

# CUIDADO É FUNDAMENTAL

Escola de Enfermagem Alfredo Pinto – UNIRIO

RESEARCH

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## DISTRIBUTION AND SPATIAL AUTOCORRELATION OF MATERNAL MORTALITY FROM PREECLAMPSIA AND ECLAMPSIA IN BRAZIL

*Distribuição e autocorrelação espacial da mortalidade materna por pré-eclâmpsia e eclâmpsia no Brasil*  
*Distribución y autocorrelación espacial de la mortalidad materna por preeclampsia y eclampsia en Brasil*

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### ABSTRACT

**Objective:** to analyze the distribution and spatial autocorrelation of maternal mortality rates from preeclampsia and eclampsia in Brazil. **Method:** an ecological, cross-sectional study of mortality rates from preeclampsia and eclampsia in women residing in Brazil in 2019. Rates were calculated according to state and region of residence. Spatial dependence was analyzed by the Global and Local Moran autocorrelation coefficient. **Results:** 278 deaths were analyzed (9.7 deaths/100.000 live births). Spatial autocorrelation indicated a high-high cluster involving the North and Northeast regions and a single low-low cluster in the South. There was a predominance of deaths in women aged 20 to 34 years (60.79%), with eight or more years of study (55.04%), without a partner (63.31%), occurring in a hospital environment (92.81%) and black/brown (70.50%). **Conclusion:** the disparities in the distribution of maternal mortality rates show the need for public policies that consider the specificities of each location for prevention actions.

**DESCRIPTORS:** Maternal mortality; Preeclampsia; Eclampsia.

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## RESUMO

**Objetivo:** analisar a distribuição e autocorrelação espacial das taxas de mortalidade materna por pré-eclâmpsia e eclâmpsia no Brasil. **Método:** estudo ecológico, transversal, das taxas de mortalidade por pré-eclâmpsia e eclâmpsia de mulheres residentes no Brasil, em 2019. Foram calculadas as taxas, segundo estado e região de residência. A dependência espacial foi analisada pelo coeficiente de autocorrelação de Moran Global e Local. **Resultados:** foram analisados 278 óbitos (9,7/100 mil nascidos vivos). A autocorrelação espacial indicou um aglomerado alto-alto envolvendo o Norte e Nordeste e um único aglomerado baixo-baixo no Sul. Houve predomínio de óbitos em mulheres de 20 a 34 anos (60,79%), com oito anos ou mais de estudo (55,04%), sem companheiro (63,31%), ocorrência no ambiente hospitalar (92,81%), e de cor preta/parda (70,50%). **Conclusão:** as disparidades na distribuição das taxas de mortalidade materna mostram a necessidade de políticas públicas que considerem as especificidades de cada local para ações de prevenção.

**DESCRITORES:** Mortalidade materna; Pré-eclâmpsia; Eclâmpsia.

## RESUMEN

**Objetivo:** analizar la distribución y autocorrelación espacial de las tasas de mortalidad materna por preeclampsia y eclampsia en Brasil. **Método:** estudio transversal ecológico de las tasas de mortalidad por preeclampsia y eclampsia en mujeres residentes en Brasil en 2019. Las tasas se calcularon según el estado y la región de residencia. La dependencia espacial se analizó mediante el coeficiente de autocorrelación Global y Local de Moran. **Resultados:** se analizaron 278 defunciones (9,7 defunciones/100.000 nacidos vivos). La autocorrelación espacial indicó un grupo alto-alto que involucraba las regiones norte y noreste y un solo grupo bajo-bajo en el sur. Predominaron las defunciones en mujeres de 20 a 34 años (60,79%), con ocho o más años de estudio (55,04%), sin pareja (63,31%), ocurridas en ambiente hospitalario (92,81%) y negras/ marrón (70,50%). **Conclusión:** las disparidades en la distribución de las tasas de mortalidad materna muestran la necesidad de políticas públicas que consideren las especificidades de cada localidad para las acciones de prevención.

