Original Article
https://doi.org/10.1590/1983-1447.2025.20240154.en

# Advanced maternal age and occurrence of infant death: Brazilian ecological study

*Idade materna avançada e ocorrência de óbito infantil: estudo ecológico brasileiro*

*Edad materna avanzada y ocurrencia de muerte infantil: estudio ecológico brasileño*

Larissa Muzel de Sousa[a]
Ivana Regina Gonçalves[a]
Ana Paula Pinho Carvalheira[a]
Ana Beatriz Henrique Parenti[a]
Hélio Rubens de Carvalho Nunes[a]
Cristina Maria Garcia de Lima Parada[a]

**How to cite this article:**
Sousa LM, Gonçalves IR, Carvalheira APP, Parenti ABH, Nunes HRC, Parada CMGL. Advanced maternal age and occurrence of infant death: Brazilian ecological study. Rev Gaúcha Enferm. 2025;46:e20240154. https://doi.org/10.1590/1983-1447.2025.20240154.en

## ABSTRACT

**Objective:** To analyze the evolution of the characteristics of infant deaths registered in Brazil among women with advanced maternal age.

**Method:** Ecological time series study using secondary data from the Mortality Information System on the evolution of infant deaths from 2011-2020. The variables assessed included: maternal, infant gestational and birth characteristics, as well as data related to death. The behavior of the variables was assessed using simple linear regression models with a normal response, with the year as the independent variable in each of the subpopulations.

**Results:** The studied sample consisted of 30,843 infant deaths among women aged 35 years or over. There was a decreasing trend for the variables race/white skin color, living in the southern region of the country, lack of schooling of the mother or up to 7 years education, paid work and vaginal delivery; there was an increase trend for the variables: race/brown skin color, mother's education level equal to or greater than 8 years and low birth weight.

**Conclusion:** The analysis revealed distinct patterns regarding sociodemographic and maternal and child health factors, highlighting the complexity of infant mortality trends and the importance of effective collective approaches.

**Descriptors:** Maternal age; Infant mortality; Causes of death; Ecological Studies; Time Series Studies.

## RESUMO

**Objetivo:** Analisar a evolução das características dos óbitos infantis registrados no Brasil entre mães com idade materna avançada.

**Método:** Estudo ecológico de séries temporais, utilizando dados secundários do Sistema de Informação de Mortalidade sobre evolução dos óbitos infantis no período de 2011 a 2020. As variáveis analisadas incluíram: características maternas, infantis, gestação e nascimento e dados relacionados ao óbito. O comportamento das variáveis foi avaliado por meio de modelos de regressão linear simples com resposta normal, com o ano como variável independente em cada uma das subpopulações.

**Resultados:** A amostra estudada foi composta por 30.843 óbitos infantis de mulheres com 35 anos ou mais. Observou-se tendência de diminuição para as variáveis: raça/cor branca, residência na região sul do país, falta de escolaridade da mãe ou até 7 anos de escolaridade, trabalho remunerado e parto vaginal; e tendência de aumento estatisticamente significativa para as variáveis: raça/cor parda, nível de escolaridade da mãe igual ou superior a 8 anos e baixo peso ao nascer.

**Conclusão:** A análise revelou padrões distintos em relação a fatores sociodemográficos e de saúde materno-infantil, destacando a complexidade das tendências de mortalidade infantil e a importância de abordagens coletivas eficazes.

**Descritores:** Idade materna; Mortalidade infantil; Causas de morte; Estudos ecológicos; Estudos de séries temporais.

[a] Universidade Estadual Paulista "Júlio de Mesquista Filho". Faculdade de Medicina de Botucatu. Departamento de Enfermagem. Botucatu. São Paulo. São Paulo. Brasil

## RESUMEN

**Objetivo:** Analizar la evolución de las características de los fallecimientos infantiles registrados en Brasil entre madres con edad materna avanzada.

**Método:** Estudio ecológico de series temporales utilizando datos secundarios del Sistema de Información sobre Mortalidad sobre la evolución de las muertes infantiles en el período de 2011-2020. Las variables analizadas incluyeron: características maternas, infantiles, de gestación y nacimiento, así como datos relacionados con el fallecimiento. El comportamiento de las variables se evaluó mediante modelos de regresión lineal simple con respuesta normal, con el año como variable independiente en cada una de las subpoblaciones.

**Resultados:** La muestra estudiada fue de 30.843 fallecimientos infantiles de mujeres de 35 años o más. Se observó una tendencia de disminución para las variables: raza/color blanco, residencia en la región sur del país, falta de escolaridad de la madre o hasta 7 años de escolaridad, trabajo remunerado y parto vaginal; y una tendencia de aumento para las variables: raza/color pardo, nivel de escolaridad de la madre igual o superior a 8 años y bajo peso al nacer.

**Conclusión:** El análisis reveló patrones distintos en relación con factores sociodemográficos y de salud materno-infantil, destacando la complejidad de las tendencias de mortalidad infantil y la importancia de enfoques colectivos eficaces.


**Descriptores:** Edad materna; Mortalidad infantil; Causas de muerte; Estudios ecológicos; Estudios de series temporales.

## INTRODUCTION

We can assert that the rate of pregnant women with advanced maternal age has steadily grown over the past few decades(1). In the United States, data from the Centers for Disease Control and Prevention (CDC) indicate that the number of births among women aged 35 to 44 years increased during the period from 2018 to 2019, and for those aged 45 and over, the rate has remained unchanged since 2015(2). In France, research revealed that maternal age increased consistently from 1995 to 2016, with the proportion of mothers aged 35 or older rising from 12.5% to 21.3% from the beginning to the end of this period(3). In the United Kingdom, in 2010, 20% of live births were to women over 35, and by 2020, this figure had risen to 24%(4). In Brazil, pregnancies among women aged 30 to 39 increased from 26.1% in 2010 to 33.8% in 2021, and for women aged 40 and over, the rate increased from 2.3% in 2010 to 3.9% in 2021(5).

Studies addressing the management of pregnancy in older women have found an increased risk of gestational diabetes mellitus, pre-eclampsia, placenta previa, miscarriage, preterm birth, and cesarean delivery, as well as adverse fetal outcomes such as chromosomal anomalies, intrauterine growth restriction, small-for-gestational-age babies, low Apgar scores, admission to neonatal intensive care units, and the occurrence of stillbirths(6).

Despite the global efforts to achieve Goal 3 of the Sustainable Development Goals (ending preventable deaths of newborns and children under 5 years of age by 2030), these rates remain unacceptably high, particularly in low- and middle-income countries(7). In 2022, the global infant mortality rate was 37 deaths per 1,000 live births, while in Brazil, the estimated rate was 13 deaths per 1,000 live births(7). Among the risk factors associated with infant mortality is advanced maternal age, defined as pregnancy in women aged 35 or older. However, there is no consensus in the literature regarding the effect of this exposure on the infant mortality rate.

