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Papers

COVID-19 in Brazil: A Look at Gender in Mortality in 2020 and 2021

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Abstract
COVID-19 is portrayed as a disease caused by the SARS-CoV-2 virus, which is extremely contagious and mainly affects the respiratory system. The pandemic has impacted the lives of men and women disproportionately, from the risk of exposure and biological susceptibility to infection to the social and economic impacts. In this sense, this research aims to analyze the relationship between gender and mortality from COVID-19 in the Brazilian Federative Units. This is an applied, exploratory and qualitative-quantitative study. Mortality rates by gender and Federation Unit were calculated based on data obtained from the Civil Registry - Transparency Portal for the years 2020 and 2021. The results show disparities in the number of deaths between men and women in various age groups. In addition, mortality rates among men were considerably higher compared to women, especially in 2021. This discrepancy was notable in men over 60, particularly in the North and Northeast regions. In addition, Roraima stood out with the highest mortality rates for both genders in the two years analyzed. These findings highlight the importance of policies and strategies that are sensitive to gender and the needs of vulnerable groups, in order to mitigate impacts during pandemic periods. Furthermore, approaches that consider gender disparities can contribute significantly to the effectiveness of public health measures and the general well-being of the population.

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INTRODUCTION

The pandemic caused by the virus *Severe Acute Respiratory Syndrome - Corona Virus* (SARS-CoV-2) - responsible for the *Corona Virus Disease* 2019 (COVID-19) has proven to be a challenging and significant public health problem that has social and economic impacts at (inter)national level.

The infectious agent of COVID-19 is Sars-CoV-2, which has a zoonotic origin, originating from wild animals with the ability to contaminate distinct species, including humans (Plowright *et al.*, 2017; Ye *et al.*, 2020). This transmission process is characterized as *spillover* – a transmission facilitated by successive processes in which pathogenic animals can establish human infections. The probability of zoonotic transmission depends on the interaction of several aspects, such as host disease dynamics, exposure, other pathogens, and human factors that influence susceptibility to infection (Plowright *et al.*, 2017).

At the end of 2019, China reported the first case of the new coronavirus. It was observed that residents of the city of Wuhan, in China, began to show symptoms of a severe acute respiratory syndrome and its exponential growth affected thousands of people in a brief period (Machado; Richter, 2020; Jin *et al.*, 2020).

Already in early February 2020, given the highly contagious and as yet unknown nature of the pathogen, China implemented social isolation measures to contain the spread of the new coronavirus. As a result of social isolation, indicators began to show a significant drop in cases of infection. Subsequently, the city of Bergamo, Italy, became a hotspot of infected and dead people, constituting a Public Health Emergency of International Concern (WHO, 2020).

On March 11, 2020, the World Health Organization (WHO) declared a pandemic of the new coronavirus, due to the SARS-CoV-2 virus. Subsequently, countries such as Spain, France, and Great Britain have been hit by the spread of the virus. The epicenter of the disease was concentrated on the American continent, mainly affecting the United States (USA) and later Brazil (Machado; Richter, 2020).

In 2022, Brazil became the second country in terms of the number of deaths (638,913 million), behind only the USA (946,120 million) (Simões, 2022). However, the socio-economic vulnerabilities associated with the inadequacy of these countries' health systems have hampered their ability to respond to the spread of the virus (Cartaxo *et al.*, 2021).

Incoherently, Brazil has one of the most progressive health legislations in the world, considered a fundamental right and an obligation of the state since 1988. Law No. 8.080/1990 established the Sistema Único de Saúde (SUS) (Unified Health System, in English), thus guaranteeing the accessibility, integrity, and universality of health services (Brito *et al.*, 2022).

In general, concerns about the pandemic are rarely assimilated to sustainability issues. However, the emergence of the new coronavirus is related to human behavior (Machado; Richter, 2020) and unsustainable consumption and production patterns, as well as inadequate eating habits, such as the consumption of wild animals on the Asian continent. The infection of the new coronavirus in humans was mainly caused by the intermediation of wild animals (Acosta *et al.*, 2020; Benvenuto *et al.*, 2020).

The outbreak of the SARS-CoV-2 virus pandemic accelerated deforestation and landscape fragmentation has taken on new forms. This scenario has increased the risk of contact between humans and hosts for viruses that cause unknown infectious diseases (Bloomfield *et al.*, 2020), as was the case with the COVID-19 pandemic. In short, the COVID-19 pandemic has raised alarm bells worldwide about the direct and indirect effects of deforestation, especially in tropical forests (Brancalion *et al.*, 2020).

It is therefore necessary to assume the agenda of concrete actions to raise awareness that natural resources are liable to be depleted. Given this, the economic model needs to be supported by the pursuit of environmental preservation, to mitigate negative impacts on the environment and climate change (Pierro; Jacobi, 2021).

As of mid-October 2022, approximately 34.7 million cases have been confirmed, of which around 686.9 thousand have resulted in death, according to data from the Johns Hopkins University Dashboard (JHU, 2022). However, studies show that the disproportionality in the groups most affected by the pandemic, i.e. groups in conditions of socio-spatial inequalities and socioeconomic vulnerability (Albuquerque; Ribeiro, 2020; Sanhueza-Sanzana *et al.*, 2021; Sugahara *et al.*, 2021), ethnic-racial and/or gender disparities (Araújo *et al.*, 2020; Jin *et al.*, 2020; Mackey *et al.*, 2020; Kim; Bostwick, 2020; Reis *et al.*, 2020, Ejaz *et al.*, 2021, Escobar *et al.*, 2021; Gariboti; Silva Júnior, 2022; Santos; Silva, 2022), have the worst COVID-19 outcomes.

In addition, the scale of the pandemic has managed to encompass economic, cultural,

social, and environmental aspects. However, the difficulty of dealing with these aspects in an integrated manner has highlighted the increased criticality of the safety of human life (Albuquerque; Ribeiro, 2020; Machado; Richter, 2020; Sugahara *et al.*, 2021).

