

Is it possible to reduce cesarean sections in hypertensive women without increasing the occurrence of negative outcomes?

Wellington Lugão da Cunha <https://orcid.org/0000-0002-8093-1387>¹; Vitor Barreto Paravidino <https://orcid.org/0000-0002-4972-1269>²; Maria do Carmo Leal <https://orcid.org/0000-0002-3047-515X>²; Rosa Maria Soares Madeira Domingues <https://orcid.org/0000-0001-5722-8127>³; Emanuele Souza Marques <https://orcid.org/0000-0002-8633-7290>¹; Eliseu Verly Junior <https://orcid.org/0000-0002-1101-8746>¹; Diana Barbosa Cunha <https://orcid.org/0000-0003-0900-5628>¹; Ana Paula Esteves Pereira <https://orcid.org/0000-0002-0236-2043>²; Tatiana Henriques Leite <https://orcid.org/0000-0002-2861-4480>¹

Abstract *The Adequate Childbirth Project (Projeto Parto Adequado - PPA) is an initiative by the National Supplementary Health Agency aimed at reducing the occurrence of cesarean sections in private hospitals in Brazil. However, it is still unknown whether the project is effective in reducing cesarean sections in hypertensive women, which is the objective of this study. This is a cross-sectional study with hypertensive women who participated in the Nascir Saudável - 2017 study. A total of 382 women were included in this analysis. The exposure variable was participation in the PPA, and the outcomes assessed were spontaneous labor onset, mode of delivery, severe maternal morbidity, and neonatal near miss. The PPA increased the likelihood of hypertensive women going into labor and having a vaginal delivery. Furthermore, the results show that participating in the PPA did not increase the likelihood of severe maternal morbidity or neonatal near miss, assessed using the World Health Organization criteria and the Nascir no Brasil study criteria. This study highlighted positive results for the Adequate Childbirth Project in promoting the physiology of childbirth, concluding that it is possible to reduce cesarean sections in hypertensive women without increasing the occurrence of negative maternal and neonatal outcomes.*

Key words Hypertension, Pregnancy, Supplementary Health, Quality of Care, Cesarean Section

¹ Instituto de Medicina Social Hesio Cordeiro, Universidade do Estado do Rio de Janeiro. R. São Francisco Xavier 524, Maracanã. 20550-013 Rio de Janeiro RJ Brasil. cunha.lugao@gmail.com

² Departamento de Epidemiologia e Métodos Quantitativos em Saúde, Escola Nacional de Saúde Pública Antônio Sérgio Arouca, Fundação Oswaldo Cruz. Rio de Janeiro RJ Brasil.

³ Instituto Nacional de Infectologia Evandro Chagas, Fundação Oswaldo Cruz. Rio de Janeiro RJ Brasil.

Introduction

Hypertension during pregnancy is the leading cause of maternal mortality in Brazil and is associated with various morbidities in women and their newborns¹. For this reason, cesarean section is often recommended in these cases, leading to a higher cesarean section rate among hypertensive women compared to low-risk pregnant women². Studies indicate that hypertensive women are up to three times more likely to undergo a cesarean section compared to normotensive women³.

However, a recent study suggests that cesarean sections may represent an additional risk factor for hypertensive women, being associated with an increase in maternal morbidity, both in low-risk hypertensive women and in severe cases^{4,5}. In this context, the current recommendation is to consider labor induction and vaginal delivery as a safe approach for terminating pregnancy in hypertensive women, reducing risks for the woman and preserving her reproductive future^{4,6}, without compromising neonatal outcomes⁴.

This recommendation is often not followed in Brazil⁵, especially in the private healthcare sector, where cesarean section is the predominant mode of delivery, regardless of the presence of hypertension or other comorbidities. In Brazil, the public sector accounts for 80% of births, with a prevalence of 43% cesarean sections. In contrast, in the private sector, 88% of births are performed through cesarean sections, representing 50% of all cesarean surgeries in Brazil⁷.

Aiming at reducing those cesarean sections without clinical indication in the private sector, the Federal Public Prosecutor's Office filed a public civil action in 2014 against the National Supplementary Health Agency (ANS). In response, the ANS, together with the Ministry of Health, the *Hospital Israelita Albert Einstein*, and the Institute for Healthcare Improvement (IHI), developed the Adequate Childbirth Project (PPA). The PPA main objective was to identify innovative and feasible care models for labor and delivery that would prioritize vaginal birth and reduce the frequency of excessive cesarean sections in the supplementary healthcare system⁸.

