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ORIGINAL ARTICLE

NUMBER OF DEATHS AND ICU BEDS DURING COVID-19 IN THE STATE OF SÃO PAULO

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ABSTRACT

Objective: to describe the number of deaths from COVID-19 and the number of Intensive Care Unit (ICU) beds in the state of São Paulo. **Method**: This is a descriptive, observational epidemiological study. Data was collected from the State Data Analysis System from October 8, 2020, to July 25, 2021. The variables considered in the study were deaths by COVID-19 and ICU beds, described using absolute frequencies, percentages, and means. **Results:** From December 2020 onwards, there was a gradual increase in the number of monthly deaths from COVID-19, peaking between March and May 2021. A progressive increase in the monthly average number of ICU beds was also observed from January 2021 onwards in the seventeen Regional Health Departments-RHD (DRS, in Portuguese). **Conclusion:** As the number of deaths increased during the period analyzed in the pandemic, there was an increase in the opening of new ICU beds; however, the monthly average number of beds remained lower than the total number of deaths in the respective RHD.

Keywords: COVID-19. Mortalidade. Unidades de Terapia Intensiva.

INTRODUÇÃO

The global health crisis caused by SARS-CoV-2 led the World Health Organization (WHO) to declare a COVID-19 pandemic in March 2020 (1). The symptoms of COVID-19 range from mild, which include fever, dry cough, dyspnea, headache, body aches, anosmia, and ageusia as well as gastrointestinal manifestations, to more severe cases, such as hypoxia, severe acute respiratory failure, and kidney failure, which at the beginning of the pandemic required more complex treatments and admissions to Intensive Care Units (ICUs)[2, 3].

In this context, given the possibility of the disease worsening in a significant number of cases and the accelerated process of transmission of the virus, the evolution of COVID-19 was accompanied by a vertiginous growth in the demand for ward and ICU beds. This has led to a rush by governments to adapt their health services to deal with the pandemic[3].

At the beginning of 2021, many health services collapsed faced with a shortage of medical equipment and supplies, medicines; the need to expand or adapt existing physical spaces to open new beds to care for those infected by the virus; and a lack of health professionals trained in intensive care, especially nursing staff, who are essential in caring for critically ill patients[2-4].

Studies carried out during this period showed that around 25% of patients infected with COVID-19 who were admitted to hospitals at the start of the pandemic required intensive care. Throughout the pandemic, this scenario changed, and the number of cases progressively decreased; however, whenever a new variant emerged, the number of cases increased. This movement of improvement in the epidemiological scenario, followed by a peak in cases, was called an epidemic wave[5, 6].

In Brazil, despite the start of vaccination in January 2021, aimed at specific groups, the emergence of new variants contributed to an increase in the number of infected people, and the number of deaths tripled compared to the previous year. While in 2020, 194,949 deaths

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were recorded, the year 2021 accumulated 619,056 deaths[7,8]. This scenario highlights that Brazil was unprepared to face the high transmission rates of COVID-19 at the beginning of the pandemic and during the second wave. The weaknesses and shortcomings of the health system were highlighted, pressured by the growing number of patients requiring care for COVID-19 and other acute chronic diseases during this period[3, 7–9].

Therefore, analyzing the dynamics of the disease about the number of ICU beds allocated to COVID-19 has proved essential in enabling an understanding of the accessibility of intensive care services and their relationship with deaths resulting from infection by the virus and then identifying the weaknesses and adequacy of the ICU's capacity to meet the demands in outbreak situations. This study aimed to describe the number of deaths from COVID-19 and the supply of ICU-COVID beds in the state of São Paulo.

METHOD

This is a descriptive, observational epidemiological study. This study was carried out in the state of São Paulo, considering the 17 Regional Health Departments (RHD), namely: RHD I-Greater São Paulo; RHD II-Araçatuba; RHD III-Araraquara; RHD IV-Baixada Santista; RHD V-Barretos; RHD VI-Bauru; RHD VII-Campinas; RHD VIII-Franca; RHD IX-Marília; RHD X-Piracicaba; RHD XI-Presidente Prudente; RHD XII-Registro; RHD XIII-Ribeirão Preto; RHD XIV-São João da Boa Vista; RHD XV-São José do Rio Preto; RHD XVI-Sorocaba; and RHD XVII-Taubaté.