The scenario created by the pandemic has intensified social inequality and income disparity, revealed by the socio-economic stability resulting from job losses and, consequently, wage cuts. In addition to financial, housing, infrastructure, and access to health inequalities, there are also ethnic, racial, educational, political, and cultural inequalities (Albuquerque; Ribeiro, 2020; Araújo *et al.*, 2020).

Added to this is the lack of infrastructure to provide the conditions that should slow down the spread of the virus, impacting the most vulnerable populations. This situation is aggravated by the lack of health insurance and resources for a balanced diet (Sugahara *et al.*, 2021). In short, access to housing, health, and infrastructure is precarious from the perspective of socio-spatial distribution (Albuquerque; Ribeiro, 2020).

Identifying vulnerable groups can reinforce and guide an innovative approach to implementing public policies based on the specific needs of each group (Araújo *et al.*, 2020). In this case, it should be emphasized that gender is a socially constructed relational category that reflects the norms and peculiarities according to the culture, society, and way of life of each region (FIOCRUZ, 2020).

Given the gaps on the subject, this study was inspired by the works of Jin *et al.* (2020), Ejaz *et al.* (2021), Gariboti and Silva Júnior (2022), and Santos and Silva (2022), in which the numbers of deaths due to COVID-19 according to gender and/or race were pointed out.

The geographical delimitation of Brazil's Federative Units (UFs) as the focus of the analysis is justified due to the intrinsic and marked socioeconomic inequality that permeates the country, with clear repercussions on access to public health services. This geographical section is appropriate, as it reflects existing regional disparities and allows for a more specific and targeted investigation of the challenges faced by each state in the context of health care.

In this context, there is an imperative need for comprehensive research to investigate the multiplicity of factors that may have exacerbated the impacts of the pandemic in the country. As highlighted by Sanhueza-Sanzana *et al.* (2021), the intention is to prevent existing gaps from getting even worse. A thorough understanding of these factors is crucial to guide public policies and health strategies that seek to reduce social inequalities, promote equitable access to these services, and strengthen the system's resilience in the face of future public health crises.

The guiding question arises from the need to verify whether there are significant differences in the number of deaths between men and women in different age groups during the COVID-19 pandemic. This research aims to analyze COVID-19 mortality by gender in the Brazilian states in the 2020-2021 period.

This study was systematized into five stages: (i) problematization of the COVID-19 pandemic; (ii) screening of databases and collection in the public databases of the IBGE Automatic Retrieval System (SIDRA) and the Civil Registry Transparency Portal - Special COVID-19 section; (iii) calculation of mortality rates by gender; (iv) discussion of the results and (v) final considerations.

MATERIAL AND METHODS

The methodology of this study is characterized as applied and exploratory, with a qualitative-quantitative approach. Exploratory research seeks to gather information on a specific phenomenon to enhance knowledge about it (Severino, 2017). The qualitative-quantitative approach is aimed at "research strategies that involve simultaneous or sequential data collection to better understand research problems" (Creswell, 2007, p. 35).

Data collection

Brazil is formed by the union of 5.570 municipalities, which are distributed in 27 UFs (Federative Units or states): Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR), Tocantins (TO), Alagoas (AL), Bahia (BA), Ceará (CE), Maranhão (MA), Paraíba (PB), Pernambuco (PE), Piauí (PI), Rio Grande do Norte (RN), Sergipe (SE), Distrito Federal (DF), Goiás (GO), Mato Grosso (MT), Mato Grosso do Sul (MS), Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Rio Grande do Sul (RS), Santa Catarina (SC). Grouped into macro-regions - North, Northeast, Midwest, Southeast, and South. Brazil's municipalities, states (UFs), and macro-regions all have their own distinct socio-economic, socio-demographic, and health peculiarities (IBGE, 2022).

For the total population and disaggregated data (gender and age group), the public database SIDRA/IBGE (2015) was used for 2015 - the year with the most recent data at the time of this research for Brazil's Federative Units (UFs).

Data was collected on the number of deaths and disaggregated (gender and age group) for the years 2020 and 2021, using data from the Civil Registry Transparency Portal, a freely accessible website (Registro Civil, 2020, 2021). This collection covered: i) exclusively the type of disease defined as COVID-19, ii) all places of death, and iii) did not include cases with gender classified as undefined.

It is important to note that the age groups projected in this research were adjusted in 10-year intervals to create a consistent scenario for data analysis in both databases.

Mortality rate

The crude mortality rate was chosen because it was in line with the objective of this study. The COVID-19 mortality rate by gender and age group per 100,000 inhabitants was calculated for all states (UFs) using the accumulated data for 2020 and 2021 using Equation (1).

$$MR = \frac{Deaths_{ni}}{Population_i} \; x \; 100{,}000 \qquad (1)$$

In which:

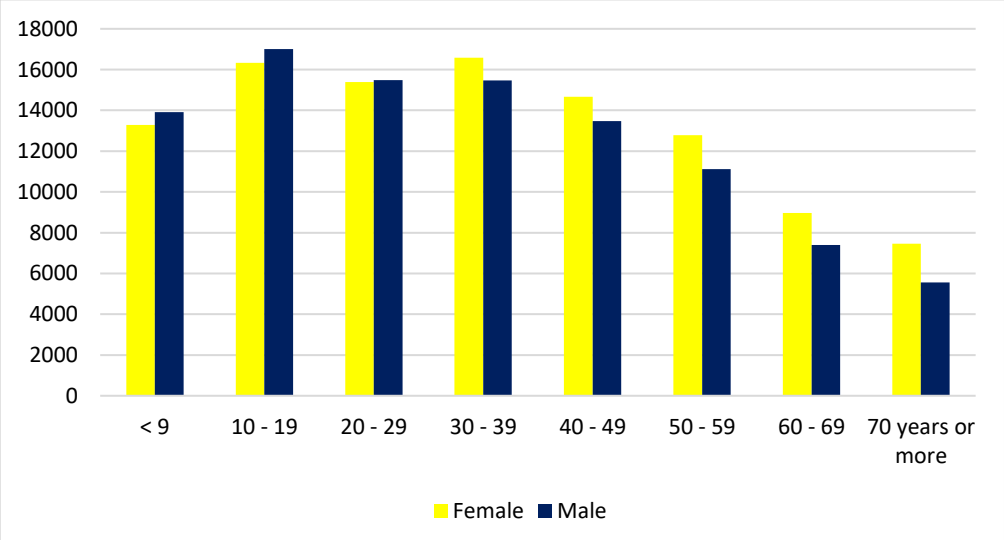
MR = mortality rate;
$Deaths_{ni}$ = number of deaths by gender by age group;
$Population_i$ = population by age group.

