Robson's ten group classification system, the number of cesarean section in the R1, R2, and R5 groups in the past 5 years had reached 78.67% of the total number of cesarean sections in the 10 groups. Therefore, parturients in these three groups were the main target populations with strategies formulated to reduce cesarean section rate in the future. In the R2 group, the number of parturients in the R2b subgroup was decreased when compared with that in the R2a subgroup, while cesarean section rate had significantly increased. The number of cesarean section in the R5 (R5a + R5b) group was large, and cesarean section rate in this group had reached over 90%. This was basically consistent with the results reported by Wu et al. [20]. In our study, the cesarean section rate in perinatals, who had a scarred uterus, was higher than that in primiparous. Additionally, the rate was much higher than that in 2012 (65.6%) and in 2014 (80.6%) in Lithuania [24]. Therefore, we can make more efforts to publicize, promote and encourage vaginal birth after caesarean section (VBAC). It has been confirmed that the incidence of short-term and long-term complications in parturients undergoing VBAC has declined [25]. For most parturients having no absolute contraindications to VABC and receiving prenatal evaluation and testing, their VBAC are successful. At the same time, the incidence of uterine rupture is effectively decreased.

Table 5. Logistic regression analysis of factors related to cesarean section rate

Independent variables	β	Standard error	Wald χ^2	*P* value	OR value	95% CI
Parity	1.107	0.055	405.575	0.000	3.026	2.717~3.370
Fetal position	0.196	0.020	95.989	0.000	1.217	1.170~1.266
Number of fetuses	2.245	0.063	1270.282	0.000	9.445	8.348~10.686
Gestational week	-0.070	0.047	92.819	0.000	1.762	1.563~1.871
Age	0.234	0.008	841.397	0.000	1.263	1.243~1.283
Education background	-0.278	0.011	636.698	0.000	0.757	0.741~0.774
Knowledge on childbirth	0.623	0.018	1204.421	0.000	1.865	1.800~1.931
Constant	-1.061	0.027	155.434	0.000	0.346	

Note: OR: odds ratio; CI: confidence interval.

Through logistics regression analysis, we found that parity, fetal position, number of fetuses, and gestational weeks were the main factors influencing the implementation of cesarean section. In addition, age, education background, and knowledge on childbirth were also important factors affecting cesarean section rate [26]. As a result, the above factors should be fully considered in the evaluation before delivery. Parturients are provided with correct and professional guidance. For parturients eligible for vaginal birth, they are supposed to be guided correctly. Moreover, perinatals are actively encouraged to receive vaginal birth. In this way, the incidence of complications in parturients and newborns is prevented as much as possible. Furthermore, the total cesarean section rate in the society is reduced.

However, this study also has certain limitations. Firstly, the data of parturients in rural and urban areas are not classified. Secondly, the follow-up data concerning postpartum complications in parturients and newborns in different groups are incomplete. These are the focuses of our subsequent research, as they might play an active role in the formulation of related strategies.

In summary, the data of parturients are standardized using the Robson classification system. We can thus compare these data and clarify the most important factors influencing cesarean section rate. Hence, we can provide guidance for clinicians to develop scientific and effective strategies to decrease cesarean section rate. In the future, on the basis of our results, we will carry out relevant measures regarding the important factors that affect cesarean section rate.

Disclosure of conflict of interest

None.

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