Hospital mortality rates between 2015 and 2022: a comparison between the pre-pandemic and pandemic period shows that COVID-19 is a critical health problem

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ABSTRACT

Introduction: COVID-19 caused 6.2 million deaths in the world. The present study aims to evaluate hospital mortality rates from 2015 to 2022, to compare the pre and during the pandemic period.

Methods: The study was carried out in a private hospital in southern Brazil. 174,013 hospital discharges between January 2015 and March 2022 were analyzed. Pearson's chi-squared test was performed to evaluate the mortality rate by year. Differences between mortality rates before and during the pandemic was tested with Student's t-test. *P*-values < 0.05 for all tests were considered significant.

Results: Mortality rates were 2.29% in 2015; 2.37% in 2016; 2.25% in 2017; 2.31% in 2018; 2.46% in 2019; 3.45% in 2020; 3.58% in 2021 and 2.77% in 2022 (*p* < 0.01). The mortality for 2020 and 2021 was higher than in the other years (3.50% ± 0.14 vs 2.34% ± 0.05; *p* < 0.01).

Conclusion: The mortality rates were significantly higher in the years 2020 and 2021, demonstrating that COVID-19 is a critical health problem.

Keywords: COVID-19; Pandemic; Mortality; Southern Brazil

INTRODUCTION

Coronavirus disease 2019 (COVID-19) pandemic spread rapidly and this scenario is concerning worldwide with more than 515 million cases and 6.2 million deaths[1]. Brazil is the Latin American country with the largest number of deaths due to COVID-19 recording more than 30 million cases and 660,000 deaths[2].

The epidemiological evaluation of COVID-19 is pivotal to understanding the pandemic profile and the hospital status resulting from the demand generated for health services. The first and second waves of the pandemic were essential for establishing the fast spread of SARS-CoV-2 in Brazil[3,4], which culminated in an overload on health systems, whether public or private[5-9].

Assessing the mortality outcome is important for a better understanding of the impact of the pandemic in the hospital context[9,10]. Therefore, the present study aims to evaluate hospital mortality rates from January 2015 to March 2022 in southern Brazil, as well as to compare rates in the pre-pandemic and during the pandemic period.

METHODS

This was a retrospective longitudinal study carried out in Brazil, in the city of Porto Alegre, at the Hospital Moinhos de Vento. This study was approved by the Institutional Review Board of the National Health Council of Brazil (approval number 4.497.118). The study analyzed data from hospital records of 174,013 hospital discharges between January 2015 and March 2022. Pearson's chi-squared test was performed to evaluate the mortality rate by year. Differences between mortality rates before and during the pandemic

was tested with Student's t-test. *P*-values < 0.05 for all tests were considered significant. SPSS, Version 23.0 for Windows (SPSS Inc., Chicago, IL, USA), and R software (R Foundation for Statistical Computing, Vienna, Austria; <http://www.R-project.org>) were used for data analysis.

Phylogenetic data of SARS-CoV-2 variants from Brazil, including phylodynamics and phylogeography were collected from the GISAID platform (https://www.gisaid.org/phylodynamics/brazil/). These data are updated by Fundação Oswaldo Cruz with 3.988 SARS-CoV-2 genomes collected between March 2020 and May 2022. The method used is the Bayesian, with Monte Carlo Markov Chains.