The PPA was implemented in three phases. Phase 1, developed between 2015 and 2016, with the objective of testing the proposed interventions in 35 public and private participating hospitals, involving 19 health insurance compa-

nies. Phase 2 expanded the project to a broader range of healthcare providers and health insurance companies. Lastly, Phase 3, launched in October 2019, aimed to disseminate effective strategies on a large scale, with the possibility of including all maternity hospitals and health insurance companies across Brazil.

In 2017, researchers from the Oswaldo Cruz Foundation conducted an external assessment study named *Nascer Saudável* in order to assess the implementation and the effects of the PPA⁹. Since its implementation, the PPA has proven to be effective in its objectives, showing that its implementation reduced the number of cesarean sections by 37% among the women participating in the study¹⁰. However, it is still unclear whether hypertensive women also benefited from this intervention.

In light of this, the objective of this study is to assess whether participation in the Adequate Childbirth Project increased the chances of hypertensive women going into labor and having a vaginal delivery, without increasing the risk of maternal morbidity and neonatal near miss.

Method

Study Design

The *Nascer Saudável* study is a hospital-based assessment study that used a mixed-methods approach to assess the effects of the PPA, considering its degree of implementation as well as its sustainability one year after being launched⁹.

The quantitative component was developed through a cross-sectional study, with data collection in two steps: the first, from March 2017 to August 2017, six to eight months after PPA first phase completion; and the second, from May 2018 to August 2018.

A brief description of the PPA

The PPA aimed to achieve its objectives by proposing interventions in four major components: 1) Governance: forming a coalition among leaders in the health sector, aligning quality and safety in childbirth and newborn care; 2) Participation of women and families: empowering women and families to actively participate in the pregnancy, childbirth, and postpartum process; 3) Reorganization of care: restructuring the childbirth care model in order to support the physiological progression of labor and ensure that cesarean sections are per-

formed based on clinical criteria; 4) Monitoring: developing information systems that enable continuous learning over time⁹.

Thus, a set of interventions was proposed based on these four pillars. Regarding governance, the healthcare team was encouraged to hold meetings to exchange information (promoting communication, sharing experiences, knowledge, and integration), define objectives as well as strategies and investments to achieve them, and also training and rewards that would motivate the team to meet the established goals. Regarding women's participation, hospitals were encouraged to run campaigns promoting vaginal birth, support birth planning, and encourage shared decision-making with the healthcare team. Additionally, the hospital also facilitated prenatal groups where pregnant women could receive information and have their questions about the reproductive process addressed. Regarding the reorganization of care, collaborative work between the medical and nursing teams was encouraged, along with the establishment of evidence-based care protocols and the promotion of a welcoming environment that would support vaginal birth. Lastly, regarding monitoring, hospitals were encouraged to track perinatal outcomes and assess women's satisfaction with the care received, as well as evaluate the interventions implemented, and making adjustments if deemed necessary.

Each of the 12 hospitals participating in Phase 1 of the PPA defined its target population. In two hospitals, the target population consisted of all primiparous women, while in another two, it included women classified within Robson groups 1 to 4¹¹; in eight hospitals, the target population consisted of women admitted by the hospital's on-call team. Women in the "Exposed to the PPA care model" group were subjected to the abovementioned project activities. Women in the "Regular care model" group were treated according to the current practice in Brazilian private hospitals, characterized by a single doctor being responsible for prenatal and childbirth care; small participation of nurses/obstetricians; a high proportion of cesarean sections before labor onset; and high levels of intervention during labor and childbirth care.

Study Population and Eligibility Criteria

All hypertensive women with full-term pregnancies who participated in the first wave of the *Nascer Saudável* study, conducted in 2017, at the eight hospitals where the PPA target popula-

tion consisted of women admitted by the on-call team, were considered eligible for this analysis.

To identify hypertensive pregnant women, all women who had at least one of the following diagnoses were classified as having hypertensive syndrome: chronic hypertension, pre-eclampsia/gestational hypertension, eclampsia, and HELLP syndrome. The data sources used included previous clinical history, prenatal data, current pregnancy history, hospitalization diagnosis, indication for cesarean section, and postpartum information available in the medical records and pregnant woman's card.

The inclusion of hospitals only where the target population consisted of women admitted by the on-call team aimed to homogenize the distribution of Robson women among the groups to be compared, once in the hospitals where the criterion was to be in Robson's 1 to 4, the entire comparison group would consist of women from groups 5 to 10, where the expected cesarean sections rate is higher.

