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**ORIGINAL ARTICLE**

# Temporal Trend and Spatial Distribution of Birth Route Rates According to Maternal Characteristics in Brazil, Between 2011 and 2020

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**Highlights**

(1). The study revealed a decline in vaginal birth rates, following a tendency for cesarean section rates to remain constant. (2). Women under 20 years of age and with less than eight years of education had higher rates of vaginal birth, when compared to cesarean section. (3). We also emphasize the need to adapt health services to follow WHO recommendations and the pregnant woman's wishes.

## ABSTRACT

*Objective*: analyzing the temporal trend and the spatial distribution of the rates of birth routes, according to the sociodemographic characteristics of the Brazilian mother. *Method*: an ecological time series study with spatial distribution of birth rates in Brazil, from 2011 to 2020. Data were selected from the Live Birth Information System. The polynomial regression model was used for trend analysis. *Results*: 29,025,461 births were analyzed. Of these, 57.22% were cesarean sections and 42.70% were vaginal births. There was an increase in cesarean section rates in all Brazilian regions, except in the Southeast, where there was an increase in vaginal birth. Among the women who had vaginal birth, most were adolescents, with low education and without a partner. The spatial distribution of cesarean section rates indicated concentration of states with high rates of this mode of birth especially in the South, Southeast and Midwest regions. *Conclusion*: cesarean section is the predominant mode of birth in Brazil, with a constant trend and variations between regions and states. Improvement in training, continuing education of health professionals and quality guidance for pregnant women and the community are essential to ensure quality health care during the perinatal period.

**Keywords:** childbirth; cesarean section; maternal health.

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## INTRODUCTION

With the advancement of science and the creation of the technocratic model, childbirth began to be seen as a pathology and the woman as a patient. This was the trigger for the change of home birth, conducted by midwives, with minimal unnecessary medical interventions, for childbirth in the hospital environment, performed by doctors. Thus, from an event without intervention and natural, childbirth became a highly medicalized event, with complications and loss of female autonomy, often permeated by obstetric violence[1].

Created to save the life of the mother and/ or baby when performed under careful indication, cesarean section has been performed indiscriminately, with rates that continue to increase worldwide[2]. However, since 1985, the World Health Organization (WHO) recommends that there is no justification for cesarean section rates higher than 15% of the total number of birth[3].

Studies show that performing cesarean sections without indication is associated with unfavorable perinatal outcomes for both mother and baby[4]. There is evidence that maternal deaths caused by cesarean sections are higher compared to vaginal[4]. In addition, the risks for anesthetic, urological, thromboembolism, infections, hemorrhages, dyspareunia and hysterectomy increase[5].

Another important point to be noted is that as the number of cesarean sections increases in the same woman, there is an increased risk of uterine rupture that, although it can be considered a rare event, when it occurs is of important severity, related to the possible need for hysterectomy, in addition to maternal and neonatal death6.

Brazil has the second highest cesarean rate in the world, behind only the Dominican Republic (58.1%)[2]. In 2019, of the 2,849,146 births recorded in Brazil, about 56.3% were performed by cesarean section[7], far exceeding the recommended by the WHO.

The high rates of cesarean section can be explained by several factors, one of which is the possibility of acute pain in labor and vaginal parturition[8]. In Brazil, an important factor related to high rates of cesarean section is most of this mode of birth in the private health service, associated with greater women's decision-making power, fear of pain and medical convenience, often disregarding perinatal risks[9].

The epidemic of cesarean sections performed in Brazil, as well as the apparent increase in the rates of this route of birth, justifies the need for surveillance and continuous monitoring of the rates of birth routes in the country, also considering the maternal sociodemographic characteristics. In this sense, this study aimed to analyze the temporal trend and spatial distribution of the rates of birth routes, according to the characteristics of the Brazilian mother.

## METHOD

This is an ecological study of time series, with spatial distribution of the rates of birth routes, according to the maternal characteristics of live births of mothers living in Brazil, occurred from 2011 to 2020.

Brazil has a total area of approximately 8.5 million square kilometers, representing 47% of South America. It is the fifth most populous country in the world, with 203,062,512 inhabitants in 2022, registering in the last census released (2010) a Human Development Index of 0.759. The country is composed of 27 federal units, grouped into five major regions, North, Northeast, South, Southeast and Midwest[10].

The data of the birth routes, separated by "vaginal", "cesarean" and "ignored" were collected according to region of residence in Brazil, through the Information System on Live Births (Sinasc),

available publicly on the website of the Department of Informatics of the Unified Health System (SUS – Datasus). The trend analysis was performed according to the mode of birth, according to maternal characteristics. The rates of vaginal birth and cesarean section were calculated year by year, by the ratio between the number of births according to type of birth, and the total number of births, multiplied by 100.