The data was collected in August 2021 from the "Complete Bulletin" website, specifically from the files named "Beds and Hospitalizations" and "Cases, Deaths and Pre-existing Diseases," made available by the State Data Analysis System (SEADE, in Portuguese), a local system that maintains an updated electronic data panel with information related to the coronavirus with a focus on the state of São Paulo[10].

The data obtained refers to the period from October 8, 2020 (the date of the first records of beds available for COVID-19) to July 25, 2021. The variables considered in the study were: death by COVID-19 and ICU beds intended for exclusive COVID-19 care reported in each RHD, according to the data available in SEADE. Because the database provided by SEADE does not have the date of death, the date of death was estimated as 14 days after the date of onset of symptoms to calculate the number of monthly deaths by RHD. This was following the period described by the Ministry of Health regarding the average time between the evolution of deaths and the onset of symptoms[11]. Therefore, a total of 10 patients who died but had no information on the date of symptom onset were excluded from the database.

Deaths from COVID-19 in the period analyzed were described using absolute and percentage frequencies (qualitative variables) and ICU-COVID beds using the average (quantitative variable), presented in tables. In addition, the visual comparison between the total number of deaths per month and the average number of ICU-COVID beds per month in the different RHD was presented in graphs.

As this was a descriptive study of the number of deaths and ICU-COVID beds in the state, no hypothesis test was used. SAS 9.4 software was used for the analysis, and R 4.1.0 software was used to construct the graphs.

This research used secondary data available on the official website of the São Paulo state government and was exempt from assessment by a research ethics committee, following Resolution 466⁄12 of the National Health Council.

RESULTS

In the period analyzed, 97286 deaths from COVID-19 were reported in the state of São Paulo. Regarding the distribution of the absolute number of COVID-19 deaths by RHD, RHDI-Greater São Paulo stands out, with the highest percentage of deaths (42.4%) and RHD XII-Registro, with less than 1%, as shown in the table.

Table. Total deaths by COVID-19 by the regional health department in the state of São Paulo from October 8, 2020, to July 25, 2021. São Carlos. SP. Brazil. 2023.

Regional Health Department	Total number of COVID-19 deaths	Percentage (%)
RHD I	41246	42,40
RHDII	2513	2,58
RHDIII	2150	2,21
RHDIV	4075	4,19
RHDIX	3350	3,44
RHDV	1151	1,18
RHDVI	4275	4,39
RHD VII	9410	9,67
RHD VIII	1356	1,39
RHD X	3308	3,40
RHD XI	2003	2,06
DRS XII	653	0,67
RHD XIII	3360	3,45
RHD XIV	2063	2,12
RHDXV	5546	5,70
RHD XVI	6500	6,68
RHD XVII	4327	4,45

According to what can be seen in Figure 1, about COVID-19 mortality, RHD I-Greater São Paulo, RHD II-Araçatuba, RHD III-Araraquara, RHD IV-Baixada Santista, RHD V-Barretos, and RHD VI-Bauru showed an upward curve in the number of deaths from December 2020 onwards. The number of deaths peaked in March 2021, except for RHD IV-Baixada Santista and RHD V-Barretos, which had a peak in the number of deaths in April.

In March and April 2021, RHD I-Greater São Paulo recorded a total number of deaths higher than the monthly average of ICU-COVID beds; in March, while more than eleven thousand deaths were recorded, the average number of ICU-COVID beds available was less than seven thousand. However, except for D I-Greater São Paulo and RHD IV-Baixada Santista, the other RHD had a lower monthly average of ICU-COVID beds than the total number of monthly deaths in the months following the peak in deaths (Figure 1).