The Robson classification is recommended by the World Health Organization (WHO) for evaluating and monitoring cesarean sections¹¹. As per this classification, women are categorized into 10 mutually exclusive groups based on parity (primiparous, multiparous), type of pregnancy (singleton or multiple), fetal presentation (cephalic, breech, transverse), presence of a previous uterine scar, gestational age (preterm or full-term), and type of labor (spontaneous, induced, or no labor). Groups 1 to 4, consisting of primiparous and multiparous women with a singleton, full-term pregnancy, with a cephalic fetus, and no previous uterine scar, are those mostly likely to have vaginal birth. Groups 6 to 9 consist of women with multiple pregnancies or with breech and transverse presentations, while group 10 includes preterm pregnancies, representing groups with a higher likelihood of cesarean sections. In its turn, group 5 consists of women with previous uterine scar, which is a relevant group in Brazil due to the high rate of women who had a prior cesarean section. These exclusions were conducted as such conditions decrease the likelihood of vaginal birth.

Women with twin pregnancy, and/or diagnosed with HIV infection, and/or diagnosed with placenta previa and/or placental abruption, and/or belonging to Robson's 6 to 9 were excluded from this analysis due to the high probability of cesarean sections under these conditions. Preterm pregnancies were also excluded due to the higher likelihood of cesarean sections and negative neonatal outcomes.

Theoretical-Operational Model

The following Directed Acyclic Graph (DAG) represents the association between participation in the PPA and the analyzed outcomes: labor, type of delivery, maternal morbidity, and neonatal near miss (Figure 1).

Exposure Variable

All women who belonged to the PPA target population in each of the eight hospitals were considered exposed to the PPA, meaning that they were admitted by the on-call team. All women who were not admitted by the on-call team were classified as having received regular care.

Definition of the Outcome

The analyses were conducted considering four separate outcomes: 1) labor, 2) type of delivery, 3) severe maternal morbidity after childbirth e 4) neonatal near miss.

The variable “*labor*” is dichotomous and was divided into two categories: spontaneous or induced labor and no labor. The variable “*type of delivery*” was classified into two categories: vaginal deliveries, including those assisted by forceps or vacuum extraction, and cesarean sections. Such information was obtained from the women’s medical records.

The definition of “*severe maternal morbidity after childbirth*” was based on the concept proposed by the WHO for severe maternal morbidity, including potentially life-threatening conditions and maternal near miss¹². A case was considered for women who presented at least one of the following conditions initiated after childbirth: hemorrhage, diagnosis of placenta accreta, uterine rupture, blood transfusion, endometritis, sepsis or severe systemic infection, return to the operating room, laparotomy, severe hypertension, severe preeclampsia and eclampsia, HELLP syndrome, hospitalization or ICU admission, seizures, O₂ saturation <90% for more than 60 minutes, acute thrombocytopenia (platelets <50,000), hysterectomy as a result of an infection or hemorrhage, intubation, and finally, mechanical ventilation ≥60 minutes not related to anesthesia. For the analyses, maternal morbidity was classified into two categories (yes/no).

The “*neonatal near miss*” was considered according to two different criteria. According to

the WHO, cases were characterized when the newborn presented at least one of the following items: birth weight less than 1,750 g, gestational age less than 33 weeks, APGAR score at the fifth minute less than 7, use of parenteral antibiotics for up to 7 days before 28 days of age; use of continuous positive airway pressure (CPAP) machine; any intubation lasting up to 7 days before 28 days of age; phototherapy in the first 24 hours of life; cardiopulmonary resuscitation; use of vasoactive drugs, anticonvulsants, surfactants, or blood products, or use of steroids to treat refractory hypoglycemia; and any surgical procedure¹³. The second criterion used was developed and validated by the *Nascer no Brasil* study, which classified a neonatal near miss case as the presence of at least one of the following items: birth weight less than 1,500 g, APGAR score less than 7 at the fifth minute of life, mechanical ventilation, gestational age less than 32 weeks, and presence of congenital malformation¹⁴.

Confounding variables

The women’s *age* was collected during a postpartum interview and categorized into three levels: up to 19 years old, between 20-34 years old, and 35 years old or older.

The women’s *education level* was used to categorically describe the study population: 1-12 years (up to complete high school), 13-15 years (incomplete higher education), and 16 years or more (complete higher education). In the main analyses, it was used as a continuous variable.

The women’s *race/skin color* was self-reported according to the Brazilian Institute of Geography and Statistics (IBGE) classification (white, Black, brown, yellow, and Indigenous). For analysis purposes, such characteristic was grouped into three categories (white, Black, and brown), as no woman in this subsample self-identified as yellow or Indigenous.

The presence of a *previous uterine scar* is a dichotomous variable (yes/no) and was obtained during the in-person interview with the women.

The *pre-pregnancy BMI* was calculated based on the weight and height information reported by the women during the hospital interview. The variable was stratified into three categories: normal weight (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), and obesity (above 30 kg/m²)¹⁵. Three cases of underweight women were excluded due to suspected data entry errors.