Subsequently, trend analysis was performed using polynomial regression, considering the rates of cesarean section and vaginal birth as dependent variables (Y), while the of the study calendar were considered independent variables (X). The moving averages of three points for data analysis were calculated, in addition to the centralization of the mean year of the study (year – 2015). We tested the simple linear regression model and then the second and third order models, when necessary. The principle of parsimony in the choice of models was observed, as well as a significant trend when the estimated model obtained p value <0.05.

The calculations of the rates of the historical series were elaborated in spreadsheets of Excel® and the polynomial regression analyzes were performed in the Statistical Package for Social Sciences (SPSS), version 20.0.

The cartographic base for the construction of the maps was downloaded in shapefile format (SHP) on the IBGE website. The spatial distribution of cesarean section rates was presented in intervals, considering the minimum to maximum rates, in rose scales, defining lighter tones for the lower rates and darker tones for the higher rates. The relative risk was also calculated and demonstrated in a map, in which light tones represent a protective factor and dark ones a risk factor for the occurrence of cesarean section. The figures were built in QGIS software version 3.10.

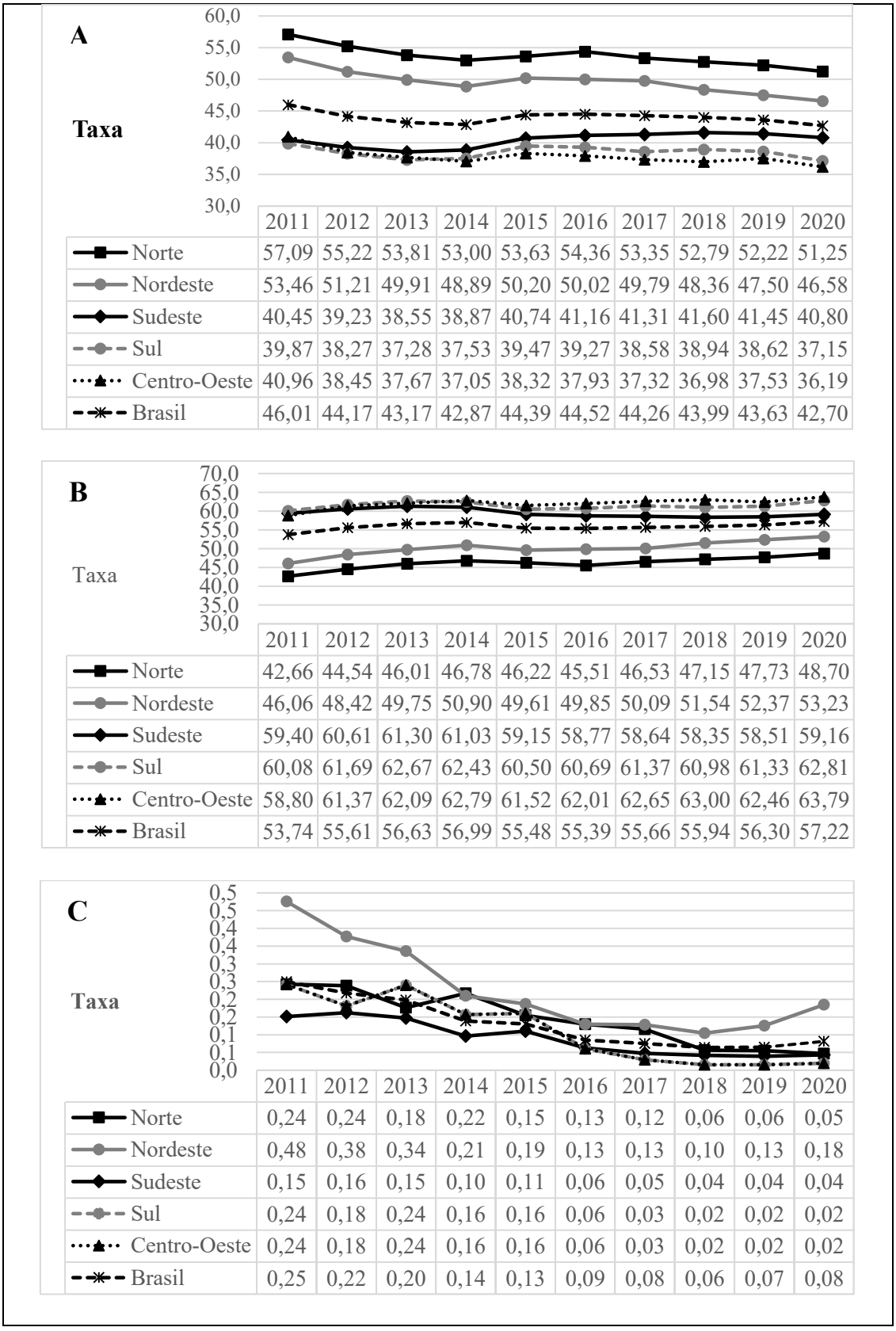
The study used exclusively secondary, non-nominal data in accordance with Resolution N 510 of 7 April 2016. Because it is a research with secondary data available on a public platform, it was not necessary to evaluate it with a Permanent Committee of Ethics in Research involving Human Beings[11].

