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Trends and epidemiological profile of maternal deaths in Brazil from 2000 to 2022

Tendência e perfil epidemiológico das mortes maternas no Brasil de 2000 a 2022

Tendencia y perfil epidemiológico de las muertes maternas en Brasil entre 2000 y 2022

Maria Fernanda Parolini Ferreira – Faculdade de Medicina de Jundiaí, Jundiaí, São Paulo, Brazil ; https://orcid.org/0009-0005-2047-0725 ; http://lattes.cnpq.br/0562953168579510 ; mariafernandaparolini@hotmail.com

Márcia Regina Campos Costa da Fonseca – Faculdade de Medicina de Jundiaí, Jundiaí, São Paulo, Brazil ; https://orcid.org/0000-0001-5131-5561 ; http://lattes.cnpq.br/3049199403380472 ; marciafonseca@g.fmj.br

ABSTRACT

Objective: To analyze trends and the epidemiological profile of maternal deaths in Brazil from 2000 to 2022. **Method:** This ecological time-series study used data extracted from the Integrated Health Surveillance Platform (Mortality and Birth Monitoring Dashboard). The investigated variables included age, race/skin color, region of residence, and type of obstetric cause of death. After calculating the maternal mortality ratios (MMRs), trends were analyzed using control charts based on the expected probabilities of the normal distribution to establish Zone C (central), Zone B (warning), and Zone A (control), with observations focused on points outside the control limits. **Results:** From 2000 to 2019, the MMR remained within the Central Zone of the chart, ranging from 52.30 in 2000 to 55.31 in 2019, followed by a marked increase during the COVID-19 pandemic (71.97 in 2020; 113.18 in 2021) and a return to pre-pandemic levels in 2022 (54.82). Women aged ≥ 40 years had the highest MMR, although a downward trend was observed after 2009 (248.70 in 2009; 150.00 in 2019; 125.70 in 2022). Black women presented the highest MMR (mean: 208.04), as did the North and Northeast regions (means: 69.51 and 68.41, respectively). Direct obstetric causes accounted for the highest MMR throughout the study period. **Conclusion:** Except during the pandemic years, MMR remained stagnant over time. Older women experienced the highest MMR, and the impact of social inequalities was evident, with Black women and those living in the North and Northeast regions also presenting higher mortality rates. More effective public policies targeting vulnerable populations are needed to reduce maternal mortality.

Descriptors: Maternal Mortality; Health Information Systems; Time Series Studies.

RESUMO

Objetivo: *Analisar a tendência e o perfil das mortes maternas no Brasil de 2000 a 2022.* ***Método:*** *Estudo ecológico de série temporal, com dados extraídos da Plataforma Integrada de Vigilância em Saúde (Painel de Monitoramento da Mortalidade e Natalidade) e com as variáveis investigadas: idade, cor/raça, região de procedência e tipo de causas obstétricas dos óbitos. Após a construção das razões de mortalidade materna (RMM), a tendência foi analisada por gráficos de controle, utilizando as probabilidades esperadas para a distribuição normal para construir as Zonas C (centrais), Zonas B (alerta) e Zonas A (controle), sendo observados os pontos fora dos limites de controle.* ***Resultados:*** *De 2000 a 2019, a RMM permaneceu na Zona Central do gráfico, sendo 52,30 em 2000 e 55,31 em 2019, com aumento expressivo na pandemia de COVID-19 (71,97 em 2020; 113,18 em 2021) e retorno em 2022 (54,82). A faixa etária de maior RMM foi a ≥ 40 anos, embora observou-se tendência de queda após 2009 (248,70 em 2009; 150,00 em 2019; 125,70 em 2022). A cor/raça negra apresentou a pior RMM (média 208,04), bem como as regiões Norte e Nordeste (médias 69,51 e 68,41, respectivamente). Das causas, as diretas foram as de maior RMM no período.* ***Conclusão:*** *Com exceção dos anos da pandemia, notou-se uma estagnação na RMM. As mulheres de maior faixa etária foram as de maior RMM, sendo evidente o impacto das desigualdades sociais, com mulheres pretas e das regiões Norte e Nordeste também apresentando maior mortalidade. Faz-se necessário políticas públicas mais assertivas para a redução da mortalidade materna, com direcionamento às populações vulnerabilizadas.*

Descritores: *Mortalidade Materna; Sistemas de Informação em Saúde; Estudos de Séries Temporais.*

