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REGIONAL HEALTH INDICATORS IN COVID-19 LETHALITY IN BRAZIL: A DESCRIPTIVE STATISTICAL ANALYSIS

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ABSTRACT

COVID-19 is a disease that has rapid transmissibility, which is portrayed in epidemiological data, in addition to being easy to transmit, it has a high degree of mortality. The fatality rates caused by COVID-19 are an important tool for the control and development of prevention strategies. Taking into account the continental dimension of the Brazilian territory and the social, economic, political and cultural inequalities of each region, state and municipality, the impacts generated by the pathology may appear heterogeneous. Therefore, the objective of the research was to compare the mortality and lethality rates of the different regions and states of the federation with their respective human development indices, socioeconomic levels and with the investments received to fight the disease. Data were collected on confirmed cases of COVID-19, the total number of beds, the number of beds provided by the HUS, the number of private beds in Tocantins, in order to calculate mortality and lethality rates between April 2020 and January 2021, available on DATASUS, Coronavirus Panel and on the portal of the State Department of Health of the State of Tocantins. Among the results, there was a negative correlation between availability of beds and the lethality rate, demonstrating that the structure of the health system corroborates the improvement in quality indicators.

Keywords: COVID-19. Lethal Rate. Public Health. Human Development.

1. INTRODUCTION

With a rapid international expansion, on December 31, 2019, the first cases reported to the World Health Organization (WHO) of the disease were received, which, until then, was defined as a "pneumonia of unknown origin", associated with principle to individuals who worked in the Seafood market, in the city of Wuhan, Chinese province of Hubei (OLIVEIRA et al., 2020). Soon after, given the high repercussion and incidence, which broke the geographical border of China, initially reaching other countries in Europe,

on January 30, 2020, the WHO established that it was a pathological outbreak caused by the new Coronavirus, responsible for causing the Severe Acute Respiratory Syndrome. It is, then, an emergency state of public health, with worldwide relevance. Months later, specifically on March 11 of the same year, due to the high expansion caused by the virus, the disease was declared by the WHO as a pandemic, already hitting exponentially in countries all over the world (SOUZA-JÚNIOR et al., 2020; WHO, 2020). SARS-CoV-2 is a β-coronavirus discovered through samples found after bronchoalveolar analysis, which were acquired from the first individuals who were notified with cases of pneumonia of unknown origin, in Hubei (MONTE et al. , 2020). In pathophysiological terms, according to the literature, when SARS-CoV-2 comes into contact with the human body, it has greater affinity for nasal, bronchial, pneumococcal epithelial cells, and in some cases, for cardiac, nephrotic, esophageal and intestinal cells . Thus, when a susceptible host comes into contact with the virus, whether through contact with respiratory droplets or contaminated aerosols, the structural glycoprotein Spike (S), which is part of the surface of COVID-19, is responsible for viral penetration into the host, and it has potential binding with the receptor of Angiotensin-Converting Enzyme-2 (ACE-2), binding, and then, to the cell membrane where the contaminated cell reproduces, quickly releasing the single strand of viral RNA in the body. host (VASCONCELOS-JÚNIOR et al., 2020; SOUZA et al., 2020).

Therefore, COVID-19 is a disease that has rapid transmissibility, which is portrayed in epidemiological data, in addition to being easy to transmit, it has a high degree of mortality. On an international level, six months after the WHO declared a pandemic state for the virus, approximately 33 million cases have already been notified, according to the Center for Systems Science and Engineering (CSSE) of the Johns Hopkins University & Medicine. , there have already been around 996 thousand deaths (HOPKINS, https://coronavirus.jhu.edu/map.html, accessed on September 27, 2020).

Regarding mortality in the main countries affected by the pandemic, according to data from the CSSE of the University & Medicine Johns Hopkins, the United States of America (USA) has approximately 7.1 million cases already confirmed, of which 204,000 are came to death. India, the second country in the ranking, has already notified around 5.9 million cases, with around 94,000 deaths. Brazil occupies third place in this same ranking, has around 4.7 million cases, reaching 141,000 deaths across the country. On the other hand, in China, the country where the initial peak of the disease occurred, around 90,000 cases have been reported to date, and of these, only 4,700 evolved to death (HOPKINS, https://coronavirus.jhu .edu/region, accessed on Sept. 27, 2020).