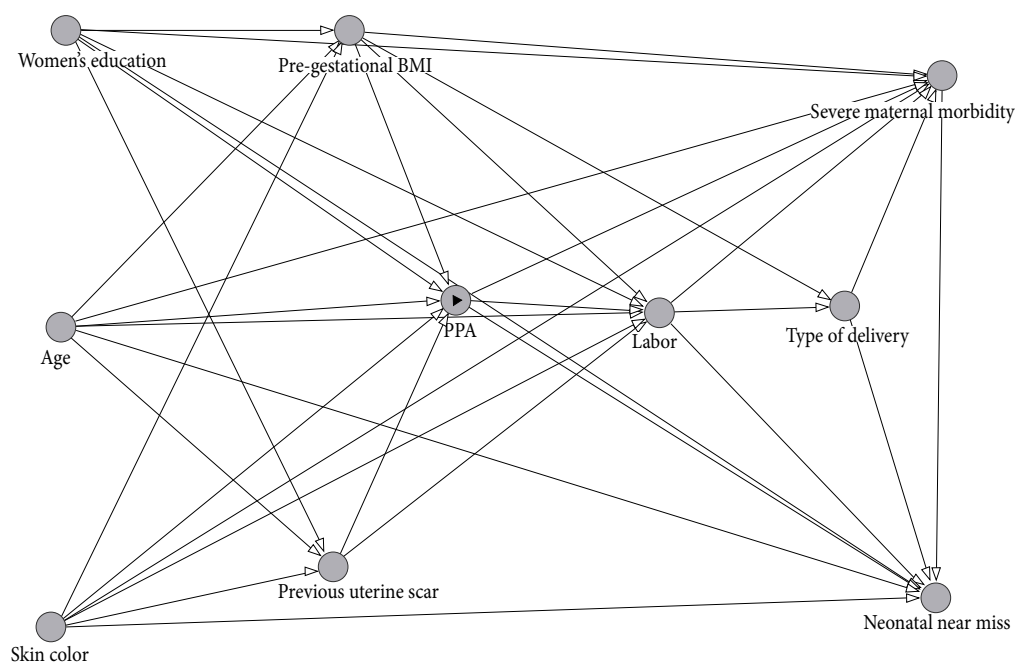


Figure 1. Directed Acyclic Graph (DAG) representing the association between participation in the Adequate Childbirth Project (PPA) and outcomes such as labor, type of delivery, maternal morbidity, and neonatal near miss.

Source: Authors.

Statistical Analysis

A descriptive analysis was conducted on the total population and stratified by group (“exposed to the PPA care model” and “regular care”), considering socioeconomic and demographic characteristics, comorbidities, and maternal and neonatal outcomes. Pearson’s chi-square test was used to assess the differences between groups for each variable analyzed.

Crude and adjusted logistic regression estimates were performed for each outcome separately in order to assess the likelihood of going into labor, vaginal delivery and the occurrence of severe maternal morbidity after delivery and neonatal near miss. The minimum set of the models adjustment variables was selected based on the literature and the relationships outlined in directed acyclic graphs using the Dagitty software.

All analyses were conducted using SAS On-Demand for Academics and Stata version 17.0.

Results

A total of 382 postpartum women assisted in eight hospitals participating in the *Nascer Saudável* study were analyzed. Table 1 presents the characteristics of the study population. Considering the total population, the majority of women (65.2%) were between 20 and 34 years old and self-identified as white (46.9%); more than half completed higher education (56.2%) and belonged to category B regarding socioeconomic status (65.7%).

The main form of hypertension was gestational hypertension/preeclampsia (43.9%), followed by chronic hypertension (24.1%). Regarding comorbidities, 40.8% had obesity, and approximately 13.9% had gestational diabetes.

Regarding the current pregnancy, nearly 57.0% of the women were primiparous, the majority (66.5%) belonged to Robson’s 1 to 4, and 35.9% reported a previous uterine scar. Regarding the analyzed outcomes, 73.1% did not go into labor, 87.4% had a cesarean section, 12.3% experienced severe maternal morbidity after

childbirth, and neonatal near miss ranged from 1.1% to 10.2%, depending on the criterion used.

Women who were part of the PPA target population were younger, mostly self-identified as brown, had lower education levels, and lower socioeconomic status. They were also more frequently eutrophic, without uterine scars, and primiparous. No differences were observed regarding the type of hypertensive syndrome or diabetes diagnosis. In the “exposed to PPA” group, a higher proportion of women experienced spontaneous or induced labor and had a vaginal delivery. There were no differences between the groups regarding the frequency of severe maternal morbidity after childbirth or neonatal near miss, regardless of the classification used.

Table 2 presents the association between the PPA and maternal and neonatal outcomes.