RESULTS AND DISCUSSION

A total of 4,551 deaths were identified in 174,013 recorded hospital discharges (2.61%). Mortality rates were 2.29% (n = 507/22,138) in 2015; 2.37% (n = 536/22,609) in 2016; 2.25% (n = 521/23,156) in 2017; 2.31% (n = 582/25,178) in 2018; 2.46% (n = 646/26,237) in 2019; 3.45% (n = 703/20,390) in 2020; 3.58% (n = 794/24,093) in 2021 and 2.77% (n = 262/10,212) in 2022 (Figure 1). The mortality rates for 2020 and 2021 were significantly higher than the other years evaluated ($p < 0.01$). In a comparison between the mortality rates during and before the pandemic period, we observed that there was a significant increase from March 2020 to March 2022 compared to the previous months from January 2015 to February 2020 (3.50% ± 0.14 vs 2.34% ± 0.05; $p < 0.01$). Month-to-month mortality rates with the pandemic waves highlighted are shown in Figure 2, with emphasis on the first wave (first variants, e.g. Alpha, Beta, and other), second (Gamma and Delta), and third (Omicron). In addition, Table 1 shows the hospital mortality rates for each month evaluated.
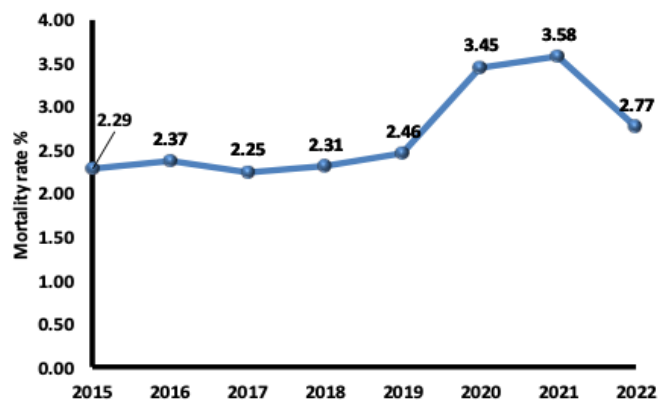

Figure 1: Hospital mortality rates between the years 2015 and 2022 in a private hospital from southern Brazil.
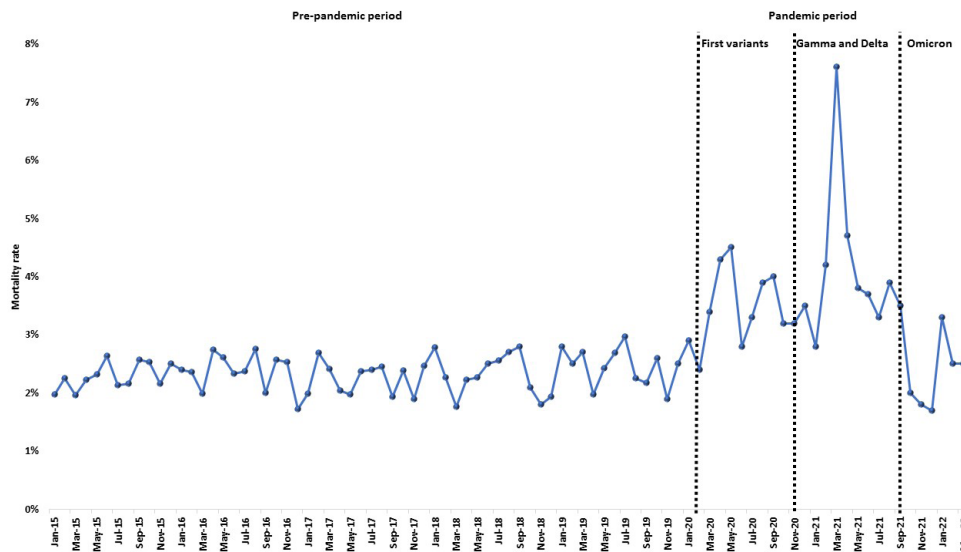

Figure 2: Monthly hospital mortality rates between 2015 and 2022 in a private hospital from southern Brazil. Pandemic waves are highlighted by vertical dashed lines.

Table 1: Hospital mortality rate in a private hospital from southern Brazil, pandemic months are highlighted in yellow.

