Comparison of proportional mortality from COVID-19 and from external causes in the state of Mato Grosso do Sul, Brazil, 2020-2021

Comparação de mortalidade proporcional por COVID-19 e por causas externas no estado de Mato Grosso do Sul, Brasil, 2020-2021

Cremildo Joáo Baptista[1*]

[1] PhD in Public Health, Adjunct Professor, Undergraduate Nursing Course, Federal University of Mato Grosso do Sul (UFMS), Coxim (MS), Brazil.

*Corresponding author: Cremildo J Baptista **–** *Email*: cremildo.baptista@ufms.br

ABSTRACT

To compare the proportional mortality from COVID-19 and external causes in the first two years of the pandemic. A time series study was conducted with data from 2018 to 2021 in Mato Grosso do Sul (MS), recorded in the Mortality Information System (SIM). From 2018 to 2021, there were 77,383 deaths from different causes in MS. The first two years of the pandemic contributed the highest proportions of deaths, with 24.6% in 2020 and 32.2% in 2021. The proportion of deaths from external causes decreased by 30.0%, with the reduction being greater in the two pandemic years, while the proportion of COVID-19 deaths increased by 132.2%. In 2021, there were 3.2 COVID-19 deaths for each death from external causes. COVID-19 was a competing cause of mortality, as the proportion of deaths from external causes decreased in the first two years of the pandemic, altering the mortality profile in MS.

Keywords: COVID-19. External causes. Proportional mortality.

RESUMO

Comparar a mortalidade proporcional por COVID-19 e causas externas nos dois primeiros anos de pandemia. Foi realizado estudo de série temporal com dados de óbitos ocorridos de 2018 a 2021 em Mato Grosso do Sul (MS), registrados no Sistema de Informação sobre Mortalidade (SIM). De 2018 a 2021, foram registradas 77.383 mortes por diferentes causas em MS. Os dois primeiros anos de pandemia contribuíram com as maiores proporções de óbitos, 24,6% em 2020 e 32,2% em 2021. A proporção de mortes por causas externas reduziu 30,0%, a redução foi maior nos dois anos de pandemia, enquanto a proporção de mortes por COVID-19 cresceu 132,2%. Em 2021, houve 3,2 mortes por COVID-19 para cada morte por causas externas. A COVID-19 foi causa concorrente de mortalidade, uma vez que a proporção de mortes por causas externas diminuiu nos dois primeiros anos de pandemia, alterando o perfil de mortalidade em MS.

Palavras-chave: Causas externas. COVID-19. Mortalidade proporcional.

INTRODUCTION

Since 2020, the 2019-coronavirus disease (COVID-19) has had a significant impact on global mortality profile and rates, besides having been a countless challenge for global public health. For instance, in Brazil, there was nearly 10% decrease in deaths from cancer and cardiovascular diseases following the onset of the COVID-19 pandemic in March 2020 [1]. Additionally, nationwide studies have reported a 22.2% excess mortality rate, with deaths surpassing expected levels in all states [2].

The relationship between COVID-19 mortality and mortality from external causes can vary based on factors such as the prevalence and severity of COVID-19, the effectiveness of public health interventions, and changes in behavior during the pandemic. Research has indicated a shift in mortality patterns during the pandemic, with some regions experiencing a decrease in deaths from external causes alongside an increase in COVID-19-related deaths [3,4].

External causes of mortality are a significant public health concern in Brazil, with traffic accidents, firearms violence, homicides, and suicide accounting for a large number of deaths [5,6]. However, the COVID-19 pandemic has emerged as the leading cause of death, resulting in a decrease in mortality from other causes [1], particularly external causes [7]. In 2020, COVID-19 became the third leading cause of death in Brazil, surpassing deaths from external causes combined. This led to an increase in total deaths compared to previous years [7], highlighting the direct and indirect effects of the pandemic on mortality patterns [4,8,9].

In 2020, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused a significant number of deaths worldwide, and underreporting of cases was a challenge in Brazil during in the early stages of the pandemic [10]. Proportional mortality is a useful tool for assessing the impact of COVID-19 on mortality rates and disease burden.

This study aims to compare the proportion of COVID-19 deaths and external causes in Mato Grosso do Sul (MS) during the first two years of the pandemic. The goal is to understand how the COVID-19 pandemic has affected mortality patterns in Brazil and its states. This comparison should provide valuable insights for local interventions and help understand sub-national impacts of the pandemic, taking into account the different political approaches at the federal, state, and municipal levels.

METHODOLOGY

A time series analysis was conducted using quantitative data on all deaths, excluding fetal deaths, that occurred from 2018 to 2021 in the State of Mato Grosso do Sul, Brazil. The data were obtained in January 2023 from the Mortality Information System (SIM) from the Department of Informatics of the Brazilian Ministry of Health (DataSUS). The study compares the proportional mortality from COVID-19 and External causes over a four-year period, encompassing two years before the pandemic and the first two years of the pandemic. Proportional mortality, a simple and systematic indicator, is considered a useful epidemiological measure for evaluating a specific cause of death in relation to other causes in a population. External causes were chosen for comparison because they are highly prevalent in Brazil and its states, and their occurrence is directly and indirectly related to social isolation measures. On one

hand, there are suicides and domestic violence, and on the other hand, traffic accidents and street homicides.

