TITLE: The Project Appropriate Birth and Reduction of Cesarean Section Rates: an analysis using the Robson classification system

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ABSTRACT

INTRODUCTION: C-section rates have been gradually increasing in both developed and developing countries, and the reasons are controversial issues. C-sections performed without medical indication may cause unnecessary risks for both the woman and her child, leading to immediate and long-term complications. In Brazil, the Project Appropriate Birth was developed to identify innovative and viable care models for labor and childbirth that value normal birth and reduce C-section rates.

OBJECTIVE: The objective of this study was to evaluate C-section rates, before and after the implementation of the Project Appropriate Birth based on the Robson 10-group classification system.

DESIGN: An observational, cross-sectional study.

SETTING: Maternity hospital in South Brazil.

POPULATION: All pregnant women attending, April 2016 through April 2017 (phase 1, pre-implementation of the Project Appropriate Birth) and June 2017 through June 2018 (phase 2, post-implementation of the Project Appropriate Birth).

METHODS: Maternal and obstetric characteristics were evaluated, including Robson's classification, based on the characteristics of pregnancy and childbirth. Chi-square test and crude and adjusted prevalence ratios were used to analyze study variables. The significance level was set at 5%.

MAIN OUTCOME MEASURES: C-section rate for each group, their contribution to the overall c-section rate and the differences in these contributions before and after PPA implementation.

RESULTS: C-section rates decreased from 62.4% to 55.6%, which represented a 10.9% reduction after the implementation of the Project Appropriate Birth. Pregnant women in Robson classification groups 1 through 4 had the greatest decrease in C-section rates, ranging from 49.1% to 38.6%, which represents a 21.5% reduction. The greatest contributors to the overall C-section rates were group 5 and group 2, accounting for more than 60% of the C-section deliveries.

CONCLUSION: The Project Appropriate Birth had an important impact on the reduction of C-section rates, especially in Robson classification groups 1 through 4, which indicates that providing mothers with evidence-based

interventions for labor and childbirth assistance will contribute to reduce C-section rates.

KEY WORDS: cesarean section; health plans and programs; Robson classification.

INTRODUCTION

Quality health care during delivery and childbirth is vital to reduce maternal and neonatal morbidity and mortality. An important global indicator for quality of maternal and newborn care assessment is the rate of C-section deliveries[1–3]. The World Health Organization (WHO)[4,5] states that C-section rates above 10-15% are not associated with reductions in maternal and neonatal mortality rates [6–8]. C-sections should only be done out of medical necessity and not to reach a specific rate. C-section is a surgery to prevent maternal risks or treat perinatal complications, and the appropriate rate must be associated with the lowest possible maternal mortality rate and perinatal morbidity and mortality [9].

In 2015, about 29.7 million children (21.1% of the 140.6 million live births) have been birthed by C-section, which corresponds to a 12% increase in relation to live births in 2000 [10]. Brazil ranks second in C-section rates worldwide, which represents 55.6% of live births [10,11]. In both developed and developing countries, C-section rates have been gradually increasing, and the reasons are controversial issues. It is believed that the increase is largely driven by C-section without medical indication [1,2,12]. According to the international literature, the most common reasons for C-sections are based on social, demographic, cultural, and economic factors [6,13–15].

Systematic reviews have evaluated different cesarean classifications, and the Robson 10-group classification system as proposed by Robson in 2001 was considered the most appropriate to compare the rates of C-section surgery [1,16]. This system helps monitor and audit institutions and provides a

standardized method of comparison between institutions, countries and time points [16–18], and is endorsed by WHO [5].

With the support of the Brazilian Ministry of Health, the National Supplementary Health Agency (ANS, in the Portuguese acronym), the Albert Einstein Israelite Hospital, and the Institute for Healthcare Improvement (IHI) developed the Project Appropriate Birth (PPA, in the Portuguese acronym), aiming to identify innovative and viable care models during labor and childbirth that value normal birth and reduce C-section rates. It is expected that by 2020, all Brazilian women will have access to evidence-based maternity care and as a positive experience [4,19–21].