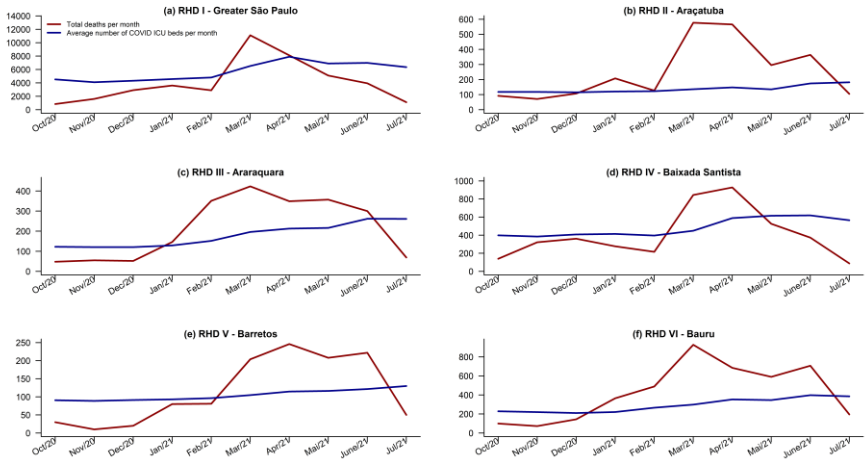


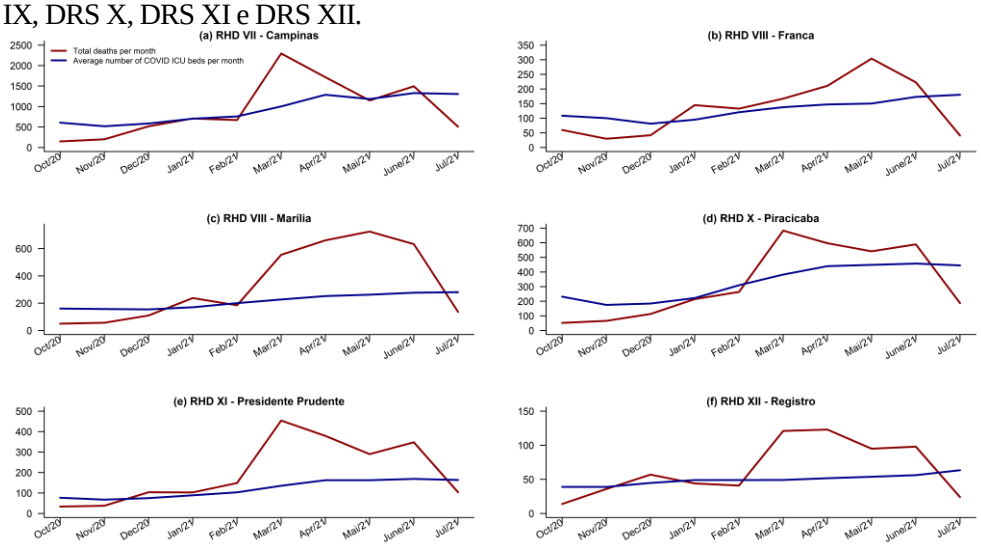
Figure 1. Total monthly deaths by COVID-19 and average monthly number of ICU-COVID beds in RHD I, RHD II, RHD III, RHD IV, RHD V, and RHD VI.

In the analysis, comprising: RHD VII-Campinas; RHD VIII-Franca; RHD IX-Marília; RHD X-Piracicaba; RHD XI-Presidente Prudente, and RHD XII-Registro, it was observed that in most RHD, the peak of deaths occurred between March and April 2021, except for RHD VIII-Franca and RHD IX-Marília, which had a peak of deaths in May.

Concerning the average number of ICU-COVID

beds and the total number of deaths, during the peak in deaths, all RHD had a lower monthly average number of ICU-COVID beds than the total number of deaths. RHD XI-Presidente Prudente and RHD VIII-Franca had a lower average number of ICU-COVID beds than the total number of monthly deaths since December and January, respectively (Figure 2).