In this study, deaths were classified as 'COVID-19' when the reported basic cause was B34.2, as 'External causes' when the underlying cause was in Chapter 20 (V01-Y89), and as 'Other causes' when they did not fit into the previous two categories, according to the International statistical classification of diseases and related health problems, tenth revision (ICD-10) from the World Health Organization (WHO). All external causes were grouped together.

Proportional mortality was calculated annually by dividing the number of observed deaths from a specific cause in a particular group by the total number of deaths in that group, and then multiplied by 100. This calculation was done for specific strata including sex, age group, race/skin color, and education level, along for a detailed analysis of the burden of COVID-19 and External causes in each selected group.

To compare the trend of proportional mortality with the pandemic period, the analysis included deaths from external causes in the two years before the pandemic. This was done to see if there was a change in the trend during the pandemic, which could indicate an impact of COVID-19 on external cause mortality. This approach considered potential seasonal variations in proportional mortality from external causes.

Age was categorized into eleven groups: 0 - 5, 6 - 9, 10 - 19, 20 - 29, 30 - 39, 40 - 49, 50 - 59, 60 - 69, 70 - 79, 80 - 89, and 90 onwards. To address missing age values, age was imputed by the median for 125 deaths (0.16%), after histogram visualization and normality test distribution. Race/skin color data were collected based on the classification of the *Instituto Brasileiro de*

Geografia e Estatística (IBGE): white, black, East Asian, mixed race/ethnic and Native American or indigenous. However, blacks and mixed-race individuals were grouped together due to self-identification patterns in Brazil and because other studies consider them together [11]. East Asian and indigenous individuals, despite their small number of deaths in each group, they were analyzed separately due to their significant presence in Mato Grosso do Sul compared to other states in the country. Sex and education level data were analyzed as originally collected.

The percentage change was calculated using the formula: (new value - earlier value) / earlier value * 100. The study presents descriptive statistics on the number and percentage of deaths for the years under analysis, categorized by cause or group of causes. Continuous variables are summarized using means, standard deviation (s.d) and interquartile range (IQR). Data for individuals with ignored race/skin color or education level were presented separately instead of being excluded.

The data were analyzed using R programming language (version 4.2.2) and RStudio IDE (version 2022.12) on Windows. This analysis involved the use of read.dbc, stringr, lubridate, arsenal and ggplot2 libraries. The data used in this study were unidentified and publicly available and did not require ethical approval in Brazil. However, the main study titled *'Epidemiologia do SARS-CoV-2/COVID-19 na Região Centro-Oeste do Brasil'* was approved by the *Comissão Nacional de Ética em Pesquisa* (CONEP) under CAAE 31437820.9.0000.0021, in accordance with Resolution nº 510/2016 on research ethical standards. This study was funded by *Fundação de Apoio ao Desenvolvimento do Ensino, Ciência e Tecnologia do Estado de Mato Grosso do Sul (*FUNDECT*)*

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RESULTS

From 2018 to 2021, there were a total of 77,383 recorded deaths in Mato Grosso do Sul (MS). In 2018 and 2019, 16,600 and 16,815 deaths were recorded, respectively, accounting for 21.5% and 21.7% of the total deaths in the state. The COVID-19 pandemic led to the highest percentages of deaths during the analyzed period, with 24.6% in 2020 and 32.2% in 2021 (Table 1).

Over the four-year period, the average age and interquartile ranges (IQR) remained unchanged, with men accounting for the highest number of deaths. The age group of 70-89 had the highest percentage of deaths from 2018 to 2020, while in 2021, the highest proportion of deaths occurred in the age group of 60-79 (Table 1).

Table 1. Main characteristics of by all cause deaths in Mato Grosso do Sul State, Brazil, 2018-2021

(Continua)