The mortality rate in this study is defined as a coefficient that expresses the relationship between the quantity and frequency of the phenomenon. Given this, the ratio makes it possible to express the existence of conditions that cannot be measured or calculated directly, in which case it indicates the degree to which mortality affects a specific population/group.

RESULTS AND DISCUSSION

When analyzing the age groups and gender of the people included in this study, the total population considered was 204,866 million inhabitants (variable - Resident population). Notably, the majority were female, totaling 105,459 million people, while approximately 99,407 million were male in 2015 (SIDRA/IBGE, 2015).

Figure 1 - Population by gender/age group for 2015 (per thousand people) in Brazil.



Source: The authors based on SIDRA/IBGE (2015).

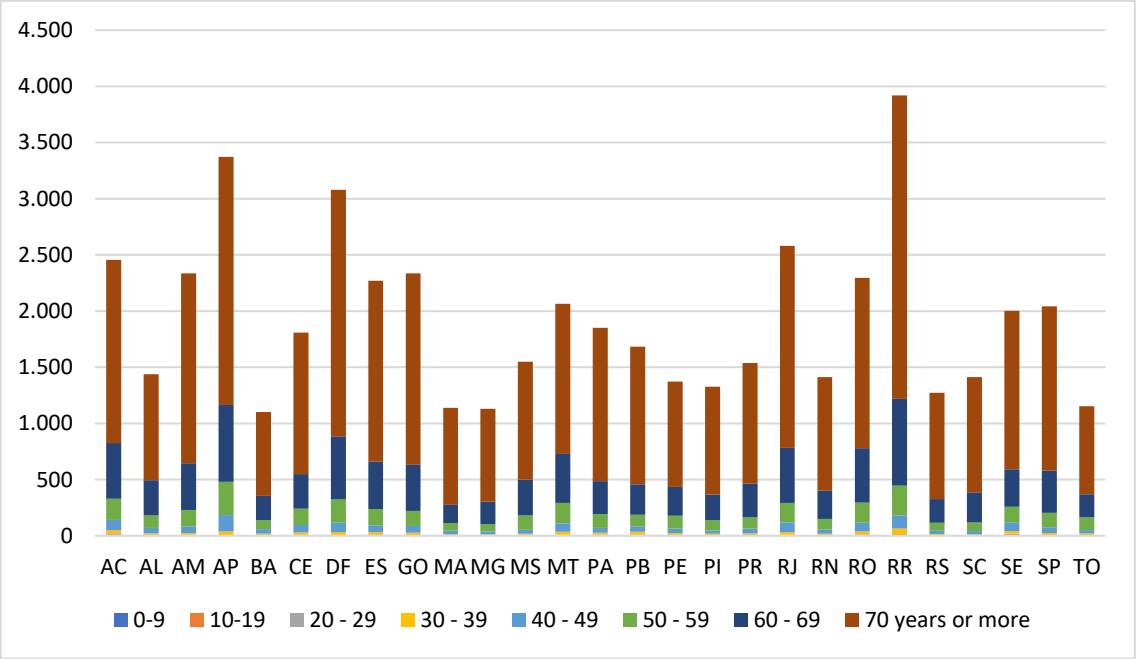
Analyzing the data on the Brazilian population in 2015, segmented by age group and gender (Figure 1), it can be seen that the 0-9, 10-19, and 20-29 age groups show a predominance of males over females. On the other hand, in the remaining age groups, the female population prevails.

According to the Pesquisa Nacional por Amostra de Domicílios Contínua - National Continuous Household Sample Survey, in English (PNAD-Contínua, 2019), there was no

change in the resident population of men (48.3%) and women (51.7%) in Brazil between 2012 and 2018. In addition, the male population belongs to the younger age group compared to the female population, as seen in the North and Northeast regions, especially in 2018.

It is important to note that COVID-19 has a higher mortality profile in older age groups, as evidenced by studies such as Instituto Pólis (2020) and Gariboti and Silva Júnior (2022). The COVID-19 mortality rates, disaggregated by states (UFs), age group, and male gender for the years 2020 and 2021 are shown in Figures 2 and 3, respectively.

Figure 2 - Male mortality rate in 2020 (per 100,000).