Figura 2. Total de óbitos mensal por covid-19 e média mensal de leitos UTI-COVID nos DRS VII, DRS VIII, DRS IX, DRS X, DRS XI e DRS XII.

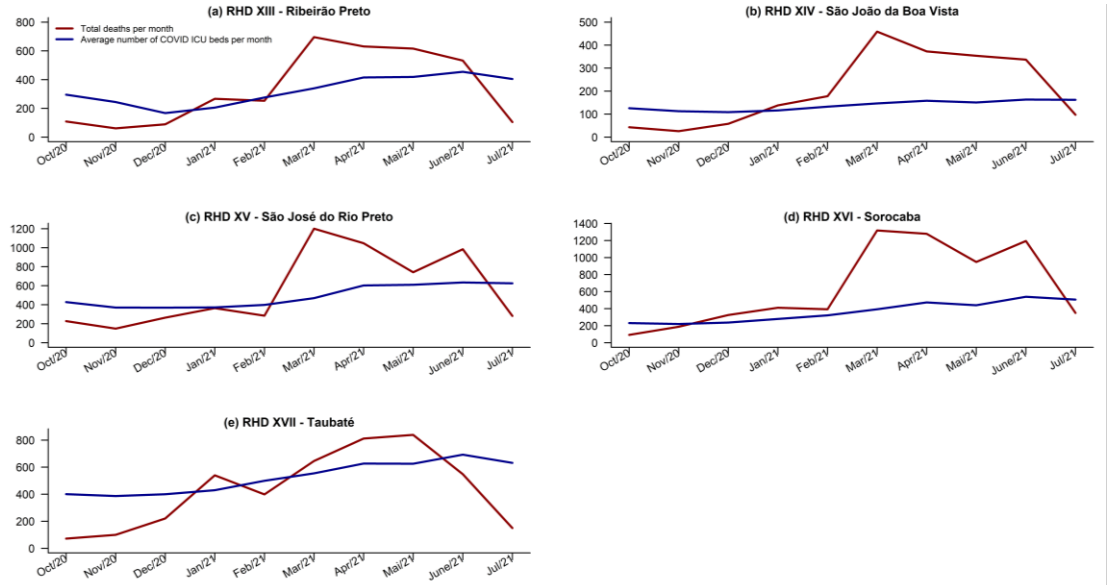


About the RHD: XIII-Ribeirão Preto; RHD XIV-São João da Boa Vista; RHD XV-São José do Rio Preto; RHD XVI-Sorocaba; and RHD XVII-Taubaté, it was observed that only RHD XVII-Taubaté had its peak number of deaths in May, while the others had their peak number of deaths in March 2021.

RHD XVI-Sorocaba had an average number of ICU-COVID beds lower than the number of monthly deaths since mid-December 2020 and RHD XIV-São João da Boa Vista since January 2021.

All the RHD, even after the months in which the peaks in deaths were recorded, continued to have a monthly average of ICU-COVID beds lower than the total number of deaths in the following months, and only in July was a monthly average of ICU-COVID beds higher than the total number of deaths observed (Figure 3).

Figura 3. Total de óbitos mensal por covid-19 e média mensal de leitos UTI-COVID nos DRS XIII, DRS XIV, DRS XV, DRS XVI e DRS XVII.



It is noteworthy that, in the analysis of the 17 RHD, only RHD XI-Presidente Prudente, RHD XII-Registro, and RHD XVI-Sorocaba had a total number of monthly deaths in December 2020 higher than the monthly average of ICU-COVID beds. It is also possible to observe that in all the RHD, there was a progressive increase in the monthly average of ICU-COVID beds from January 2021 onwards, especially in the periods corresponding to the peak of deaths.

After the peak period of deaths, a decline in the total number of deaths in the following months was observed in the RHD in general, as well as a reduction in the average number of ICU-COVID beds. After June, in most RHD, the average number of ICU-COVID beds once again rose above the total number of monthly deaths.