Characteristic	2018	2019	2020	2021	Total
	16,600 (21.5%)	16,815 (21.7%)	19,051 (24.6%)	24,917 (32.2%)	77,383 (100%)
Sex					
Female	6963 (41.9%)	7143 (42.5%)	7878 (41.4%)	10590 (42.5%)	32574 (42.1%)
Male	9637 (58.1%)	9672 (57.5%)	11173 (58.6%)	14327 (57.5%)	44809 (57.9%)
Age					
Mean age (s.d; IQR)	64.6 (22.6; 53.7 – 81.1)	64.8 (22.4; 54.0 – 81.2)	65.4 (21.5; 54.8 – 81.1)	64.4 (20.42; 53.2 – 79.3)	64.8 (21.6; 53.6 – 80.6)
Age group					
0 to 5	606 (3.7%)	581 (3.5%)	538 (2.8%)	543 (2.2%)	2268 (2.9%)
6 to 9	45 (0.3%)	43 (0.3%)	39 (0.2%)	46 (0.2%)	173 (0.2%)
10 to 19	275 (1.7%)	285 (1.7%)	236 (1.2%)	291 (1.2%)	1087 (1.4%)
20 to 29	600 (3.6%)	596 (3.5%)	632 (3.3%)	732 (2.9%)	2560 (3.3%)
30 to 39	777 (4.7%)	794 (4.7%)	920 (4.8%)	1352 (5.4%)	3843 (5.0%)
40 to 49	1214 (7.3%)	1188 (7.1%)	1433 (7.5%)	2280 (9.2%)	6115 (7.9%)
50 to 59	2063 (12.4%)	2097 (12.5%)	2355 (12.4%)	3661 (14.7%)	10176 (13.2%)
60 to 69	3017 (18.2%)	2991 (17.8%)	3564 (18.7%)	4957 (19.9%)	14529 (18.8%)
70 to 79	3431 (20.7%)	3539 (21.0%)	4084 (21.4%)	5135 (20.6%)	16189 (20.9%)
80 to 89	3264 (19.7%)	3323 (19.8%)	3677 (19.3%)	4241 (17.0%)	14505 (18.7%)
90 +	1308 (7.9%)	1378 (8.2%)	1573 (8.3%)	1679 (6.7%)	5938 (7.7%)
Race/Skin color					
White	7967 (48.0%)	7859 (46.7%)	8774 (46.1%)	11634 (46.7%)	36234 (46.8%)
Black/Mixed race	7847 (47.3%)	8187 (48.7%)	9405 (49.4%)	12312 (49.4%)	37751 (48.8%)
Asian	189 (1.1%)	156 (0.9%)	175 (0.9%)	248 (1.0%)	768 (1.0%)

Characteristic	2018	2019	2020	2021	Total
	16,600 (21.5%)	16,815 (21.7%)	19,051 (24.6%)	24,917 (32.2%)	77,383 (100%)
Native American	538 (3.2%)	556 (3.3%)	622 (3.3%)	624 (2.5%)	2340 (3.0%)
Unknown	59 (0.4%)	57 (0.3%)	75 (0.4%)	99 (0.4%)	290 (0.4%)
Education					
Illiterate	3190 (19.2%)	3304 (19.6%)	3197 (16.8%)	3781 (15.2%)	13472 (17.4%)
Elementary school	9128 (55.0%)	9366 (55.7%)	10307 (54.1%)	12829 (51.5%)	41630 (53.8%)
High school	1722 (10.4%)	1946 (11.6%)	2544 (13.4%)	3967 (15.9%)	10179 (13.2%)
Incomplete College education	192 (1.2%)	202 (1.2%)	240 (1.3%)	332 (1.3%)	966 (1.2%)
Complete College education	708 (4.3%)	715 (4.3%)	998 (5.2%)	1702 (6.8%)	4123 (5.3%)
Unknown	1660 (10.0%)	1282 (7.6%)	1765 (9.3%)	2306 (9.3%)	7013 (9.1%)

s.d = standard deviation ; min-max = minimum – maximum

In the period analyzed, 48.8% of deaths were among blacks and mixed-race died individuals. In 2018, the majority of deaths (48.0%) were among whites, but in the following years, blacks and mixed-race individuals became the majority, accounting for 49.4% of deaths each year. People with elementary education made up the majority of deaths in study period (53.8%), with 55.0% in 2018 and 51.5% in 2021. People with no formal education accounted for the second largest proportion of deaths in the analyzed period (Table 1).
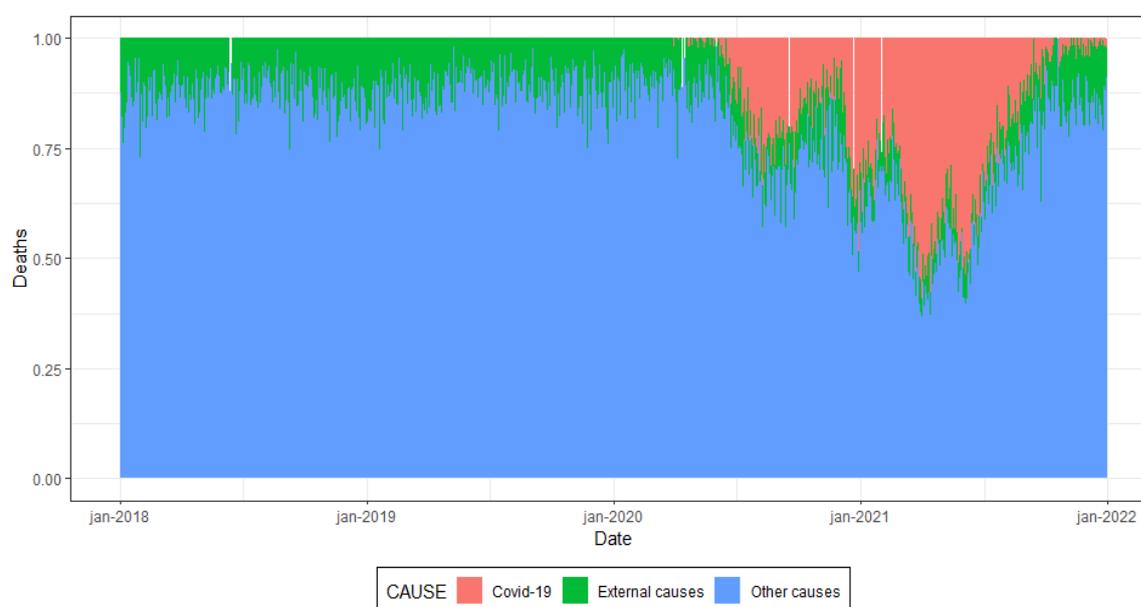