**DESCRIPTORES:** Mortalidad materna; Preeclampsia; Eclâmpsia.

## INTRODUCTION

Preeclampsia is a pregnancy-specific hypertensive disorder that in its severe forms, eclampsia and hellp syndrome, represents one of the leading causes of maternal mortality in the world.<sup>1</sup> Of unknown etiology, it usually appears after the 20th week of gestation, when hypertension with proteinuria occurs.<sup>2</sup>

Estimates indicate that more than half a million women die each year from causes related to hypertensive disorders during pregnancy. In addition, about 10 million are left with sequelae from complications suffered in the gravid-puerperal cycle, thereby increasing long-term cardiovascular risk.<sup>3-4</sup>

Preeclampsia affects 2% to 8% of all pregnancies worldwide, and overall, 10% to 15% of direct maternal deaths are associated with preeclampsia and eclampsia.<sup>5-6</sup> In the United States, the epidemiological profile of maternal death is black women (rate of 42.8 per 100,000 live births), without a partner (22.8/100,000 live births) and with low education (24.2/100,000 live births), with hypertensive disorders in pregnancy being an important cause.<sup>7</sup>

In Brazil, in the period from 2010 to 2017, pre-eclampsia was the second leading cause of maternal mortality (10.48%), surpassed only by eclampsia (14.06%). When analyzing by regions of the country, it was also found that the most affected regions were the Southeast with 329 deaths from preeclampsia (35%), and the Northeast with 326 deaths (34.6%), followed by the North (10.8%), Midwest (10.2%) and lastly the South (9.4%).<sup>8</sup>

Although the causes for its occurrence are not fully known, among the main risk factors are nulliparity, severe hypertensive

syndromes in the previous pregnancy, chronic diseases (diabetes, hypertension, kidney disease, and thrombophilias), obesity, twin pregnancy, and gestational trophoblastic disease.<sup>5</sup>

In this scenario, pre-eclampsia and eclampsia remain a public health problem that is difficult to solve. The high number of deaths shows the need for improvements in prevention and coping strategies, since maternal deaths from these causes could be preventable through qualified assistance. In this sense, the link between prenatal and childbirth, with at least the minimum number of prenatal consultations, quality guidance, investigation of family and personal history of the pregnant woman contribute to the identification of any warning signs.<sup>9</sup>

Maternal death goes far beyond epidemiological data, it indicates the health situation of women related to the quality of prenatal care and socioeconomic conditions.<sup>10</sup> Considering that the maternal mortality ratio is still high throughout the country, maintaining important regional differences, and that preeclampsia and eclampsia are among the main causes of these deaths, this work aims to analyze the distribution and spatial autocorrelation of maternal mortality rates for preeclampsia and eclampsia in Brazil.

## METHOD

This is an ecological, cross-sectional study of maternal mortality rates for pre-eclampsia and eclampsia of residents in Brazil in the year 2019.

Brazil is located in South America, bordering 10 other countries of the American continent, except only Chile and Ecuador. It is the fifth largest country in the world and occupies an area of 8,510,345.538 km<sup>2</sup>. It has a population of more than 211 million inhabitants, is divided into 27 states and 5570 municipalities.<sup>11</sup>

Data on maternal deaths from preeclampsia and eclampsia were obtained from the Sistema de Informações sobre Mortalidade (SIM), available online at the Departamento de Informática do SUS (Datasus). The year 2019 was selected in order to obtain quantitatively adequate sample for data analysis and updated.

For the selection of maternal deaths from preeclampsia and eclampsia, the International Classification of Diseases in its tenth revision (CID-10) was used, and the deaths classified as O14 – Gestational [pregnancy-induced] hypertension with significant proteinuria; and O15 – Eclampsia were selected. Maternal deaths from preeclampsia and eclampsia were then analyzed considering the variables: age (<20 years, 20 to 34, 35 and more), education (< 8 years; ≥ 8 years), race/color (white, black/black, yellow, and indigenous), partner (yes = married, living together; no = single, widowed, separated), place of occurrence (hospital; other).