Participation in the PPA increased the chances of women going into labor (OR=4.7; 95%CI 2.7-8.0) and having a vaginal delivery (OR=8.6; 95%CI 3.7-20.0). There were no differences between the groups regarding severe maternal morbidity after childbirth (OR=0.81; 95%CI 0.4-1.6) nor regarding neonatal near miss, whether by the criterion adopted by the WHO (OR=1.5; 95%CI 0.7-3.1) or by the criterion developed by the *Nascer no Brasil* study (OR=0.5; 95%CI 0.3-7.2).

Discussion

The results of this study indicated that the PPA was effective in increasing the chances for hypertensive women treated in the private sector to go into labor and have a vaginal delivery.

Table 1. Socioeconomic, clinical, and obstetric characteristics, as well as maternal and neonatal outcomes, according to exposure to the Adequate Childbirth Project. Brazil, 2017.

Variables (n)	Total n (%)	Regular Care n (%)	PPA n (%)	p-value
Age (years old)				
<20	10 (2.6)	2 (0.9)	8 (5.5)	0.021
20-34	249 (65.2)	155 (65.6)	94 (64.4)	
>35	123 (32.2)	79 (33.5)	44 (30.1)	
Skin Color				
White	179 (46.9)	129 (54.6)	50 (34.2)	<0.001
Black	37 (9.7)	21 (8.9)	16 (11.0)	
Brown	166 (43.4)	86 (35.4)	80 (54.8)	
Education				
Elementary School	19 (5.0)	8 (3.4)	11 (7.5)	<0.001
High School	148 (38.8)	77 (32.7)	71 (48.6)	
Higher Education	214 (56.2)	150 (63.9)	64 (43.8)	
Socioeconomic status				
A	95 (24.9)	46 (19.5)	49 (33.5)	0.002
B	251 (65.7)	162 (67.6)	89 (61.0)	
C, D and E	36 (9.4)	28 (11.9)	8 (5.5)	
BMI*				
Eutrophic	97 (25.9)	43 (18.7)	54 (37.2)	<0.001
Overweight	125 (33.3)	77 (33.5)	48 (33.1)	
Obesity	153 (40.8)	110 (47.8)	43 (29.7)	
Chronic hypertension				
No	290 (75.9)	173 (73.3)	117 (80.1)	0.129
Yes	92 (24.1)	63 (26.7)	29 (19.9)	
Gestational hypertension/Pre-eclampsia				
No	214 (56.1)	137 (58.0)	77 (52.7)	0.283
Yes, before labor	143 (37.4)	87 (36.9)	56 (38.4)	
Yes, after labor	25 (6.5)	12 (5.1)	13 (8.9)	

it continues

Table 1. Socioeconomic, clinical, and obstetric characteristics, as well as maternal and neonatal outcomes, according to exposure to the Adequate Childbirth Project. Brazil, 2017.

Variables (n)	Total n (%)	Regular Care n (%)	PPA n (%)	p-value
Gestational Diabetes				
No	329 (86.1)	199 (84.3)	130 (89.0)	0.194
Yes	53 (13.9)	37 (15.7)	16 (11.0)	
Previous uterine scar				
No	245 (64.1)	135 (57.2)	110 (75.3)	<0.001
Yes	137 (35.9)	101 (42.8)	36 (24.7)	
Parity				
Primiparous	218 (57.0)	124 (52.6)	94 (64.4)	0.002
1-2 deliveries	158 (41.4)	111 (47.0)	47 (32.2)	
≥3 deliveries	6 (1.6)	1 (0.4)	5 (3.4)	
Robson Classification 1-4				
No	128 (33.5)	94 (39.8)	34 (23.3)	<0.001
Yes	254 (66.5)	142 (60.2)	112 (76.7)	
Type of Labor				
Spontaneous	85 (22.4)	29 (12.4)	56 (38.4)	<0.001
Induced	17 (4.5)	3 (1.3)	14 (9.6)	
No labor	278 (73.1)	202 (86.3)	76 (52.0)	
Type of Delivery				
Vaginal	48 (12.6)	8 (3.4)	40 (27.4)	<0.001
C-Section	332 (87.4)	226 (96.6)	106 (72.6)	
Severe maternal morbidity after childbirth				
No	335 (87.7)	205 (86.9)	130 (89.1)	0.529
Yes	47 (12.3)	31 (13.1)	16 (10.9)	
Neonatal near miss “Nascer no Brasil” Criteria				
No	378 (98.9)	233 (98.7)	145 (99.3)	0.584
Yes	4 (1.1)	3 (1.3)	1 (0.7)	
Neonatal near miss “WHO” Criteria				
No	343 (89.8)	215 (91.1)	128 (87.7)	0.281
Yes	39 (10.2)	21 (8.9)	18 (12.3)	

*Three underweight women were considered missing.