Figure 1. Time series of daily COVID-19, 'External causes' and 'Other causes' deaths proportions in Mato Grosso do Sul State, Brazil, 2018-2021.
Fonte: Os autores. A série foi construida a partir dos óbitos diários registrados no estado de MS.

The graph in Figure 1 illustrates the daily proportions of COVID-19 deaths, External causes and 'Other causes' in MS from January 1, 2018 to December 31, 2021. In 2021, the proportion of COVID-19 deaths exceeded the proportion of deaths from 'Other causes' on certain days. The proportion of deaths due to external causes decreased during the pandemic period, dropping from 12.0% in 2018 to 8.4% in 2021, a 30.0% reduction. In the two years before the pandem-ic, external causes accounted for an average of 11.7% of deaths, which decreased to 10.0% in the first year and then to 8.4% in the second year of the pandemic. Meanwhile, the proportion of deaths due to COVID-19, increased from 11.8% in the first year of the pandemic to 27.4% in the second year, representing a 132.2% rise in the contribution to the total number of deaths in MS (Table 2).

Table 2. Number and percentage of COVID-19 (B.342) and External causes (Cap. XX) deaths in Mato Grosso do Sul State, Brazil, 2018-2021

Year	COVID-19 (B.342)	External causes (Cap. XX)	Other causes	Total (100%)
2018	-	1985 (12.0%)	14615 (88.0%)	16.600
2019	-	1910 (11.4%)	14905 (88.6%)	16.815
2020	2244 (11.8%)	1906 (10.0%)	14901 (78.2%)	19.051
2021	6834 (27.4%)	2084 (8.4%)	15999 (64.2%)	24.917

During the study period, people who died from external causes were, on average, at least 20 years younger than individuals who died from COVID-19. The age group of 10-29 accounted for the majority of deaths from external causes, while COVID-19 was responsible for the majority of deaths in older age groups, from 60 to 79 years in the first year of the pandemic and from 40 to 59 years in the second year. The proportions of deaths from external causes decreased by 33.3% for females and by 28.4% for males, while the proportions of deaths from COVID-19 increased by 128.0% for females and by 135.4% for males during the period (Table 3).

In the first year of the pandemic, there was 1.2 COVID-19 death for each death from external causes. In the second year, this ratio increased to 3.2 COVID-19 deaths for every death from external causes. Throughout this period, the most common external cause of death was intentional self-harm injuries by hanging, stran-gulation, and suffocation at home (X70.0).

In 2018, the proportion of deaths from external causes was 9.9% among deaths of white individuals, and 25.3% among deaths of Native Americans. Native Americans had the highest proportion of deaths from external causes over the four-year period. Excluding those with un-known race/skin color, both the proportion of deaths from external causes (17.5%) and from COVID-19 (16.7%) were higher among Native Americans in the first year of the pandemic. They still had the highest proportion of deaths from external causes (20.2%) in the second year of the pandemic, but the highest proportion of deaths from COVID-19 (28.8%) was found among white individuals (Table 3). The proportional mortality of people with unknown race/skin color is also noteworthy. Since 2020, both the proportional mortalities from COVID-19 and external causes have been high.

Table 3. Proportional mortality from COVID-19 and External causes in Mato Grosso do Sul State, Brazil, 2020-2021