Regarding Brazil, according to data made available by the Coronavirus Brazil portal (https://covid.saude.gov.br/) developed by the Ministry of Health (MS), the different regions of the country have high averages in the Mortality Index for each 100,000 inhabitants, with the North region, with 80.3, the one with the highest death rate to date; followed by the Midwest region with 75.3; Southeast with 72.4; Northeast with 67.7; and the South region with the lowest mortality rate with a rate of 39.0. As for the Brazilian states with the highest Mortality Rates for every 100,000/inhabitants, there are Rio de Janeiro with 105.7; Roraima with 105.2; Ceará with 97.6; Sergipe with 87.7; Holy Spirit with 86.8; and Pernambuco with 85.3 (BRAZIL, https://covid.saude.gov.br/, updated on Sept. 26, 2020).

Therefore, due to the growing number of infected people across the country, greater public investments in health, enabling and offering new Intensive Care Unit (ICU) beds, human resources and better infrastructure for support were and are being needed assistance, recovery and combat to the new Coronavirus. According to data made available by the Brazilian government, until August 21, 2020, the MS had already invested 72.5 billion reais to fight the pandemic, which were redistributed among all 26 states in the country and the Federal District. Of this amount, 52.6 billion reais were allocated to routine services of the Health Unified System (HUS) and 19.9 billion to COVID-19 (BRASIL, 2020a). Regarding the creation of new ICU beds, the MS has already qualified 12 thousand of approximately 12,200 of the beds requested, throughout the country, for the rehabilitation and treatment of clients affected by COVID-19, of which 247 are reserved for pediatric intensive care. There was also an investment with the reinforcement of about 10,300 pulmonary ventilators, distributed by the MS in all states, to help in the care of clients in serious condition. Finally, 241.3 million reais were invested in Personal Protective Equipment (PPE), including aprons, gloves, surgical masks, N-95, gel alcohol, glasses and face shields, for the supply and guarantee of human resources and protection assistance to the multidisciplinary health team, who are acting on the front line in the fight against Coronavirus (BRASIL, 2020b). Before talking about the lethality caused by COVID-19, it is worth emphasizing the concepts and differences involving the terms mortality and lethality. According to the literature, mortality is a relevant health indicator that makes it possible to quantify and assess the health conditions of a given population, it is calculated by dividing the total number of deaths by the number of people in the risk group. Lethality, on the other hand, is defined as the measure of the severity of a given disease, it clearly and objectively exposes the impact that a pathology or health problem can lead to the death of affected individuals, the calculation to determine the lethality rate is made from the division between the number of deaths caused by a pathology by the total number of cases of this disease (GOMES, 2015).

According to WHO data, as of September 14, 2020, the global fatality rate was approximately 3.3%. In Brazil, the rate was higher than the world index, reaching 3.7%, with large variations between regions, depending on the socioeconomic situation of each Brazilian territory, which highlights the need for greater attention to this indicator, so that they are appropriate measures have been taken for the correct management of this pandemic outbreak (BMJ, 2020). Thus, motivated by the purpose of developing a research with a prevalent and impacting theme that encompassed the social, economic, cultural and political aspects of society, and soon after,

sensitized by the chaotic scenario caused by the COVID-19 pandemic, the idea was adopted to carry out this epidemiological study in order to identify the mortality and lethality rates arising from this disease in different regions and states of our country. And yet, collaborate by bringing possible strategic plans to be applied in health services, for the control, prevention and treatment of pandemic diseases, since holistic knowledge about the prevalence of mortality rates, lethality and intensive care coverage can contribute by demonstrating in data quantitative and qualitative characteristics of certain regions that are suffering from high mortality rates due to COVID-19 (BRASIL, 2020c). Given the above, the objective of the research was to compare the mortality and lethality rates of the different regions and states of the federation (UF) with their respective human development indices, socioeconomic levels and with the investments received to fight the disease.

2. REGIONAL MORTALITY BY COVID-19 IN BRAZIL

The frantic spread of the pathology between continents, countries and cities around the world was accelerated due to globalization and the lack of knowledge, until then, about the importance of applying restrictive and preventive measures by the general population (SOUZA, 2020). Only with the targeted and active mobilization by the WHO in monitoring the number of cases and the viral expansion, generated by the human-to-human transmission of COVID-19, with an incubation period of 2 to 14 days, the agency specialized in global health, instituted the first measures to be adopted for the prevention and confrontation of Coronavirus (PAHO, 2020b). While there is still no vaccine available against the virus, the WHO also launched the "Immunization Program in the context of the COVID-19 Pandemic", whose purpose is to direct, encourage and accelerate research in the scientific community for the development and applicability of immunobiologicals . Also in March, some candidate vaccines for Coronavirus entered the clinical study phase, and other studies were in the pre-clinical phase (WHO, 2020a). Concomitant with these advances, health services are facing the unrestrained growth of demand at all levels of health care, due to the mortality and lethality rates caused by the pandemic, and also the indirect mortality generated by diseases that are already preventable and treatable , mainly through vaccination, which have grown noticeably. And in fact, it is something that needs attention, as in the last global pandemic outbreak, due to Ebola, deaths reported by other diseases such as malaria, measles, tuberculosis and HIV, surpassed the death rates due to Ebola, which reveals deficiencies in the health service, in their management and prevention.

