ORIGINAL ARTICLE

Temporal analysis of maternal mortality due to COVID-19: a cross-sectional study

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Abstract

Objectives: to analyze maternal mortality due to COVID-19 in Brazil among pregnant and postpartum women of reproductive age (10-49 years) between 2020 and 2024.

Methods: this is a descriptive, cross-sectional study based on secondary data from the Brazilian Obstetric Observatory. The study population included women of reproductive age, pregnant women, and postpartum women, with a confirmed diagnosis of COVID-19. Sociodemographic, clinical, and outcome variables were analyzed using absolute and relative frequencies distributed by year. Time trend graphs were constructed using Python software with (Pandas and Matplotlib libraries).

Results: a peak in maternal morbidity and mortality was identified in 2021, accounting for approximately 70% of all cases recorded during the analyzed period. Women aged 20 to 34 years represented 63% of cases, and those of brown race (mixed race) accounted for 56%. The Southeast region concentrated 45% of the records. The most frequent respiratory symptoms were fever (12,000 cases) and dyspnea (10,000). 38% of patients required ICU admission, and 16% received invasive ventilatory support, with a case-fatality rate of 12%.

Conclusion: the COVID-19 pandemic exacerbated maternal mortality in Brazil, especially in 2021, highlighting racial and regional inequalities in access to and quality of obstetric care.

Key words *COVID-19, Pregnancy, Postpartum period, Maternal mortality, Health information systems*

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Introduction

The World Health Organization (WHO) estimated approximately 287,000 maternal deaths worldwide, mostly in low- and middle-income countries.[1] In Brazil, the maternal mortality ratio remains high, with reports of 64.4 deaths per 100,000 live births in 2016 – a figure over ten times higher than that of developed countries.[2]

In 2020, the global Maternal Mortality Ratio (MMR) was 223 per 100,000 live births. To achieve the target reduction to fewer than 70 deaths until 2030, an annual decline of 11.6% would be required. Nevertheless, stark inequalities persist: while countries like Poland demonstrated rates of only two deaths per 100,000 live births, South Sudan reached 1,223.[3,4]

The pandemic represented a turning point in the maternal mortality trend. Estimates indicate a 70% excess in maternal deaths in the first 15 months of the COVID-19 pandemic in Brazil.[4-6] Globally, the impact was equally profound: in the United States, approximately one-quarter of maternal deaths from 2020 to 2021 were associated with Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection.[5] As the pandemic progressed, severe systemic flaws were identified, such as the scarcity of Intensive Care Unit (ICU) beds and ventilatory support. Furthermore, the association between COVID-19 and comorbidities – such as hypertension, diabetes, and obesity – significantly worsened the clinical outcomes among pregnant women.[6,7]

Regional studies have highlighted higher vulnerability in areas with geographic and social barriers, such as the Xingu region and Ceará state, as well as a higher risk among Black and Indigenous women, reflecting historical inequalities.[8,9] Although vaccination has reduced the case severity, the late inclusion of pregnant and postpartum women into priority groups and vaccine hesitancy limited the initial response.[10]

Given this scenario, the present study is justified by the need to understand the effects of the pandemic on maternal health, emphasizing time trends alongside regional and racial inequalities. Thus, the objective was to assess maternal mortality due to COVID-19 in Brazil among women of childbearing age, including pregnant and postpartum women, from 2020 to 2024.

Methods

This descriptive, cross-sectional study, was conducted in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist. The study population consisted of women of childbearing age (10-49 years), including pregnant and postpartum women with records indexed in the Brazilian Obstetric Observatory (OOBr), who resided across all federative units of Brazil.

The study period (2020–2024) was selected to encompass the complete epidemiological cycle of the COVID-19 pandemic in Brazil. This timeline spans from the initial detection of cases in 2020 – which imposed immediate and unprecedented challenges on obstetric care – through the pandemic peaks of 2021 and 2022 characterized by high infection rates and healthcare system collapse, to the post-pandemic transition phase in 2023 and 2024. This extended window enables a comprehensive assessment of maternal morbidity and mortality trends, capturing the emergency, mitigation, and stabilization phases.