The analyses were performed using descriptive statistics, represented by absolute and relative frequencies, and calculation of maternal mortality rates (MST). The MST was calculated by the ratio of the number of maternal deaths from preeclampsia/eclampsia divided by the number of live births in the same place and year, multiplied by 100 thousand.

Spatial distribution and autocorrelation was done by means of the Índice de Moran Local (LISA), using smoothed MSTs. To visualize the areas with statistically significant spatial autocorrelation ( $p < 0.05$  – LISA), representative maps of the Local Moran Index were used for each indicator studied.

This analysis makes it possible to identify and compare the values of each specific state with the values of its neighboring states, that is, to identify conglomerates of states with high MST, and neighboring states with high rates (high-high); and states with low MST and neighboring states with low MST (low-low); or even areas without significant autocorrelation. For the calculation and cartographic representation of the Local Moran Index the statistical programs Geoda, version 1.18.0 and QGIS, version 3.16 were used.

Since this is a research with secondary data available in a public platform, it was not necessary ethical appreciation by the Permanent Committee for Ethics in Research.

## RESULTS

We analyzed 278 maternal deaths due to preeclampsia and eclampsia that occurred in Brazil in 2019 (MST of 9.7 deaths per 100,000 live births). The North region had the highest MST for these causes (14.9), followed by the Northeast (13.0), Midwest (8.2), Southeast (7.8), and South (4.9). Among the states, the worst indicators were found in Ceará (27.1), Maranhão (23.8), and Tocantins (20.4), while the lowest rates were found

in Santa Catarina (1.0), the Federal District (2.3), and Sergipe (3.0) (Table 1).

The spatial distribution of maternal mortality rates for preeclampsia and eclampsia shows more expressive values among the states of the Northern region, especially Pará, Roraima and Tocantins, and also in the Northeastern region, especially in the states of Maranhão, Piauí and Alagoas (Figure 1).

Regarding spatial autocorrelation, a high-high cluster was identified involving the states of Pará, Tocantins, Maranhão and Piauí, i.e., states with high MST for preeclampsia and eclampsia, surrounded by states that also have high rates. The state of Rio Grande do Sul was the only one to present low-Low autocorrelation, i.e., a state with low MST for preeclampsia and eclampsia, surrounded by states that also had low rates (Figure 1).

Regarding the socioeconomic profile of maternal deaths, there was a predominance of deaths in women aged 20 to 34 years (60.79%), with eight or more years of schooling (55.04%), without partner (63.31%), with deaths occurring in the hospital environment (92.81%), and black or brown (70.50%) (Figure 2).

The analysis of the socioeconomic profile of maternal deaths by region indicated that the Northeast region had the highest proportion of maternal mortality due to preeclampsia and eclampsia in adolescents (19.15%), and the lowest maternal education (38.30%). Deaths in black and brown women were not predominant only in the South region. For all Brazilian regions, there was a higher incidence in women without a partner and with the occurrence of death in the hospital (Table 3).

## DISCUSSION

This study brought important information on the MST due to preeclampsia and eclampsia in Brazil by considering the space where the women were inserted and bringing reflections on the conditions involved. The data show that the MST for these causes remains high in Brazil (9.7/100,000), unlike other countries such as Iran, where the rates are significantly lower (4.7).<sup>12</sup>

Looking at the global picture, the magnitude of preeclampsia and eclampsia varies around the world. High numbers are seen in Ethiopia (12.4%) and Bangladesh (14.0%).<sup>13-14</sup> On the other hand, China and Sweden recorded much lower numbers (2.3% and 2.9%, respectively).<sup>15</sup>

There are also important regional disparities in the MST among Brazilian regions and states. Higher rates were recorded in the North, especially in the states of Roraima and Tocantins, and in the Northeast. The high incidence of maternal mortality due to preeclampsia and eclampsia generally coincides with regions where there is a predominance of a population with low socioeconomic status and failures in health care.<sup>16</sup>

A study that identified factors associated with poor access to health services in Brazil, emphasized that living in the North and Northeast regions, in rural areas and not having a private health insurance plan are directly related to low quality services.<sup>17</sup> These results are of great relevance because they reinforce the inequalities in access to health services among population groups.