Characte-ristic	2018 n (%)		2019 n (%)		2020 n (%)		2021 n (%)	
	COVID-19	External causes	COVID-19	External causes	COVID-19	External causes	COVID-19	External causes
Sex								
Female	-	421 (6.0)	-	405 (5.7)	986 (12.5)	380 (4.8)	3019 (28.5)	419 (4.0)
Male	-	1564 (16.2)	-	1505 (15.6)	1258 (11.3)	1526 (13.7)	3815 (26.6)	1665 (11.6)
Mean age (s.d; IQR)	-	43.8 (23.0; 25.7- 58.7)	-	43.8 (22.2; 26.2 - 58.0)	69.6 (14.6; 60.4 - 80.5)	42.2 (21.2; 26.1- 55.6)	63.6 (15.6; 52.7 - 74.9)	42.7 (21.3; 25.7 - 56.3)
Age group								
0 to 5	-	60 (9.9)	-	47 (8.1)	1 (0.2)	63 (11.7)	10 (1.8)	47 (8.7)
6 to 9	-	12 (26.7)	-	8 (18.6)	1 (2.6)	14 (35.9)	2 (4.4)	13 (28.3)
10 to 19	-	184 (66.9)	-	180 (63.2)	1 (0.4)	136 (57.6)	2 (0.7)	203 (69.8)
20 to 29	-	413 (68.8)	-	379 (63.6)	13 (2.1)	419 (66.3)	89 (12.2)	411 (56.1)
30 to 39	-	341 (43.9)	-	346 (43.6)	56 (6.1)	362 (39.3)	416 (30.8)	399 (29.5)
40 to 49	-	269 (22.2)	-	284 (23.9)	148 (10.3)	297 (20.7)	871 (38.2)	304 (13.3)
50 to 59	-	239 (11.6)	-	223 (10.6)	325 (13.8)	217 (9.2)	1373 (37.5)	269 (7.4)
60 to 69	-	151 (5.0)	-	149 (5.0)	526 (14.8)	165 (4.6)	1577 (31.8)	164 (3.3)
70 to 79	-	106 (3.1)	-	132 (3.7)	580 (14.2)	105 (2.6)	1435 (27.9)	134 (2.6)
80 to 89	-	153 (4.7)	-	114 (3.4)	448 (12.2)	93 (2.5)	852 (20.1)	97 (2.3)
90 +	-	57 (4.4)	-	48 (3.5)	145 (9.2)	35 (2.2)	207 (12.3)	43 (2.6)
Race/Skin color								
White	-	788 (9.9)	-	702 (8.9)	1015 (11.6)	705 (8.0)	3352 (28.8)	718 (6.2)
Black/Mixed--race	-	1022 (13.0)	-	1061 (13.0)	1083 (11.5)	1073 (11.4)	3310 (26.9)	1213 (9.9)
Asian	-	31 (16.4)	-	19 (12.2)	28 (16.0)	8 (4.6)	69 (27.8)	15 (6.0)
Native American	-	136 (25.3)	-	123 (22.1)	104 (16.7)	109 (17.5)	80 (12.8)	126 (20.2)
Unknown	-	8 (13.6)	-	5 (8.8)	14 (18.7)	11 (14.7)	23 (23.2)	12 (12.1)
Education								
Illiterate	-	161 (5.0)	-	135 (4.1)	294 (9.2)	106 (3.3)	638 (16.9)	210 (5.6)
Elementary	-	851 (9.3)	-	962 (10.3)	1178 (11.4)	745 (7.2)	3395 (26.5)	787 (6.1)
High school	-	230 (13.4)	-	306 (15.7)	414 (16.3)	366 (14.4)	1525 (38.4)	425 (10.7)
Incomplete College	-	40 (20.8)	-	60 (29.7)	46 (19.2)	50 (20.8)	147 (44.3)	46 (13.9)
Complete College	-	61 (8.6)	-	66 (9.2)	200 (20.0)	60 (6.0)	772 (45.4)	66 (3.9)
Unknown	-	642 (38.7)	-	381 (29.7)	112 (6.3)	579 (32.8)	357 (15.5)	550 (23.9)

s.d = standard deviation; min-max = minimum – maximum

In Mato Grosso do Sul, COVID-19 accounted for higher proportion of deaths among white, blacks/mixed race, and Asians deaths over the course of the pandemic. However, the contribution of external causes to total deaths decreased during the same period. This trend was different for Native Americans, as the relative contribution of external causes to their total deaths increased from 17.5% in 2020 to 20.2% in 2021, while the contribution of COVID-19 decreased from 16.7% to 12.8% in the same period (Table 3).

Over the four-year period, excluding individuals with unknown education levels, the proportions of deaths from external causes were higher among those with incomplete college education. Among individuals with no education, the

proportional mortalities from external causes declined from 2018 to 2020 but increased in 2021. Meanwhile, the COVID-19 proportionate mortality increased in this group during the two years of the pandemic.

DISCUSSION

There was a notable increase in the number of deaths over the pandemic years, what is known as excess mortality, indicating the direct and indirect impact of the pandemic. Figure 1 shows peaks in deaths that correspond to the peaks of the pandemic waves. For instance, the first wave of the pandemic in Brazil began in February 2020 and lasted until October 2020, with a peak between May and July. Furthermore, the proportion of deaths from external causes decreased during the analyzed period.

The most common cause of death among younger deaths was external causes, while COVID-19 was more prevalent cause among deaths of older people. External causes were most common among deaths of both males and females aged 10-29, while COVID-19 was the leading cause among deaths of individuals aged 40-79. This reflects the mortality pattern of COVID-19 and the well-known risk factors associated with the disease that can lead to death.