## RESULTS

We analyzed 29,025,461 births of residents in Brazil, from 2011 to 2020. Over 10, there has been a decline in vaginal birth rates in the country, from 46.01% in 2011 to 42.70% in 2020. The only region where there was no reduction in vaginal birth rates is the Southeast region, which had a rate of 40.45% in 2011 and 40.80% in 2020 (Figure 1A).

Regarding cesarean sections, Brazil recorded an increase in the rate, from 53.74% in 2011 to 57.22% in 2020. Behavior like that observed between the regions of the country, especially the South and Midwest, where the rates were more expressive. On the other hand, the Southeast region maintained the indexes in the period (Figure 1B).

There was a significant nationwide decline in births whose birth route was filled as ignored. In 2011, these cases accounted for 0.25% of live births, falling to 0.08% in 2020. The region with the most significant reduction was the Northeast, with proportions ranging from 0.48% to 0.18% in the period (Figure 1C).




| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Norte | 57,09 | 55,22 | 53,81 | 53,00 | 53,63 | 54,36 | 53,35 | 52,79 | 52,22 | 51,25 |
| Nordeste | 53,46 | 51,21 | 49,91 | 48,89 | 50,20 | 50,02 | 49,79 | 48,36 | 47,50 | 46,58 |
| Sudeste | 40,45 | 39,23 | 38,55 | 38,87 | 40,74 | 41,16 | 41,31 | 41,60 | 41,45 | 40,80 |
| Sul | 39,87 | 38,27 | 37,28 | 37,53 | 39,47 | 39,27 | 38,58 | 38,94 | 38,62 | 37,15 |
| Centro-Oeste | 40,96 | 38,45 | 37,67 | 37,05 | 38,32 | 37,93 | 37,32 | 36,98 | 37,53 | 36,19 |
| Brasil | 46,01 | 44,17 | 43,17 | 42,87 | 44,39 | 44,52 | 44,26 | 43,99 | 43,63 | 42,70 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Norte | 42,66 | 44,54 | 46,01 | 46,78 | 46,22 | 45,51 | 46,53 | 47,15 | 47,73 | 48,70 |
| Nordeste | 46,06 | 48,42 | 49,75 | 50,90 | 49,61 | 49,85 | 50,09 | 51,54 | 52,37 | 53,23 |
| Sudeste | 59,40 | 60,61 | 61,30 | 61,03 | 59,15 | 58,77 | 58,64 | 58,35 | 58,51 | 59,16 |
| Sul | 60,08 | 61,69 | 62,67 | 62,43 | 60,50 | 60,69 | 61,37 | 60,98 | 61,33 | 62,81 |
| Centro-Oeste | 58,80 | 61,37 | 62,09 | 62,79 | 61,52 | 62,01 | 62,65 | 63,00 | 62,46 | 63,79 |
| Brasil | 53,74 | 55,61 | 56,63 | 56,99 | 55,48 | 55,39 | 55,66 | 55,94 | 56,30 | 57,22 |

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Norte | 0,24 | 0,24 | 0,18 | 0,22 | 0,15 | 0,13 | 0,12 | 0,06 | 0,06 | 0,05 |
| Nordeste | 0,48 | 0,38 | 0,34 | 0,21 | 0,19 | 0,13 | 0,13 | 0,10 | 0,13 | 0,18 |
| Sudeste | 0,15 | 0,16 | 0,15 | 0,10 | 0,11 | 0,06 | 0,05 | 0,04 | 0,04 | 0,04 |
| Sul | 0,24 | 0,18 | 0,24 | 0,16 | 0,16 | 0,06 | 0,03 | 0,02 | 0,02 | 0,02 |
| Centro-Oeste | 0,24 | 0,18 | 0,24 | 0,16 | 0,16 | 0,06 | 0,03 | 0,02 | 0,02 | 0,02 |
| Brasil | 0,25 | 0,22 | 0,20 | 0,14 | 0,13 | 0,09 | 0,08 | 0,06 | 0,07 | 0,08 |

Figure 1 – Historical series of rates of birth routes (A – vaginal delivery; B – cesarean section; C – Unknown), according to region of residence. Brazil, 2011 to 2020.