In Brazil, on February 3, 2020, Ordinance No. 188 of the MS was created, which brought relevant considerations about the emergency state involving public health, corresponding to the third level of a risk classification, which is due to the new human infection by Sars-CoV-2. The objective of this action was to approve and bring to the knowledge of the entire population the sanitary and administrative measures, to be implemented as soon as possible throughout the country, to combat and prevent the pandemic, even though there are still no reported cases in the country (OLIVEIRA et al., 2020). Days later, precisely on February 26, the MS notified in Brazil the first case of an individual contaminated by COVID-19, in the city of São Paulo and, since then, all states, metropolises and other cities have entered the state of surveillance and alert. Hand hygiene measures, respiratory etiquette and the use of masks by suspicious persons and by the general population were reinforced, the use of homemade masks was established, due to the high demand of the population and the limited supply of surgical masks for all. Even with the adoption of such measures, the disease progressed rapidly, in less than 30 days following, losing the character of imported cases, being defined as community-based transmission (CRODA; GARCIA, 2020). During the month of March, with the community transmission decree, the strategies included clinical, epidemiological and laboratory management, from that month on, suspected cases were analyzed if the person had a history of close or home contact with a person who had been laboratory confirmed for Coronavirus, who presented fever and/or at least one of the clinical manifestations of a respiratory nature, in the last 14 days after contact, and who were unable to conduct specific laboratory investigations (CAVALCANTE et al., 2020; BRAZIL, 2020e).

Some surveys were carried out to observe how the hospital care capacity is found in several countries. As conclusions, it was noted that if measures are not taken to expand the offer of more hospital beds or if measures are not applied to prevent the contamination of the population by the virus, there is a great possibility of saturation of health services in a period relatively short. Also because the hospitalization needs of clients with COVID-19 are associated with modifiable and non-modifiable factors, such as age and existing clinical conditions, which cause different impacts, as the outbreak spreads in each global region (NORONHA et al., 2020). Regarding the total number of ICUs available in Brazil, there were around 29.9 thousand units, of which 14.1 thousand were offered by the HUS and 15.8 thousand were provided by private hospitals. Regarding the 450 Brazilian health microregions, 126 did not have ICUs, neither by the HUS nor by the private services, with the largest percentage of absence of units found in the Northeast region, with about 44%. Another 145 health regions did not have ICUs by HUS, with a higher rate also in the Northeast region, with 45%. And without the presence of private ICUs, 188 health micro-regions were counted, with the highest rate also in the Northeast region, with 42% (MOREIRA, 2020). In another study, the availability and supply of ICU beds in Brazil was found to be present in all Brazilian macro-regions, with the exception of the coastal region of the state of Ceará, which had a nil supply . The two macro-regions that presented positive supply were the west of the state of Amazonas and the state of São Paulo (NORONHA et al., 2020). Regarding the macro-regions with lower ICU supply rates, most were found in the North and Northeast regions. On the other hand, among all the macro-regions that had the highest ICU supply rates were the states of Goiás, Mato Grosso, Mato Grosso do Sul, Paraná, Rio Grande do Sul, São Paulo and Santa Catarina. In the provision of beds in ICUs, it is clear that there is an interdependence between the public and private sectors. Regarding the offer of private ICUs, it was null in 8 macro-regions located especially in the states of the North

region. In 6 macro-regions, the availability of beds in private ICUs corresponded to around 70%, in the states of Ceará, Espírito Santo, Goiás, Mato Grosso, Piauí and Rio de Janeiro (NORONHA et al., 2020).

Therefore, investment for the immediate creation of Campaign Hospitals is necessary, and needs to be directed through strategies and a policy for hiring qualified professionals, essential equipment and materials, to provide adequate and efficient care. It is noted that the expansion of health services was already taking place in many metropolitan regions of the country. Until the month of April, according to the National Register of Health Establishments (CNES), approximately 80 Campaign Hospitals had been cataloged for the care support of patients affected by COVID-19, which resulted in around 6,300 beds (NOGUEIRA et al., 2020). Regarding the investment in the supply of devices for Mechanical Ventilation (MV), in the Brazilian health macro-regions. In 2019, the country had about 57.3 devices, of which 72% were offered by HUS. The average MV between macro-regions is approximately 2 for every 10 thousand/inhabitants , with high distribution throughout the national territory (NORONHA et al., 2020).