RESUMEN

Objetivo: *Analizar la tendencia y el perfil de las muertes maternas en Brasil de 2000 a 2022.* ***Método:*** *Estudio ecológico de serie temporal, con datos extraídos de la Plataforma Integrada de Vigilancia en Salud (Panel de Monitoreo de la Mortalidad y Natalidad) y con las variables investigadas: edad, raza/color, región de procedencia y tipo de causas obstétricas de los óbitos. Tras la construcción de las Razones de Mortalidad Materna (RMM), la tendencia fue analizada mediante gráficos de control, utilizando las probabilidades esperadas para la distribución normal con el fin de construir las Zonas C (centrales), Zonas B (alerta) y Zonas A (control), observándose los puntos fuera de los límites de control.* ***Resultados:*** *De 2000 a 2019, la RMM permaneció en la Zona Central del gráfico, siendo 52,30 en 2000 y 55,31 en 2019, con un aumento expresivo durante la pandemia de COVID-19 (71,97 en 2020; 113,18 en 2021) y retorno en 2022 (54,82). El grupo etario con mayor RMM fue el de ≥ 40 años, aunque se observó una tendencia a la disminución después de 2009 (248,70 en 2009; 150,00 en 2019; 125,70 en 2022). La raza/color negra presentó la peor RMM (media de 208,04), así como las regiones Norte y Nordeste (medias de 69,51 y 68,41, respectivamente). En cuanto a las causas, las directas fueron las que presentaron mayor RMM en el período.* ***Conclusión:*** *Con excepción de los años de la pandemia, se observó una estagnación en la RMM. Las mujeres de mayor edad fueron las que presentaron mayor RMM, evidenciándose el impacto de las desigualdades sociales, con mujeres negras y de las regiones Norte y Nordeste también presentando mayor mortalidad. Se hace necesario implementar políticas públicas más efectivas para la reducción de la mortalidad materna, con énfasis en las poblaciones vulnerabilizadas.*

Descriptores: *Mortalidad Materna; Sistemas de Información en Salud; Estudios de Series Temporales.*

INTRODUCTION

Maternal death is one of the most serious violations of women's human rights because it is preventable in 92% of cases and occurs predominantly in developing countries[1].

The World Health Organization (WHO) defines maternal death as the death of a woman during pregnancy or within 42 days after the end of pregnancy, regardless of pregnancy duration or location, from any cause related to or aggravated by pregnancy. Deaths resulting from accidental or incidental causes are excluded from the maternal mortality ratio (MMR)[2].

Maternal deaths can be classified as direct or indirect causes. Direct causes include complications occurring during pregnancy, childbirth, or the postpartum period. These complications may result from interventions, omissions, incorrect treatment, or inadequate health care provided to women. Indirect causes are defined as the worsening of preexisting diseases or diseases developed during pregnancy, aggravated by the physiological effects imposed on the maternal body[2].

The MMR is an indicator that enables the analysis of population, geographic, and temporal variations in maternal mortality, identifying inequalities and circumstances requiring targeted actions and specific investigations[3].

Brazil experienced a marked increase in MMR, rising from 57.9 maternal deaths per 100,000 live births in 2019 to 74.7 in 2020, a pattern observed across all regions of the country[4].

Maternal mortality can be considered the product of interactions among multiple factors, serving as an important parameter for evaluating women's health and, more broadly, the health status of a country's population. However, maternal mortality also reflects social inequalities, as elevated rates are observed not only in underdeveloped and developing regions but also across disparities related to race, educational attainment, and the socioeconomic conditions of pregnant women[5-8].

Maternal mortality has also been identified as a consequence of inadequate health care provided to women and violations of sexual and reproductive rights. Its persistence in Brazil remains a major concern and requires the implementation of public policies aimed at reduction, considering that most maternal deaths are preventable[7,8].

In 2015, the United Nations (UN) introduced the 2030 Agenda, a sustainable development framework for the subsequent 15 years encompassing 17 Sustainable Development Goals (SDGs). The third SDG established the target of reducing the global maternal mortality rate to fewer than 70 deaths per 100,000 live births. Since Brazil had already achieved this global target, the Ministry of Health revised the national goal to reduce MMR to a maximum of 30 deaths per 100,000 live births[9].