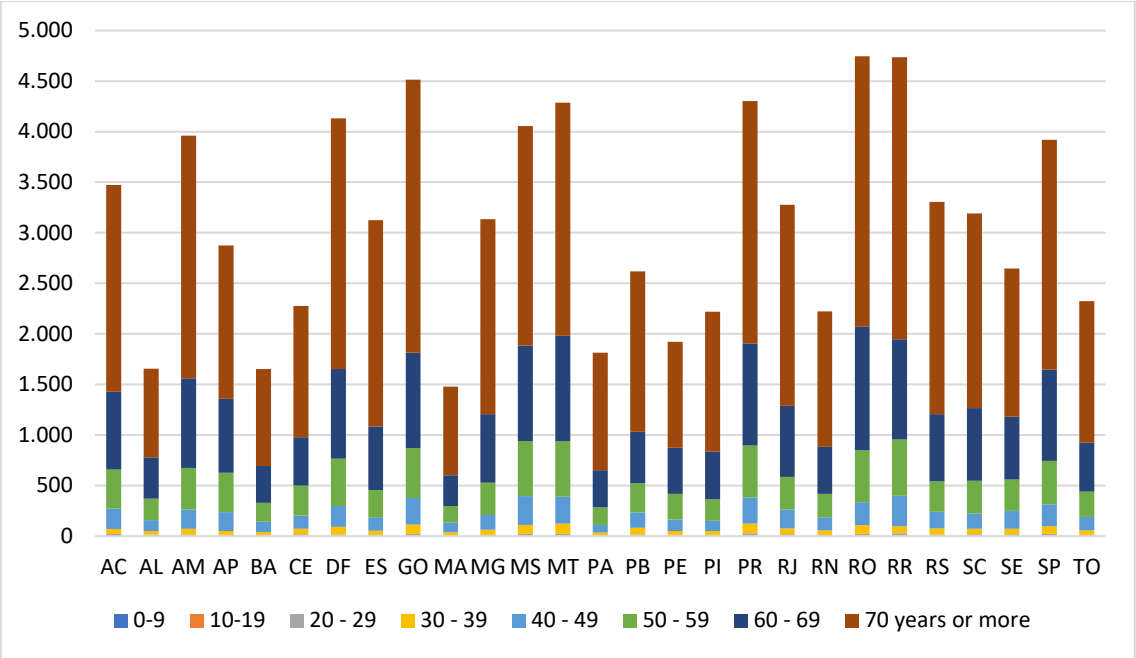


Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2020).

In 2020, the highest mortality rates among men were recorded in Roraima (3,918), Amapá (3,372), and the Federal District (3,079) per 100,000 male inhabitants. On the other hand, the lowest rates were observed in Bahia (1,101), Minas Gerais (1,129) and Maranhão (1,139) per 100,000 men. There is also a significant increase in mortality rates as the age groups advance. The North region has the highest mortality rates, with Acre having the highest mortality rate in the 0-9 and 10-19 age groups, Espírito Santo in the 19-29 age group, Roraima in the 30-39, 50-59, 60-69 and 70+ age groups and Amapá in the 40-49 age group (Figure 2).

The highest male mortality rates for 2021 (Figure 3) were recorded in Rondônia (4,746), Roraima (4,736), and Goiás (4,514), representing the number of deaths per 100,000 men. In contrast, the lowest rates were recorded in Maranhão (1,477), Bahia (1,652), and Alagoas (1,655) per 100,000 men. In that year, the following states had the highest mortality rates in their respective age groups: Acre 0-9 years, Alagoas 10-19 years, Paraná 20-29 years, Mato Grosso 30-39 and 60-69 years, and Roraima 40-49, 50-59 and 70 years or more.

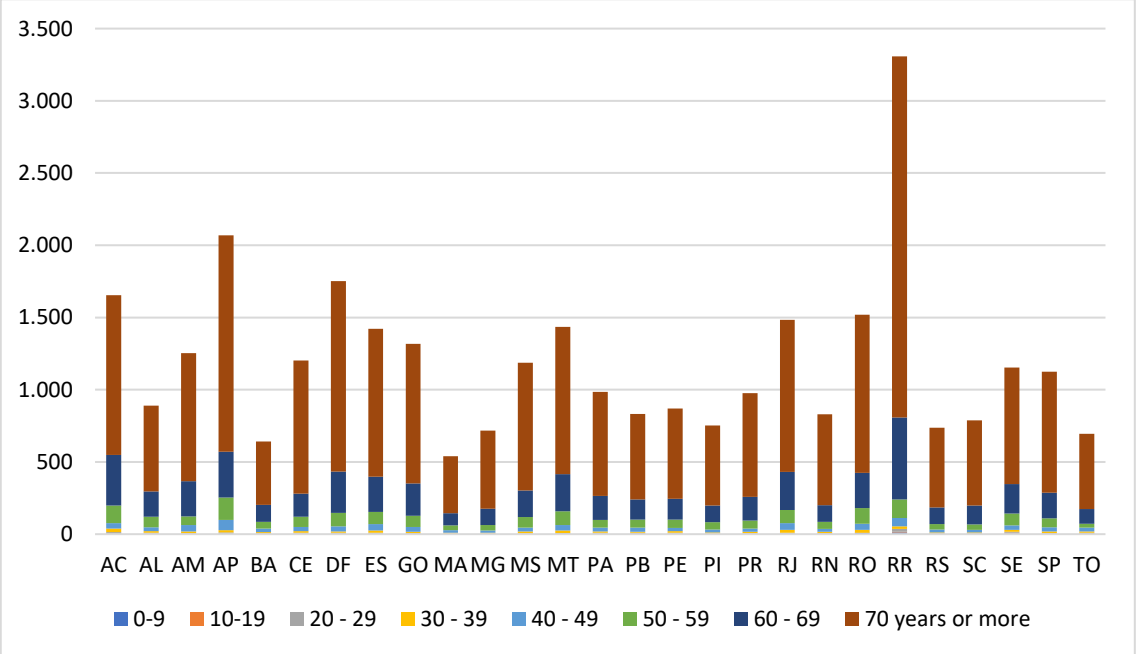
Figure 3 - Male mortality rate in 2021 (per 100,000).



Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2021).

Although there are variations in mortality rates between 2020 and 2021, there is a notable trend towards higher rates in some states, especially in the North, and a significant increase in the older age groups. These observations highlight the importance of understanding the dynamics of mortality rates in different age groups and regions for a more effective approach to public health. Now the COVID-19 mortality rates, disaggregated by states (UFs), age group, and female gender for the years 2020 and 2021 are shown in Figures 4 and 5, respectively.

Figure 4 - Female mortality rate in 2020 (per 100,000).