Inclusion criteria comprised all registered cases of pregnant and postpartum women of childbearing age (10–49 years) hospitalized with a confirmed diagnosis of COVID-19 – validated via RT-PCR, rapid test, or clinical-epidemiological criteria – between January 1, 2020, and December 31, 2024. Records with missing data in critical variables, such as obstetric status, case outcome, or diagnostic confirmation, were excluded. For variables with partially missing information (e.g., race/skin color or comorbidities), the "unknown" category was retained to evaluate data completeness. No statistical imputation methods were applied.

Data were extracted from the public database of the OOBr, which consolidates records from the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe), linked to the Department of Informatics of the Unified Health System (DATASUS) and the Brazilian Ministry of Health. The OOBr is a well-established platform for research on COVID-19 and maternal health in Brazil, recognized in both national and international literature for its accuracy and continuous updates.

Study variables were categorized into three dimensions: (1) sociodemographic: age (stratified by age groups), self-reported race/skin color (White, Black, Brown [mixed-race], Yellow [Asian], Indigenous, and unknown), and region of residence; (2) clinical: presence of comorbidities (e.g., diabetes, obesity, cardiovascular diseases, and chronic respiratory diseases) and respiratory symptoms (fever, cough, dyspnea, among others); and (3) outcomes: clinical evolution (recovery or death), Intensive Care Unit (ICU) admission, ventilatory support requirement (invasive or non-invasive), and gestational or postpartum stage.

A descriptive analysis was performed using absolute and relative frequencies for all variables of interest across the study period. To evaluate time trends, annual proportions were calculated for each variable, and line graphs were constructed to visualize longitudinal patterns and variations among the groups. The observed trends

were subsequently interpreted based on contextual health factors and compared with the existing literature.

Data organization and visualization were conducted using Python software, utilizing the Pandas and Matplotlib libraries. Given the purely descriptive nature of this research, inferential or predictive modeling was not performed. This cross-sectional approach effectively captured the distribution of events over time, facilitating a clear characterization of maternal health patterns and trends throughout the pandemic.

As this study relied exclusively on publicly accessible secondary data, it was exempted from review by an Institutional Review Board / Research Ethics Committee. Data were analyzed in an aggregated format without individual identification, thereby ensuring confidentiality.

Results

The time-trend analysis evidenced a significant increase in maternal mortality and morbidity records in 2021, followed by a progressive reduction in the subsequent years (Figure 1). Women aged 20-34 years accounted for approximately two-thirds of the cases, with a predominance of Brown (mixed-race) women and residents of the Southeast and Northeast regions. This pattern reflects regional and racial inequalities regarding the impact of the pandemic on maternal health.

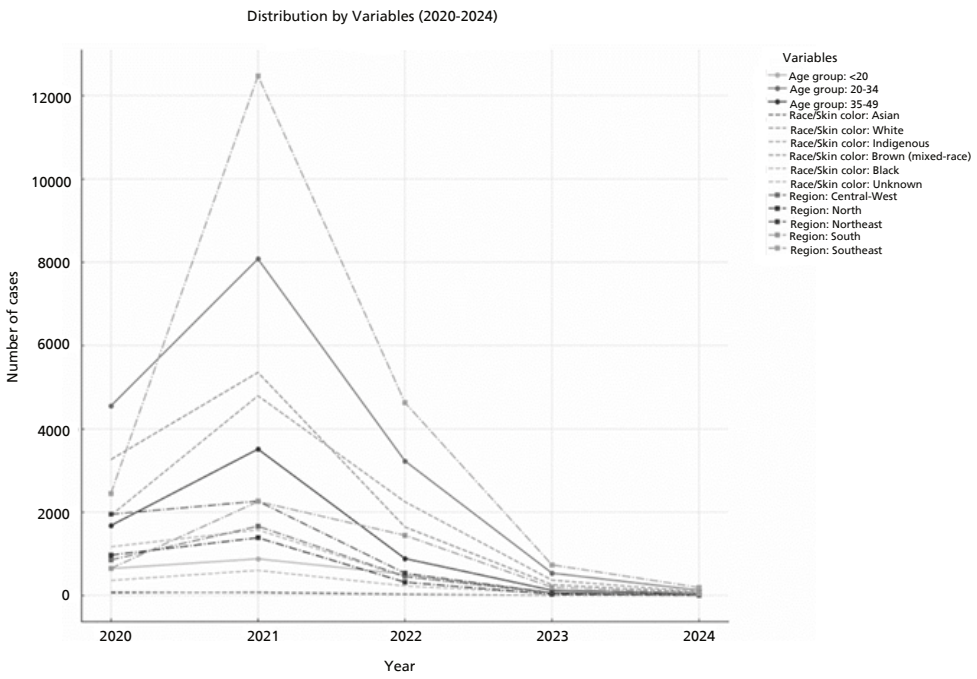
Among the recorded symptoms, fever and respiratory manifestations were the most frequent. In 2021, fever (approximately 12,000 cases), dyspnea (around 10,000 cases), and cough (nearly 9,000 cases) predominated, followed by a sharp decline starting in 2022 (Figure 2). Gastrointestinal symptoms and the loss of smell or taste occurred with much lower frequency. Across all symptoms, a consistent pattern emerged: a substantial increase in records up to 2021, followed by a marked reduction in the subsequent years (2022–2024).