Several initiatives aimed at strengthening maternal health care, improving prenatal care, childbirth assistance, neonatal care, and postpartum services have been implemented nationwide. Among these initiatives are Rede Cegonha, restructured and renamed in 2024 as Rede Alyne for Comprehensive Maternal and Infant Care, the Maternal and Child Mortality Reduction Plan for Preventable Causes (PREMMICE), and the Zero Maternal Deaths by Hemorrhage Strategy, promoted jointly with the Pan American Health Organization (PAHO). These actions seek to establish educational measures and improve health professional training to reduce maternal mortality nationwide[10].

Another important strategy established in Brazil is the Maternal Mortality Committee, implemented through the Comprehensive Women's Health Care Policy (PAISM). These committees serve as management tools that enable the investigation of maternal deaths within their coverage areas and the evaluation of health care quality provided to women, supporting public policies and intervention measures[1].

As maternal mortality represents a key public health indicator, understanding its epidemiological profile and trends in Brazil is essential for developing prevention strategies, particularly those targeting populations with greater vulnerability.

Therefore, this study aimed to analyze the profile and trends of maternal deaths in Brazil from 2000 to 2022.

METHOD

This ecological time-series study with a quantitative approach analyzed trends and the epidemiological profile of maternal mortality in Brazil from 2000 to 2022.

Ecological studies compare associations between diseases or health conditions and exposure factors across geographically defined and comparable populations, such as countries, regions, cities, and neighborhoods, while also considering temporal comparisons[11].

Data were obtained from the Integrated Health Surveillance Platform[12] of the Ministry of Health, specifically the Maternal Mortality Monitoring Dashboard (deaths) and the Birth Monitoring Dashboard (live births). This source was selected because, at the time of data collection in September 2023, data from the Department of Informatics of the Unified Health System (DATASUS) had not yet been fully consolidated.

Study variables available on the platform included age group (< 19 years, 20-29 years, 30-39 years, ≥ 40 years, unknown/not reported); race/skin color (White, Black, Brown, Asian, Indigenous, unknown/not reported); region of residence (North, Northeast, Southeast, South, Midwest); and obstetric causes of death (direct, indirect, unspecified).

Data collection was conducted by two researchers experienced in studies using secondary data sources, particularly governmental databases. One researcher independently verified the collected data to ensure accuracy. Subsequently, the dataset was stored in an Excel spreadsheet before being transferred to the professional responsible for statistical analyses.

Initially, descriptive analyses (absolute and relative frequencies) were performed to characterize maternal deaths according to the investigated variables. Subsequently, maternal mortality ratios (MMRs) were calculated for these variables using the following formula: the number of deaths among women residing in a given area due to causes and conditions classified as maternal death divided by the number of live births among resident mothers, multiplied by 100,000[13].

MMR trend analyses were conducted using control charts. This methodology assumes that if data distribution does not demonstrate trends over time and random variation follows a normal distribution, 68.3% of observations are expected to fall within 1 standard deviation (SD) from the mean, 95.4% within 2 SDs, and 99.7% within control limits, corresponding to 3 SDs from the mean. Based on these probabilities, Zone C (Central Zone), Zone B (Warning Zone), and Zone A (Control Zone) were established. Control charts evaluated the occurrence of the following patterns indicating points outside control limits: at least 6 consecutive years with increasing or decreasing rates; at least 9 consecutive years with rates on the same side of the curve (above or below the mean); 2 of 3 consecutive years with rates in Zone A; and 4 of 5 consecutive years with rates in Zone B or beyond[14]. Statistical analyses were performed using R software[15].

Data used in this study are publicly available through the Integrated Health Surveillance Platform and do not allow identification of individuals included in the analyzed databases. Therefore, ethics committee review was waived (Protocol 2023/1033).

RESULTS

Between 2000 and 2022, a total of 39,567 deaths of women residing in Brazil due to causes and conditions classified as maternal death were recorded.

The predominant profile of maternal deaths involved women aged 20-29 years (40.07%) and 30-39 years (37.89%), Brown women (48.11%), residents of the Southeast (34.52%) and Northeast (33.69%) regions, and deaths resulting from direct obstetric causes (65.83%).

Figure 1 shows that from 2000 to 2019, the MMR remained within the Central Zone (Zone C) of the control chart, with no defined trend, varying by 5.76%, from 52.30 in 2000 to 55.31 in 2019. In 2020, MMR increased by 30.12%

(71.97), reaching the boundary between the Upper Central Zone and the Upper Warning Zone. Subsequently, in 2021, MMR increased by 57.26% (113.18), exceeding control limits (above the Upper Control Zone [Zone A]), indicating an outlier MMR substantially higher than the historical pattern. In 2022, MMR declined by 51.56% (54.82).