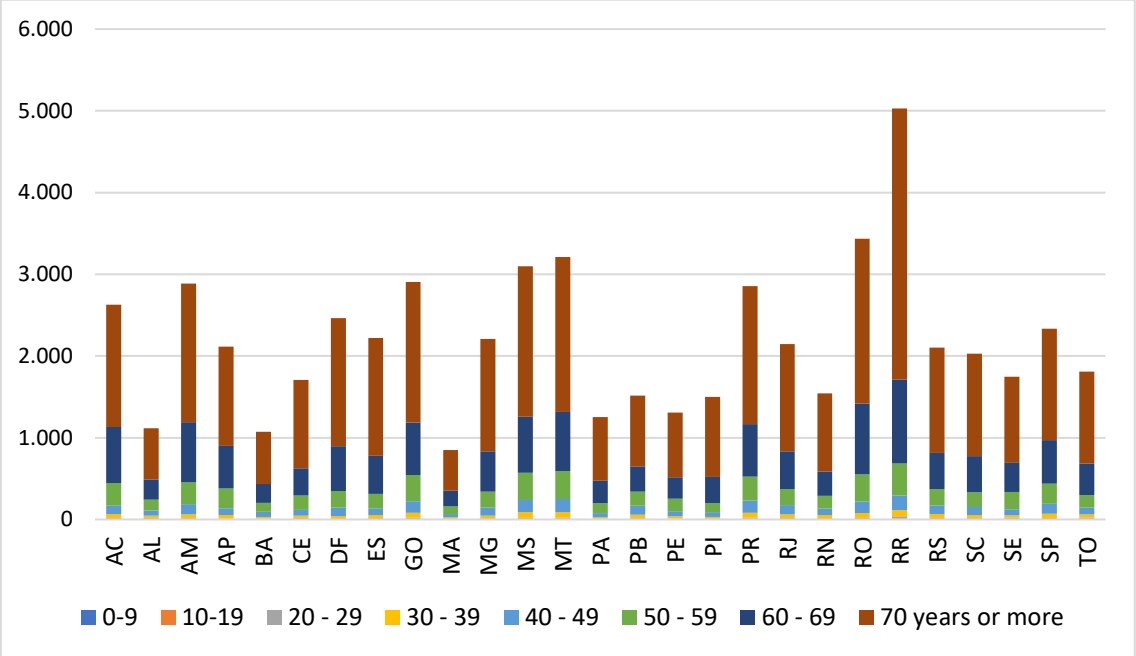
Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2020).

In 2020, in the context of the analysis of female mortality rates, the states of Roraima, Amapá, and the Federal District stand out as having the highest rates, registering 3,308, 2,069, and 1,752 deaths per 100,000 women, respectively. In addition, the analysis by age group revealed that Roraima led in several categories, covering the age groups 0-9, 20-29,

60-69, and 70 and over. Mato Grosso do Sul stood out in the 10-19 age group, while Amapá had significantly higher rates in the 30-39, 40-49, and 50-59 age groups (Figure 4).

In the 2021 scenario, there was an increase in female mortality rates, with the states of Roraima, Rondônia, and Mato Grosso standing out as having the highest rates, with 5,030, 3,435, and 3,210 deaths per 100,000 women, respectively. As for mortality rates by age group, Sergipe led the way in the 0-9 age group, while Roraima showed the highest rates in the other age groups (Figure 5).

Figure 5 - Female mortality rate in 2021 (per 100,000).



Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2021).

In 2021 (Figures 3 and 5) there was a significant increase in mortality rates for both genders compared to 2020 (Figures 2 and 4). In addition, the 10-19 age group had the lowest mortality rates compared to the other age groups, for both males and females.

The data show that there are disparities in the geospatial distribution of COVID-19 mortality rates between genders and age groups in the states (UFs), demonstrating that the pandemic has disproportionately affected men and women in different age groups in the Federative Units (UFs). It should be noted that the COVID-19 mortality data collected did not consider possible underreporting, which occurred due to limited testing, asymptomatic cases, difficulty in accessing tests, and underreporting of deaths.

Although health indicators have improved between 1990 and 2016, there is a dominance of significant disease burdens in the North and Northeast regions when compared to the South and Southeast. This was repeated and exacerbated by COVID-19, especially in northern Brazil (Silva *et al.*, 2021). These findings corroborate the data presented since the regions mentioned showed the worst outcomes in cases of COVID-19. In 2021, the state of Maranhão recorded the highest proportion of poor people (57.90) in Brazil, as indicated by Neri (2022), and, contrary to expectations, had the lowest mortality rates.

In Brazil, poverty and unemployment levels were on the rise in 2022 (Boing *et al.*, 2022). At the start of the pandemic, Brazil faced significant challenges, with around 3 in 10 Brazilians living in poverty and 8% in extreme poverty, figures that have remained relatively stable since 2012. However, the threat of a substantial increase in these rates during the pandemic was mitigated with the implementation of the government's fiscal package and the direct cash transfer initiative, benefiting approximately 67 million people. Although there was a notable reduction in poverty rates in 2020 due to these measures, the dependence of Brazilian families on state support became evident when government assistance decreased, resulting in a sharp increase in poverty rates in the face of adverse labor market conditions (The World Bank, 2022).

The irregularity in the distribution and transmission of SARS-CoV-2 in Brazil and,

consequently, in the number of deaths, has revealed an unequal health and sanitation structure in terms of risk exposure, closely associated with the high percentage of socially marginalized populations, excluded and segregated in areas with environmentally unhealthy living conditions (Albuquerque; Ribeiro, 2020; Guedes *et al.*, 2023).