Some international studies have not found differences in infant deaths when comparing the extremes of age groups, such as women aged 18 or younger to those aged 40 or older(8,9). In an Indian study, a non-linear effect was observed: in some states; the resulting graph had a U-shape, indicating that the risk of infant mortality was higher both at the beginning and at the end of the mother's reproductive period. In other states, the pattern resembled an elongated L, meaning that the risk of infant mortality was very high at the beginning of the reproductive period and decreased gradually, remaining stable thereafter(10). However, several studies have found an association between advanced maternal age and unfavorable birth outcomes, including infant mortality(11,12).

Infant and fetal mortality surveillance is considered a priority in many countries in order to abide to the commitments made by governments in defense of children and in alignment with the UN Sustainable Development Goals (SDGs). Monitoring these deaths is an important strategy for reducing infant and fetal mortality, as it highlights high mortality rates and enables the implementation of measures to prevent avoidable deaths through healthcare services(13).

In this connection, avoidability classifications have been used to analyze infant and fetal deaths considering their prevention potential, focusing on deaths caused by potentially treatable issues. The classification system

published by the Fundação Sistema Estadual de Análise de Dados has been used for assessing infant mortality in Brazil; the system suggests eight groupings of causes of infant death, according to the ICD-10(14).

Given the increasing number of older women pregnancies, it is crucial that we improve our understanding of the factors influencing infant mortality within this specific age group. The lack of clear consensus on the impact of advanced maternal age on infant mortality highlights the need for more detailed investigation. Hence the objective of this study was to review the evolution of the characteristics of infant deaths registered in Brazil among mothers with advanced maternal age and to compare the age subgroups of 35-40 years and 41 years or older in 2011 and 2020.

## METHOD

This is an ecological time series study conducted in Brazil that reviewed proportional infant mortality. The unit of analysis was the year, covering the period from 2011 to 2020, in Brazil, a country with an estimated population of 203.1 million inhabitants in 2022(5). The studied period is justified as it aimed to review a complete decade, thus allowing for the observation of consistent and significant patterns and trends over time, facilitating a deep and comprehensive understanding of trends in infant mortality among advanced maternal age women.

Secondary data from the Mortality Information System (SIM), issued by the Department of Informatics of the Unified Health System (DATASUS) and accessible online without access restrictions, were used. Access date: June 29, 2022. Since 1976, the SIM has collected information from the standard Death Certificates in use in the national territory, retrieving essential data to produce mortality statistics, fundamental for the analysis of the health situation, and for the surveillance, monitoring and evaluation of public policies. The system that has shown completeness was classified as excellent (less than 5% incompleteness). Despite the disparities in the quality of different dimensions of the SIM, studies indicate that improvements have been made over time in the mortality data records of the Brazilian population(15).

The study population included 49,388 women aged 35 or older, whose infants died within their first year of life during the research period. A total of 18,545 women (37.5%) were excluded due to incomplete data, reducing the sample to 30,843 women; however, analysis of the excluded group reveals that it does not differ from the sample. The study variables are shown in Chart 1.

For the statistical analysis, the evolution of the proportional mortality time series according to the observed characteristics was investigated by adjusting simple linear regression models with normal response, with the year as an independent variable in each of the subpopulations, that is, the evolution of mortality rate was investigated in the population of women between 35 and 40 years of age and in women aged 41 years or more. Linear trend models can be used to describe the behavior of time series (17. It is a statistical approach that allows modeling the relationship between a dependent variable and one or more independent variables. In addition, the annual variation rate and its respective 95% confidence interval were estimated for the general population. The adequacy of the models' fit in terms of homoscedasticity and residuals normality was evaluated by investigating the standardized residuals; in order to measure the portion of total variability explained by the years, the multiple determination coefficient (R2) was calculated. The effect of years on the behavior of the series was considered statistically significant at $p<0.05$ and the analyses were performed with the SPSS v.21 software.

Preservation of ethical aspects was ensured, in accordance with the Resolution of the National Health Council Nº. 510 dated April 7, 2016, sole paragraph, which states that research using publicly accessible information shall not be registered or evaluated by the Comitê de Ética em Pesquisa/Comissão Nacional de Ética em Pesquisa(18) (CEP, National Research Ethics Committee). Thus, as this is a research with a publicly accessible database, it was not necessary to refer it to the Research Ethics Committee.

## RESULTS

The characteristics of mothers aged 35 years or older, whose children died, as well as information on infants and deaths, are shown in Table 1. The Southeast region recorded the highest occurrence of deaths with 43,0% (13,255); 41,8% (12,896) of the cases occurred among women with 8 or more years education, 61,0%

**Chart 1** – Variables analyzed in the study according to Maternal and Child Characteristics, Pregnancy and Childbirth Data and Death Data. Brazil, 2011-2020. Botucatu, São Paulo, Brasil, 2024.

| Variable | |
|---|---|
| **Maternal Characteristics** | |
| Region of residence | North, Northeast, Midwest, Southeast, South |
| Maternal age (years) | 35 to 40; 41 or older |
| School attendance (years) | None, 1-3, 4-7, 8-11 and 12 or more |
| Paid job | Yes, No |
| Number of living children | 0, 1-2, 3-4, 5 or more |
| Number of dead children | 0, 1-2, 3-4, 5 or more |
| **Child characteristics** | |
| Gender | Female, Male |
| Race/skin color | White, Black, Yellow, Brown, Indigenous |
| Low weight at birth | Yes, No, Ignored |
| Congenital malformation | Yes, No |
| **Pregnancy and Childbirth Data** | |
| Type of pregnancy | Single, Multiple |
| Type of delivery | Vaginal, Cesarean |
| Gestational age (weeks) | Up to 36, 37-41, 42 or over |
| **Death Data** | |
| Place of occurrence | Hospital, Other |
| Avoidability classification according to the State Data Analysis System Foundation – (SEADE)[16]. | Reducible by immunoprevention, reducible by adequate pregnancy control; reducible by adequate care during childbirth, reducible by early prevention, diagnosis and treatment; Reducible by partnerships with other sectors; Unavoidable death and death from ill-defined causes |

Source: Mortality information system, 2011-2020

(18,813) had paid jobs, 49,6% (15,287) had 1-2 living children, and 62,1% (19,161) had no deceased children. A total of 53,6% (16,535) of the deaths was of male children, 52,5% (16,223) had white skin, 69,4% (21,392) had low birth weight, 89,4% (27,572) were born from a singleton pregnancy, by cesarean section (63,9%), and 68,2% (21,033) were premature. Of the total infants who died, 29,5% had some type of malformation. 95,9% (29,569) of the deaths occurred in a hospital setting, and 30,3% (9,319) death cases were classified as reducible through prevention, diagnosis, and early treatment actions (Table 1).