In view of the scenario showing high C-section rates, this study aims to categorize pregnant women according to the Robson classification system and assess C-section rates before and after the implementation of the Project Appropriate Birth in a maternity hospital in southern Brazil.

METHODS

Study design, Data sources and Participants

This was an observational, cross-sectional study on parturients attending a maternity hospital in southern Brazil (Hospital Nossa Senhora da Conceição – HNSC). Three thousand births on average occur annually in this maternity hospital, which is a reference for high-risk pregnancies for the entire region of southern Santa Catarina State, Brazil. The maternal and child center encompasses an obstetric center, human milk bank, rooming-in space, and neonatal intensive care unit.

The research data were collected April 2016 through June 2018. Period 1 refers to the pre-implementation of the PPA (April 2016 to April 2017) and period 2 refers to the post-implementation of the PPA (June 2017 to June 2018). May 2017 was considered a transition period and, therefore, excluded from the study.

All parturients from the period of interest in the study were included, with no exclusion. In case of twin pregnancy, the mother's data was counted only

once. Research data were collected from the electronic medical records (Tasy®).

The PPA intervention

The aim of the PPA was to promote activities to improve childbirth care in Brazil in order to encourage vaginal delivery [20]. The PPA hypothesis was centered on the possibility that evidence-based changes in the delivery care model, with the participation of maternity care professionals and other stakeholders, would contribute to implement good practices, thus reducing C-section rates and unnecessary obstetric interventions.

In November 2016, hospitals and maternity hospitals across Brazil could apply to participate in the PPA; the selection criteria for the hospitals to participate were the following: volume of deliveries – at least 500 per year; cesarean section rate – preferably equal to or greater than 75% per year; geographic location – hospitals throughout all regions of the country located both in state capitals and in different municipalities. In February 2017, the selection of 153 hospitals was disclosed, including the HNSC in Tubarão, Santa Catarina.

After the implementation of the PPA, the maternity hospital began to make changes and improvements to stick to the project guidelines and objectives, which included the following: scheduling visits to the maternity hospital guided by obstetric nurses; promoting lectures and events related to normal birth for the general population; training course for pregnant women focused on physiological childbirth, encouraging the companion's participation during labor; telling stories about births carried out in the maternity hospital to motivate other women; centralized scheduling of elective C-sections at 39 weeks gestation; developing a model birth plan; standardizing a routine for collecting, organizing and disseminating project data; establishing an organizational learning framework to be commonly used in the obstetric center; developing care protocols; forming a multidisciplinary team in childbirth care with the active participation of obstetric nurses; daily rounds by the maternal and child center staff; providing non-pharmacological methods, labor analgesia

and changing birth positions; placing doulas to support women throughout labor and childbirth; encouraging early skin-to-skin contact and breastfeeding; bathing the newborn only after 24 hours of birth; training of medical and nursing staff; providing pre-delivery, delivery and post-delivery rooms [4].

Variables and Robson Classification System

Sociodemographic characteristics examined in the study included maternal age (<20, 20-34, and> 35 years), race/skin color (white, brown, black, indigenous, yellow), marital status (with or without a partner), education (illiterate, complete or incomplete primary education, complete or incomplete secondary education, complete or incomplete higher education, postgraduate), religion (Catholic, evangelical, no religion, others); obstetric parity (0, 1, ≥2), previous normal delivery (0, 1, ≥2), previous C-section (0, 1, ≥2), type of pregnancy (singleton or multiple), type of delivery (vaginal, forceps or vacuum-extractor, C-section). High-risk pregnancies included the following complications: hypertensive syndromes; hemorrhagic syndrome; active infectious diseases; cardiopathy, pneumopathy, neurological, renal, autoimmune and severe psychiatric disorders; alcoholism, drug addiction; fetal growth restriction and congenital malformations.

Robson Classification System

The Robson classification system includes the following obstetric variables: parity (nulliparous, multiparous with or without a previous uterine scar), onset of delivery (spontaneous, induced or pre-labor C-section), fetal presentation (cephalic, breech or transverse lie), number of fetuses (singleton or multiple), and gestational age (term, preterm). Individual groups are defined by these characteristics in a mutually exclusive and totally inclusive manner, in which all pregnant women are included, and no woman is classified into more than one group. This classification system does not require data on indications for C-section or perinatal results. In this study, all women were classified into one of the 10 groups described by Robson [17]. Groups 2 and 4 were subdivided into a (induced labor) and b (pre-labor C-section), and group 5 was subdivided into 5.1 (one previous C-section) and 5.2 (two or more previous C-sections).