Clinical variables followed the same temporal pattern (Figure 3), encompassing clinical status, Intensive Care Unit (ICU) admission, ventilatory support requirement, and clinical evolution. The postpartum period was the most affected clinical state. In 2021, 38% of patients required ICU admission, 16% received invasive ventilatory support, and the case-fatality rate reached 12%, declining gradually in subsequent years.

Regarding race/skin color, a predominance of cases was observed among Brown (mixed-race) women (56%), followed by White (31%) and Black women (10%) (Figure 4). Although the majority of the population achieved clinical recovery, Black women exhibited a higher proportion of ICU admissions and deaths. The underrepresentation of Indigenous and Asian groups suggests potential underreporting and strained access to healthcare services.

Figure 1

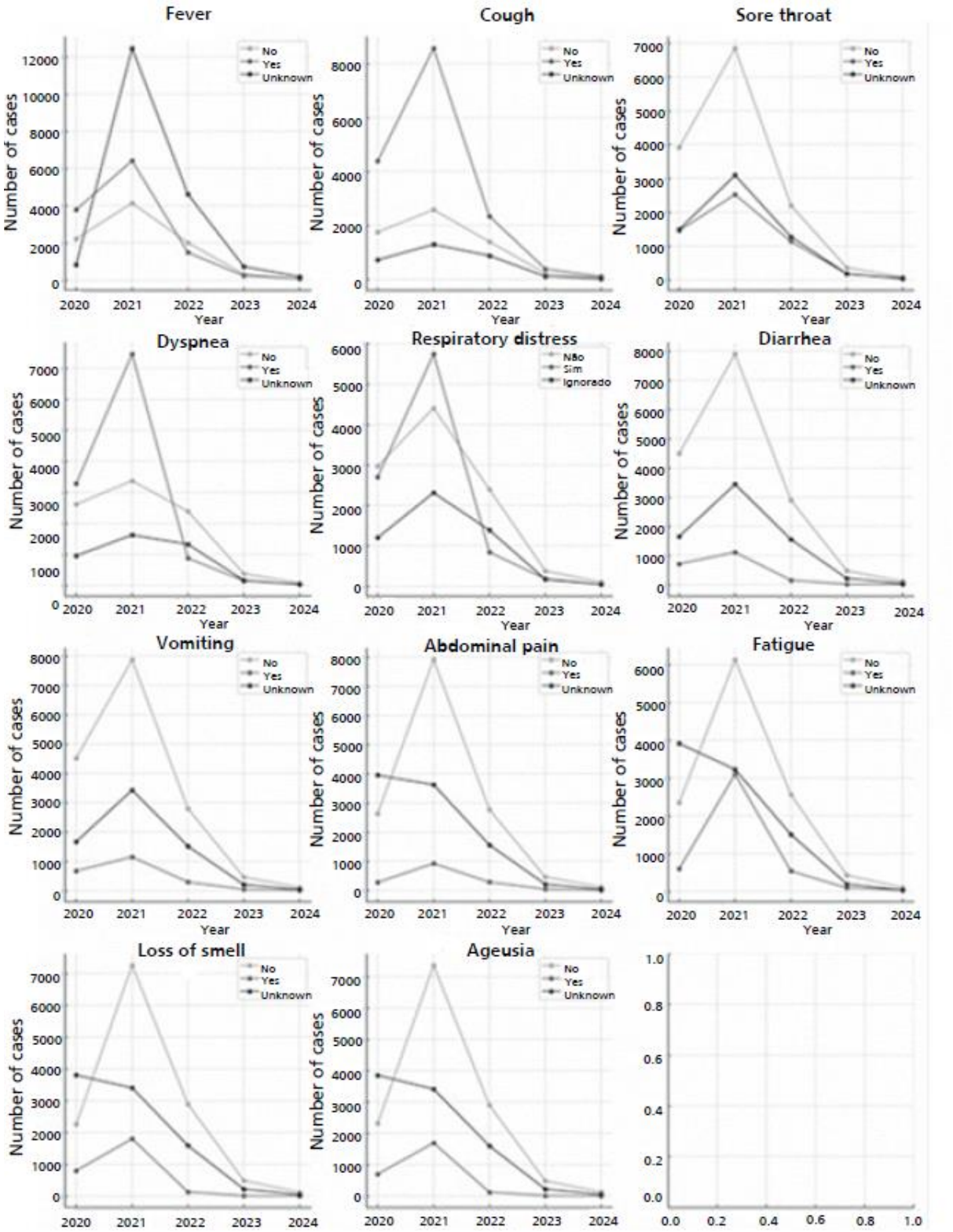
Distribution by sociodemographic and regional variables of pregnant and postpartum women with COVID-19. Brazil, 2020-2024.