Table 2 is related to the trend behavior of infant death for women aged 35 years and over. The variables in which there was a statistically significant increase trend in the annual rate, considering the magnitude of the highest (1345,4%) to the lowest variation (41,3%), are: school years (8-11 and 12 years or more), race/brown skin color, gestational age at birth between 22 and 27 weeks, 1-2 children, residence in the Northeastern region and congenital malformation, low birth weight, death reducible by partnership with other sectors and death that occurred in the hospital setting (Table 2).

The variables in which there was a statistically significant decrease trend in the annual rate, include: number of live children, 1-7 years schooling, race/white skin color, paid maternal job, 5 or more live children, living in the South region, birth by vaginal delivery, lack of education, death reducible by early prevention, diagnosis and treatment, death outside the hospital setting and gestational age at birth of 42 weeks or more (Table 2).

Table 3 shows the comparison of infant death trends for the subgroups 35-40 years of age and 41 years or more.

Comparing the age groups 35-40 years and 41 years or more, we observe that in the younger group, the variables: 8 to 11 years of school attendance, 1 to 2 live children, race/brown skin color and low birth weight had a statistically significant increase trend, also observed in the general group of 35 years or more and there was a trend of statistically significant decrease in the case of birth in the South region, low schooling (0-7 years), 5 or more live children, paid maternal job, number of live children, white skin color and vaginal delivery (Table 3).

Only for the subgroup 35-40 years, there was a statistically significant increase trend for the variables: living in the Northeastern region, 12 or more years of schooling, presence of congenital malformation, childbirth between 22 and 27 weeks, death in the hospital and reducible death by partnership with other sectors and statistically significant decrease trend for: birth at 42 weeks or more of gestational age, death outside the hospital setting and death reducible by prevention, early diagnosis and treatment. A single variable had a statistically significant decrease trend only in the subgroup of 41 years of age or more: childbirth between 37-41 weeks (Table 3).

## DISCUSSION

This study aimed to review the evolution of the infant deaths' characteristics among late pregnant women, deaths that occurred in Brazil during the period 2011-2020, considering the women age group of 35 years or more. The study also aimed to compare the subgroups 35-40 years and 41 years or more. There was no stability for the variables: residence in the South region, which showed a downward trend; schooling, with a downward trend until incomplete elementary school and increased afterwards, evidenced by the growth of women with up to two children and decrease in five-children mothers; color/ race, with a tendency to be reduced in white skin women and increased in brown skin women; low birth weight, showed a tendency to increase and vaginal delivery, a tendency to decrease.

The Southeast region exhibited the highest rate of women aged 35 or over whose infants died; this is an expected condition, considering that the Southeast is the most populous region in this country. In the decade of the study, for the general group and for the younger subgroup, an increasing trend in infant deaths was observed in the Northeast region, while there was a downward trend in the South region in both age groups. Births occurring in regions with unfavorable socioeconomic conditions, such as the Northeastern region, with high poverty rates and extensive cities' peripheral areas, are more likely to record infant deaths(19) thus explaining the upward trend observed. In contrast, a downward trend was observed in the Southern region, comprising three states characterized as having a

**Table 1** – Maternal, child, pregnancy and childbirth characteristics and infant deaths according to the Mortality Information System (n=30,843). Brazil, 2011-2020. Botucatu, São Paulo, Brasil, 2024.

| Characteristics | n | % |
|---|---|---|
| **MATERNAL** | | |
| **Dwelling region** | | |
| North | 2.708 | 8.8 |
| North East | 7.120 | 23.1 |
| Midwest | 2.631 | 8.5 |
| Southeast | 13.255 | 43.0 |
| South | 5.129 | 16.6 |
| **Mothers' age (years)** | | |
| 35 to 40 | 25.062 | 81.3 |
| 41 or older | 5.781 | 18.7 |
| **School attendance (years)** | | |
| None | 1.199 | 3.9 |
| 1-3 | 2.741 | 8.9 |
| 4-7 | 6.069 | 19.7 |
| 8-11 | 12.896 | 41.8 |
| 12 or more | 7.938 | 25.7 |
| **Paid job** | | |
| Yes | 18.813 | 61.0 |
| No | 12.030 | 39.0 |
| **Number of living children** | | |
| 0 | 4.329 | 14.0 |
| 1-2 | 15.287 | 49.6 |
| 3-4 | 6.935 | 22.5 |
| 5 or more | 4.292 | 13.9 |

**Table 1** – Cont.

| Characteristics | n | % |
|---|---|---|
| **Number of dead children** | | |
| 0 | 19.161 | 62.1 |
| 1-2 | 10.339 | 33.5 |
| 3-4 | 1.094 | 3.5 |
| 5 or more | 249 | 0.9 |
| **CHILDREN** | | |
| **Gender** | | |
| Female | 14.308 | 46.4 |
| Male | 16.535 | 53.6 |
| **Race/skin color** | | |
| White | 16.223 | 52.5 |
| Black | 882 | 2.9 |
| Yellow | 81 | 0.3 |
| Brown | 13.345 | 43.3 |
| Indigenous | 312 | 1.0 |
| **Low weight at birth** | | |
| Yes | 21.392 | 69.4 |
| No | 9.384 | 30.4 |
| Ignored | 67 | 0.2 |
| **Congenital malformation** | | |
| Yes | 9.098 | 29.5 |
| No | 21.745 | 70.5 |
| **PREGNANCY AND BIRTH** | | |
| **Type of pregnancy** | | |
| Singleton | 27.572 | 89.4 |

**Table 1** – Cont.

| Characteristics | n | % |
|---|---|---|
| Multiple | 3.271 | 10.6 |
| **Type of delivery** | | |
| Vaginal | 11.142 | 36.1 |
| Cesarean | 19.701 | 63.9 |
| **Gestational age at birth (weeks)** | | |
| Up to 36 | 21.033 | 68.2 |
| 37-41 | 9.583 | 31.1 |
| 42 or more | 227 | 0.7 |
| **DEATH** | | |
| **Place of occurrence** | | |
| Hospital | 29.569 | 95.9 |
| Other | 1.274 | 4.1 |
| **Avoidability classification** | | |
| Reducible by immunoprevention | 41 | 0.1 |
| Reducible by adequate pregnancy control | 5.621 | 18.2 |
| Reducible by adequate care during childbirth | 2.944 | 9.5 |
| Reducible by early prevention, diagnosis and treatment | 9.319 | 30.3 |
| Reducible by partnerships with other sectors | 5.769 | 18.7 |
| Unavoidable death | 6.185 | 20.1 |
| Death from ill-defined causes | 964 | 3.1 |