Statistical analysis

The data were entered into Epi Info version 7.2 and Microsoft Excel spreadsheet, and exported to SPSS version 21.0 for analysis. Quantitative variables were described as measures of central tendency and dispersion. Qualitative variables were described in absolute (n) and relative (%) frequency. The main outcome of the study was the rate of C-sections. The characteristics of pregnant women included in the study were reported for each period, along with the proportion of women undergoing C-section. The following was analyzed for each period and Robson classification groups: relative size of the obstetric population (% = n of women in the group / total N women x 100), total C-section rate (% = n of C-sections in the group / total N women in group x 100), the absolute contribution to the total C-section rate (% = n of C-sections in the group / total N women) and the relative contribution to the total C-section rate (Number of C-sections in the group) / (total number of C-section deliveries) x100 [22].

Comparisons of C-section rates before and after the implementation of the Project Appropriate Birth were made by comparing proportions using Pearson's Chi-square test and Z-test following the Bonferroni method. The prevalence ratio (PR) of C-section rates before and after PPA implementation was calculated with 95% confidence intervals (CI) and a 5% significance level. The PRs were adjusted according to the sociodemographic variables, e.g., age, education, race/skin color in Model 1, plus high-risk pregnancy, considering the presence of maternal complications (n = 837; 13%) in Model 2, using Poisson Regression method with a robust error variance.

The percentage change in C-rates, or percentage reduction based on the pre-implementation period, was calculated by using the formula:

$$\left(\frac{Final\,rate - initial\,rate}{Initial\,rate}\right) \times 100$$

Ethical Considerations

This research follows the guidelines and regulatory standards for research involving human beings, proposed by Resolution No. 466/2012 of the

National Health Council of Brazil, and obtained approval from the local Research Ethics Committee (Opinion No. 3,215,923).

RESULTS

In this study, all 6,238 women admitted for delivery were included and classified into one of the Robson classification groups. Of the total, 3,135 were included in the pre-implementation period of the PPA (period 1) and 3,103 in the post-implementation period (period 2). There was a total of 6,379 births, a higher figure than the number of participants, due to 137 twin births and 2 triplet births, which together accounted for 2.2% of total births (Table 1).

The mean maternal age was 28 years old (SD ± 6.41), ranging from 13 to 48 years old (Interquartile range 32.6); 89.9% of the patients were Whites; 52.7% had at least complete secondary education; 86.3% of the patients had a steady partner; 70.8% were Catholic.

Regarding parity, 2,580 (41.4%) parturient women were primipara; 17% of them had at least one previous normal delivery; 22.4% had at least one previous C-section; 16.1% had previous abortions.

Tables 2A and 2B show the distribution of parturient women into the Robson classification groups during the study periods. Both in period 1 and period 2, participants in groups 1 through 4 accounted for around 60%, those in groups 6 through 9 accounted for approximately 5%, and those in group 10 accounted for around 10% in both periods. Group 5 was the largest group in both periods, accounting for around 25% of the parturient women, followed by group 2 with approximately 20% of the total. Robson classification groups 2 and 5 together accounted for 61.9% and 67.6% of C-rates in periods 1 and 2, respectively.

The general C-section rate in this study was 59%, being 62.4% in period 1 and 55.6% in period 2, which represented a 10.9% statistically significant reduction in C-section rates after the implementation of the PPA (Table 3).

The greatest reduction in C-section rates occurred in groups 1 through 4, showing a rate of 49.1% in period 1 and 38.6% in period 2. Therefore, there was a statistically significant reduction of 21.4% ($p < 0.001$) in C-section rates in these groups after the implementation of the project [PR 0.79 (95% CI 0.73-0.85)]. Groups 3 and 4 were the groups with the highest reduction rate, 74.8% ($p < 0.001$). In group 5, there was a decrease in cesarean rates, from 88.7% to 83.7% ($p = 0.005$). Groups 6 through 9 also had a reduction in C-section rates, but it was not statistically significant ($p = 0.082$). Group 10 showed a slight but non-significant increase in C-section rates after the implementation of the PPA.