Source: Prepared by the author, with data extracted from the Brazilian Obstetric Observatory (OOBr).

Figure 2

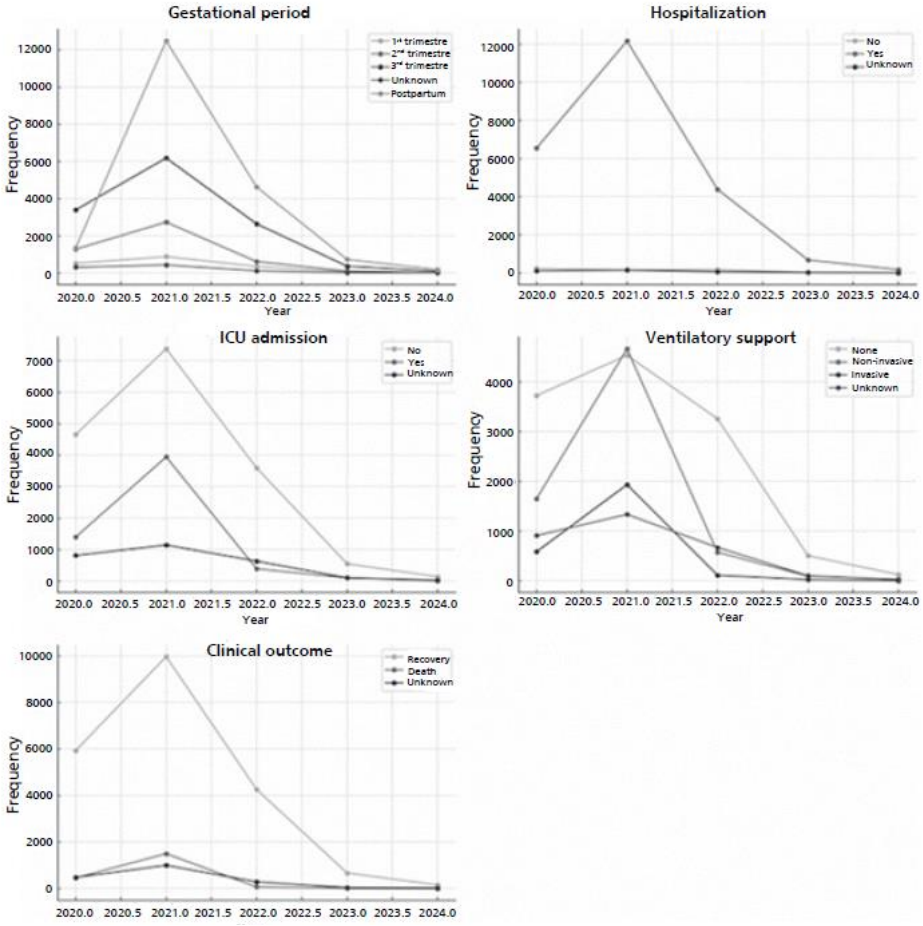
Temporal trends of signs and symptoms in pregnant and postpartum women with COVID-19. Brazil, 2020–2024.