Source: Mortality information system, 2011-2020
n: Number of individuals

**Table 2** – Trend behavior of variables related to infant deaths of women aged 35 years or older (n=30,843).Brazil, 2011-2020. Botucatu, São Paulo, Brasil, 2024.

| Characteristics | General: ≥ 35 years) β‡(CI 95%)†p§ | Annual rate of change %(CI)† | R2* |
|---|---|---|---|
| **MATERNAL** | | | |
| **Region of residence** | | | |
| North | 0.06 (-0.05 : 0.18) 0.243 | 14.8 (-10.9 : 51.4) | 0.16 |
| North East | 0.43(0.25 : 0.60) **0.001** | **169.2 (77.8 : 298.1)** | 0.16 |
| Midwest | 0.07(-0.12 : 0.27) 0.393 | 17.5 (-24.1 : 86.2) | 0.16 |
| Southeast | -0.15(-0.44 : 0.14) 0.278 | -29.2 (-63.7 : 38.0) | 0.16 |
| South | -0.42(-0.68 : -0.15) **0.007** | **-62.0 (-79.1 : -29.2)** | 0.16 |
| **School attendance (years)** | | | |
| 0 | -0.27(-0.42 : -0.12) **0.003** | **-46.3 (-62.0 : -24.1)** | 0.70 |
| 1-3 | -0.97(-1.16 : -0.78) **<0.001** | **-89.3 (-93.1 : -83.4)** | 0.95 |
| 4-7 | -0.98(-1.16 : -0.80) **<0.001** | **-89.5 (-93.1 : -84.2)** | 0.95 |
| 8-11 | 1.16(0.93 : 1.39) **<0.001** | **1345.4 (751.1 : 2354.7)** | 0.94 |
| 12 or more | 1.06(0.81 : 1.31) **<0.001** | **1048.2 (545.7 : 1941.7)** | 0.92 |
| **Paid job** | -0.70(-1.08 : -0.33) **0.003** | **-80.0 (-91.7 : -53.2)** | 0.70 |
| **Number of living children** | -1.43(-2.16 : -0.71) **0.002** | **-96.3 (-99.3 : -80.5)** | 0.72 |
| 0 | 0.13(-0.18 : 0.44) 0.359 | 34.9 (-33.9 : 175.4) | 0.11 |
| 1-2 | 0.53(0.35 : 0.71) **<0.001** | **238.8 (123.9 : 412.9)** | 0.86 |
| 3-4 | -0.02(-0.26 : 0.22) 0.833 | -4.5 (-45.0 : 66.0) | 0.01 |
| 5 or more | -0.64(-0.82 : -0.46) **<0.001** | **-77.1 (-84.9 : -65.3)** | 0.90 |
| **Dead children** | | | |
| 0 | -0.17(-0.78 : 0.43) 0.526 | -32.4 (-83.4 : 169.2) | 0.01 |
| 1-2 | 0.22(-0.34 : 0.78) 0.383 | 66.0 (-54.3 : 502.6) | 0.01 |
| 3-4 | -0.02(-0.26 : 0.21) 0.833 | -4.5 (-45.0 : 62.2) | 0.01 |

**Table 2** – Cont.

| Characteristics | General: ≥ 35 years) β‡(CI 95%)†p§ | Annual rate of change %(CI)† | R2* |
|---|---|---|---|
| 5 or more | -0.02(-0.07 : 0.02) 0.270 | -4.5 (-14.9 : 4.7) | 0.01 |
| **CHILDREN** | | | |
| **Male** | -0.15(-0.38 : 0.08) 0.170 | -29.2 (-58.3 : 20.2) | 0.22 |
| **Race/skin color** | | | |
| White | -0.91(-1.15 : -0.66) **<0.001** | **-87.7 (-92.9 : -78.1)** | 0.90 |
| Black | 0.07(-0.03 : 0.16) 0.137 | 17.5 (-6.7 : 44.5) | 0.25 |
| Yellow | 0.00 (-0.03 : 0.03) 0.780 | 0.0 (-6.7 : 7.2) | 0.01 |
| Brown | 0.86(0.65 : 1.07) **<0.001** | **624.4 (346.7 : 1074.9)** | 0.92 |
| Indigenous | -0.02(-0.06 : 0.02) 0.350 | -4.5 (-12.9 : 4.7) | 0.11 |
| **Low weight at birth** | 0.33(0.18 : 0.48) **0.001** | **113.8 (51.4 : 202.0)** | 0.76 |
| **Congenital malformation** | 0.43(0.23 -0.63) **0.001** | **169.2 (69.8 : 326.6)** | 0.76 |
| **PREGNANCY AND BIRTH** | | | |
| **Singleton pregnancy** | -0.07(-0.27 : 0.13) 0.453 | -14.9 (-46.3 : 34.9) | 0.70 |
| **Vaginal delivery** | -0.33(-0.52 : -0.14) **0.004** | **-53.2 (69.8 : -27.6)** | 0.67 |
| **Gestational age (weeks)** | | | |
| Up to 22 | -0.31(-0.58 : -0.04) **0.029** | **-51.0 (-73.7 : -8.8)** | 0.47 |
| 22-27 | 0.54(0.26 : 0.83) **0.002** | **246.7 (82.0 : 576.1)** | 0.71 |
| 28-31 | 0.01(-0.22 : 0.23) 0.954 | 2.3 (-39.7 : 69.8) | 0.01 |
| 32-36 | 0.03(-0.20 : 0.25) 0.791 | 7.2 (-4.5 : 77.8) | 0.01 |
| 37-41 | -0.17(-0.35 : 0.00) 0.050 | -32.4 (-55.3 : 0.0) | 0.40 |
| 42 or more | -0.09(-0.11 : -0.07) **<0.001** | **-18.7 (-22.4 : -14.9)** | 0.90 |
| **DEATH** | | | |
| Death in hospital | 0.15(0.06 : 0.24) **0.006** | **41.3 (14.8 : 73.8)** | 0.63 |
| Death in other locations | -0.15(-0.24 : -0.06) **0.006** | **-29.2 (-42.5 : -12.9)** | 0.64 |