Jan-15	1.97%	Jan-17	1.99%	Jan-19	2.80%	Jan-21	2.80%
Feb-15	2.25%	Feb-17	2.69%	Feb-19	2.50%	Feb-21	4.20%
Mar-15	1.96%	Mar-17	2.41%	Mar-19	2.70%	Mar-21	7.60%
Apr-15	2.23%	Apr-17	2.04%	Apr-19	1.98%	Apr-21	4.70%
May-15	2.32%	May-17	1.98%	May-19	2.43%	May-21	3.80%
Jun-15	2.64%	Jun-17	2.37%	Jun-19	2.69%	Jun-21	3.70%
Jul-15	2.13%	Jul-17	2.40%	Jul-19	2.97%	Jul-21	3.30%
Aug-15	2.16%	Aug-17	2.45%	Aug-19	2.26%	Aug-21	3.90%
Sep-15	2.57%	Sep-17	1.94%	Sep-19	2.17%	Sep-21	3.50%
Oct-15	2.53%	Oct-17	2.39%	Oct-19	2.60%	Oct-21	2.00%
Nov-15	2.16%	Nov-17	1.89%	Nov-19	1.90%	Nov-21	1.80%
Dec-15	2.51%	Dec-17	2.46%	Dec-19	2.50%	Dec-21	1.70%
Jan-16	2.40%	Jan-18	2.78%	Jan-20	2.90%	Jan-22	3.30%
Feb-16	2.36%	Feb-18	2.27%	Feb-20	2.40%	Feb-22	2.50%
Mar-16	1.99%	Mar-18	1.77%	Mar-20	3.40%	Mar-22	2.50%
Apr-16	2.74%	Apr-18	2.23%	Apr-20	4.30%	-	-
May-16	2.61%	May-18	2.27%	May-20	4.50%	-	-
Jun-16	2.33%	Jun-18	2.50%	Jun-20	2.80%	-	-
Jul-16	2.37%	Jul-18	2.56%	Jul-20	3.30%	-	-
Aug-16	2.76%	Aug-18	2.70%	Aug-20	3.90%	-	-
Sep-16	2.00%	Sep-18	2.80%	Sep-20	4.00%	-	-
Oct-16	2.57%	Oct-18	2.10%	Oct-20	3.20%	-	-
Nov-16	2.53%	Nov-18	1.80%	Nov-20	3.20%	-	-
Dec-16	1.72%	Dec-18	1.94%	Dec-20	3.50%	-	-

In the present study, we identified that mortality rates detected in 2020 and 2021 were higher than in the other years evaluated. Mortality rates increased significantly for the period from March 2020 to March 2022. The critical points for mortality rates were in the first wave (between March and September 2020), the second (between November 2020 and September 2021), and the third (October 2021 and March 2022) (Figure 2). The first wave of COVID-19 cases peaked between July and November 2020, causing an Intensive Care Unit (ICU) occupancy rate of 79.1% ± 5.6%. The second wave, presented a critical period of cases between December 2020 and June 2021, with an emphasis on March 2021. This wave was critical for the hospital's health system, reaching an average of 91.6% ± 3.1% of ICU occupancy rate. Finally, the third wave presented the concentration of cases and deaths in the first quarter of 2022 with an ICU occupancy rate of 81.0% ± 4.3%.

The COVID-19 pandemic in Brazil was characterized by the co-circulation of multiple variants as a consequence of different independent introduction events occurring through time. The rapid spread of Gamma and Delta was also mirrored by a large increase in the number of hospitalizations and deaths[11].