Source: Authors.

Additionally, the findings show that participation in the PPA did not influence severe maternal morbidity after childbirth or neonatal near miss, reinforcing the safety of vaginal birth for the study target population.

The PPA has shown to be an effective strategy in promoting the physiology of childbirth and reducing cesarean section rates in private hospitals¹⁰. Although the proposed interventions were diversely implemented and had low adherence in the participating hospitals¹⁶, the project demonstrated a 37% reduction in cesarean sections among women with a Robson classification of 1 to 4¹⁰. However, the increase in vaginal births might have been limited to spe-

cific subgroups that do not include hypertensive women. The results of the current study demonstrate that the PPA reduced the proportion of cesarean sections among hypertensive women, an objective not originally stated by the project, although it would have been desirable.

Despite the positive results from other studies showing the benefits of vaginal birth for hypertensive women^{4,5}, Brazil has an interventionist culture in childbirth care, which often leads to the perception that cesarean section is the safest option for women with this condition. Furthermore, it is important to note that women treated in the private sector have a “preference” for cesarean sections, especially multiparous

Table 2. Odds Ratio (OR) and Confidence Interval (CI95%) for labor, type of delivery, severe maternal morbidity after childbirth, and neonatal near miss.

	Crude OR	95%CI	p-value	Ajusted OR ^a	95%CI	p-value
Labor						
Regular care	Ref	---	---	Ref	---	---
PPA	5.8	3.5-9.5	<0.001	4.7	2.7-8.0	<0.001
Type of delivery (vaginal)						
Regular care	Ref	---	---	Ref	---	---
PPA	10.7	4.8-23.7	<0.001	8.6	3.7-20.0	<0.001
Severe maternal morbidity after childbirth						
Regular care	Ref	---	---	Ref	---	---
PPA	0.81	0.4-1.5	0.530	0.81	0.4-1.6	0.566
Neonatal near miss “WHO”						
Regular care	Ref	---	---	Ref	---	---
PPA	1.4	0.7-2.8	0.284	1.5	0.7-3.1	0.262
Neonatal near miss “Nascer no Brasil”						
Regular care	Ref	---	---	Ref	---	---
PPA	0.5	0.1-5.1	0.590	0.5	0.3-7.2	0.632

Note: ^aAdjusted for age, race/skin color, education, previous uterine scar, pre-gestational BMI.

Source: Authors.

women with a previous C-section¹⁷, making this issue even more complex. Still, despite the cultural aspect and the alleged preference for cesarean sections in a given context, our study showed that the PPA was able to reduce the cesarean section rate in this population without increasing negative maternal and neonatal outcomes, which points out the feasibility of the PPA not only in reducing cesarean sections but also in promoting safe and healthy outcomes for women and newborns.

In this context, it is essential to promote and strengthen initiatives like those suggested by the PPA, both in public institutions and especially in the private ones. In another publication evaluating the PPA, the component “Reorganization of Care” - one of the PPA four pillars - was identified as the most important factor in increasing vaginal births in the assessed private hospitals¹⁰. The combination of measures such as avoiding the scheduling of elective cesarean sections, providing women with information and access to good practice during labor and delivery, and, finally, respecting the birth plan, showed an 80% probability of vaginal birth¹⁰, which highlights the importance of changing the practice offered by the healthcare professionals involved in maternity care.

Moreover, the reduction of cesarean sections as a public policy should be supported by mass

campaigns explaining the risks of cesarean sections without clinical reasons for both the woman and the baby, as well as the advantages of a vaginal birth. Regarding hypertensive women, it is important to inform that a cesarean section can be an additional risk factor, increasing the risk of maternal morbidity and mortality.

In addition to labor and mode of delivery, the present study also investigated the relationship between the PPA and severe maternal morbidity. The “postpartum” focus aimed to exclude complications prior to the exposure to the PPA, as well as to highlight any potential adverse events on maternal health as a result of the program. Considering the data availability, the chosen criterion combined the WHO definitions for “potentially life-threatening conditions” and “maternal near miss”, emphasizing that they are all criteria for severe maternal morbidity. Our results show that there was no difference regarding frequency in post-childbirth maternal morbidity among the analyzed groups, evidencing the safety of vaginal birth in hypertensive women, which corroborates the findings of previous studies^{4,5}. The outcome of maternal death could not be evaluated due to the lack of such cases.