**Table 2** – Cont.

| Characteristics | General: ≥ 35 years) β‡(CI 95%)†p§ | Annual rate of change %(CI)† | R2* |
|---|---|---|---|
| **Reducible by** | | | |
| Immunoprevention | -0.02(-0.04 : 0.00) 0.060 | -4.5 (-8.8 : 0.0) | 0.38 |
| Adequate pregnancy control | 0.19(-0.02 : 0.41) 0.070 | 54.9 (-4.5 : 157.0) | 0.35 |
| Adequate care during childbirth | -0.08(-0.24 : 0.09) 0.329 | -16.8 (-42.5 : 23.0) | 0.12 |
| Early prevention, diagnosis and treatment | **-0.25(-0.46 : -0.39) 0.026** | **-43.8 (-65.3 : -59.3)** | 0.48 |
| Partnerships with other sectors | **0.19(0.016 : 0.37) 0.036** | **54.9 (2.3 : 134.4)** | 0.44 |
| Unavoidable death | -0.01(-0.16 : 0.13) 0.864 | -2.3 (-30.8 : 34.9) | 0.01 |
| Death from ill-defined causes | -0.03(-0.08 : 0.02) 0.178 | -6.7 (-16.8 : 4.7) | 0.22 |

Source: Mortality information system, 2011-2020
†CI: Confidence interval; *R2: Coefficient of determination; ‡β: Regression coefficient; §p: p-value

**Table 3** – Trend behavior of variables related to infant deaths in general and by age groups of women aged 35-40 years or over 41 Brazil, 2011-2020. Botucatu, São Paulo, Brasil, 2024

| Characteristics | 35-40 years (n=25.062) | ≥ 41 years (n=5.781) |
|---|---|---|
| | β‡(CI 95%)†*p*§ | β‡(95%CI†) *p*§ |
| **MATERNAL** | | |
| **Dwelling region** | | |
| North | 0.08(-0.03 : 0.19) 0.117 | -0.02(-0.24 : 0.21) 0.854 |
| North East | **0.48(0.28 : 0.68) 0.001** | 0.19(-0.10 : 0.49) 0.166 |
| Midwest | 0.06(-0.14 : 0.26) 0.515 | 0.14(-0.16 : 0.45) 0.316 |
| Southeast | -0.22(-0.47 : 0.02) 0.066 | 0.20(-0.47 : 0.87) 0.507 |
| South | **-0.40(-0.63 : -0.17) 0.004** | **-0.52(-0.98 : -0.06) 0.032** |
| **School attendance (years)** | | |
| 0 | **-0.25(-0.39 : -0.10) 0.005** | **-0.38(-0.72 : -0.05) 0.030** |
| 1-3 | **-1.00(-1.15 : -0.85) <0.001** | **-0.87(-1.41 : -0.32) 0.006** |
| 4-7 | **-0.99(-1.19 : -0.79) <0.001** | **-0.94(-1.31 : -0.58) <0.001** |
| 8-11 | **1.08(0.85 : 1.31) <0.001** | **1.53(1.03 : 2.03) <0.001** |
| 12 or more | **1.16(0.94 : 1.38) <0.001** | **0.67(-0.01 : 1.34) 0.052** |
| **Paid job** | **-0.67(-1.07 : -0.27) 0.005** | **-0.86(-1.58 : -0.14) 0.024** |
| **Number of living children** | **-1.35(-1.98 : -0.73) 0.001** | **-1.97(-3.41 : -0.53) 0.013** |
| 0 | 0.15(-0.19 : 0.49) 0.332 | 0.07(-0.32 : 0.47) 0.671 |
| 1-2 | **0.48(0.25 : 0.71) 0.001** | **0.82(0.08 : 1.56) 0.034** |
| 3-4 | -0.06(-0.26 : 0.14) 0.521 | 0.10(-0.59 : 0.79) 0.749 |
| 5 or more | **-0.57(-0.71 : -0.44) <0.001** | **-1.00(-1.45 : -0.55) 0.001** |
| **Dead children** | | |
| 0 | -0.25(-0.84 : 0.34) 0.351 | 0.19(-0.60 : 0.98) 0.589 |
| 1-2 | 0.28(-0.28 : 0.84) 0.280 | -0.04(-0.75 : 0.67) 0.900 |
| 3-4 | -0.02(-0.12 : 0.08) 0.652 | -0.06(-0.31 : 0.18) 0.564 |

**Table 3** – Cont.

| Characteristics | 35-40 years (n=25.062) | ≥ 41 years (n=5.781) |
|---|---|---|
| 5 or more | -0.01(-0.06 : 0.04) 0.702 | -0.09(-0.19 : 0.01) 0.069 |
| **CHILDREN** | | |
| **Male** | -0.16(-0.39 : 0.06) 0.137 | -0.09(-0.75 : 0.56) 0.749 |
| **Race/skin color** | | |
| White | **-0.96(-1.24 : -0.68) <0.001** | **-0.70(-1.10 : -0.31) 0.003** |
| Black | 0.07(-0.03 : 0.17) 0.168 | 0.07(-0.09 : 0.23) 0.367 |
| Yellow | 0.00(-0.03 : 0.03) 0.831 | -0.01(-0.05 : 0.04) 0.726 |
| Brown | **0.91(0.67 : 1.14) <0.001** | **0.68(0.27 : 1.08) 0.005** |
| Indigenous | -0.01(-0.05 : 0.03) 0.482 | -0.03(-0.14 : 0.07) 0.500 |
| **Low weight at birth** | **0.28(0.05 : 0.51) 0.023** | **0.50(0.03 : 0.98) 0.040** |
| **Congenital malformation** | **0.42(0.19 : 0.64) 0.003** | 0.40(-0.35 : 1.15) 0.256 |
| **PREGNANCY AND BIRTH** | | |
| **Singleton pregnancy** | -0.01(-0.19 : 0.16) 0.868 | -0.34(-0.74 : 0.06) 0.084 |
| **Vaginal delivery** | **-0.22(-0.45 : 0.00) 0.049** | **-0.75(-1.25 : -0.25) 0.009** |
| **Gestational age (weeks)** | | |
| Up to 22 | **-0.32(-0.60 : -0.05) 0.027** | -0.27(-0.60 : 0.07) 0.101 |
| 22-27 | **0.59(0.26 : 0.91) 0.003** | 0.41(-0.02 : 0.85) 0.060 |
| 28-31 | 0.03(-0.20 : 0.26) 0.770 | -0.09(-0.59 : 0.41) 0.684 |
| 32-36 | -0.07(-0.31 : 0.18) 0.559 | 0.37(-0.09 : 0.83) 0.104 |
| 37-41 | -0.13(-0.36 : 0.09) 0.214 | **-0.36(-0.69 : -0.03) 0.035** |
| 42 or more | **-0.10(-0.13 : -0.06) <0.001** | -0.06(-0.13 : 0.01) 0.067 |
| **DEATH** | | |
| Death in hospital | **0.16(0.05 : 0.27) 0.011** | 0.10(-0.15 : 0.34) 0.389 |
| Death in other locations | **-0.16(-0.27 : -0.05) 0.011** | -0.10(-0.34 : 0.15) 0.389 |