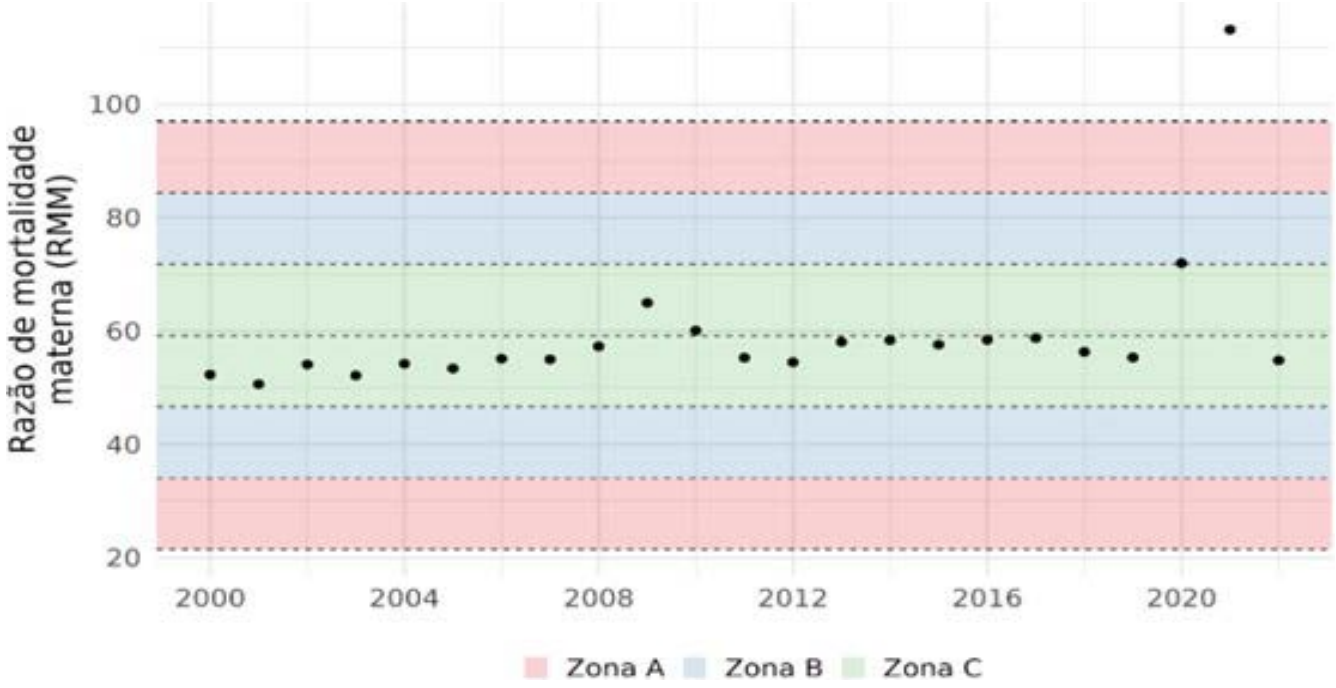

Figure 1. Control chart of the maternal mortality ratio in Brazil from 2000 to 2022.
Source: Integrated Health Surveillance Platform

MMR according to maternal age group, excluding missing data, demonstrated that women aged ≥ 40 years had the highest mortality, with a historical mean (2000-2022) of 203.87, whereas women aged ≤ 19 years had the lowest mortality (mean: 42.31). All age groups experienced marked increases during 2020-2021.

Regarding control charts (Figure 2), among mothers aged ≤19 years, 9 consecutive years with MMR below the mean were observed between 2000 and 2008, indicating lower MMR during this period relative to subsequent years. In this age group, MMR increased by 26.99%, from 31.98 in 2000 to 40.61 in 2020. In 2021, MMR increased by 54.62% (62.79), exceeding the upper control limit. In 2022, MMR declined by 33.06% (42.03).

For women aged 20-29 years, 9 consecutive years with MMR below the mean were also observed between 2000 and 2008. In this age group, MMR increased by 27.75%, from 41.80 in 2000 to 53.40 in 2020. In 2021, MMR increased by 57.30% (84.00), exceeding the Upper Control Zone, and returned to 44.60 in 2022, representing a 46.90% reduction.

Among women aged 30-39 years, MMR declined by 19.97%, from 84.76 in 2000 to 67.83 in 2019. In 2020, MMR increased by 47.40% (99.98), approaching the Upper Warning Zone. In 2021, MMR increased by 60.69% (160.66), exceeding the Upper Control Zone, and returned to 65.45 in 2022, representing a 59.26% reduction.