Polynomial regression analysis showed a constant trend of vaginal birth in Brazil ($p$=0.814) and in the South ($p$=0.340), also visualized through correlation coefficients, which suggest weak correlation between variables. The Southeast region was the only one with an increasing trend in vaginal birth rates, with an average increase of 0.38% per year ($r^2$=0.84). The North, Northeast and Midwest regions showed a decreasing trend, with an average annual reduction of 0.34%, 0.43% and 0.21%, respectively. It is worth noting that the Midwest region had the lowest average rate of vaginal birth (37.81%) and the North region the highest average rate (53.76%) (Figure 2).

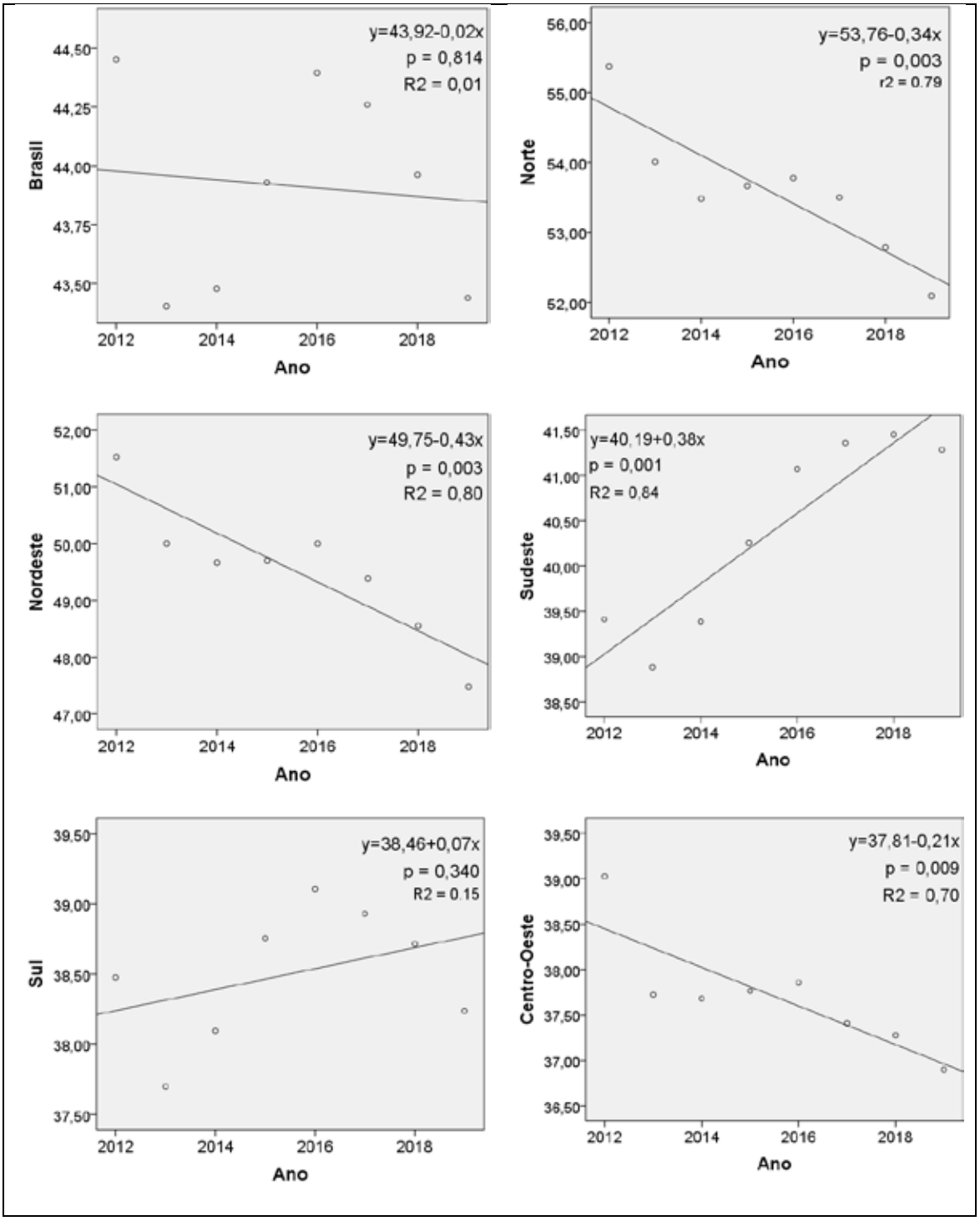



Figure 2 – Trend in vaginal birth rates, according to region of residence. Brazil, 2011 to 2020.

In the analysis of the trend of cesarean sections, it was observed that this was not statistically significant for Brazil ($p$=0.590) and the South region ($p$=0.324), also showing a constant trend for this mode of birth in these strata, as well as for vaginal birth. The only region with a reduction in cesarean birth rates was the Southeast region, with an average reduction of 0.37% per year ($r^2$=0.83). The Midwest, North and Northeast regions showed an increasing trend, with an average annual increase of 0.25%, 0.37% and 0.47%, respectively. It should be noted that the North region presented the lowest mean cesarean birth rate (46.09%) and the Midwest region the highest average rate (62.06%) (Figure 3).