**Table 3** – Cont.

| Characteristics | 35-40 years (n=25.062) | ≥ 41 years (n=5.781) |
|---|---|---|
| **Reducible by** | | |
| Immunoprevention | **-0.03(-0.05 : 0.00) 0.042** | 0.01(-0.02 : 0.04) 0.501 |
| Adequate pregnancy control | 0.23(-0.01 : 0.48) 0.061 | 0.06(-0.28 : 0.40) 0.694 |
| Adequate care during childbirth | -0.10(-0.24 : 0.05) 0.160 | 0.03(-0.37 : 0.42) 0.876 |
| Early prevention, diagnosis and treatment | **-0.30(-0.54 : -0.07) 0.018** | 0.00(-0.37 : 0.38) 0.989 |
| Partnerships with other sectors | **0.26(0.10 : 0.41) 0.005** | -0.09(-0.49 : 0.30) 0.602 |
| Unavoidable death | -0.04(-0.25 : 0.17) 0.654 | 0.07(-0.39 : 0.52) 0.741 |
| Death from ill-defined causes | -0.02(-0.09 : 0.04) 0.465 | -0.07(-0.23 : 0.09) 0.329 |

Source: Mortality information system, 2011-2020
n: Number of individuals
†CI: Confidence interval; ‡β: Regression coefficient; §p: p-value.

high human development index(20). This intraregional variation is often reported in different countries(21,22).

There was a trend towards a growth in infant deaths in the general group and in the two subgroups when the mothers' category with 8 or more years of study was analyzed and a tendency to decrease in the case of the lowest schooling levels. The association between low maternal education and infant mortality is one of the most consistently established relationships in public health, especially when developing countries such as Brazil are considered(22). So, how can we explain the trend towards a growth in the number of deaths in the categories of higher education? A possible explanation consists in understanding infant death as an event determined by multiple factors. For example, we observe the same trend of deaths growth in children of brown skin color mothers and, the decrease in white skin mother' children. Associated with other vulnerability factors, black and brown skin children have a higher risk of death when compared to white skin children, a fact explained by the relationship of black and brown race/color with poorer socioeconomic status, lower access to health services and less access to quality education(23).

The trend of decreased paid job identified in the general group and in both subgroups that experienced infant deaths was considered negative. Research conducted in Oman, a country located on the southeast coast of the Arabian Peninsula, found that the employment status of both father and mother is associated with reduced infant mortality(24) evidencing that working parents have better behavior in seeking care and use of the health services(25), which has an impact on the reduction of mortality rates(26).

The reviews carried out in the present study indicate in the general group and in the two subgroups that involve infant deaths there is a tendency to a reduction of deaths in the category of mothers with five or more children and children death cases growth among women with 1-2 children. This reflects the results of a review of the fertility rate in Brazil. Data from the National Family Observatory, indicate that the fertility rate in this country has been continuously declining in recent decades; between 2010 and 2020 the reduction went from 1,87 to 1,53 children and women with more than eight years schooling have, on average, half the number of children up to three years formal education(27).

Low birth weight, a variable closely associated with prematurity, tended to cause an increase of deaths in the general group and in the two subgroups of this study, a result consistent with the reports in the national and international literature(28,29). A CDC report found that low birth weight was the second largest cause of

infant death in the USA between 2019-2020, second only after congenital malformation(29). There was also a tendency to death cases increase in the categories extreme preterm (22-27 weeks) and post-term in the general group and younger subgroup, as well as a tendency to a death decrease in the full-term birth category in the subgroup of older women.

With regard to the association between prematurity and infant death, already well described in the literature, it stems from incomplete child development, which results in greater vulnerability to infections, complications and possible sequelae, with advanced maternal age being a risk factor for its occurrence(30). Infant deaths of full-term birth infants are less expected, since these children are protected by the adequacy of their gestational age; in fact the gestational age is associated with the development of the fetus, impairing the functionality of organs and systems, as it occurs in prematurity(31). Thus, a positive aspect to be emphasized is the fact that women aged 41 years or more had in the decade of this study a reduction trend in newly born deaths at the end of pregnancy.

There was a tendency towards a reduction in deaths among infants born from vaginal delivery for the general group and the two subgroups. The relationship between a decrease in the frequency of vaginal delivery, or an increase in cesarean sections, as maternal age advances, has been consensually reported(32), despite the negative consequences of birth by cesarean operation, both for the current and future pregnancies, including when considering infant death. In California, the risk of infant death was 51% higher (95% CI, 1,46-1,57; p<0,001) in cesarean section when compared to vaginal delivery(33).

As for congenital malformations, there was a tendency towards a significant increase during the study period in the general group. International studies with women over 35 years of age found the same result(34, possibly due to genetic alterations related to advanced maternal age(35). However, contrary to what was expected, when assessing the malformations by subgroup, it is evident that the increasing trend was only among the younger mothers, which may have occurred due to the small size of the older subgroup.

Regarding the preventability of death, according to the classification set forth by the Sistema Estadual de Análise de Dados do Estado de São Paulo (SEADE, State of São Paulo Data Analysis System) (16). women in the general group and in the younger subgroup showed a downward trend in deaths classified as reducible by prevention, early diagnosis and treatment, and increased trend of preventable deaths by partnership with other sectors. Expansion in coverage of access to health services, existence of conditional programs of income transfer, promotion and support for breastfeeding and the existence of programs to promote vaccination have been identified in Brazilian studies as causes for the decrease in infant mortality rate in recent decades, highlighting the country's commitment to achieving the United Nations Sustainable Health and Welfare Development Goal(36).

It should be noted that both in the general group and in the younger mothers' subgroup, there was an increase in the trend of hospital infant deaths and a decrease in deaths occurring in other health services, in the public way or at home. With this result, we can infer a greater possibility of access to higher-complexity healthcare services.

Finally, it is emphasized that systematic investigations conducted by mortality prevention committees for death surveillance help to understand patterns and trends in mortality, especially fetal and infant mortality. These investigations contribute to the improvement of records, the quality of health services, population development, and the reduction of mortality rates(37).