As observed, the lowest indices were seen in the coastal macro-region of Ceará, with an offer of approximately 0.07 MV for every 10,000/inhabitants, being also the only macro-region that did not have ICU beds. On the other hand, the macro-regions with an offer lower than 0.5 MV for every 10 thousand/inhabitants were the same ones that sometimes did not have public ICUs, sometimes did not have private ICUs, being insufficient to meet the regional demand. The states that presented the largest offer of MV by HUS were Espírito Santo, Florianópolis and Mato Grosso. Regarding the offer of VM in the private network, this ranges from 0 to about 55%, being higher in Mato Grosso, Rio de Janeiro and São Paulo (NORONHA et al., 2020).

3. MATERIALS AND METHODS

A documentary, retrospective, statistical and descriptive research was carried out through the collection and correlation of data available on the official websites of the Ministry of Health, the State Health Departments, the Department of Informatics of the Brazilian Unified Health System (DATASUS) and the Coronavirus Panel (https://covid.saude.gov.br/), in order to tabulate the data made available between the months of April 2020 and January 2021. Through the results obtained from the analysis, we sought to verify the causes that denote the discrepancy and variation in mortality and lethality rates by COVID-19 in the State of Tocantins. The sample included the number of confirmed, recovered, follow-up cases and the deaths of individuals affected by COVID-19, in the State of Tocantins, between April 2020 and January 2021. All data that were incomplete were excluded from the sample. or inconsistent, or in any way impair the statistical analysis of the survey. First, data were collected on confirmed cases of COVID-19, the total number of beds, the number of beds provided by the HUS, the number of private beds in Tocantins, in order to calculate the mortality and lethality rates between April of 2020 and January 2021, available on DATASUS, Coronavirus Panel and on the portal of the State Department of Health of the State of Tocantins. On the DATASUS website, the total number of beds, the beds provided by the HUS and the private ones in Tocantins were collected. On the SESAU website, confirmed cases and deaths were collected, based on this information, lethality values were calculated, in order to correlate and attribute to the tabulated values. Data were compared and correlated to assess the discrepancy between lethality rates between the months observed. Being tabulated in a Microsoft Excel spreadsheet, so that statistical analyses, graphs and tables could be developed. The correlation of the collected data was analyzed using Pearson's coefficient in order to assess the degree of linear association and using the Chi-square test for parametric and non-parametric variables. Values were shown through tables and graphs generated by STATA®, considering the significance level of $p<0.05$ or 5%.

4. RESULTS AND DISCUSSION

Data available at DATASUS and at SESAU of the State of Tocantins, between the months of April 2020 and January 2021, were evaluated on: the total number of beds available for cases of COVID-19; the number of beds available through HUS; number of private beds; mortality rate; numbers of confirmed cases; and lethality rate in the corresponding period. With this information, correlations of significance levels between these variables were performed (Table 1).

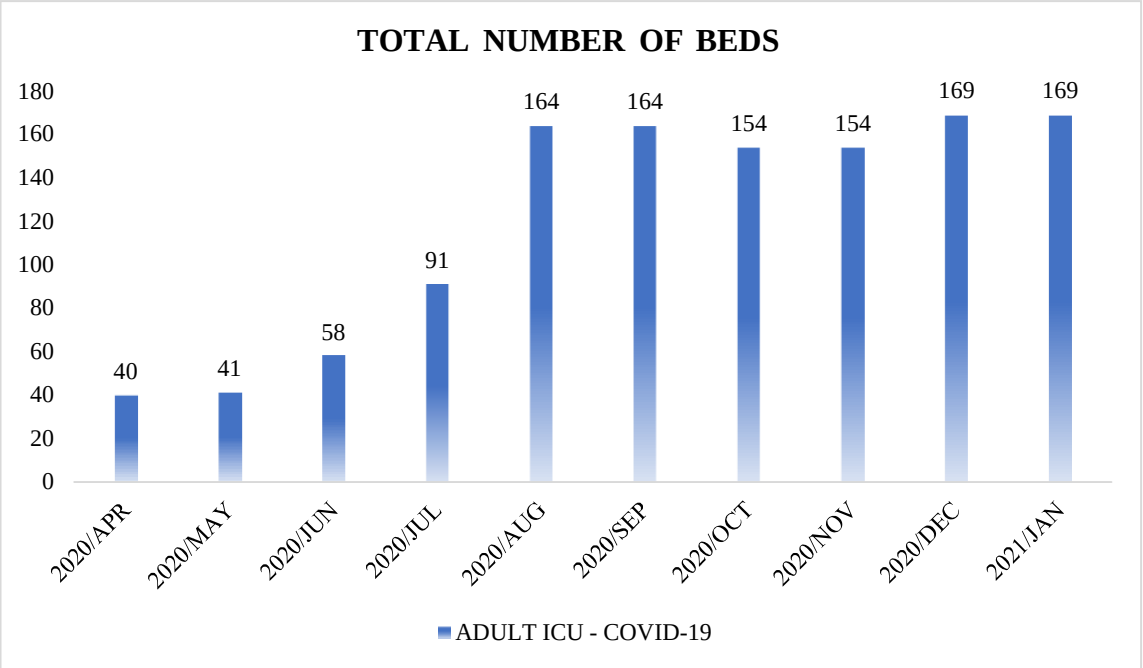
Table 1: Correlations and Significance Level of the variables.