For women aged ≥40 years, 10 consecutive years with MMR above the mean were observed from 2000 (258.00) to 2009 (248.70), indicating elevated MMR during this period. From 2010 to 2020, 11 consecutive years below the mean were observed, indicating reduced MMR relative to the preceding period. This pattern suggests a declining trend after 2009, with a 39.69% reduction from 248.70 in 2009 to 150.00 in 2019. In 2020, MMR increased by 21.20% (181.80), and in 2021 by 38.34% (251.50), reaching the Upper Warning Zone. In 2022, MMR decreased by 50.02% (125.70).

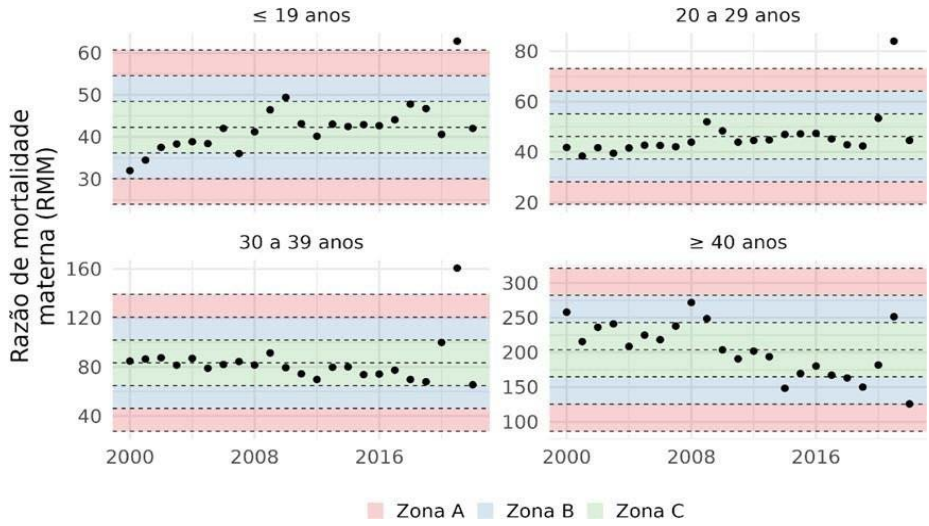

Figure 2. Control chart of the maternal mortality ratio in Brazil from 2000 to 2022, according to maternal age group.
Source: Integrated Health Surveillance Platform

White and Asian women presented the lowest MMRs (historical means: 50.20 and 50.23, respectively), whereas Black women showed the highest MMR (mean: 208.04).

Control charts (Figure 3) demonstrated that among White women, 15 consecutive years with MMR below the mean occurred between 2000 and 2014, suggesting increased rates afterward. MMR increased by 18.76%, from 41.47 in 2000 to 49.25 in 2019. In 2020, MMR increased by 31.63% (64.83), and in 2021 by 86.61% (120.98), exceeding the upper control limit. In 2022, MMR returned to 48.37, representing a 60.02% decline.

Among Black women, substantially higher MMR values were observed, increasing by 124.86%, from 183.19 in 2000 to 411.93 in 2010. From 2011 to 2022, 12 consecutive years below the mean were observed, indicating a declining trend compared with the previous period. MMR decreased from 137.43 in 2011 to 104.41 in 2019, representing a 24.03% reduction. In 2020, MMR increased by 22.25% (127.64), and in 2021 by 52.59% (194.76). In 2022, MMR decreased by 46.36%, returning to 104.47.

Among Brown women, MMR increased by 6.85%, from 50.19 in 2000 to 53.63 in 2019. In 2020, MMR increased by 28.31% (68.81, Upper Warning Zone), and in 2021 by 45.33% (100.00), exceeding the upper control limit. In 2022, MMR decreased by 47.52%, returning to 52.48.

Asian and Indigenous women showed substantial fluctuations over time, without a defined trend.