The different adjustment models used, considering sociodemographic (age, education, race) and clinical (high-risk pregnancy) variables, did not change the crude estimates (Table 4), indicating a reduction in C-section rates in all categories and, separately, for Robson classification groups 1 through 4 and group 5.

The main indications for cesarean section, both in period 1 and period 2, were the same: non-reassuring fetal status, previous cesarean section, induction failure, and breech presentation. C-section indications that presented the greatest reductions with the implantation of the PPA were intrapartum indications, such as cephalopelvic disproportion, induction failure, and dystocia (data not shown).

DISCUSSIONS

Main findings

C-section rates had a significant reduction after the implementation of the PPA, with all Robson classification groups having reduced or kept stable their contributions. Parturient women classified into groups 1 through 4, who were the major target audience of the PPA, showed the greatest reduction in C-section rates.

Group 5 and group 2 had the greatest impact on C-section rates. Together, they accounted for 61.8% of the C-sections in period 1 and 67.6% in period 2.

Strengths and Limitations

This is one of the pioneering studies that have evaluated the results of implementing the PPA in a Brazilian hospital setting. The inclusion of all women admitted for delivery and the collection of data from each woman's medical record was exhaustive, although very important for the reliability of Robson classification system, which is a useful and reproducible tool for monitoring C-section rates.

Our results have some limitations that are intrinsic to the Robson classification system, such as the lack of other epidemiological information [45,53], mainly in relation to women with advanced maternal age (over 35 years old) who are at high risk for preeclampsia, gestational diabetes and, consequently, C-section [54].

Interpretation

C-sections without medical indication cause unnecessary risks to the health of the women and her baby, and have immediate and long-term risks, especially when performed before 39-week gestation [23–26]. These risks can persist for many years after delivery, and may also compromise future pregnancies [2,4,5,13,23,27–29]. Furthermore, as with any surgical intervention, there is a risk of death from the surgery itself or from the health status of each patient [29]. Although it is still a rare event, studies estimate that the risk of death from an emergency intrapartum C-section is up to fourfold greater than vaginal delivery, and the risk of maternal death during birth increases in pregnancies after a previous C-section, due to an increased risk for uterine rupture and placental implantation abnormalities [30–33].

Brazil has one of the highest C-section rates in the world (55.6%) together with the Dominican Republic (59.6%), China (52.5%), Cyprus (52.2%), and Egypt (51.7%) [10,34–36]. C-section rates have increased substantially over the years, without an understanding of their determinants and future consequences [1,10,37]. The main rationale behind this fact is that social, demographic, cultural, and economic factors are associated with the maternal request for the type of

delivery. In addition, pregnant women believe that C-section is an almost risk-free procedure, which contributes to the increase in the number of C-sections [6,10,13,14,38,39].

Healthcare providers are particularly important to help mother's decisions about birthing methods [40,41]. A systematic review showed that obstetricians were directly involved in the decision to perform a C-section and are a determinant factor for the overall C-section rates in any country [42].

Although there is almost a universal consensus that C-section use has increased beyond the reasonable level of need in many countries, effective interventions to optimize use have proven elusive [39,43]. The PPA is based on strategies that prioritize positive human relationships, address beliefs about childbirth and quality care, promote respectful and collaborative multidisciplinary teamwork, thus being an effective tool for increasing the physiological labor process and safe childbirth. The implementation of evidence-based guidelines, using a standard classification system, likewise, is paramount to improve care and allow for comparisons between healthcare services in different settings [4,39].

The results of this study have shown a significant reduction in the overall C-section rates after the implementation of the PPA, especially among women classified into Robson classification groups 1 through 4 (single, full-term, cephalic pregnancy, without a previous uterine scar, differentiating each other only for parity and labor onset). These women are the main focus of the PPA and also of the "Safe prevention of the primary cesarean delivery" movement of the American College of Obstetricians and Gynaecologists (ACOG)[27,44]. The greatest decline in C-section rates occurred among women in group 1 and group 3, but women in group 2a and those in groups 4a and 4b also had a reduction in their C-section rates.