Correlations and Significance Level	Total number of beds	Number of public beds	Number of private beds	Mortality	Confirmed cases	Lethality
Total number of beds	1	0,735	0,830	0,558	0,684	-0,524
Number of public beds	0,735	1	0,234	0,561	0,727	-0,374
Number of private beds	0,830	0,234	1	0,341	0,384	-0,444
Mortality	0,558	0,561	0,341	1	0,955	0,156

Confirmed cases	0,684	0,727	0,384	0,955	1	-0,097
Lethality	-0,524	-0,374	-0,444	0,156	-0,097	1

Through the tabulation of these data, it was possible to observe the relationship between the analyzed variables. The first one, between the positive correlation of mortality data and confirmed cases, which resulted in 0.955, revealing that the more cases were confirmed, the greater the data referring to mortality in the period. In the correlation between the total number of beds and the mortality rate, it showed a positive result equivalent to 0.558, something surprising, as it was expected that with a greater availability of beds, there would be a drop in mortality rates, however, which what was observed was a positive relationship in which even with a greater number of beds available, there was no reduction in mortality rates. This is justified by the positive relationship that occurred between the total number of available beds and the number of confirmed cases in the period, which was equivalent to 0.684, demonstrating that the supply of beds may have increased due to the increase in the number of cases, which consequently also increased the mortality rate. On the other hand, between the ratio of total number of beds and the lethality rate, this resul ted in a negative correlation of -0.524, meaning that with the increase in the availability of beds, there was a reduction in the lethality rate during the period evaluated. A negative correlation was also observed between the lethality variables and the confirmed cases, which corresponded to -0.097, demonstrating that with the increase in confirmed cases, there was a decrease in lethality. However, in the correlation between mortality and lethality data, this resulted in positive, revealing the growth of both data, which resulted in 0.156. The results found show that between the period from April 2020 to January 2021, in the state of Tocantins, the total number of beds in the Adult ICU dedicated to the hospitalization of patients with COVID-19 had a higher number of beds in the months of December and January, both 169 beds; followed by the months of August and September, both 164 beds; and October and November, both 154 beds, as described below (Graph 1).

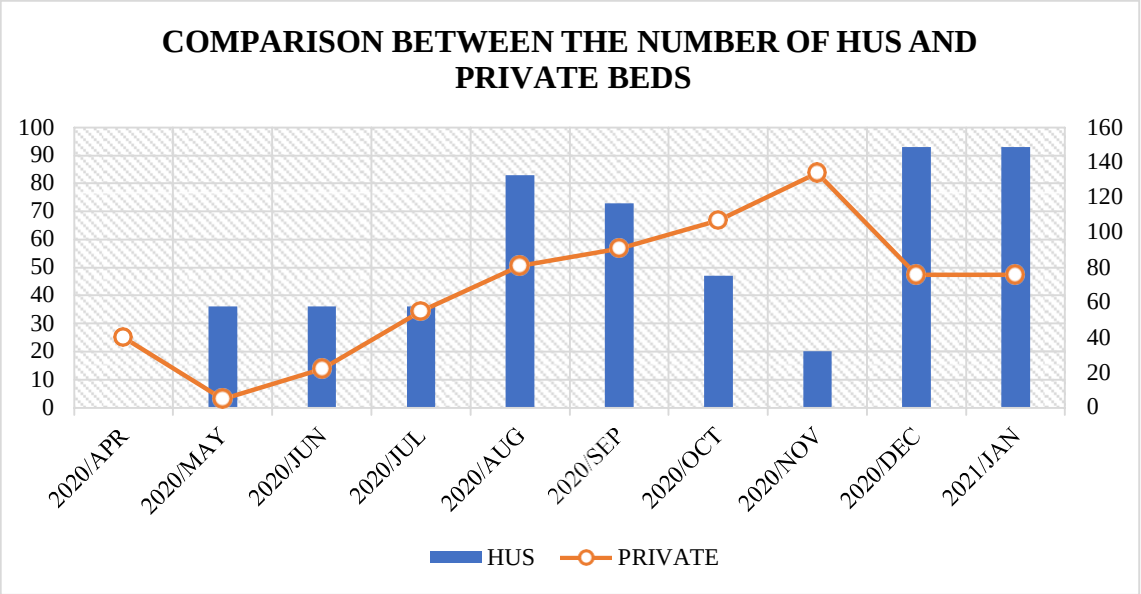
Graph 1: Total Number of Adult ICU Beds for COVID-19, from April 2020 to January 2021, in the state of Tocantins.