The mortality rates for the first wave caused by the first variants (e.g. Alpha, Beta, and others) peaked between July and September 2020. The second wave, leveraged by the Gamma and later by the Delta, presented a critical period of mortality between December 2020 and September 2021, mainly in March 2021. Finally, the third wave caused by the Omicron presented the concentration of deaths between January and March 2022. The rapid spread of multiple variants was also mirrored by a large increase in the number of cases and deaths. The co-circulation of variants in Brazil, evaluated by phylodynamic (Figure 3A) and phylogeographic methods, reinforces the periods of pandemic waves observed in the present study (Figure 3B). This in turn reinforces that, due to the emergence of variants that appear to induce a substantial evasion against neutralizing antibody response, it is important to strengthen genomic effort within the country and how vaccination remains a critical process to protect the vulnerable population, still at risk of infection and death[11].
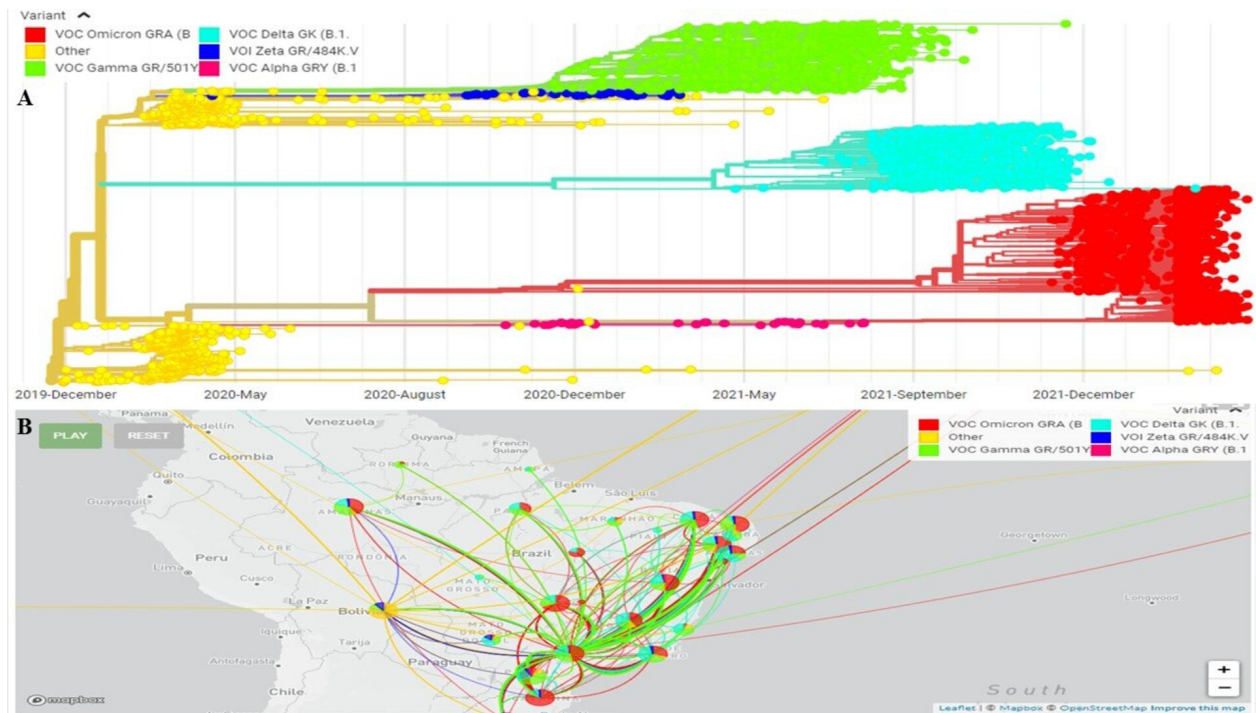
Figure 3: A: Molecular evolution of SARS-COV-2 variants in Brazil; B: Phylogeography of SARS-CoV-2 variants in Brazil. Data extracted from GISAID (Global Initiative on Sharing All Influenza Data; Available in <https://www.gisaid.org/phylodynamics/brazil/> Accessed in June 06, 2022).

Festive events in Brazil such as Christmas and New Year 2020 and 2021 had an impact on the COVID-19 pandemic waves. This can be seen in our study, where the highest mortality rates occurred in periods underlying these events. Vaccination in Brazil started on January 17, 2021, which resulted in a substantial drop in the mortality rate after May 2021. However, in early 2022, the appearance of the omicron variant was responsible for the increased mortality rates, but more lightly when compared to the peak of 2021 (mainly March 2021).

A high number of patients required intensive care at the same time leading to an elevated risk of collapsing the health care systems. Until effective and specific treatments are available, supportive measures are a primary factor for critically ill patients. Providing such care at a high-quality level for the large number of patients to be treated is a major challenge for all healthcare systems in the world[12-15].

This study has some limitations. First, the study population only included patients within the Rio Grande do Sul state. Second, the data were collected from the electronic health record database. This precluded the level of detail possible with a manual medical record review. However, the present study showed important mortality rates during the pandemic period, allowing the conclusion that COVID-19 is a critical health problem.

Compliance with ethical standards

All participants signed an informed consent form and this study was approved by the Institutional Review Board of the National Health Council of Brazil (approval number 4.497.118).

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Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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