A study limitation is the fact that this study was conducted using a secondary database, which limits control over the quality and the inclusion of relevant variables or new forms of data disaggregation. On the other hand, using a population-based database is beneficial as it provides relevant information for reviewing the profile of infant mortality at a national level. We emphasize that there are massive investments aimed at improving the quality of the SIM (Mortality Information System), and that its data are considered excellent in terms of completeness and data agreement(15).

## CONCLUSION

This study showed that for women aged 35 or over, the variables that did not remain stable along the decade were associated with dwelling location, education, maternal job, number of children, skin color/race,

type of delivery, and infant low birth weight. A single significant result was found exclusively in the group over 41 years old: a decreasing trend in infant deaths among full-term born children.

It was concluded that the analysis of infant mortality trends in Brazil between 2011 and 2020 for women over 35 years old presents distinct patterns concerning sociodemographic factors and motherhood. These findings highlight the complexity of infant mortality trends and the importance of effective collective approaches. Hence, the relevant role of public policies aimed at improving access to prenatal care and reducing health disparities and promoting social equity is emphasized.

In this regard, these results may encourage healthcare professionals, especially nurses, to take actions to prevent infant mortality, by implementing educational programs for older mothers, expanding and improving the quality of medical care, and supporting managers in developing strategies that ensure social determinants of health, such as education, income, and housing.

## REFERENCES


1. Nieto MC, Barrabes EM, Martínez SG, Prat MG, Zantop BS. Impact of aging on obstetric outcomes: defining advanced maternal age in Barcelona. BMC Pregnancy Childbirth. 2019;19(1). https://doi.org/10.1186/s12884-019-2415-3
2. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Schwartz S, Horon I. Births: Final data for 2019. National Vital Statistics Reports [Internet]. 2021[cited 2024 May 30];70(2). Available from: https://pubmed.ncbi.nlm.nih.gov/33814033/
3. Trinh NTH, Visme S, Cohen JF, Bruckner T, Lelong N, Adnot P, *et al*. Recent historic increase of infant mortality in France: a time-series analysis, 2001 to 2019. Lancet Reg Health Eur. 2022;16. https://doi.org/10.1016/j.lanepe.2022.100339
4. Garcia M, Walker KF, Thornton JG. Management of pregnancy complications in women of advanced maternal age. Obstet, Gynaecol Reprod Med. 2022;32(6):101-4. https://doi.org/10.1016/j.ogrm.2022.04.001
5. Instituto Brasileiro de Geografia e Estatística (IBGE). Estatísticas do registro civil 2021: Brasil [Internet]. 2021[cited 2024 May 30];38:1–178. Available from: https://www.ibge.gov.br/estatisticas/sociais/populacao/9110-estatisticas-do-registro-civil.html?edicao=36288
6. Glick I, Kadish E, Rottenstreich M. Management of pregnancy in women of advanced maternal age: improving outcomes for mother and baby. Int J Womens Health. 2021;13:751-9. https://doi.org/10.2147/IJWH.S283216
7. Hug L, Liu Y, Nie W, Sharrow D, You D, Cao B, *et al*. The Demographic and Health Surveys (DHS) Program, ICF [Internet]. 2023[cited 2024 May 30]. Available from: https://www.icf.com/clients/health/demographic-health-surveys-technical-assistance
8. Nourkami-Tutdibi N, Tutdibi E, Faas T, Wagenpfeil G, Draper ES, Johnson S, *et al*. Neonatal morbidity and mortality in advanced aged mothers: maternal age is not an independent risk factor for infants born very preterm. Front Pediatr. 2021;9. https://doi.org/10.3389/fped.2021.747203
9. Shobiye DM, Omotola A, Zhao Y, Zhang J, Ekawati FM, Shobiye HO. Infant mortality and risk factors in Nigeria in 2013–2017: a population-level study. EClinicalMedicine. 2022;51. https://doi.org/10.1016/j.eclinm.2022.101622
10. Ranjan M, Dwivedi LK. Infant mortality and death clustering at the district level in India: a Bayesian approach. Spat Spatiotemporal Epidemiol. 2022;41. https://doi.org/10.1016/j.sste.2022.100481
11. Kortekaas JC, Kazemier BM, Keulen JKJ, Bruinsma A, Mol BW, Vandenbussche F, *et al*. Risk of adverse pregnancy outcomes of late and post term pregnancies in advanced maternal age: a national cohort study. Acta Obstet Gynecol Scand. 2020;99(8). https://doi.org/10.1111/aogs.13828
12. Shekari M, Shirzadfardjahromi M, Ranjbar A, Mehrnoush V, Darsareh F, Roozbeh N. Advanced maternal age and adverse obstetrical and neonatal outcomes of singleton pregnancies. Gynecol Obstet Clin Med. 2022;2(4). https://doi.org/10.1016/j.gocm.2022.10.004
13. World Health Organization (WHO). Making every baby count: audit and review of stillbirths and neonatal deaths [Internet]. 2016[cited 2024 May 30]. 144p. Available from: https://www.who.int/publications/i/item/9789241511223
14. Dias BAS, Santos Neto ET, Andrade MAC. Classificações de evitabilidade dos óbitos infantis: diferentes métodos, diferentes repercussões? Cad Saude Publica. 2017;33(5). https://doi.org/10.1590/0102-311X00125916
15. Romaguera AA, Guimarães ALS, Oliveira CM, Cardoso MD, Bonfim CV. Concordância e completude dos dados sobre nascidos vivos e óbitos infantis. Acta Paul Enferm. 2020;33. https://doi.org/10.37689/acta-ape/2020A00309
16. Ministério da Saúde (BR), Comitê de Prevenção do Óbito Infantil e Fetal. Manual de vigilância do óbito infantil e fetal [Internet]. 2009[cited 2024 May 30]. 96 p. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/manual_obito_infantil_fetal_2ed.pdf
17. Morettin PA Toloi CM. Análise de séries temporais: modelos lineares univariados 3 ed. Blucher; 2004. 455p.
18. Conselho Nacional de Saúde (CNS). Resolução nº 510 de 07 de abril de 2016. Trata sobre as diretrizes e normas regulamentadoras de pesquisa em ciências humanas e sociais [Internet]. 2016[cited 2024 May 30]. Available from: https://www.gov.br/conselho-nacional-de-saude/pt-br/acesso-a-informacao/legislacao/resolucoes/2016/resolucao-no-510.pdf/view
19. Viellas EF, Franco Netto TL, Gama SGN, Baldisserotto ML, Prado Neto PFD, Rodrigues MR, *et al*. Child birth care for adolescents and advanced maternal age in maternities linked to Rede Cegonha. Cienc Saude Colet. 2021;26(3). https://doi.org/10.1590/1413-81232021263.12492020
20. Programa das Nações Unidas para o Desenvolvimento (PNUD). Desenvolvimento humano nas macrorregiões Brasileiras [Internet]. 2016[cited 2024 May 30]. 55 p. Available from: http://repositorio.ipea.gov.br/bitstream/11058/6217/1/Desenvolvimento%20humano%20nas%20macrorregi%C3%B5es%20brasileiras.pdf