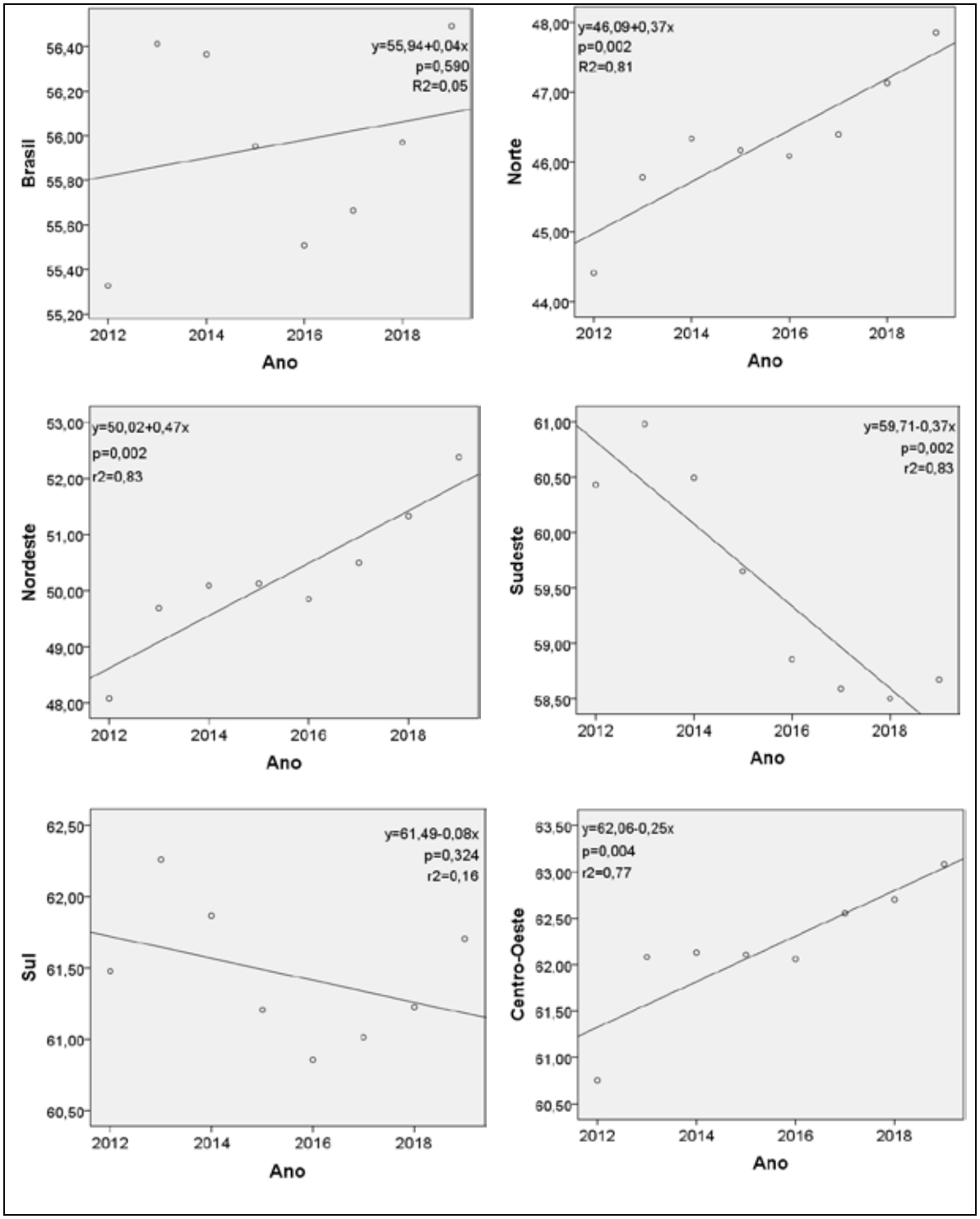



Figure 3 – Trend in cesarean section rates, according to region of residence. Brazil, 2011 to 2020.

Regarding maternal characteristics, the polynomial regression analysis showed differences according to the birth route. Regarding age, the average rate of adolescent women was higher in vaginal birth compared to cesarean section (24.27% and 12.69%, respectively), with a decreasing trend for both birth routes. In relation to women aged 35 or more, there was a higher prevalence of cesarean sections, with an increasing trend in both birth routes (Table 1).