The groups with the greatest impact on C-section rates were group 5 and group 2. They accounted for the highest C-section rates in both period 1 and period 2, as well as in a Brazilian nationally-based study and studies in countries such as France, Canada, and the United States [36,45–47]. Given that C-section rates have been steadily increasing in recent decades [33,48], the proportion of women with previous cesarean delivery (group 5) has been increasing as well. Group 5 accounted for approximately one-third of all C-sections, in both periods. However, there was a significant reduction in C-

section rates in group 5, with no increase in complications (data not shown), which shows that vaginal delivery after a previous C-section, when performed in ideal conditions, is clinically safe and contributes to reduce maternal morbidity associated with multiple cesarean deliveries [49–51]. A study carried out in Brazilian hospitals participating in an initiative to improve quality care also found an increase in vaginal births as compared to years 2014-2016 [20].

C-section rates and contributions remained practically unchanged groups 6 through 9, with a small, non-significant reduction of 4.2% after the PPA implementation. In this subset of participants, group 7 had the greatest reduction, and group 9 had a C-section rate of 100% in both periods, as expected.

Our data demonstrated that women belonging to group 10 represented 10% of all births in both periods, being the only group that had a slight, though not significant, increase in C-section rates. These data were very similar to those of a national survey conducted in Brazil [36], in which group 10 represented 9.7% of the childbirths and had a C-section rate of 50.1%, as well as in Latin America, in which group 10 represented 7.1% of the childbirths and had a C-section rate of 43% [52]. Contrastingly, countries with low rates of preterm births have lower C-section rates in this group than those found in our study. The C-section rate is 37% in the United states[47], 7.1% in the Netherlands [51], and 8.3% in France [45].

Conclusion

The PPA is an innovative project that has shed light on this gloomy field of the increase in C-section rates in Brazil, without understanding its determinants or without regard for its future consequences. This study demonstrated concrete results that this project could provide evidence-based interventions to promote changes in childbirth care, with the participation of all involved in the process, thus contributing to reduce C-section rates.

Robson classification system is a tool freely available to all health institutions to help examine C-section rates and identify groups that may benefit from specific actions, such as the PPA. It is extremely important that the PPA is extended to all maternity hospitals, not only in Brazil, but also in other countries

with such a high C-section rate. The main goal should be to reduce elective C-sections and those without medical indication. Waiting for the right time for the baby to be born should be stimulated, as well as vaginal delivery should be encouraged, even after a previous C-section delivery.

Conflict of interests

The authors declare that they have no conflict of interest.

Authors' contributions

Conception: DFDM. Design & development: DFDM e BPMI. Questionnaire development: DFDM, BPMI, and KBDC. Data collection: DFDM, ARW, DD, DA, GFK, KMZ, KBDC, NVG, and OTF. Data analysis: DFDM and BPMI. Preparation of tables: DFDM and BPMI. Initial draft of the manuscript: DFDM and BPMI. Manuscript writing, review, and approval: All authors.

BLOCK ABSTRACT

The Project Appropriate Birth is an innovative project that has demonstrated concrete results, showing that interventions based on scientific evidence lead to real changes in childbirth care, contributing to reduce C-section rates. When a C-section has no medical indication, it causes unnecessary health risks to the woman and her baby, leading to immediate and long-term risks. The aim of the PPA is to promote activities to improve childbirth care and encourage vaginal delivery. In this study, 6,238 pregnant women admitted to the hospital for delivery were included and classified into one of the Robson 10-group

classification. Findings revealed a 10.9% reduction in the overall C-section rate after the implementation of the PPA. This study is one of the pioneering studies that examine the results of the PPA implementation.