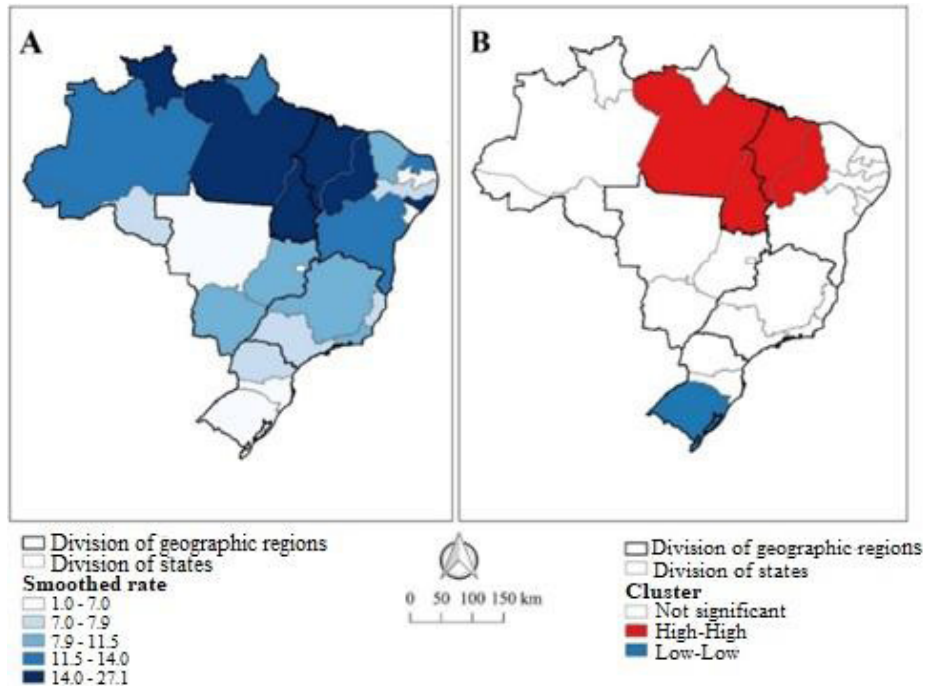
**Table 1** – Distribution of maternal deaths from preeclampsia and eclampsia, according to regions of residence. Brazil, 2019

	Deaths	Live births	MST†
<b>Brazil</b>	<b>278</b>	<b>2849146</b>	<b>9,7</b>
<b>North Region</b>	<b>47</b>	<b>313696</b>	<b>14,9</b>
Rondônia	2	27028	7,3
Acre	2	16280	12,2
Amazonas	9	77622	11,5
Roraima	3	14620	20,5
Pará	24	138341	17,3
Amapá	2	15356	13,0
Tocantins	5	24449	20,4
<b>Northeast Region</b>	<b>105</b>	<b>805275</b>	<b>13,0</b>
Maranhão	27	113317	23,8
Piauí	13	47933	27,1
Ceará	14	129185	10,8
Rio Grande do Norte	6	44031	13,6
Paraíba	4	57701	6,9
Pernambuco	10	133359	7,4
Alagoas	7	49803	14,0
Sergipe	1	32697	3,0
Bahia	23	197249	11,6
<b>Southeast Region</b>	<b>87</b>	<b>1102997</b>	<b>7,8</b>
Minas Gerais	21	256892	8,1
Espírito Santo	4	54925	7,2
Rio de Janeiro	17	207989	8,1
São Paulo	45	583191	7,7
<b>Southern Region</b>	<b>19</b>	<b>386097</b>	<b>4,9</b>
Paraná	11	153469	7,1
Santa Catarina	1	98032	1,0
Rio Grande do Sul	7	134596	5,2
<b>Midwest Region</b>	<b>20</b>	<b>241081</b>	<b>8,2</b>
Mato Grosso do Sul	5	43695	11,4
Mato Grosso	4	58852	6,7
Goias	10	96112	10,4
Distrito Federal	1	42422	2,3