Other studies may use mortality rates instead of proportional mortality, but Brazilian data support the fact that young people of both sexes are mainly affected by external causes compared to older individuals [5,12]. During the pandemic, adults and older individuals were the most affected by COVID-19 [13,14], as also noted among deaths analyzed in this study. A nationwide study [7] observed that in 2020, deaths among people aged 0-19 were lower than expected, with a reduction in mortality rates from external causes. The same study also reported that in 2020, the highest proportional excess deaths occurred in people between 40 and 59 years old, which coincided with COVID-19 deaths and with a fall in deaths due to external causes.

During the COVID-19 pandemic, older people were more vulnerable to severe illness and death from COVID-19, while younger people were less affected. However, it should be noted that COVID-19 can still affect people of all ages, and there have been cases of severe illness and death among younger people as well [14]. Meanwhile, there are many factors that can contribute to death from external causes in younger people, such as accidents, violence, and suicide [5,13]. In the Brazilian context, these causes of death may be related to various factors, including risk-taking behaviors [5], social and institutionalized racism, social inequalities [15], and mental disorders. It is known that people who are poorer, less educated, indigenous, and black/brown color have higher morbidity and insufficient and timely access to adequate health services [16,17], which can lead to increased mortality [5,18].

Intentionally self-harm injuries such as hanging, strangulation, and suffocation at home were the most common external causes of death in this study, while homicide from aggression was the leading external cause from 2000 to 2010 [12]. The increase in intentional self-harm during the pandemic can be attributed to a combination of factors, including the negative psychological effects of restrictive measures, economic challenges, and uncertainty. A study in Mid-West Brazil reported a 7.4% increase in suicide deaths after the beginning of the pandemic [19], and the study suggests that socially marginalized subpopulations

have been significantly affected by the pandemic in various aspects of life. Certain population groups were unable to adhere to social distancing measures due to economic pressures and other factors.

During the first quarter of the pandemic, there was a 19.1% decrease in medical procedures related to external causes in Brazil [16]. In this study, proportional mortality due to external causes showed a downward trend from 2018 to 2021 in both sexes, consistent with the trend of the number of deaths from external causes reported when comparing 2020 to the previous five years [4]. Additionally, from the first to the second year of the pandemic, i.e., from 2020 to 2021, the proportional mortality from external causes decreased significantly by 16.0%. This suggests a possible impact of social isolation measures [20], which reduced mobility and mortality from external causes [21] and other respiratory causes related to air pollution and respiratory viruses [22]. Conversely, proportional mortality due to COVID-19 tended to increase in the first two years of the pandemic.

Males were nearly three times more affected by external causes than females, but the differences were minimal for COVID-19. A study analyzing data from 1998 to 2017 found disparities between males and females in external causes of death [23]. Another study reported higher excess deaths among men, black, yellow, and indigenous people during the COVID-19 pandemic in Brazil, in contrast to women and white people [4]. It is well-known that men tend to die more from external causes than women due to a combination of biological, behavioral, and social factors.

Data from 2007 to 2016 revealed high mortality rates from external causes in Mato Grosso do Sul compared to other Brazilian states [12].

However, this study found a decrease in proportional mortality from external causes during the study period, which is consistent with findings reported elsewhere [7]. There was a notable steep drop observed from 2020 to 2021, possibly due to an increase in deaths from other causes, including COVID-19, which emerged in 2020. The overload of health services with COVID-19 cases may have led to an increase in deaths due to the lack of adequate and timely assistance for other clinical conditions [16,17].

Race/ethnicity and skin color are important indicators of inequalities in morbidity and mortality from different causes in Brazil. Researchers have shown significant racial disparities in excess mortality during the COVID-19 pandemic, with non-white individuals being the most affected [7]. For example, black individuals experienced 27.8% excess deaths compared to 17.6% for white individuals [2]. In the present study, significant racial differences were found, with indigenous people having the highest proportional mortality, while black/mixed race individuals had intermediate mortality for both external causes and COVID-19. However, in 2021, there was an unexpected shift, with whites having the highest proportional mortality for COVID-19 (28.8%), followed by Asians (27.8%) and then by black/mixed (26.9%). The higher proportional mortality among whites could be attributed to their higher income, compared to black people, which allow them to travel and potentially exposing them to the COVID-19. The study also found that Native Americans had the highest proportional deaths for both external causes and COVID-19 in many of the years analyzed, aligning with previous forecasts Brazil [24]. This is concerning and highlights the disproportionate impact of the pandemic on historically marginalized communities and expos-

es pre-existing structural inequalities and racial injustices in Brazil.

Although COVID-19 mortality rates are generally higher among less educated and poorer people in Brazil [25], this study found that the proportional mortality due to COVID-19 was not higher for died individuals with lower levels of educational. In the data analyzed, individuals with incomplete college education had the highest proportional mortality due to external causes, followed by those with a high school education. Meanwhile, individuals with a completed college degree had higher proportional deaths from COVID-19, but the proportional mortalities were similar to those of people with incomplete college education. Studies have shown that mortality rates from COVID-19 in Brazil have a decreasing gradient with higher levels of education, with the rate among illiterate people being three times higher than that of people with a college degree [17]. This pattern was also observed in other study [15] for mortality due to external causes and can be explained by the fact that education is often a proxy for socioeconomic conditions. It has been demonstrated that social conditions in different regions of Brazil influence the incidence and mortality due to COVID-19 [25].