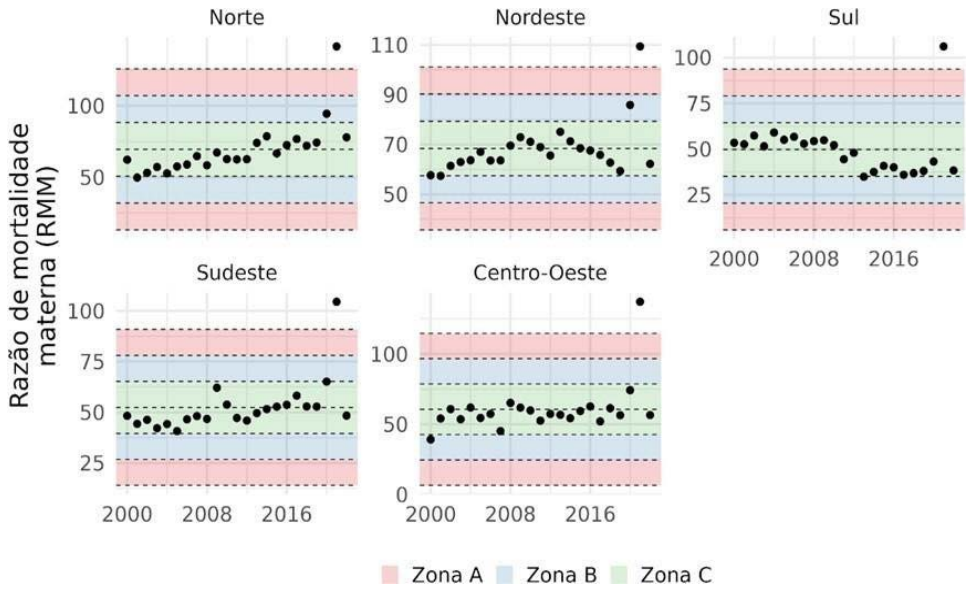

Figure 3. Control chart of MMR in Brazil from 2000 to 2022 according to race/skin color.
Source: Integrated Health Surveillance Platform

Overall, the South region had the lowest MMR (mean: 43.21), whereas the North and Northeast regions had the highest MMRs (means: 69.51 and 68.41, respectively). A marked increase in MMR during 2020 and 2021 was observed across all Brazilian regions.

Regional control charts (Figure 4) showed that in 2020, MMR in the North and Northeast regions reached the Upper Warning Zone (94.49 and 85.90, respectively). In 2021, MMR exceeded control limits (above Zone A), indicating values substantially above historical levels. That year, MMR increased by 49.84% (141.58) in the North and 27.35% (109.39) in the Northeast. The South, Southeast, and Midwest regions also showed MMR values exceeding upper control limits in 2021 (106.08, 104.48, and 137.11, respectively). In 2022, MMR declined by 63.86% (38.34) in the South, 53.74% (48.33) in the Southeast, and 58.79% (56.50) in the Midwest.

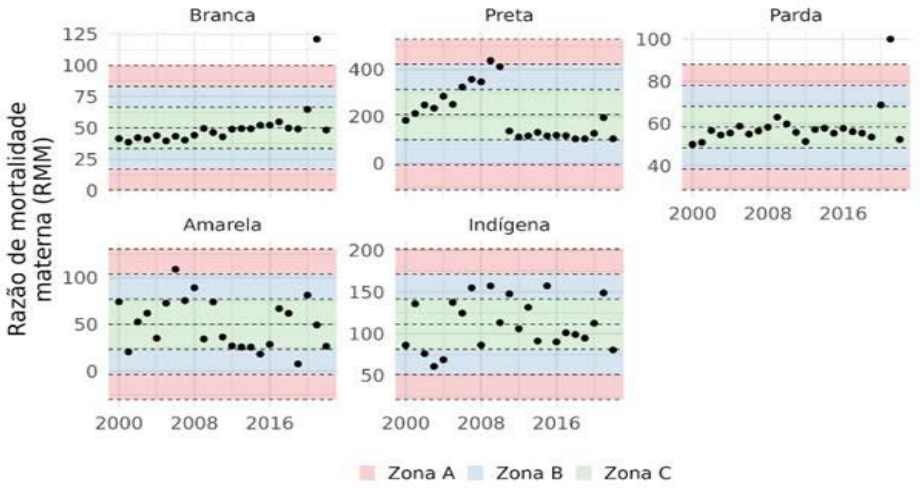

Figure 4. Control chart of MMR in Brazil from 2000 to 2022 according to geographic region.
Source: Integrated Health Surveillance Platform

Regarding obstetric causes of death, unspecified causes showed the lowest MMR (mean: 1.87), whereas direct obstetric causes showed the highest MMR (mean: 38.76).

Control charts (Figure 5) demonstrated marked fluctuations in MMR due to direct causes, including 7 consecutive years of increasing rates between 2003 and 2009.