Source: DATASUS, 2021.

Comparing the beds provided by HUS and the private network, it is noted that in the months of May, June, August, December and January the largest number of beds offered were from the HUS network; however, in April, July, September, October and November, the largest number of beds was provided by the private network. In a few months, there was a great discrepancy in terms of the offer of beds in both services. In April 2020, no data were found on HUS beds in the state, and a total of 40 were offered by the private network. In May, there was an important difference in the availability of beds by HUS (n=36) and by the private network (n=5). On the other hand, the private network in October (n= 107) and November (n= 134) provided a much larger number of beds, compared to SUS, which in the same months provided only 47 and 20, respectively (Graph 2) .

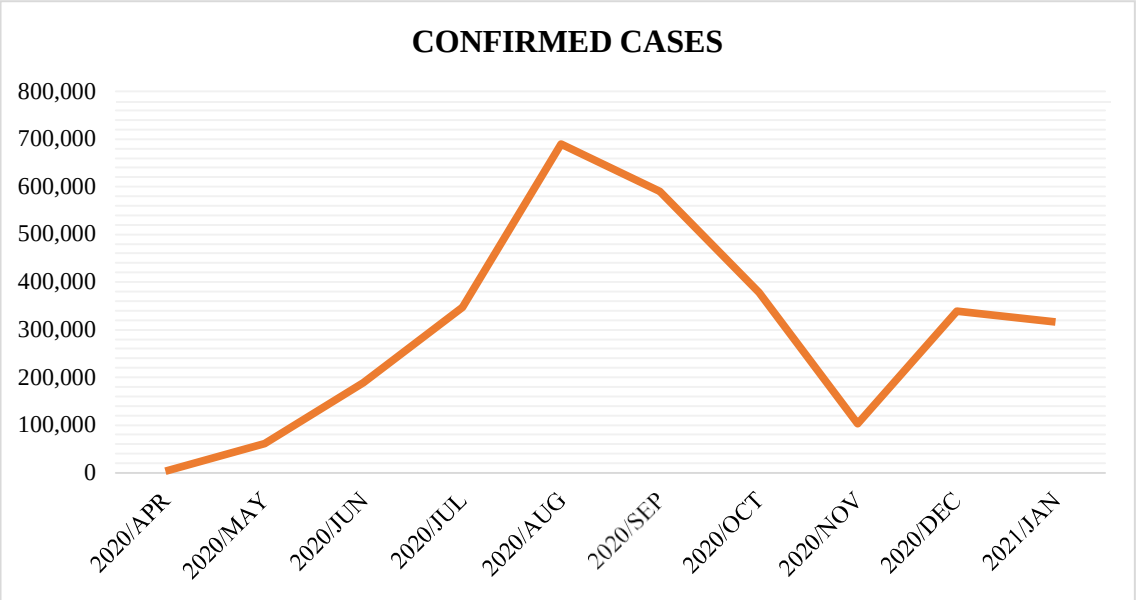
Graph 2: Comparison between the number of beds provided by HUS and the private network, between April 2020 and January 2021, in the state of Tocantins.



Source: DATASUS, 2021.

As for the cases confirmed by COVID-19, between the months of April and January, in the state of Tocantins, there was a constant growth in the number of confirmed cases, reaching within this period the highest peak in the month of August, with 689,916 cases, then presented a decrease in the number of cases between September (590,864 cases), October (377,766) and November (102,781), rising again in the month of December (339,181) (Graph 3).