DISCUSSION

This study indicated that all the RHD in the state of São Paulo increased the number of new ICU-COVID beds opened, as can be seen from the monthly averages. However, especially in the period corresponding to the peak of deaths, the monthly averages of ICU-COVID beds remained below the total number of deaths recorded, pointing to a possible shortage of ICU beds for COVID-19 patients.

Regarding mortality from COVID-19 in the state of São Paulo, RHD I-Greater São Paulo stood out as having the highest number of deaths from the disease.

It should be noted that the first case of the disease was recorded in the municipality of São Paulo, where there are airports and large shopping centers that attract a large flow of people from different regions of the country and abroad[12]. In this way, the fact that some people were asymptomatic may have contributed to the transmission of the virus in this RHD and, subsequently, to the spread of new variants to other RHD in the state and other regions of the country.

In several countries, while there was no vaccine for the disease at the beginning of the pandemic, various measures to deal with the SARS-CoV-2 virus were implemented to contain the spread of the disease. Also, as a form of prevention, measures such as the use of masks, physical distancing, hand hygiene, widespread testing for COVID-19, and lockdowns[13, 14].

In Brazil, there have been several challenges in implementing public policies, even when they are backed by solid scientific foundations. In addition to pressure from economic sectors, the federal government has adopted denialism positions with a tendency to minimize the pandemic in the world and in the country, positioning itself against measures to deal with the virus such as the use of masks, physical isolation, and measures to restrict mobility[13, 14].

During the health crisis in the country, the Federal Supreme Court gave the states, the Federal District, and the municipalities the power to decide to implement measures to deal with the pandemic[15]. However, due to the

federal government's inaction in implementing measures to deal with the virus at a national level, the autonomy granted to state and municipal governments in implementing these actions has led to differences in adherence to certain measures. An analysis showed that in the Federal District, pandemic response measures were implemented on March 11, 2020, while in the other Federative Units, they were implemented between March 13 and 28, 2020[16].

However, behavioral, and socioeconomic factors can also influence adherence to non-pharmacological measures to deal with the virus[12]. One analysis showed that during the pandemic, among those most exposed to the risk of falling ill and dying from the disease were residents of agglomerations, also known as "*favelas"*(slums), and people in underemployment and/or informal work. In addition, people with no schooling had lethality rates three times higher than those with higher education[17].

That said, São Paulo, in absolute terms, is the state with the highest number of houses in agglomerations, with 1,066,813 households, and the municipality of São Paulo has the highest number of households in agglomerations when looking at the municipalities, with 529,921 subnormal agglomerations [17, 18].

Thus, the high number of deaths observed in this study in RHD I-Greater São Paulo may be related to the fact that the municipality of São Paulo, as well as being the most populous city in the country, also has many households in areas of extreme socioeconomic vulnerability. The difficulty in accessing health services, basic resources such as piped water, and the existence of jobs that did not allow the home office format (street vendors, maids, cleaners, delivery boys, among others) may have influenced the spread of the virus in this population [12, 17].

However, it is important to consider the periods when measures to deal with the virus are more flexible, since the increase in deaths observed in this study in the last quarter of 2020 may be related to the population's fatigue in the face of compliance with measures to deal with COVID-19, after almost a year of pandemic, plus the end-of-year and carnival festivities, which promote crowds and may have contributed to the spread of the virus, in addition to the reduction in measures to deal with the disease[19,20].

It should be noted that, in December 2020, in Manaus, the Gamma variant (lineage P.1) was identified, which in January 2021, corresponded to 91% of the samples in the same municipality; and, on April 20, 2021, it had already been registered in 43 countries. Patients with the gamma variant (20%) required longer hospital stays when compared to those infected with other variants. Thus, this variant has been linked to greater transmissibility, high lethality, and a higher risk of reinfection with the coronavirus[21].

Soon after the emergence of the Gamma variant, on January 18, 2021, the national vaccination campaign against COVID-19 began. However, since the beginning of the pandemic, the federal government has had several setbacks concerning the vaccine, which have resulted in vaccination being delayed[22]. Due to the unavailability of sufficient doses of immunizers, the vaccine was initially offered to people most susceptible to worsening and death from the disease and to those needed to keep the health services workforce functioning[7].