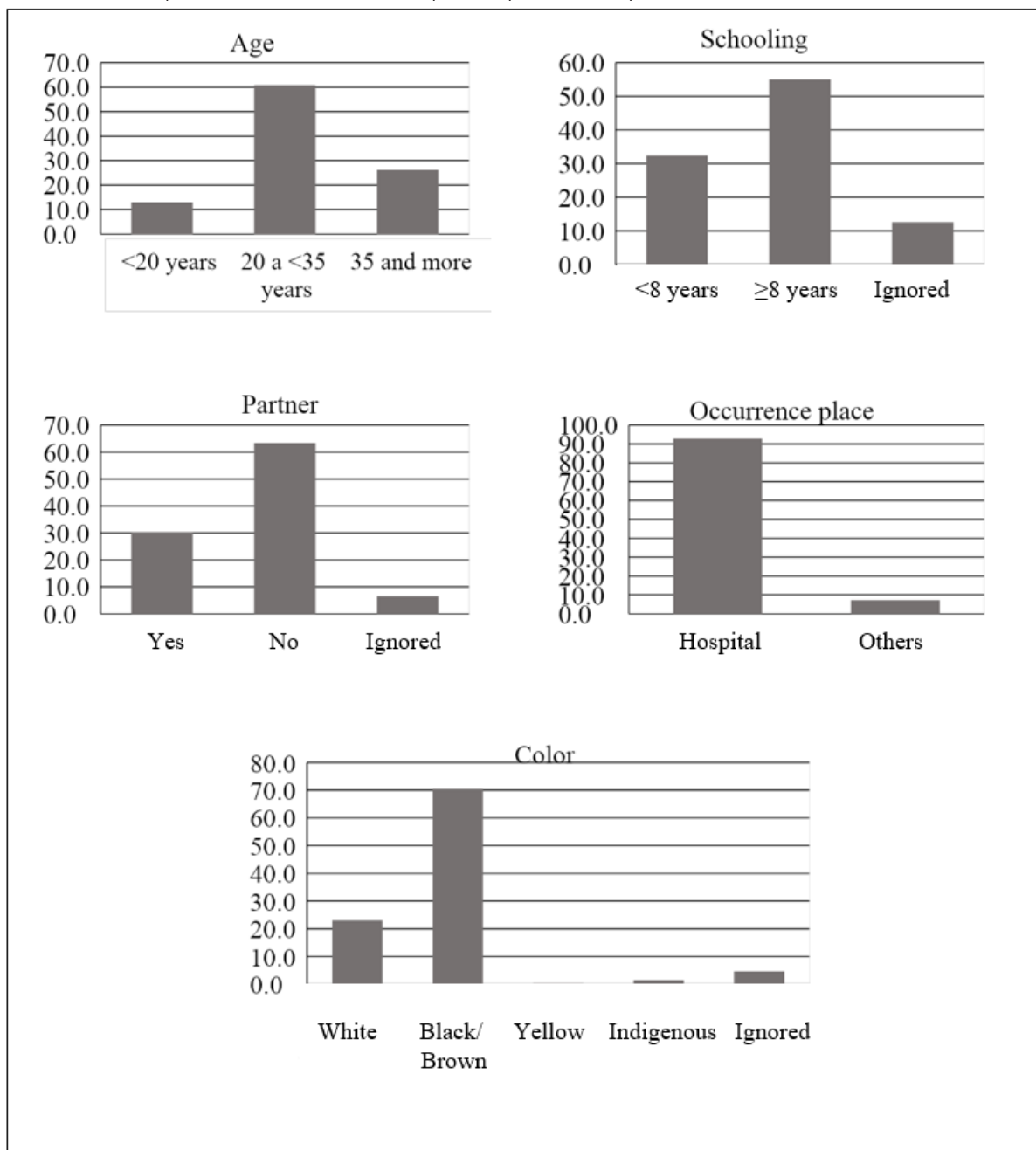
† Maternal mortality rates calculated per 100,000 live births.