Source: Prepared by the author, with data extracted from the Brazilian Obstetric Observatory (OOBr).

Figure 3

Temporal analysis of clinical characteristics in pregnant and postpartum women with COVID-19. Brazil, 2020–2024.

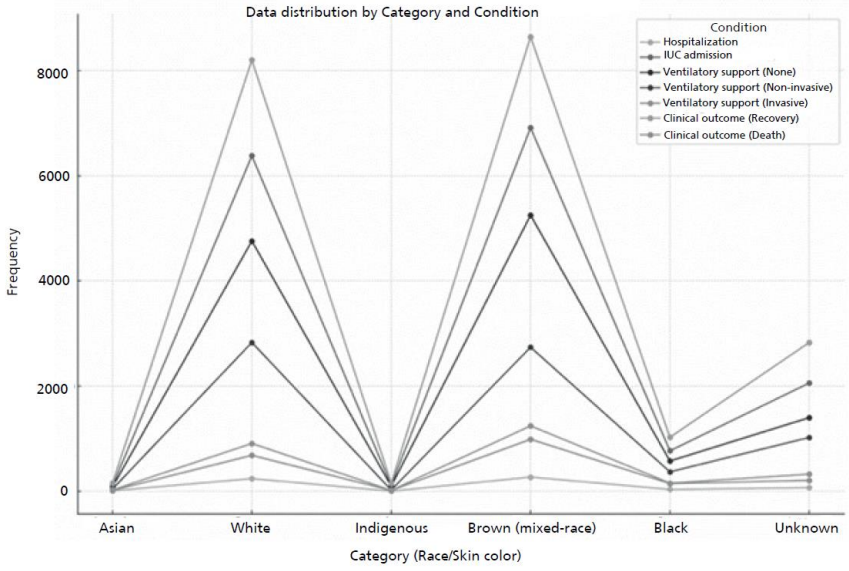


ICU=intensive care unit.

Source: Prepared by the author, with data extracted from the Brazilian Obstetric Observatory (OOBr).

Figure 4

Distribution of clinical conditions and outcomes by race/skin color category in pregnant and postpartum women with COVID-19. Brazil, 2020–2024.



ICU=intensive care unit.

Source: Prepared by the author, with data extracted from the Brazilian Obstetric Observatory (OOBr).

Discussion

The findings of this study evidenced a significant impact of the COVID-19 pandemic on maternal mortality in Brazil, characterized by a peak in 2021 and a gradual reduction in subsequent years. This temporal pattern aligns with trends observed in other middle-income countries, where healthcare system strain, delayed diagnosis, and scarcity of critical resources – such as ICU beds and ventilators – increased the vulnerability of pregnant and postpartum women.[11,12]

The high concentration of cases among women aged 20–34 years reflects the demographic profile of fertility in Brazil; however, the elevated mortality within this cohort highlights critical gaps in the coverage and quality of obstetric care.[13] Prior literature on the COVID-19 pandemic in Brazil underscores that Black and Brown (mixed-race) individuals faced a higher likelihood of severe hospitalization due to an increased prevalence of comorbidities—such as hypertension and diabetes—alongside substantial barriers to early healthcare access.[14] Furthermore, national and international studies have consistently demonstrated a higher risk of adverse outcomes among Black women, which are intrinsically linked to social determinants of health, accessibility barriers, and institutional racism.[15,16]