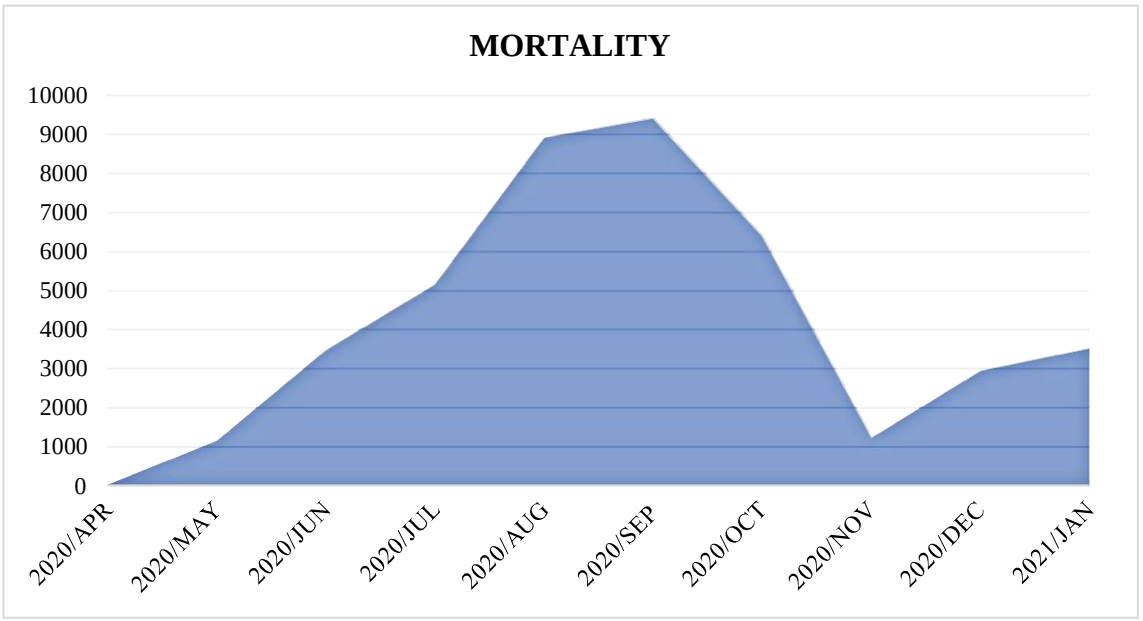
Graph 3: Cases Confirmed by COVID-19, between April 2020 and January 2021.



Source: Tocantins State Health Department, 2021

Regarding mortality rates during the interval between April 2020 and January 2021, in the state of Tocantins, it presented it s highest rates in the months of September (9,404 deaths), August (8,914 deaths) and in October (6,406 deaths) (Graph 4).

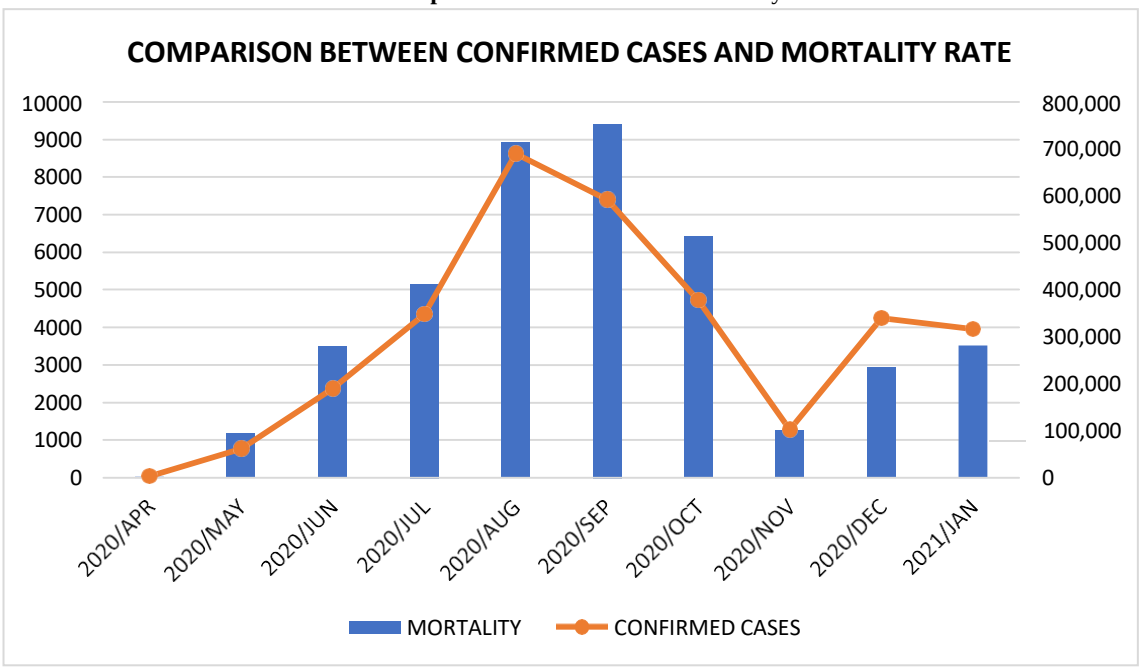
Graph 4: Mortality by COVID-19, between April 2020 and January 2021.