This study has limitations. Firstly, the data on deaths for 2020 and 2021 may be subject to minimal updates in both the number and underlying cause of death due to the delay in updating official data. However, this delay is unlikely to significantly change the current findings, given the quality of death certificates filled out by physicians in Brazilian municipalities [13]. Secondly, the quality of the secondary data on mortality is somewhat limited [26], which may slightly bias these findings, as well as the underreporting of COVID-19 cases in the initial stages of the pandemic [10,27] in

Brazil and elsewhere. Thirdly, the trends in proportional mortality by cause or group of causes should be analyzed with caution as they are influenced by concomitant trends in the number of deaths attributed to other causes [28]. Lastly, it is important to consider population differences by age and local/regional issues, as the impact of COVID-19 can vary widely depending on factors such as population density, healthcare resources, and government implemented policies, including adherence to non-pharmacological interventions, such as mask usage and vaccination.

CONCLUSION

During the study period, COVID-19 was the leading cause of death in Mato Grosso do Sul, surpassing all external causes combined. Despite pandemic-related mobility restrictions, external causes ranked second among the most frequent causes of death. This may have been exacerbated by social isolation, potentially leading to suicide and domestic violence-related deaths. among other factors. These findings highlight the importance of addressing external causes and controlling vulnerabilities contribute to such deaths in Brazil.

Given that a large number of deaths from external causes and a significant portion of COVID-19 deaths are preventable, after availability of vaccines for COVID-19, it is crucial for policymakers and public health officials to address these issues. This involves addressing factors related to COVID-19, external causes and other key contributors to mortality. Additionally, it is important to focus on improving public health and preventive measures for individuals of all ages, races, and educational levels by increasing

investments and strengthening the Brazilian Unified Health System - SUS.

In conclusion, comparing proportional mortality indicators over time or among different population groups is valuable for identifying changes in mortality patterns. This can help prioritize public health interventions and targeted policies to reduce mortality from specific causes or in specific groups. In addition, focusing on proportional mortality can provide insights into the effectiveness of prevention or treatment programs for specific causes of death. Further research is needed to understand the relationship between mortality from COVID-19 and external causes and to develop strategies to reduce deaths from both causes.

REFERENCES

1. Jardim BC, Migowski A, Corrêa F de M, Silva GA e. Covid-19 in Brazil in 2020: impact on deaths from cancer and cardiovascular diseases. Rev. Saude Publica. 2022;56:22. doi:10.11606/S1518-8787.2022056004040

2. Teixeira RA, Vasconcelos AMN, Torens A, et al. Excess Mortality due to natural causes among whites and blacks during the COVID-19 pandemic in Brazil. Rev Soc Bras. Med. Trop. 2022;55(Suppl I):e0283-2021. doi:10.1590/0037-8682-0283-2021

3. Zheng XY, Tang SL, Ma SL, et al. Trends of injury mortality during the COVID-19 period in Guangdong, China: A population-based retrospective analysis. BMJ Open. 2021;11:e045317. doi:10.1136/bmjopen-2020-045317

4. Santos AM dos, de Souza BF, de Carvalho CA, et al. Excess deaths from all causes and by COVID-19 in Brazil in 2020. Rev Saude Publica. 2021;55(71). doi:10.11606/s1518-8787.2021055004137

5. Dare AJ, Irving H, Guerrero-López CM, et al. Geospatial, racial, and educational variation in firearm mortality in the USA, Mexico, Brazil, and Colombia, 1990–2015: a comparative analysis of vital statistics data. Lancet Public Health. 2019;4(6):e281-e290. doi:10.1016/S2468-2667(19)30018-0

6. Malta DC, Soares Filho AM, Pinto IV, et al. Association between firearms and mortality in Brazil, 1990 to 2017: A global burden of disease Brazil study. Popul Health Metr. 2020;18(Suppl 1):19. doi:10.1186/s12963-020-00222-3

7. Santos AM dos, de Souza BF, de Carvalho CA, et al. Excess deaths from all causes and by COVID-19 in Brazil in 2020. Rev Saude Publica. 2021;55:71. doi:10.11606/s1518-8787.2021055004137

8. Zeiser FA, Donida B, Costa CA da, et al. First and second COVID-19 waves in Brazil: A cross-sectional study of patients' characteristics related to hospitalization and in-hospital mortality. The Lancet Regional Health-Americas. 2022;6:100107. doi: 10.1016/j.lana.2021.100107

9. Sansone NMS, Boschiero MN, Marson FAL. Epidemiologic Profile of Severe Acute Respiratory Infection in Brazil During the COVID-19 Pandemic: An Epidemiological Study. Front Microbiol. 2022;13:911036. doi:10.3389/fmicb.2022.911036