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Chart 1 - Robson Classification system

Robson Classification System	
1	Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labor
2	Nulliparous women with a single cephalic pregnancy, ≥37weeks gestation who either had labour induced or were delivered by caesarean section before labour
3	Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labor
4	Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37weeks gestation who either had labour induced or were delivered by caesarean section before labour
5	All multiparous women without a previous uterine scar, with at least one prevous uterine scar, with a single cephalic pregnancy, ≥37weeks 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, <37 weeks gestation, including women with previous uterine scars

692 Table 1 – Sociodemographic and obstetric characteristics of parturient women attending a
693 hospital in southern Brazil April 2016 through June 2018, according to the period considered for
694 the implementation of the Project Appropriate Birth (**N = 6238**).

	Total		Period 1		Period 2	
	n	%	n	%	n	%
Total	6238	100	3135	50.3	3103	49.7
Maternal age						
< 20	702	11.3	339	10.8	363	11.7
20-34	4555	73.0	2299	73.3	2256	72.7
≥ 35	981	15.7	497	15.9	484	15.6
Race/Skin color						
White	5606	89.9	2826	90.1	2780	89.6
Brown	131	2.1	50	1.6	81	2.6
Black	343	5.5	168	5.4	175	5.7
Indigenous	12	0.2	8	0.3	4	0.1
Unknown	146	2.3	83	2.6	63	2.0
Marital status						
Single	793	12.7	375	12.0	418	13.5
Married	2624	42.1	1356	43.2	1268	40.8
Civil union	2759	44.2	1375	43.9	1384	44.7
Divorced	47	0.8	21	0.7	26	0.8
Widowed	10	0.1	4	0.1	6	0.2
Unknown	5	0.1	4	0.1	1	0.0
Education						
Primary school (complete or not)	1659	26.6	812	26.3	847	27.9
Secondary–incomplete higher	3289	52.7	1635	52.9	1654	54.5
Higher education–postgraduate	1177	18.9	641	20.8	536	17.6
Unknown	113	1.8	47	1.5	66	2.1
Religion						
Catholic	4415	70.8	2259	72.0	2156	69.5
Evangelical	1386	22.2	683	21.8	703	22.6
No religion	177	2.8	72	2.3	105	3.4
Other	200	3.2	97	3.1	103	3.3
Unknown	60	1.0	24	0.8	36	1.2
Parity (previous pregnancy)*						
0	2580	41.4	1335	42.6	1245	40.1
1	1973	31.6	969	30.9	1004	32.4
≥ 2	1685	27.0	831	26.5	854	27.5
Previous delivery						
0	4503	72.2	2286	72.9	2217	71.4
1	1062	17.0	511	16.3	551	17.8

≥ 2	673	10.8	338	10.8	335	10.8
Previous C-section						
0	4405	70.6	2240	71.4	2165	69.8
1	1397	22.4	682	21.8	715	23.0
≥ 2	436	7.0	213	6.8	223	7.2
Type of pregnancy						
Singleton	6099	97.8	3066	97.8	3033	97.8
Multiple	139	2.2	69	2.2	70	2.2
Type of delivery						
Vaginal	2553	40.9	1179	37.6	1374	44.3
Forceps/Vacuum	3	0.1	0	0.0	3	0.1
C-section	3682	59.0	1956	62.4	1726	55.6

*Abortion was considered as a previous pregnancy

Table 2 – Robson classification groups of parturient women attending a hospital in southern Brazil 2016 through 2018, according to period 1 (pre-implementation of the project) and period 2 (post-implementation of the project). **N=6238**

A. Pre-implementation period – 1

	Number of normal births	Number of C-sections	Total number of births	Group size (%)[1]	C-section rate in the group (%)[2]	Absolute contribution to C-section rate (%)[3]	Relative contribution to C-section rate (%)[4]
1	405	228	633	20.19	36.02	7.27	11.66
2	92	522	614	19.58	85.01	16.65	26.69
3	397	76	473	15.09	16.07	2.42	3.89
4	68	103	171	5.45	60.23	3.28	5.26
5	88	688	776	24.76	88.65	21.94	35.17
6	1	49	50	1.59	98.00	1.56	2.51
7	3	46	49	1.56	93.88	1.47	2.35
8	2	68	70	2.23	97.14	2.17	3.48
9	0	12	12	0.38	100.00	0.38	0.61
10	123	164	287	9.15	57.14	5.23	8.38
	1179	1956	3135	100	62.39		100