Source: Tocantins State Health Department, 2021.

Making a comparison between the confirmed cases and the mortality rate, during the corresponding period, it is observed that in the months of August and September, where the highest rate of confirmed cases occurred, respectively 689,916 and 590, 864, it was also in these same months that the higher mortality data, corresponding to 8,914 and 9,404.

Graph 5: Confirmed cases and mortality rate



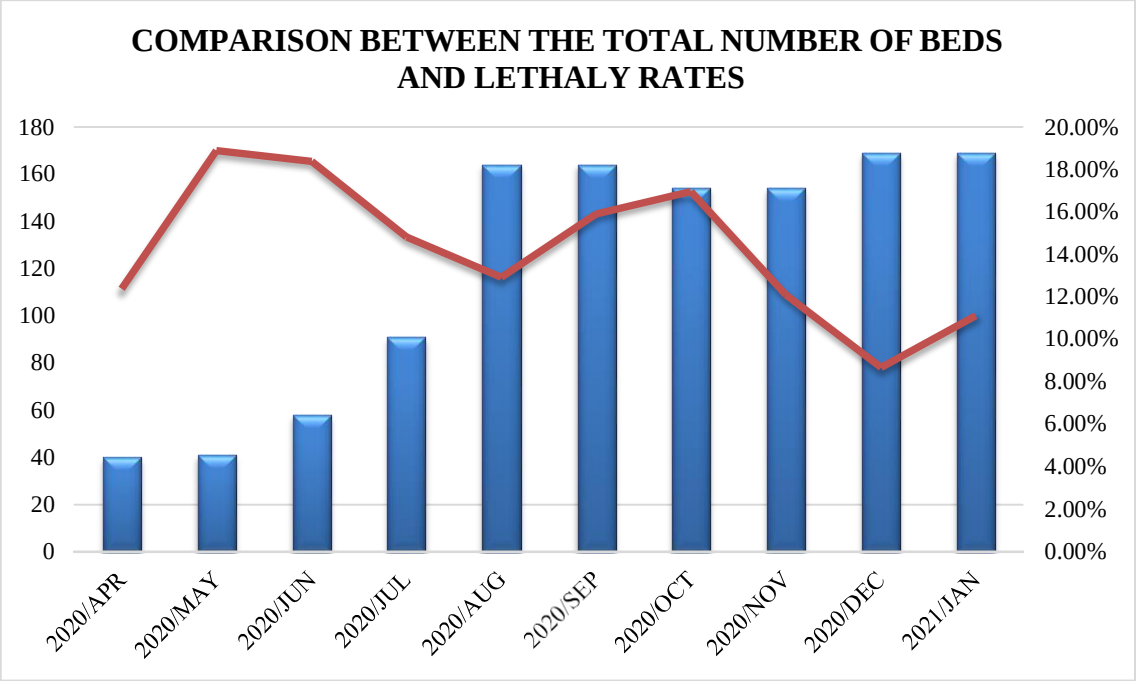
In view of the confirmed cases in the corresponding period, in the state of Tocantins, and the mortality rate, the relationship between these two variables through the lethality rate is presented below (Graph 6). The months with the highest rates, in this case, were May (18.88%), June (18.39%) and October (16.96%).

Graph 6: Lethality by COVID-19, between April 2020 and January 2021.

Source: Tocantins State Health Department, 2021

Comparing the variables total number of beds in the Adult ICU and the Lethality Rates, in the delimited period, in the state of Tocantins, it was observed that in December, one of the months with the greatest availability of beds, the lethality rate was the lowest recorded in the period, showing that when there were more beds available, the lower was the registered mortality rate. In May, when HUS and private beds were made available (n=41), one of the months with the lowest number of available beds, it was also the month with the highest mortality rate (18.88%).

Graph 7: Comparison between the Total Amount of Adult ICU Beds for COVID-19, between April 2020 and January 2021 in the state of Tocantins, and the Lethality Rates.



Source: Tocantins State Health Department, 2021

5. CONCLUSION

It was observed that in the first year of the COVID-19 pandemic, there were discrepancies between the availability of beds and the number of cases, that there is a direct relationship between the spread of the disease and its mortality, and that the availability of beds tends to to reduce lethality. Other studies should be carried out based on the months following this study for further conclusions about public health policies.

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