10. Jagodnik KM, Ray F, Giorgi FM, Lachmann A. Correcting under-reported COVID-19 case numbers: estimating the true scale of the pandemic. medRxiv. Published online 2020:1-6. doi:10.1101/2020.03.14.20036178

11. Bailey SR, Telles EE. Multiracial versus collective black categories: Examining census classification debates in Brazil. Ethnicities. 2006;6(1):74-101. doi:10.1177/1468796806061080

12. Souza AMG de, da Silva Costa KT, Bento de Morais TN, de Andrade FB. Overview of the mortality from external causes of reproductive-age women in Brazil. Medicine (United States). 2022;101(1):e28508. doi:10.1097/MD.0000000000028508

13. Vasconcelos AMN, Ishitani L, Abreu DMX, França E. Covid Adult Mortality in Brazil: An Analysis of Multiple Causes of Death. Front Public Health. 2022;9:788932. doi:10.3389/fpubh.2021.788932

14. Baptista EA, Queiroz BL, Lima EEC. Regional COVID-19 mortality in Brazil by age. Vienna Yearbook Popul Res. 2022;20:349-365. doi:10.1553/populationyearbook2022.res2.3

15. de Oliveira RG, da Cunha AP, dos Santos Gadelha AG, Carpio CG, de Oliveira RB, Corrêa RM. Racial inequalities and death on the horizon: Covid-19 and structural racism. Cad Saude Publica. 2020;36(9):e00150120. doi:10.1590/0102-311X00150120

16. Bigoni A, Malik AM, Tasca R, et al. Brazil's health system functionality amidst of the COVID-19 pandemic: An analysis of resilience. The Lancet Regional Health-Americas. 2022;10:100222. doi:https://doi.org/10.1016/j.lana.2022.100222

17. Szwarcwald CL, Boccolini CS, da Silva de Almeida W, Soares Filho AM, Malta DC. COVID-19 mortality in Brazil, 2020-21: consequences of the pandemic inadequate management. Archives of Public Health. 2022;80:255. doi:10.1186/s13690-022-01012-z

18. Horta BL, Silveira MF, Barros AJD, et al. Prevalence of antibodies against SARS-CoV-2 according to socioeconomic and ethnic status in a nationwide Brazilian survey. Rev Panam Salud Publica. 2020;44:e135. doi:10.26633/RPSP.2020.135

19. Ornell F, Benzano D, Borelli WV, et al. Differential impact on suicide mortality during the COVID-19 pandemic in Brazil. Braz J Psychiatry. 2022;44(6):628-634. doi:10.47626/1516-4446-2022-2581

20. Silva LLS da, Lima AFR, Polli DA, et al. Social distancing measures in the fight against covid-19 in Brazil: Description and epidemiological analysis by state. Cad Saude Publica. 2020;36(9):e00185020. doi:10.1590/0102-311X00185020

21. Calderon-Anyosa RJC, Kaufman JS. Impact of COVID-19 lockdown policy on homicide, suicide, and motor vehicle deaths in Peru. Prev Med. 2021;143:106331. doi:10.1016/j.ypmed.2020.106331

22. Son JY, Fong KC, Heo S, Kim H, Lim CC, Bell ML. Reductions in mortality resulting from reduced air pollution levels due to COVID-19 mitigation measures. Sci Total Environ. 2020;744:141012. doi:10.1016/j.scitotenv.2020.141012

23. Baptista EA, Queiroz BL, Pinheiro PC. Regional distribution of causes of death for Small areas in Brazil, 1998–2017. Front Public Health. 2021;9:601980. doi:10.3389/fpubh.2021.601980

24. Colonia SRR, Cardeal LM, de Oliveira RA, Trinca LA. Assessing COVID-19 pandemic excess deaths in Brazil: Years 2020 and 2021. PLoS One. 2023;18(5):e0272752. doi:10.1371/journal.pone.0272752

25. Santos AAL dos, Silva JP da, Silva TCL da, Souza TA de, Miranda FAN de, Torres G de V. Influência de indicadores sociais na incidência e mortalidade da COVID-19 no Brasil em Junho de 2020. Saude Pesq. 2022;15(1):e9559. doi:10.17765/2176-9206.2022v15n1.e9559

26. Teixeira RA, Ishitani LH, França E, Pinheiro PC, Lobato MM, Malta DC. Mortality due to garbage codes in Brazilian municipalities: Differences irate estimates by the direct and bayesian methods from 2015 to 2017. Rev Bras Epidemiol. 2021;24(Supl 1):e210003. doi:10.1590/1980-549720210003.supl.1

27. Orellana JDY, da Cunha GM, Marrero L, Moreira RI, da Costa Leite I, Horta BL. Excess deaths during the COVID-19 pandemic: underreporting and regional inequalities in Brazil. Cad Saude Publica. 2020;36(1):e00259120. doi:10.1590/0102-311X00259120

28. Ahmad FB, Anderson RN. The Leading Causes of Death in the US for 2020. JAMA. 2021;325(18):1829-1830. doi:10.1001/jama.2021.5469