After six months of campaigning, only 22.8% of the vaccinated population received two doses or a single dose, and 52.9% received the first dose of the vaccine [23]. The low percentage of people immunized against the disease and the presence of a highly transmissible and more lethal variant in the country may have contributed to the high mortality rate in 2021 in the state of São Paulo.

In Brazil, this same behavior with the increase in mortality from COVID-19 was observed in the country in general in 2021. In this context, an analysis pointed to three other waves of deaths in Brazil during the COVID-19 pandemic. The first wave lasted from February 23 to July 25, 2020, with peak mortality in the 30th epidemiological week of 2020, when 7,677 weekly deaths were reported. The second took place between November 8, 2020, and April 10, 2021, with a peak in deaths in the 14th week of 2021, with triple the number of deaths, with 21,141 deaths in one week. The third wave was the shortest, from December 26, 2021, to May 21, 2022, in the 6th epidemiological week of 2022, with a total of 6,246 deaths[24].

On March 20, 2021, the period corresponding to the second wave of deaths, the general situation in the country was extremely critical, in a scenario in which 17 states and the Federal District had bed occupancy rates of over 90%, including São Paulo[25].

Before the pandemic, there was already inequality in the distribution of beds in Brazil, especially concerning the distribution of the number of ICU-COVID beds per 100,000 inhabitants. The lowest rates of ICU beds were observed in the North, with Roraima having 4 beds per 100 inhabitants and Amapá, Acre, Amazonas, and Pará having less than 9 beds per 100 inhabitants. On the other hand, the highest rates were observed in the Federal District, with the highest indicator recorded in the entire country, with 30 beds/100 inhabitants, followed by the Southeast region, with São Paulo having 19 beds/100 inhabitants, Espírito Santo with 20 beds/100 inhabitants, and Rio de Janeiro with 25 beds/100 inhabitants[26, 27].

Although the state of São Paulo had one of the highest rates of ICU-COVID beds, this study indicated that all the RHD in the state had a progressive increase in the number of ICU-COVID beds over the months. The number of deaths also increased, with a few exceptions. In 2021, the RHD was unable to supply the number of beds needed, especially during the period corresponding to the peak in deaths.

Subsequently, the peak of deaths in Brazil passed. In 2021, after six months of the COVID-19 vaccination campaign, in July, although the numbers of cases (an average of 46,700 new cases per day) and deaths (1,300 deaths per day) were still very high, for the first time since the beginning of December 2020, no state had an ICU-COVID bed occupancy rate of more than 90% [28].

These findings correspond to those observed in this study, that is, from July 2021 onwards, in the state of São Paulo, by analyzing the RHD, a decline was observed in both the total number of deaths and the monthly average number of ICU-COVID beds. This reduction in mortality is directly related to the expansion of vaccination in the country.

Several factors have challenged state and municipal managers in terms of expanding ICU-COVID beds and dealing with the pandemic, such as inaction by the federal government in coordinating coping actions; devaluation and low adherence to non-pharmacological measures to contain and block transmission by the population in some periods; slowness in the vaccination campaign due to the purchase of insufficient doses for the population; and the emergence of new variants with greater transmissibility and lethality that resulted in 2021 in the highest peak of deaths since the beginning of the pandemic [7, 13, 14, 21, 21].

However, the opening of new ICU beds requires governments to provide much more than just the physical space to set them up; in addition to investing in the acquisition of high-cost equipment needed for the infrastructure, their opening is also conditional on the acquisition of trained human resources[4, 29].

In the hospitalization sectors for patients with COVID-19, including ICUs, among health professionals, the highest percentages correspond to nursing professionals who work directly in the care of critically ill patients. An adequate number of these workers is essential to mitigate work overload, ensure the quality of care provided, and, consequently, reduce deaths. However, during the pandemic, there has been a shortage of these professionals, and to provide care for patients with COVID-19, there has been an acceleration in the process of recruiting workers, extending contracts, including temporary staff, and transferring sectors to places dedicated to caring for patients affected by the virus [4, 30].