One of the most complex study outcomes was the neonatal near miss. It is important to note that there is no consensus in the literature on its definition¹⁸. Therefore, due to its impor-

tance, we chose to work with two classifications: one suggested by the WHO and another validated by the *Nascer no Brasil* study. The WHO classification considers a larger amount of information, as it takes into account several aspects related to the care of a newborn in the first days of life. However, these are difficult-to-access details, making it challenging to compare data with larger epidemiological studies, where, often, we do not have detailed data or secondary data sources. On the other hand, the pragmatic classification proposed by the *Nascer no Brasil* study is easier to operationalize, allowing comparability with national and international studies, especially from developing countries, and it also has high sensitivity (73.5%) and specificity (98%)¹⁹. Considering both criteria, the PPA was not found to be associated with neonatal near miss.

To better understand the results of this study, it is necessary to analyze its strengths and limitations. Among the weaknesses, it is important to highlight that the women in the “Exposed to the PPA Care Model” and “Regular Care” groups were treated in the same hospital, which may have led to contamination between the groups analyzed. As a result, the effect found regarding all outcomes may be underestimated. Additionally, the sample was limited to women who were admitted by the on-call teams, with the aim of balancing the distribution into Robson groups. The inclusion of hospitals where the target population consisted exclusively of women in Robson groups 1 to 4 would likely result in more favorable outcomes for the PPA, with a higher frequency of vaginal births, which

would probably be attributed to the characteristics of the women themselves rather than the intervention itself. Thus, while this strategy allowed for a better comparison between the PPA and regular care groups, it does not allow for inferences about the PPA outcomes in women who were not admitted by the on-call team. Only full-term pregnancies were included, being the results not applicable to preterm births, whether spontaneous or medically induced. Finally, a convenience sample of hospitals was used, which may limit the representativeness of the findings for the private sector in Brazil. In contrast, as a strength, we highlight the standardized data collection conducted by trained professionals, including interviews with postpartum women, data from medical records, and prenatal care cards. This approach allowed for a comprehensive assessment of care in a sample that was representative of each hospital included in the study. It is noteworthy that the study was conducted in private hospitals, which present the highest prevalence of cesarean sections in Brazil. These hospitals should be a priority target for strategies aimed at reducing the prevalence of cesarean sections without clinical justification and at improving women and newborns health care.

Finally, this study showed positive results of the Adequate Birth Project (PPA) in promoting the physiology of childbirth, concluding that it is possible to reduce cesarean sections in hypertensive women treated in the private sector, without increasing the occurrence of negative maternal and neonatal outcomes.

Collaborations

WL Cunha: conception, analysis, interpretation of results, and manuscript writing. VB Paravidino: conception, analysis, interpretation of results, final revision. MC Leal: funding, data collection, conception, interpretation of results, final revision. RMSM Domingues: funding, data collection, conception, interpretation of results, final revision. APE Pereira: funding, data collection, conception, final revision. DB Cunha: interpretation of results, final revision. E Verly Junior: interpretation of results, final revision. ES Marques: conception, interpretation of results, final revision. TH Leite: conception, analysis, interpretation of results, final revision.

Funding

Bill and Melinda Gates Foundation - OPP1142172. DECIT/MoH Brazil/CNPq - 401715/2015-9.

Data availability statement

The data sources adopted in the research are indicated in the article's body.