B. Post-implementation period - 2

	Number of normal births	Number of C-sections	Total number of births	Group size (%)[1]	C-section rate in the group (%)[2]	Absolute contribution to C-section rate (%)[3]	Relative contribution to C-section rate (%)[4]
1	432	102	534	17.21	19.10	3.29	5.91

2	171	502	673	21.69	74.59	16.18	29.09
3	412	24	436	14.05	5.50	0.77	1.39
4	97	72	169	5.45	42.6	2.32	4.17
5	129	664	793	25.56	83.73	21.40	38.47
6	4	52	56	1.80	92.86	1.68	3.01
7	3	54	57	1.84	94.74	1.74	3.13
8	7	62	69	2.22	89.86	2.00	3.59
9	0	7	7	0.23	100.00	0.23	0.41
10	122	187	309	9.96	60.52	6.03	10.83
	1377	1726	3103	100	55.62		100

[1] (Number of births in the group) / (total number of births) x100

[2] (Number of C-section deliveries) / (number of births in the same Robson classification group) x100

[3] (Number of C-section deliveries in the group / (total number of births) x 100

[4] (Number of C-section deliveries in the group) / (total number of C-section deliveries) x 100

Table 3 – C-section rates according to Robson classification system in the pre-implementation period (1) and post-implementation period (2) of the Project Appropriate Birth in a hospital in southern Brazil, 2016 through 2018 **(N=6238).**

Robson Classification	Period 1 (%)	Period 2 (%)	Variation %	PR# (95% CI)	P-value
All (1 a 10)	62.4	55.6	-10.9%	0.89 (0.86-0.93)	<0.0001*
1 a 4 (n=3703)	49.1	38.6	- 21.4%	0.79 (0.73-0.85)	<0.0001*
1 e 2 (n=2454)	60.1	50.0	-20.2%	0.83 (0.77–0.89)	<0.001*
3 e 4 (n=1249)	27.8	15.9	-74.8%	0.57 (0.46-0.71)	<0.001*
5 (n=1569)	88.7	83.7	-0.6%	0.94 (0.91-0.98)	0.005*
6 a 9 (n=370)	96.7	92.6	-4.2%	0.96 (0.91-1.00)	0.082
10 (n=596)	57.1	60.5	+5.9%	1.06 (0.93-1.21)	0.403

*statistically significant difference. Pearson's chi-square test, 5% significance level

PR = prevalence ratio considering period 1 as the reference category (before PPA implementation).

Table 4 – Prevalence ratios (PR)# adjusted for C-section rate according to Robson classification and sociodemographic characteristics of women in the post-implementation period (2) in relation to the pre-implementation period (1) of the Project Appropriate Birth in a hospital in southern Brazil, 2016 through 2018. **(N=5986)***

Robson Classification	Model1	Model 2

	PR (95%CI)	PR (95%CI)
All (1 to 10)	0.91 (0.87-0.95) ¤	0.89 (0.86-0.93) ¤
1 to 4 (n=3543)	0.80 (0.75-0.86) ¤	0.79 (0.74-0.85) ¤
1 e 2 (n=3676)	0.84 (0.78-0,90) ¤	0.83 (0.77-0.89) ¤
3 e 4 (n=1220)	0.58 (0.47-0.73) ¤	0.58 (0.46-0.72) ¤
5 (n=1548)	0.96 (0.92-0,99) ¤	0.96 (0.92-0,99) ¤
6 to 9 (n=350)	0.95 (0.91-1.00)	0.97 (0.93-1.01)
10 (n=570)	1.09 (0.96-1.25)	1.08 (0.94-1.24)

PR = prevalence ratio considering period 1 as the reference category (before PPA implementation), estimated by Poisson regression model with a robust error variance.
* Cases with unknown information for the adjustment variables were excluded: age, education (n = 113), race (n = 139), high-risk pregnancy.

Model 1 - considering the variables age (continuous), education and race/skin color of the mother.
Model 2 - considering the variables age (continuous), education and race/skin color of the mother, and high-risk pregnancy.
¤ statistically significant at the 5% significance level (p-value <0.05).