This study has some limitations to be considered: the particularities of each RHD in the state were not assessed, such as population density, adequate number of health professionals in ICUs for COVID-19, vaccination rates against COVID-19 and other socioeconomic and environmental variables that could influence mortality from the disease.

However, this study proves that the state of São Paulo, although it has had difficulties in expanding ICU-COVID beds during the pandemic, has maintained the expansion of beds. At the same time, the number of deaths has risen, especially in the most critical periods. Access to health services, especially highly complex ones, directly affects the outcome of health problems since patients must be

guaranteed timely access to quality health services. Therefore, investing in strategies to strengthen the Unified Health System and implementing coordinated actions to act effectively in health crisis scenarios is essential.

CONCLUSION

This study indicated that the highest percentage of deaths observed in the state corresponded to RHD I-GreaterSão Paulo. In addition, as the number of deaths rose during the pandemic, all the RHD increased the number of new ICU-COVID beds opened; however, the monthly average number of beds remained lower than the total number of deaths in the respective RHD.

NÚMERO DE ÓBITOS E DE LEITOS EM UTI DURANTE A COVID-19 NO ESTADO DE SÃO PAULO

RESUMO

Objetivo: descrever o número de óbitos por Covid-19 e de leitos de Unidade de Terapia Intensiva (UTI) no estado de São Paulo. **Método**: trata-se de um estudo epidemiológico observacional descritivo. Os dados foram coletados no Sistema Estadual de Análise de Dados, no período de 08 de outubro de 2020 a 25 de julho de 2021. As variáveis consideradas no estudo foram óbitos por Covid-19 e leitos UTI, descritas por meio de frequências absolutas, percentuais e médias. **Resultados**: a partir de dezembro de 2020 foi observada uma elevação gradual do número de óbitos mensais por Covid-19,registrando o pico entre os meses de março a maio de 2021. Também foi observado um aumento progressivo da média mensal de leitos UTI a partir de janeiro de 2021 nos dezessete Departamentos Regionais de Saúde (DRS). **Conclusão**: à medida que os óbitos foram se elevando durante o período analisado na pandemia, houve ampliação quanto à abertura de novos leitos UTI, no entanto, as médias mensais de leitos permaneceram inferioresao número total de óbitos nos respectivos DRS.

Palavras-chave: COVID-19. Mortalidade. Unidades de Terapia Intensiva.

NÚMERO DE ÓBITOS Y CAMAS EN UCI DURANTE LA COVID-19 EN EL ESTADO DE SÃO PAULO-BRASIL

RESUMEN

Objetivo: describir el número de óbitos por covid-19 y de camas de Unidad de Cuidados Intensivos (UCI) en el estado de São Paulo/Brasil. Método: se trata de um estudio epidemiológico observacional descriptivo. Los datos fueron recogidos en el Sistema Estadual de Análisis de Datos, en el período de 08 de octubre de 2020 a 25 de julio de 2021. Las variables consideradas en el estudio fueron óbitos por covid-19 y camas UCI, descritas por medio de frecuencias absolutas, porcentuales y promedios. Resultados: a partir de diciembre de 2020 se observó una elevación gradual del número de óbitos mensuales por covid-19, registrando su máximo entre los meses de marzo a mayo de 2021. También se observó un aumento progresivo del promedio mensual de camas UCI a partir de enero de 2021 en los diecisiete Departamentos Regionales de Salud (DRS). Conclusión: conforme los óbitos se fueron elevando durante el período analizado en la pandemia, hubo ampliación en cuanto a la apertura de nuevas camas UCI, sin embargo, los promedios mensuales de camas permanecieron inferiores al número total de óbitos en los respectivos DRS.

Palabras clave: COVID-19. Mortalidad. Unidades de Cuidados Intensivos.

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