21. Lalangui K, Maya KR, Sánchez-Carrillo C, Cortéz GS, Quentin E. The spatio-temporal dynamics of infant mortality in Ecuador from 2010 to 2019. BMC Public Health. 2022;22(1):e1841. https://doi.org/10.1186/s12889-022-14242-1
22. Wang S, Wu J. Spatial heterogeneity of the associations of economic and health care factors with infant mortality in China using geographically weighted regression and spatial clustering. Soc Sci Med. 2020;263:e113287. https://doi.org/10.1016/j.socscimed.2020.113287
23. Pícoli RP, Cazola LHO, Nascimento DDG. Child mortality and classification of its preventability by skin color or ethnicity in Mato Grosso do Sul, Brazil. Ciên Saúde Coletiva. 2019;24(9). https://doi.org/10.1590/1413-81232018249.26622017
24. Eltayib RAA, Al-Azri M, Chan MF. The Impact of Sociodemographic, Macroeconomic, and Health Status and Resources on Infant Mortality Rates in Oman: evidence from 1980 to 2022. Eur J Investig Health Psychol Educ. 2023;13(6):986–99. https://doi.org/10.3390/ejihpe13060075
25. Maia LTS, Souza WV, Mendes ACG. Individual and contextual determinants of infant mortality in Brazilian state capitals: a multilevel approach. Cad Saúde Pública. 2020;36(2). https://doi.org/10.1590/0102-311X00057519
26. Bugelli A, Silva RB, Dowbor L, Sicotte C. The determinants of infant mortality in Brazil, 2010–2020: a scoping review. Int J Environ Res Public Health. 2021;18(12). https://doi.org/10.3390/ijerph18126464
27. Ministério dos Direitos Humanos e da Cidadania (BR). Fatos e Números: Famílias e Filhos [Internet]. 2020[cited 2024 May 30]. Available from: https://www.gov.br/mdh/pt-br/navegue-por-temas/observatorio-nacional-da-familia/fatos-e-numeros/familias-e-filhos-no-brasil.pdf
28. Odongkara B, Nankabirwa V, Ndeezi G, Achora V, Arach AA, Napyo A, *et al*. Incidence and risk factors for low birth weight and preterm birth in post-conflict Northern Uganda: a community-based cohort study. Int J Environ Res Public Health. 2022;19(19):e12072. https://doi.org/10.3390/ijerph191912072
29. Xu J, Murphy SL, Kochanek KD, Arias E. Mortality in the United States, 2021: NCHS Data Brief [Internet]. 2022[cited 2024 May 30];(456). Available from: https://www.cdc.gov/nchs/data/databriefs/db456.pdf
30. Maia MRG, Morceli G, Silva SU, Carvalho MDB, Pelloso SM. Idade materna e associação com intercorrências na gestação e parto. Res, Soc Develop. 2021;10(5). https://doi.org/10.33448/rsd-v10i5.14471
31. Rêgo MGS, Vilela MBR, Oliveira CM, Bonfim CV. Óbitos perinatais evitáveis por intervenções do Sistema Único de Saúde do Brasil. Rev Gaucha Enferm. 2018;39. https://doi.org/10.1590/1983-1447.2018.2017-0084
32. Correa-de-Araujo R, Yoon SS. Clinical outcomes in high-risk pregnancies due to advanced maternal age. J Womens Health. 2021;30(2). https://doi.org/10.1089/jwh.2020.8860
33. Ratnasiri AWG, Lakshminrusimha S, Dieckmann RA, Lee HC, Gould JB, Parry SS, *et al*. Maternal and infant predictors of infant mortality in California, 2007-2015. PLoS ONE. 2020;15(8):e0236877. https://doi.org/10.1371/journal.pone.0236877
34. Almli LM, Ely DM, Ailes EC, Abouk R, Grosse SD, Isenburg JL, *et al*. Infant mortality attributable to birth defects-United States, 2003–2017. MMWR Morb Mortal Wkly Rep. 2020;69(2). https://doi.org/10.15585/mmwr.mm6902a1
35. Rydahl E, Declercq E, Juhl M, Maimburg RD. Cesarean section on a rise, does advanced maternal age explain the increase? a population register-based study. PLoS One. 2019;14(1). https://doi.org/10.1371/journal.pone.0210655
36. Saltarelli RMF, Prado RRD, Monteiro RA, Malta DC. Trend in mortality from preventable causes in children: contributions to the evaluation of the performance of public health services in the Southeast Region of Brazil. Rev Bras Epidemiol. 2019;22:e190020. https://doi.org/10.1590/1980-549720190020
37. Lodi GSF, Lima ED, Ribeiro LDCC, Guedes HM. Perfil e funcionamento de comitês municipais de prevenção da mortalidade materna, infantil e fetal. Rev Enferm Cent-Oeste Min. 2020;10. https://doi.org/10.19175/recom.v10i0.3537

## Availability of data and material

Access to the dataset may be granted upon request to the corresponding author.

## Authorship contribution

Project administration: Cristina Maria Garcia de Lima Parada
Formal analysis: Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes; Cristina Maria Garcia de Lima Parada
Conceptualization: Cristina Maria Garcia de Lima Parada
Data curation: Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes, Cristina Maria Garcia de Lima Parada, Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira
Writing – original draft: Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes; Cristina Maria Garcia de Lima Parada
Writing- review & editing: Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Cristina Maria Garcia de Lima Parada
Investigation: Cristina Maria Garcia de Lima Parada
Methodology: Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes; Cristina Maria Garcia de Lima Parada
Software: Hélio Rubens de Carvalho Nunes
Supervision: Cristina Maria Garcia de Lima Parada
Validation: Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes; Cristina Maria Garcia de Lima Parada
Visualization: Larissa Muzel de Sousa, Ivana Regina Gonçalves, Ana Paula Pinho Carvalheira, Ana Beatriz Henrique Parenti, Hélio Rubens de Carvalho Nunes; Cristina Maria Garcia de Lima Parada

## Conflict of interest

The authors declare that there is no conflict of interest.

**Corresponding author:**
Ana Beatriz Henrique Parenti
Email: a.parenti@unesp.br

**Associate editor:**
Helena Becker Issi

Received: 06.06.2024
Approved: 10.21.2024

**Editor-in-chief:**
João Lucas Campos de Oliveira