Table 1 – Trend of maternal characteristics, according to mode of birth. Brazil, 2011 to 2020

| | Average rate | β1 | r2 | *p* | Trend |
|---|---|---|---|---|---|
| **Vaginal birth** | | | | | |
| **Maternal age** | | | | | |
| < 20 years | 24.27 | -0.76 | 0.93 | <0.001 | ↓ |
| 20 to 34 years | 66.64 | +0.31 | 0.82 | 0.002 | ↑ |
| 35 and more | 9.09 | +0.45 | 0.98 | <0.001 | ↑ |
| **Education** | | | | | |
| <8 years | 30.33 | -2.40 | 0.99 | <0.001 | ↓ |
| ≥8 years | 67.90 | +2.51 | 0.99 | <0.001 | ↑ |
| **Partner** | | | | | |
| Yes | 48.48 | +0.64 | 0.58 | 0.028 | ↑ |
| No | 50.22 | -0.61 | 0.54 | 0.037 | ↓ |
| **Type of pregnancy** | | | | | |
| Only | 99.08 | +0.01 | 0.66 | 0.014 | ↑ |
| Double and more | 0.80 | -0.02 | 0.94 | <0.001 | ↓ |
| **Cesarean section** | | | | | |
| **Maternal age** | | | | | |
| < 20 years | 12.69 | -0.62 | 0.97 | <0.001 | ↓ |
| 20 to 34 years | 71.07 | -0.28 | 0.99 | <0.001 | ↓ |
| 35 and more | 16.24 | +0.90 | 0.99 | <0.001 | ↑ |
| **Education** | | | | | |
| <8 years | 16.30 | -1.23 | 0.98 | <0.001 | ↓ |
| ≥8 years | 82.17 | +1.35 | 0.98 | <0.001 | ↑ |
| **Partner** | | | | | |
| Yes | 60.62 | -0.37 | 0.36 | 0.117 | - |
| No | 38.33 | +0.41 | 0.41 | 0.085 | - |
| **Type of pregnancy** | | | | | |
| Only | 96.81 | -0.04 | 0.92 | <0.001 | ↓ |
| Double and more | 3.08 | +0.05 | 0.98 | <0.001 | ↑ |

Regarding schooling, the results show a higher average rate of low schooling among women who had vaginal birth, and a tendency to reduce vaginal birth and cesarean sections in women with less than eight of schooling. Women with a partner (married or in consensual union) comprised the largest proportion of cesarean sections and smaller among those with vaginal birth. In addition, there was an increase in single pregnancy in vaginal birth ($p$=0.014) and increased double pregnancy and more when birth was by cesarean section ($p$<0.001) (Table 1).

The spatial distribution of cesarean sections showed concentration of the most significant average rates of this mode of birth in the South, Southeast and Midwest regions. On the other hand, the states with lower rates were concentrated in the North and Northeast of the country. In the same sense, states with higher relative risk for cesarean birth were grouped in the South, Southeast and Midwest of Brazil (Figure 4).