For indirect causes, 9 consecutive years with MMR below the mean were observed from 2000 to 2008, indicating lower rates during this period. MMR due to indirect maternal causes increased by 51.44%, from 11.10 in 2000 to 16.81 in 2019. In 2020, MMR increased by 83.70% (30.88, upper boundary of the Warning Zone), and in 2021 by 134.55% (72.43), exceeding upper control limits. In 2022, MMR decreased by 77.77% (16.10).

Unspecified causes demonstrated substantial fluctuation throughout the period without a defined trend. MMR declined by 2.67%, from 1.87 in 2000 to 1.82 in 2022.

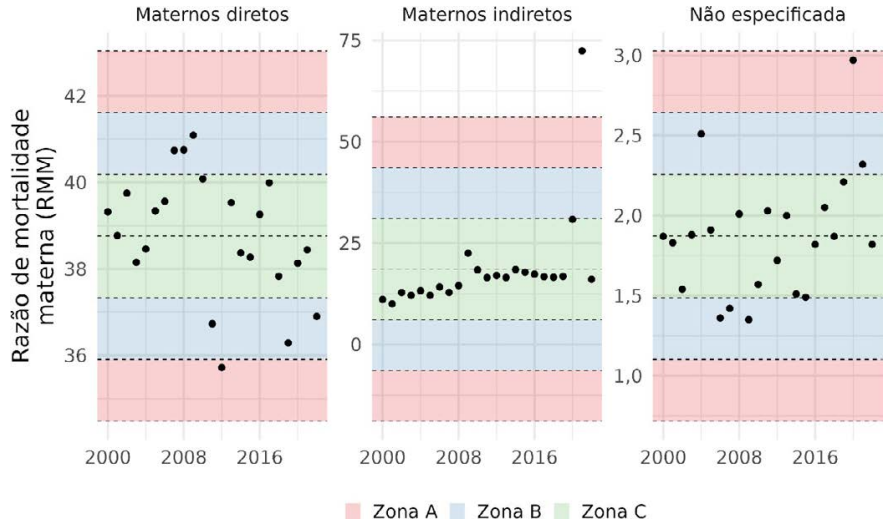

Figure 5. Control chart of the maternal mortality ratio from 2000 to 2022, according to obstetric cause.
Source: Integrated Health Surveillance Platform

DISCUSSION

Maternal death is an important indicator of population quality of life and is preventable in most cases[1]. Overall, maternal deaths result from delays in receiving adequate health care. Strengthening maternal health care networks within the Unified Health System (SUS) is therefore essential to reduce barriers to care and ensure comprehensive health care for women. Integration across health care levels, particularly primary health care and improved qualification of referral obstetric services, constitutes a key structural strategy for ensuring timely access, continuity of care, and reducing preventable maternal mortality nationwide[2].

From 2000 to 2019, overall MMR showed no defined trend, remaining within the Central Zone of the control chart, except in 2009. This change may be related to the Influenza A (H1N1) epidemic, which increased risks of complications, hospitalization, and death among pregnant women[16].

In 2020 and 2021, MMR increased markedly nationwide during the COVID-19 pandemic. During this period, maternal health care services were disrupted, including prenatal care, partly because pregnant women avoided health care services due to uncertainty and fear of exposure and partly because health care systems prioritized COVID-19 treatment over other conditions[17]. Delays in maternal disease management and infection screening were observed. Moreover, COVID-19 may amplify inflammatory responses in individuals with comorbidities such as preeclampsia and obesity during pregnancy, increasing fatality risk[18].

In 2022, following improved disease control, MMR returned to the Central Zone of the control chart, approaching prepandemic levels.

Health managers and health professionals must develop strategies to address stagnation in MMR reduction. Health care systems should operate across all care levels by ensuring early and qualified prenatal care, preventing pregnancy-related diseases, planning childbirth care, defining referral centers, and facilitating referral to higher-complexity services when needed. Training health care teams and implementing protocols tailored to maternal care needs are also essential[19].

Women aged 20-29 years represented the largest proportion of maternal deaths, consistent with findings from a study conducted in Ribeirão Preto, Brazil (63.9%)[20], which may reflect the higher frequency of pregnancies in this age group. However, women aged ≥ 40 years had the highest MMR (historical mean: 203.87). Pregnancies after age 35 are associated with increased obstetric complications, including hemorrhage, preterm birth, and fetal malformations[21]. These women are also more likely to have chronic conditions, such as hypertension, increasing risks of adverse maternal outcomes, including maternal death[22].