Source: Prepared by the authors based on data from the SIM and the Information Sistema de Informação sobre Nascidos Vivos (SINASC).

**Figure 1** – Distribution of maternal mortality rates for preeclampsia and eclampsia, according to state of residence (A) and its clusters (B). Brazil, 2019



Source: Prepared by the authors from SIM and SINASC data.

**Figure 2** – Socioeconomic profile of maternal deaths from preeclampsia and eclampsia. Brazil, 2019

**Source:** Prepared by the authors from SIM and SINASC data.

**Table 3** – Socioeconomic profile of maternal deaths from preeclampsia and eclampsia, according to regions of residence. Brazil, 2019

	North		Northeast		Southeast		South		Midwest		Brazil	
	n	%	n	%	n	%	N	%	n	%	n	%
<b>Age</b>												
<20 years	9	19,15	15	14,29	8	9,19	1	5,26	3	15,00	36	12,95
20 to <35 years old	30	63,83	61	58,10	56	64,37	10	52,63	12	60,00	169	60,79
35 and more	8	17,02	29	27,62	23	26,44	8	42,11	5	25,00	73	26,26
<b>Education</b>												
<8 years	18	38,30	39	37,14	22	25,29	4	21,05	7	35,00	90	32,37
≥8 years	23	48,94	48	45,71	55	63,22	14	73,68	13	65,00	153	55,04
Ignored	6	12,77	18	17,14	10	11,49	1	5,26	-	-	35	12,59
<b>Race/color</b>												
White	3	6,38	10	9,52	32	36,78	16	84,21	3	15,00	64	23,02

**Table 3 – Cont.**

Black/Brown	37	78,72	86	81,90	53	60,92	3	15,79	17	85,00	196	70,50
Yellow	-	-	-	-	1	-	-	-	-	-	1	0,36
Indigenous	4	8,51	-	-	-	-	-	-	-	-	4	1,44
Ignored	3	6,38	9	8,57	1	1,15	-	-	-	-	13	4,68
<b>Partner</b>												
Yes	11	23,40	25	23,81	34	39,08	9	47,37	5	25,00	84	30,22
No	32	68,09	68	64,76	51	58,62	10	52,63	15	75,00	176	63,31
Ignored	4	8,51	12	11,43	2	2,30	-	-	-	-	18	6,47
<b>Place</b>												
Hospital	40	85,11	95	90,48	85	97,70	19	100	19	95,00	258	92,81
Other	7	14,89	10	9,52	2	2,30	-	-	1	5,00	20	7,19

**Source:** Prepared by the authors from SIM and SINASC data.

The onset of preeclampsia and eclampsia has been associated with several personal, socioeconomic and demographic risk factors, although the relationship is still not entirely clear.<sup>18</sup> A meta-analysis involving 30 countries found an association between preeclampsia and eclampsia with the country's income, with low – and middle-income countries being responsible for the highest MST related to the grievance.<sup>19</sup>

Other associated factors are family and personal history, such as age over 32 years, black/brown color, primigravidae, nulliparous, gestational age of disease onset after 20 weeks, delivery before 37 weeks gestation, family history of diabetes and hypertension, history of hypertension prior to pregnancy, obesity, kidney and liver disease, anemia, infections or sepsis, pre-eclampsia or eclampsia, hypersodium or hyperprotein diet, sedentary lifestyle, low education, multiple pregnancies, among others.<sup>20</sup>

The present study also evidenced that in all Brazilian regions the majority of deaths were of black/black women, except in the South region, where white women represented the majority of cases. Studies carried out in the North and Northeast regions of the country also show that the most vulnerable group to maternal death is composed of black and brown women, without a partner, with 8 to 11 years of schooling, and in the 20 to 39 age group.<sup>16,21</sup> In addition to the higher prevalence, black and brown skin color has already been described as a factor associated with poor access to health services.<sup>17</sup>

Despite Brazil being a miscegenated country, the existing structural racism hinders the access to essential services by the black/pardarado population. Situations such as inequitable treatment, disadvantages in access to benefits and little provision of actions and policies aimed at this public contribute to inequality.<sup>22</sup>

A survey conducted with women assisted during prenatal and childbirth care at SUS, observed worse socioeconomic conditions in the black/pardar women, revealing the situation of vulnerability experienced by them.<sup>23</sup> In this sense, it is believed that equal access to essential services could positively impact MST.