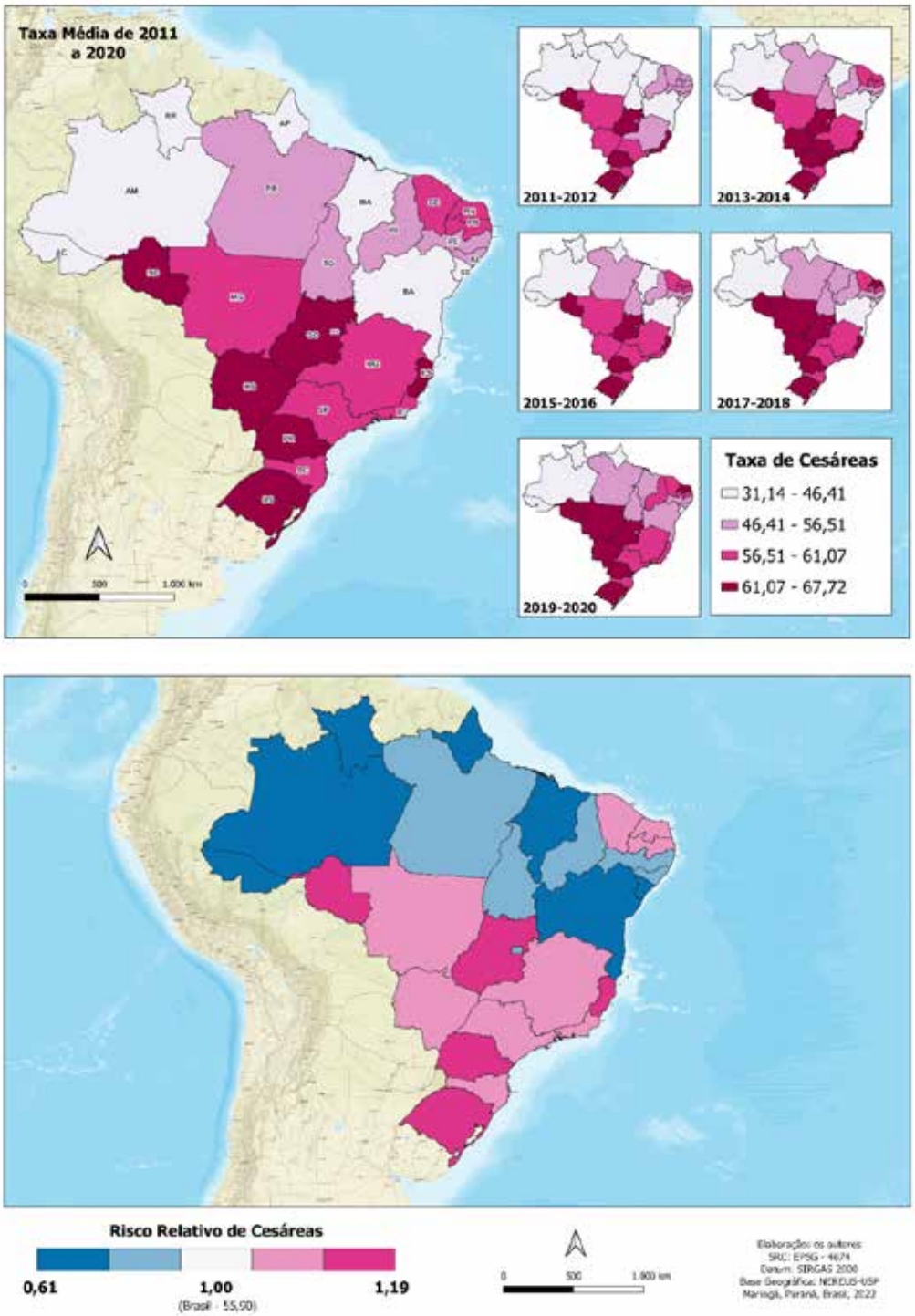



Figure 4 – Spatial distribution and relative risk of cesarean section rates, according to state of residence. Brazil, 2011 to 2020.

## DISCUSSION

The present study performed temporal analysis and spatial distribution of the rates of birth routes in Brazil, according to maternal characteristics, from 2011 to 2020. There was a decline in vaginal birth rates in the country, except for the Southeast. In addition, the national rate of cesarean section in 2020 (57.22%) represented 3.8 times more than that recommended by the WHO[3].

Researchers highlight the desire of women for cesarean section due to the belief in reducing their suffering and pain during the period of childbirth. The fear of suffering in vaginal birth occurs, in many cases, due to lack of information or understanding, with the false conception that cesarean section is an easier process, with greater probability of scheduling and control over the birth, less risky, with fewer complications, and with the possibility of tubal ligation during the procedure[12]. A systematic review study identified that among the factors that most influence women by opting for cesarean section are medical influence, clinical indication and fear of pain[13].

In Brazil, it has become common sense that cesarean section is the best and safest way of birth[13]. Studies seek to understand this choice, in addition to the maternal factors mentioned above, there are medical factors, such as convenience, better compensation and shorter duration of the procedure. For several professionals, surgical intervention is justified to reduce maternal and neonatal mortality. However, scientific evidence shows that the natural process of childbirth contributes to a decrease in infection rates and perinatal complications[13].

It is worth mentioning that in more developed countries than Brazil, cesarean rates are close to the recommendations of up to 15% of WHO, such as the Netherlands, Finland and Norway with rates around 16%, Russia with 13% and Switzerland with 11.3%. On the other hand, England and Canada have about 27% cesarean sections, and France and Japan 20%. Portugal, Poland and Italy, followed by Australia and the United States the rates are between 30 and 35%[14].

As for the regions of Brazil, the highest rates of cesarean sections were concentrated in the South and Midwest regions. Studies have shown that the increase in cesarean sections in the country occurs unevenly. An integrative review, with data from 2015 to 2020, indicates an intimate relationship between cesarean section and cultural, social and economic factors[8].

The only region in the country where there was an increase in vaginal birth rates was the Southeast region. In Minas Gerais, there is an attempt to offer humanized care in the period prior to birth, during birth and in the postpartum period[15]. In addition, the state of São Paulo and the metropolitan region I of the state of Rio de Janeiro have, since 2015, specific laws implemented to encourage humanized childbirth and the protection of the rights of women and children, which may have contributed to increased rates of vaginal birth in the region[16-17].

Regarding the polynomial regression analysis of maternal characteristics in Brazil, differences are observed according to the mode of birth. Regarding age, the average rate of adolescent women was higher in vaginal birth compared to cesarean section, but with a decreasing trend for both birth routes. This data is in line with previous research that showed a trend of reduction of 3.5% per year in the fertility rate among Brazilian adolescents. This reduction was attributed to SUS Public Policies, such as the Family Health Strategy (FHS) and the School Health Program (SHP)[18]. Another fact to consider is the woman's desire to become a qualified professional, aiming for a field of work that brings her financial security, which results in a tendency to postpone motherhood[19].