Regarding race/skin color, Brown women accounted for the largest number of maternal deaths, likely reflecting their demographic representation in Brazil[23]. However, Black women showed the highest MMR (mean: 208.04). Black race/skin color may be associated with increased risks of hypertensive disorders during pregnancy[24]. Race may also reflect disparities in health care access and quality, contributing to maternal deaths among Black and Brown women. Historically, Black populations in Brazil experience worse social indicators and continue to face structural racism, including within health care settings, which may create barriers to care[25]. These inequities may also reduce representation in health decision-making and policy development, perpetuating disparities by failing to address specific population needs[25].

Despite governmental initiatives, regional heterogeneity, inadequate death certificate completion, and underreporting of maternal deaths remain important challenges nationwide[26]. Areas with better reporting systems and improved maternal health care may report higher numbers of maternal deaths[27], potentially contributing to the elevated frequency observed in the Southeast region.

When MMR was analyzed by geographic region, the North and Northeast presented the highest rates. Health care access and organization remain unequal across the country. Persistent poverty in these regions intensifies barriers to prenatal care through limited access to health care and lower educational attainment[27]. In the Northeast, lower rates of early prenatal care initiation and greater care-seeking displacement for childbirth assistance have been reported, indicating failures in guaranteeing pregnant women's right to establish prior referral links with maternity services[28].

Therefore, isolated health care interventions are insufficient in vulnerable regions. Broader policies targeting social determinants of health are necessary to reduce observed inequalities[29].

The South region had the lowest MMR (mean: 43.21). Prenatal care in this region is considered more accessible compared with other Brazilian regions and includes greater guidance regarding pregnancy risks, potentially improving management of maternal comorbidities[30].

Regarding obstetric causes, direct causes were the most frequent, consistent with studies conducted in Ribeirão Preto, São Paulo (77.8%)[20], Teresina, Piauí (69.4%)[31], and nationwide between 2011 and 2021 (59.83%)[7]. Direct causes showed the highest MMR and substantial fluctuation over time. This pattern may be associated with hospital and maternity care management practices and access to intensive care units (ICUs). Clinical protocols are frequently updated, requiring continuous professional training and adaptation[22]. However, preparation remains uneven across health care services.

Adequate prenatal care aims to reduce complications and improve perinatal outcomes. Nevertheless, persistent deficiencies remain, including limited access, delayed initiation, insufficient consultations, shortages of equipment and supplies, and incomplete or inadequate procedures, negatively affecting care quality and timely interventions[28].

Primary health care (PHC) plays an essential role in women's health care and management of maternal complications. However, prenatal care indicators within PHC remain below expected targets, directly influencing MMR[2].

Although this study contributes important findings, some limitations should be acknowledged. Secondary data sources may present quality issues, including missing fields in death certificates and coding inconsistencies. Nevertheless, mortality databases remain among the most reliable and comprehensive epidemiological sources available.

Despite these limitations, time-series mortality studies represent valuable epidemiological tools for generating hypotheses, identifying vulnerable populations, and indirectly evaluating the effectiveness of public health policies.

CONCLUSION

The findings of this study demonstrate that maternal mortality, except during the pandemic years, has remained stagnant over time. Although the MMR showed a declining trend, it remained higher among women aged 40 years or older and Black women. Regarding causes of death, a marked increase in indirect maternal deaths was observed between 2020 and 2021, which highlights the impact of the indirect effects of COVID-19 on this group of causes. Concerning geographic regions, although the impact of the pandemic was observed nationwide, social inequalities and disparities in maternal and child health care remain evident in Brazil, with the North and Northeast regions presenting the poorest maternal mortality indicators.

Despite the implementation of strategies in recent years, as well as improvements and advances in maternal health care services, Brazil remains far from achieving the target established by the Ministry of Health of no more than 30 deaths per 100,000 live births. Allocating resources to populations and regions with greater vulnerability, together with implementing targeted action plans addressing the most frequent obstetric causes of death, may contribute to improving health care strategies and reducing maternal mortality in Brazil.

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First Author and Correspondence Address
Maria Fernanda Parolini Ferreira
Faculdade de Medicina de Jundiaí
Department of Public Health
Rua Francisco Telles, 250
Bairro: Vila Arens
CEP: 13202-550 / Jundiaí (SP) – Brazil
E-mail: mariafernandaparolini@hotmail.com

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