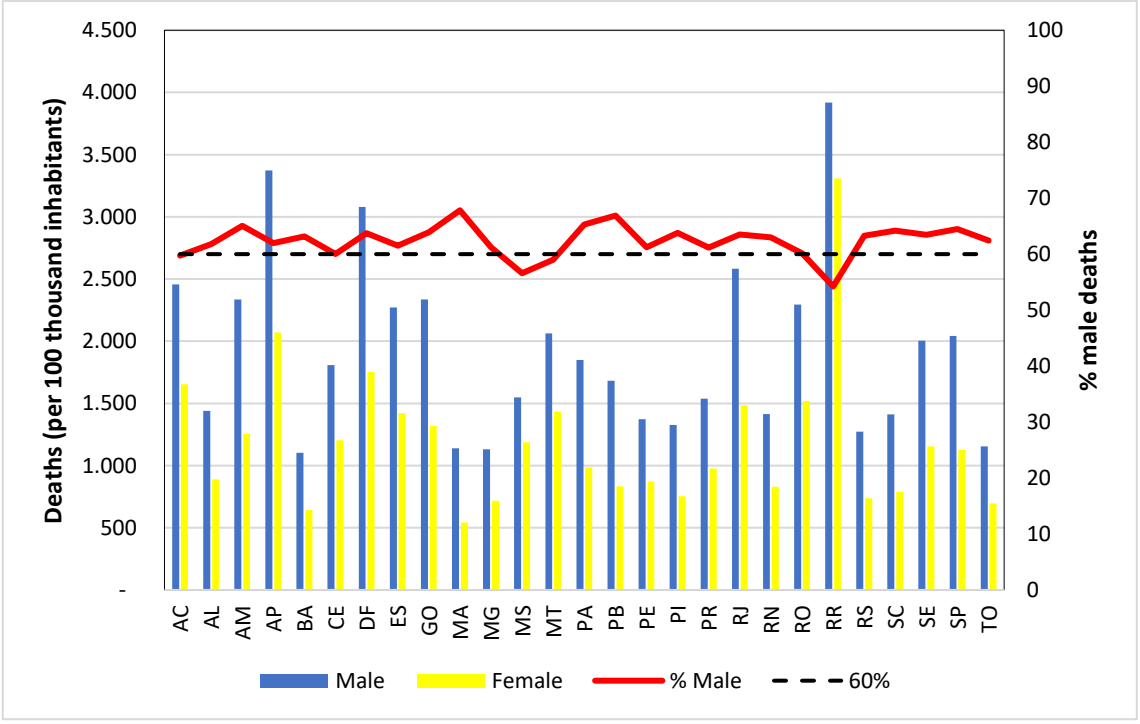
A study conducted in 131 countries suggested an association between the introduction and intensification of non-pharmaceutical measures and the level of transmission of SARS-CoV-2. The results elucidated, that isolated non-pharmaceutical measures, including closing schools and workplaces, were associated with a reduction in SARS-CoV-2 transmission (Li *et al.*, 2020). However, the implementation of sanitation measures and social distancing has proved to be a major fallacy for economically vulnerable people living in subnormal settlements (Barreto *et al.*, 2021).

During the pandemic period, the federal government's position caused a polarization of ideas, characterized by a denialist stance at odds with scientific evidence. This divergence of perspectives has had a direct impact on the strategies for dealing with the pandemic, considering, above all, the need to maintain or obtain income even in the face of isolation measures. The approach adopted reveals significant variation according to the socioeconomic inequalities of the population (Siqueira *et al.*, 2022).

In this context, approximately 30.9% of the elderly population opted for social distancing, with women being the ones who adhered to this practice the most. However, despite these preventive measures, around 21.9% of the elderly reported a worsening in their health condition during the pandemic, as observed by Romero *et al.* (2021).

The relationship between the accumulated mortality rates for the states (UFs) by gender for the years 2020 and 2021 is shown in Figures 6 and 7, respectively.

Figure 6 - Mortality rate by gender in the states (UFs) in 2020.

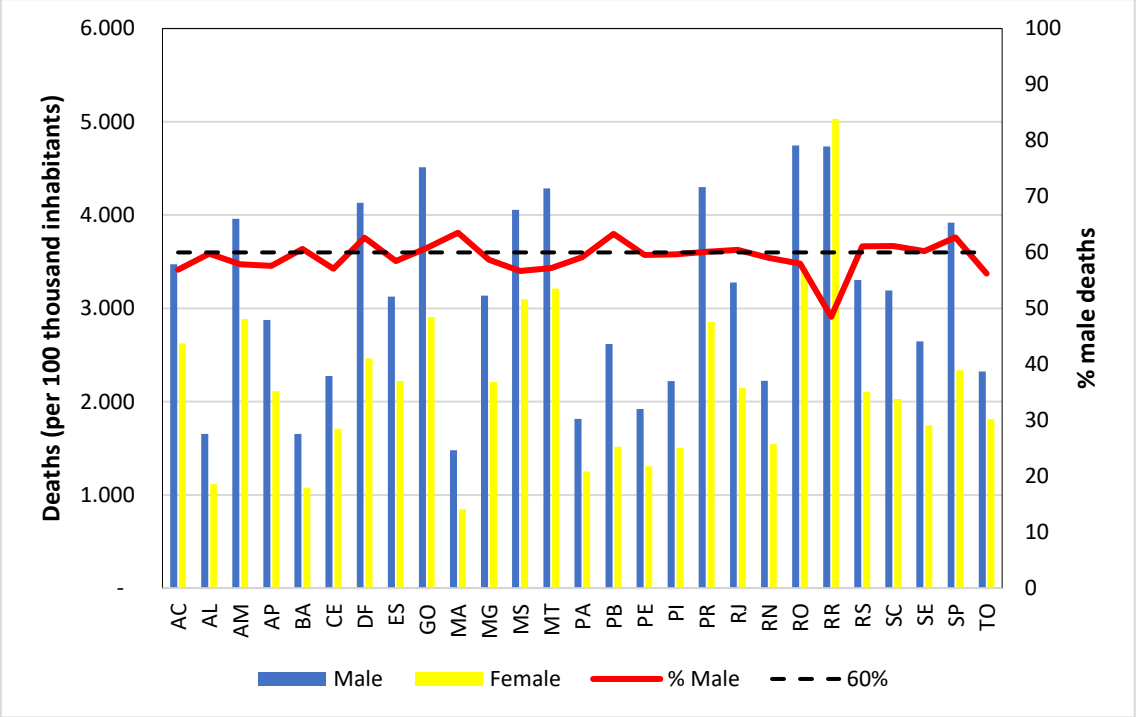


Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2020).

The analysis (Figure 6) shows that in 2020, except for Acre, Mato Grosso do Sul, Mato Grosso, and Roraima, the mortality rate among males exceeded 60%. This trend can be explained by the greater exposure of men to COVID-19, reflecting a pattern observed throughout the country. It is worth noting that Roraima stood out as one of the states with the highest mortality rates for both genders.

A study conducted by Boing *et al.* (2022) focused on analyzing the disparities resulting from COVID-19 in Brazil in the 2020-2021 period, based on the per capita index, revealed that 55.6% of deaths occurred among males, corroborating the observation of gender inequalities in COVID-19 mortality.

Figure 7 - Mortality rate by gender in the states (UFs) in 2021.



Source: The authors based on SIDRA/IBGE (2015) and Registro Civil (2021).