In view of the results shown, that the adolescent woman had a higher rate of vaginal birth, this may be related to the fact that the adolescent has psychosocial immaturity in relation to older women, or because it has a disadvantaged socioeconomic condition and depends solely on the SUS[20].

In this context, we recall that on March 5, 2021, Law 768/2021 was approved, which guarantees the pregnant woman the right to choose the birth route also in the Unified Health System – SUS, as well as the use of analgesia, even when choosing the normal birth, since the medical indications have been observed[21]. However, until the conclusion of this study, no studies were found in the scientific literature that discussed the factors related to the choice of the new research is needed to investigate its impact on birth indicators in the country.

In relation to women aged 35 and over, there is a higher prevalence among those who had cesarean section, as well as an increasing trend in both birth routes. Financial independence, access to information, better socioeconomic status and the spread of contraceptive methods are some of the factors that stimulate the decision for late gestation[22]. In addition, the desires of modern women are no longer restricted only to motherhood, there are other possibilities that awaken satisfaction and happiness, such as academic and professional career[23]. One of them showed that women with better socioeconomic status make up the majority of cesarean part[24].

According to several studies conducted in Brazil, women with better education and higher financial income were submitted to cesarean sections according to their maternal desires, reinforcing the idea that the choice of the mode of birth is more associated with financial issues than the medical indications themselves[25-27]. The results show even higher prevalence of low schooling among women who had vaginal birth. Women with low schooling tend to be those with lower socioeconomic status, reinforcing the statements in the literature, which observed that the choice of birth route is associated with financial issues[25-27].

Women with a partner (married or in consensual union) comprised the largest proportion of cesarean sections and smaller among those with vaginal birth. A support network is essential in the face of a moment as unique as pregnancy. The woman goes through physical, emotional and psychological changes, and the support of the partner is fundamental in the face of the choices regarding the way of birth, from the accompaniment in the consultations, to the preparation for the arrival of the baby as support to the woman during so many changes[28], support and greater financial contribution. The absence of a partner among women with vaginal birth also reinforces the claims regarding the association of the birth route with financial questions[25-27].

The spatial distribution of rates and the analysis of the relative risk for the occurrence of cesarean sections indicated that the states with high numbers of this route of birth belong to the South, Southeast and Midwest Brazilians, socioeconomically favored regions. This situation corroborates other studies in the sense that the choice of cesarean section is influenced by cultural, social and economic factors[8] and that women with higher socioeconomic status represent the majority of cesarean births[24].

The decision by way of birth should be analyzed and taken together with the woman, respecting her autonomy and providing scientifically based information, from prenatal care to the moment of birth[29]. For this to occur in a clear and effective way is fundamental for the decision of the way of birth, an approach of the professional with the pregnant woman, clarifying their doubts and anxieties about their choice. Because of the fragmented care in the SUS, there is a lack of communication among professionals, and thus the inability to provide continuous quality care with better health results[30].

As a limitation of this research, the absence of the record of the way of birth represented in 2020 in 0.08% of the records stands out. Quality information and up-to-date databases are necessary for health situation analysis and evidence-based decision-making[31].

## CONCLUSION

The present study revealed a decline in vaginal birth rates in Brazil in the period analyzed. Brazil continues with a constant trend of cesarean section rates already considered high, and the Southeast region is the only one to show a decreasing trend. Women under 20 of age and less than eight of schooling had higher rates of vaginal birth when compared to cesarean section.

Despite the initiatives of the public and private sector, with recommendations and encouragement of vaginal birth, the prospect that Brazil will reach 15% of the total cesarean birth,

recommended by the WHO, is not yet glimpsed. Cesarean section stands out in the scenario, with high rates of caesarean sections on request or based on non-clinical indications, such as convenience of scheduling, fears and myths, which characterizes the current obstetric profile. For changes to occur, more effective public policies are needed that contain the unnecessary performance of this surgical procedure.

By the trend analysis carried out in this study, cesarean sections will continue to be high, which emphasizes the need for elaboration of new conducts aimed at their reduction. Family planning and excellent prenatal care, with emphasis on the quality of health services, can contribute to reducing the rate of cesarean section. We highlight the importance of the academic training of health professionals, especially obstetrics, so that it is aligned with good practices, humanization of care and promotion of safe birth and birth. We also emphasize the need for adequacy of health services to follow the recommendations of the WHO and the wishes of the pregnant woman.

The results of this study portray the increase in cesarean birth over time and the characteristics of women in both birth routes, contributing to the direction of awareness actions. However, new studies are necessary for the analysis of the consequences on the health of the population.

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