Regionally, the Southeast exhibited the highest absolute number of cases, which aligns with its high population density and concentration of specialized referral centers. Conversely, the North and Northeast regions maintained disproportionately high mortality rates. This distribution reflects structural inequalities within the obstetric care network and varying response capacities among local healthcare systems.[17-19]

The decline in cases observed from 2022 onward coincides with the rollout of COVID-19 vaccination campaigns and the progressive reorganization of healthcare services. Numerous studies have confirmed the protective effect of immunization during pregnancy and the postpartum period, significantly reducing hospitalizations and deaths. Nevertheless, the delayed inclusion of pregnant and postpartum women into vaccine priority groups, compounded by vaccine hesitancy, initially limited these public health benefits.[9,20,21]

These results reinforce the need to strengthen the maternal mortality surveillance of and integrate morbidity and mortality databases, thereby enabling the early detection of pregnant women with Severe Acute Respiratory Syndrome (SRAG). The pandemic exposed gaps within the Mortality Information System (SIM) and in the timely case reporting, ultimately compromising the response of health authorities.[22,23]

The observed racial and regional disparities highlight the persistence of social determinants of health and structural racism in maternal mortality. Addressing these inequities requires public policies that integrate universal access, health education, and targeted strategies for vulnerable populations, with a distinct emphasis on high-quality prenatal care and safe delivery environments.[24,25]

The lessons learned from the pandemic must guide future public health crisis preparedness. Integrating specific obstetric protocols into emergency contingency plans, fostering multidisciplinary teams, and ensuring equitable access to vaccines and emerging therapeutics are essential measures to prevent future surges in maternal mortality.[26]

We also recognize the underrepresentation of minority racial groups (Indigenous, Asian, and "unknown" categories) in the registry, which may underestimate the true magnitude of disparities and introduce information bias. Future research utilizing linked individual-level databases could employ multivariate analyses, time-series modeling, and more robust predictive techniques. This would significantly advance the understanding of maternal mortality determinants and contribute to the quality improvement of health information systems.

Among the study limitations, we highlight the strictly descriptive nature of the analysis, which relied on the frequency distribution of variables over time without applying inferential tests or multivariate modeling. This approach was chosen because the central objective was to characterize the temporal behavior of the indicators and describe the observed sociodemographic and clinical patterns. This methodological choice was deliberate, given the constraints of the Brazilian Obstetric Observatory database, which compiles aggregated and heterogeneous data that lack the potential for individual-level data linkage. This format inherently limits the control for confounding factors and the utilization of more complex analytical methods. Despite these restrictions, this descriptive approach offers clear advantages for the proposed objective, as it enabled a comprehensive characterization of the temporal trends and regional and racial disparities in COVID-19-related maternal mortality, thereby providing valuable baselines for epidemiological monitoring and future individual-level data research.

In conclusion, the COVID-19 pandemic significantly aggravated maternal mortality in Brazil, particularly in 2021, and exacerbated preexisting racial and regional inequalities. The reduction observed from 2022 onward reflects the impact of vaccination campaigns and the reorganization of healthcare services; however, it failed to eliminate the structural barriers that affect pregnant and postpartum women in vulnerable contexts. Public policies focused on equity must prioritize strengthening obstetric

care, continuously monitoring maternal mortality, and expanding access to timely, high-quality care to reduce disparities and prevent future surges within public health emergency scenarios.

Authors' contribution

Santos GG: conceptualization, investigation, methodology, data curation, formal analysis, software, visualization, writing – original draft, and writing – review & editing.

Vidotti GAG: conceptualization, investigation, methodology, supervision, visualization, writing – original draft, and writing – review & editing.

Bermejo Gil BM and López Pedraza L: methodology, supervision, visualization, writing – original draft, and writing – review & editing.

All authors approved the final version of the article and declare no conflict of the interest.

Data availability

All datasets supporting this study are included in the article.

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