References

1. World Health Organization (WHO). *Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division: executive summary* [Internet]. [cited 2024 jul 4]. Available from: <https://www.who.int/publications/i/item/9789240069251>.
2. Abalos E, Cuesta C, Carroli G, Qureshi Z, Widmer M, Vogel JP, Souza JP; WHO Multicountry Survey on Maternal and Newborn Health Research Network. Pre-eclampsia, eclampsia and adverse maternal and perinatal outcomes: a secondary analysis of the World Health Organization Multicountry Survey on Maternal and Newborn Health. *BJOG* 2014; 121(Supl. 1):14-24.
3. Linhares JJ, Macêdo NM, Arruda GM, Vasconcelos JL, Saraiva TV, Ribeiro AF. Fatores associados à via de parto em mulheres com pré-eclâmpsia. *Rev Bras Ginecol Obstet* 2014; 36(6):259-263.
4. Koopmans CM, Bijlenga D, Groen H, Vijgen SM, Aarnoudse JG, Bekedam DJ, Berg PP, Boer K, Burggraaf JM, Bloemenkamp KW, Drogtróp AP, Franx A, Groot CJ, Huisjes AJ, Kwee A, Loon AJ, Lub A, Papatonis DN, Post JA, Roumen FJ, Scheepers HC, Willekes C, Mol BW, Pampus MG; HYPITAT study group. Induction of labour versus expectant monitoring for gestational hypertension or mild pre-eclampsia after 36 weeks' gestation (HYPITAT): a multicentre, open-label randomised controlled trial. *Lancet* 2009; 374(9694):979-988.
5. Amorim MMR, Katz L, Barros AS, Almeida TS, Souza AS, Faúndes A. Maternal outcomes according to mode of delivery in women with severe pre-eclampsia: a cohort study. *J Matern Fetal Neonatal Med* 2015; 28(6):654-660.
6. Esteves-Pereira AP, Deneux-Tharaux C, Nakamura-Pereira M, Saucedo M, Bouvier-Colle MH, Leal MC. Caesarean Delivery and Postpartum Maternal Mortality: A Population-Based Case Control Study in Brazil. *PLoS One* 2016; 11(4):e0153396.
7. Nakamura-Pereira M, Carmo Leal M, Esteves-Pereira AP, Domingues RM, Torres JA, Dias MA, Moreira ME. Use of Robson classification to assess cesarean section rate in Brazil: the role of source of payment for childbirth. *Reprod Health* 2016; 13(Supl. 3):128.
8. Nacional de Saúde Suplementar (ANS - Brasil). *Cartilha nova organização do cuidado ao parto e nascimento para melhores resultados de saúde: Projeto Parto Adequado - fase 1*. Rio de Janeiro: ANS; 2016.
9. Torres JA, Leal MDC, Domingues RMSM, Esteves-Pereira AP, Nakano AR, Gomes ML, Figueiró AC, Nakamura-Pereira M, Oliveira EFV, Ayres BVDS, Sandall J, Belizán JM, Hartz Z. Evaluation of a quality improvement intervention for labour and birth care in Brazilian private hospitals: a protocol. *Reprod Health* 2018; 15(1):194.
10. Leal MC, Domingues RMSM, Fonseca TCO, Leite TH, Figueiró AC, Pereira APE, Theme-Filha MM, Ayres BVS, Scott O, Sanchez RC, Borem P, Osti MCM, Rosa MW, Andrade AS, Peixoto Filho FM, Nakamura-Pereira M, Torres JA. The effects of a quality improvement project to reduce caesarean sections in selected private hospitals in Brazil. *Reprod Health* 2024; 20(Supl. 2):194.

11. World Health Organization (WHO). *Robson Classification: Implementation Manual*. Geneva: WHO; 2017.
12. Say L, Souza JP, Pattinson RC; WHO working group on Maternal Mortality and Morbidity classifications. Maternal near miss--towards a standard tool for monitoring quality of maternal health care. *Best Pract Res Clin Obstet Gynaecol* 2009; 23(3):287-296.
13. Pileggi-Castro C, Camelo Jr JS, Perdoná GC, Musisi-Pinhata MM, Cecatti JG, Mori R, Morisaki N, Yunis K, Vogel JP, Tunçalp Ö, Souza JP; WHO Multicountry Survey on Maternal and Newborn Health Research Network. Development of criteria for identifying neonatal near-miss cases: analysis of two WHO multicountry cross-sectional studies. *BJOG* 2014; 121(Supl. 1):110-118.
14. Silva AAM, Leite ÁJM, Lamy ZC, Moreira MEL, Gurgel RQ, Cunha AJLA, Leal MC. Morbidade neonatal near miss na pesquisa Nascir no Brasil. *Cad Saude Publica* 2014; 30(Supl. 1):S182-S191.
15. Brasil Ministério da Saúde (MS). *Manual de Gestão de Alto Risco*. Brasília: MS; 2022.
16. Torres JA, Leite TH, Fonseca TCO, Domingues RMSM, Figueiró AC, Pereira APE, Theme-Filha MM, Ayres BVS, Scott O, Sanchez RC, Borem P, Osti MCM, Rosa MW, Andrade AS, Peixoto Filho FM, Nakamura-Pereira M, Leal MC. An implementation analysis of a quality improvement project to reduce cesarean section in Brazilian private hospitals. *Reprod Health* 2024; 20(Supl. 2):190.
17. Domingues RMSM, Dias MAB, Nakamura-Pereira M, Torres JA, Orsi E, Pereira APE, Schilithz AOC, Leal MC. Processo de decisão pelo tipo de parto no Brasil: da preferência inicial das mulheres à via de parto final. *Cad Saude Publica* 2014; 30(Supl. 1):S101-S116.
18. Medeiros PB, Bailey C, Andrews C, Liley H, Gordon A, Flenady V. Neonatal near miss: A review of current definitions and the need for standardisation. *Aust N Z J Obstet Gynaecol* 2022; 62(3):358-363.
19. Kale PL, Jorge MHPM, Laurenti R, Fonseca SC, Silva KS. Pragmatic criteria of the definition of neonatal near miss: a comparative study. *Rev Saude Publica* 2017; 51:111.

Article submitted 20/09/2024

Approved 05/11/2024

Final version submitted 07/11/2024

Chief editors: Maria Cecília de Souza Minayo, Romeu Gomes, Antônio Augusto Moura da Silva, Vania de Matos Fonseca