Unlike the scenario shown above, the data for 2021 shows a more even distribution. In several states, the percentage of male deaths has fallen below 60%. However, some states stood out as exceptions, keeping their male death rates above this threshold. The states in this condition in 2021 are Bahia, Federal District, Goiás, Maranhão, Paraíba, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, Sergipe and São Paulo. This change in the distribution of data between states shows variations in mortality by gender and suggests the importance of a more detailed analysis of the causes underlying this evolution (Figure 6).

It should be noted that in the Brazilian context, in 2020, the mortality rate for men and women was 7.33% and 4.41%, respectively (Datasus, 2020). In the following year, 2021, there was an increase in these rates, reaching 8.48% for men and 5.36% for women, as indicated by data from DataSUS - Mortality Rate by Federative Unit and Sex (Datasus, 2021). Therefore, these statistics reveal that the disparity in the mortality rate between genders is not exclusively related to COVID-19.

As noted above, Roraima stood out as the state with the highest mortality rates, differing significantly from the others. This disparity can be attributed, in part, to the fact that the capital, Boa Vista, has become an epicenter of the pandemic. COVID-19 is known for its high contagiousness and ease of spread, and the considerable concentration of cases in the capital may have had a direct impact on the spread of the virus. It is important to note that Boa Vista is home to approximately two-thirds of Roraima's total population, which makes it a critical pivotal point in the dynamics of the pandemic in the state. This high population concentration, combined with the highly contagious nature of the virus, has contributed to the significantly higher mortality rates observed in Roraima (Senhoras; Gomes, 2020).

In addition to the spatial asymmetry between the municipalities in the interior of Boa Vista concerning the COVID-19 pandemic, there was also a profile of social asymmetry that replicates trends in Brazil in terms of age groups and gender. This is consistent with the average population of Roraima (Senhoras; Gomes, 2020).

These findings converge with the research by Boing *et al.* (2022), who pointed out that, in general, the Brazilian municipalities with the lowest Gross Domestic Product (GDP) per capita faced a more pronounced impact from COVID-19. The same authors emphasize that the greater vulnerability to mortality caused by COVID-19 is strongly associated with individuals with lower levels of education and reduced income.

Analysis of COVID-19 risk groups reveals a striking association with sociodemographic and socioeconomic factors (Borges; Crespo, 2020; Cestari *et al.*, 2021). Within this spectrum, Borges and Crespo (2020) point out that people of color or race, specifically blacks and browns,

stand out as part of this vulnerable group, due to pre-existing characteristics. In addition, the research reveals a significant correlation between lower schooling and greater propensity to risk, indicating that those with incomplete primary education are more likely to be in the risk group than those with complete higher education.

It is well known that gender has a significant impact on susceptibility to infectious diseases, with women showing a considerable immunological advantage over men (Schurz *et al.*, 2019; Foresta *et al.*, 2021). This phenomenon is attributed to the presence of the X chromosome, which contains several genes related to the immune system. While men have only one X chromosome, women have two, giving them a potentially more robust immune system (SCHURZ *et al.*, 2019).

To investigate the immunological differences between males and females, Takahashi *et al.* (2020) conducted an analysis of patients diagnosed with COVID-19 between March 18 and May 9, 2020. The study revealed that men have higher levels of certain chemokines and cytokines, which can potentiate the effects of COVID-19 on their bodies. In addition, the research found that women produce more T-cells, which play a crucial role in the immune response against diseases and consequently tend to show milder symptoms of infection.

Co-morbid conditions and the incidence of COVID-19 were also significantly higher in males compared to females. The mortality rate from COVID-19 increases significantly with age; in this study, men had significantly higher mortality rates from COVID-19 compared to the female population aged 40 to 60. It should be noted that the mortality rate in the under-40 age group was lower in both genders (Ejaz *et al.*, 2021). In addition, after hospitalization, women are less likely to die from COVID-19, however, in the most severe stage of the disease the risk of dying is relatively equal to that of men (Raimondi *et al.*, 2021).

Although men and women are equally susceptible to COVID-19 infection, death outcomes for men were higher than for women (Mukherjee; Pahan, 2021). This profile is similar to what happened during the flu epidemic in 1918 in the United States - a demographic event with a very high level of virulence, leading to the death of more than 20 million people, in which a strong difference in the number of deaths between men and women was observed - a difference in the mortality rate of 174 per 100,000 for men compared to women, in addition to the age profile of mortality, from 25 to 34 years (Noymer; Garenne, 2000).

Gomes *et al.* (2007) point out that the higher morbidity and mortality among men compared to women is because they are less likely to seek health services. This is a complex issue, multifaceted, and influenced by multiple factors, including cultural aspects. Culture plays a significant role in determining health behaviors, affecting individuals' perceptions of the need for medical care and the way they approach their health. In addition, men often associate strength and health with not showing weakness or resisting medical care, which can lead men to postpone or avoid seeking preventive medical care.

Globally, women have been most affected by the measures implemented to contain the pandemic (Dang; Nguyen, 2021). Discussions on gender and COVID-19 mostly focus on the impacts on women's lives, due to the increase in domestic violence during social isolation and its relationship with household chores (Breton *et al.*, 2020).

However, the health community must strengthen actions against the risks related to men in times of pandemic, given that men's health is more fragile than that of women (Breton *et al.*, 2020). Furthermore, the pandemic has revisited one of the most pressing issues of a systemic crisis. There are countless consequences resulting from this scenario, such as increased job insecurity, lack of health care, and inequalities concerning age, class, gender, and race, which contribute to the spread of the virus and the risk of infection (Pierro; Jacobi, 2021).

Jin *et al.* (2020) reported in their case analysis that male patients tend to have more severe conditions compared to female patients. The study highlighted that the number of COVID-19-related deaths among men was 2.4 times higher than among women. In summary, men with COVID-19 were more likely to face more serious clinical outcomes and deaths.

Although the mortality rate for men is higher than for women, confirmed cases of COVID-19 are distributed relatively evenly between men and women, reproducing trends that have occurred internationally and in Brazil. In addition, the characteristics of race, color, or ethnicity are comparable to demographic characteristics, thus indicating that most people have an equivalent profile (Senhoras; Gomes, 2020).