Maternal age is a determining factor for complications during pregnancy. In the present research, most of the women who progressed to death were in the age group of 20 to 34 years, followed by the age group of 35 years or older. Similar data were reported in previous research that analyzed preeclampsia mortality from 2010 to 2017 in Brazil, in which 41.30% of deaths were recorded in the 20 to 29 age group, followed by the 30 to 39 age group (40.13%).<sup>8</sup>

However, researchers who evaluated pregnant women over the age of 35 found some type of complication in more than 70% of the women analyzed. The most prevalent complications were preeclampsia, gestational diabetes, gestational hypertension, and premature rupture of membranes.<sup>24</sup>

These results show the importance of adequate prenatal care in all age groups, aiming at the early identification of any warning sign that may lead to unfavorable outcomes.

Low education also seems to play an important role in gestational complications. The data from this study indicate that most pregnant women had 8 years or more of schooling, corroborating the literature.<sup>8,25</sup>

Nevertheless, the Ministry of Health considers low education (less than 5 years of schooling) a risk factor for pregnancy complications due to the consequent lack of learning and low access to information. These factors can make prenatal consultations inefficient due to lack of understanding.<sup>26</sup> Low education can also be associated with an unwanted pregnancy, since an unplanned pregnancy can lead women to abandon their academic career to provide for their own child.<sup>25</sup>

Most of the women analyzed in this study did not have a partner, and can be considered a vulnerable group to the development of gestational complications. This is because women without a partner take on all the responsibilities without emotional support, safety, and support during this period.<sup>27</sup> These situations can cause uncontrolled blood pressure with an impact on hypertensive syndromes during pregnancy.<sup>20</sup>

Finally, the place of occurrence of maternal death was the hospital in most of the cases analyzed. According to some research, the occurrence of maternal death in hospital predominates, since pregnant women with preeclampsia and eclampsia are often hospitalized during pregnancy,<sup>4</sup> with clinical management that inspires various care and is based on the severity of the condition and gestational age. Therefore, pregnancy termination may be necessary, as well as magnesium sulfate in the most severe forms, aiming to prevent seizures.<sup>26</sup>

In this perspective, qualified care is fundamental because most deaths related to preeclampsia and eclampsia are preventable if women receive timely, skilful, evidence-based care.<sup>28</sup>

Aiming to qualify the maternal and child care network and reduce maternal deaths, the Brazilian federal government launched the Rede Cegonha in 2011. The strategy aims to offer reproductive planning, humanized care to pregnancy to childbirth and puer-

perium, according to risk classification.<sup>29</sup> Even so, the country has a long way to go to eradicate preventable maternal deaths.

This study has some limitations due to the use of secondary data, subject to incomplete information and under-enumeration of deaths. However, the SIM coverage has been gradually expanded, consolidating itself as an excellent tool for population-based research.<sup>30</sup>

## CONCLUSION

Most of the maternal deaths from preeclampsia and eclampsia recorded in Brazil were young women (20 to 34 years), with 8 years or more of schooling, black/male, without a partner and occurring in the hospital. It is evident the regional inequalities in MST among Brazilian states and regions. The most expressive rates are concentrated in the North and Northeast regions of the country, showing the need for actions that consider the local specificities for planning actions.

Qualified assistance through family planning, qualified prenatal care, risk stratification, referral services, multidisciplinary care, and work within what is recommended by the Care Networks can help reduce unfavorable outcomes.

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