Gender relations and the subsequent impact on health have consistently shown that men have poorer health and lower life expectancy compared to women. The Global Health Report 50/50 2020 points out that many global health organizations have not yet responded

adequately to the evidence on the gender-related burden of disease - the lack of gender responsiveness is particularly pronounced in men's health. In summary, the report stresses that non-communicable diseases, some associated with serious COVID-19 infections, are particularly neglected by the global health system (Global Health 50/50, 2020).

Thus, it is of utmost importance to recognize the extent of disease outbreaks that affect men and women unequally, being a fundamental step towards understanding the impacts of health emergencies on different individuals and communities and for the creation of policies and interventions (Wenham *et al*., 2020).

In general, social determinants expose the asymmetries associated with social, socio-spatial, racial, ethnic, cultural, and gender inequalities (Albuquerque; Ribeiro, 2020). Thus, the high mortality rates caused by the COVID-19 pandemic have increased among the most vulnerable groups in society - the poor, Black people, residents of peripheral areas, and those in situations of economic instability (Santos; Silva, 2022).

The results obtained in the study by Dang and Nguyen (2021) point to a significant gender disparity in the economic impact of the outbreak. It was found that women face a considerable disadvantage, with a 24% higher probability of permanently losing their jobs compared to men. In addition, expectations of a drop in women's labor income, which is 50% higher than men's, indicate greater financial vulnerability for women during crises such as COVID-19. These findings highlight the importance of adopting measures and policies that mitigate the unequal impact of the pandemic on women, guaranteeing equal opportunities and financial protection.

However, few studies include gender and race perspectives on COVID-19, although there is evidence that these characteristics play a critical role in shaping the risk of disease, death, and other related harms. International initiatives seek a commitment to gender-sensitive research, aimed at health equity and the recognition of inequalities and human rights in the context of the COVID-19 pandemic (Garcia, 2020).

The unfolding of the COVID-19 pandemic has contradicted a widespread myth regarding the democratic characteristics of SARS-CoV-2, bringing gender and racial inequalities to light with its occurrences and impact on the implementation of recommended control measures. In previous epidemics, the structural inequalities of race, gender, and vulnerability of health services were ignored, causing this pattern to be perpetuated in the fight against the COVID-19 pandemic (Reis *et al*., 2020).

In the context of the COVID-19 pandemic, the need to reverse the ecological imbalances created by traditional models is even more important through a more comprehensive and interdisciplinary vision that links the environment to the economy, society, and health. If the country does not implement and expand measures to strengthen science-based risk governance institutions, unprecedented diseases are likely, and new epidemics could be more devastating (Pierro; Jacobi, 2021).

The aforementioned findings can support a possible explanation based on gender bias in COVID-19, as well as providing a foundation for the promotion of new gender-based approaches, as well as the formulation of new public policies capable of filling the gaps in the care and treatment of men and women in a specialized way.

FINAL CONSIDERATIONS

The COVID-19 pandemic has exposed and exacerbated gender inequalities and the weaknesses of the health system in Brazil and around the world. To answer the research question of this study, it was possible to verify that there were differences in the number of deaths between men and women in different age groups during the COVID-19 pandemic.

The crisis triggered by the COVID-19 pandemic has increased the burden on the SUS, resulting in an alarming increase in the number of cases and deaths, which has contributed to disparities in the number of accesses to health services (public and private) in all Brazilian regions.

It is crucial to recognize that officially recorded health data can mask the true incidence of cases in vulnerable areas. Under-reporting of cases in these areas is problematic, as it can result in inadequate responses from public health authorities, further exacerbating the situation in communities already facing significant challenges.

In the field of health, the search for new knowledge to deal with potential pandemics is essential. In addition, promoting changes in dietary patterns, promoting the conservation of biodiversity, and sharing scientific information and knowledge are fundamental to ensuring the health and well-being of present and future generations in the face of emergency challenges such as outbreaks, epidemics, and pandemics. These actions aim to provide efficient and

adaptable responses to unforeseen and dynamic circumstances that may arise.

The research objective was met by analyzing COVID-19 mortality by gender in the Brazilian states. It is important to note that the COVID-19 pandemic has caused more deaths in men than in women. However, women have been most affected by the consequences of the pandemic, threatening the achievements of the democratic regime in educational, cultural, social, economic, and geospatial terms.

Based on the results presented, it is possible to infer that the epidemiological profile of mortality most affected by COVID-19 in Brazil is represented by men over the age of 60, mainly in the North and Northeast regions. Gender emerged as a strong predictor of SARS-CoV-2 infection and mortality, with a significant increase in mortality following infection.

The limitations of this study are related to the lack of detailed official data on race/ethnicity, color, gender, and geography. The absence of this information reinforces the disparities and vulnerabilities that exist in specific groups, be they men, women, or LGBTQIA+ people. Furthermore, the reliability of the data is questionable due to the magnitude of the pandemic period and the complexity of overseeing several different databases. However, efforts to identify and address these gaps can contribute to promoting gender, race, and color equity.

The analysis of mortality rates due to SARS-CoV-2 infection, considering gender and the intersection with other factors, can contribute to reducing gender disparities. In addition to the biological differences between men and women, inequalities in access to health services and exposure to risks have played a fundamental role in creating an unequal scenario between the sexes.

Furthermore, among the questions to be investigated in future research, it is suggested to investigate: What are the political, ideological, and religious motivations in Brazil regarding the spread of COVID-19? How have the incorrect use of masks, social isolation, the dissemination of unscientific treatment advice, and resistance to vaccination impacted the COVID-19 pandemic? What is the percentage of men per state (UFs) among vulnerable groups: the elderly, immunosuppressed, and those with comorbidities?

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AUTHOR CONTRIBUTION

Walef Pena Guedes conceived the study, developed the methodology; curated data, wrote the original draft, reviewed and edited the manuscript. Cibele Roberta Sugahara curated the data, developed the methodology, wrote the original draft, reviewed and edited the manuscript. Denise Helena Lombardo Ferreira performed data curation; wrote the original draft and supervised. Mariana Inês Paludi wrote the original draft, reviewed and edited the manuscript.