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# Hospitalizations for respiratory diseases in Mato Grosso do Sul and relationships with age and climate

## *Internações por doenças respiratórias no Mato Grosso do Sul e relações com idade e clima*

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## ABSTRACT

*Background:* Hospitalizations due to respiratory diseases are one of Brazil's main causes of hospitalization worldwide. Environmental conditions can influence the occurrence of respiratory diseases, increasing morbidity rates and the demand for health services. *Objective:* This study aims to analyze hospitalizations for respiratory diseases in the five most populous municipalities in the state of Mato Grosso do Sul from 2013 to 2021 among populations according to their self-declaration. *Method:* The study adopts a quantitative approach, using data collected from the open databases, considering the climatic variable of average temperature to understand the trends of respiratory diseases in these regions. *Results:* Whites are the majority in the municipalities, except for Corumbá, where pardos are larger. As for hospitalizations for respiratory diseases, there was a difference between pardos in the municipalities of Campo Grande, Três Lagoas and Corumbá. In Dourados and Ponta Porã, indigenous people are the most affected. *Conclusion:* It was observed that whites are the majority, except in Corumbá, where the number of pardos is more significant. Hospitalization rates varied according to each municipality's self-declaration option and age groups. It was observed that indigenous people have higher percentages of hospitalizations, especially among children aged 0 to 5 years.

**Palavras-chave**: Respiratory diseases, self-declaration, temperature.

## RESUMO

Introdução: As internações por doenças respiratórias são uma das principais causas de internação no Brasil no mundo. As condições ambientais podem influenciar na ocorrência de doenças respiratórias, aumentando as taxas de morbidade e a demanda por serviços de saúde. Objetivo: Este estudo tem como objetivo analisar as internações por doenças respiratórias nos cinco municípios mais populosos do estado de Mato Grosso do Sul no período de 2013 a 2021 entre as populações segundo sua autodeclaração. Método: O estudo adota uma abordagem quantitativa, usando dados coletados em bancos de dados abertos, considerando a variável climática de temperatura média para entender as tendências de doenças respiratórias nessas regiões. Resultados: Os brancos são maioria nos municípios, exceto em Corumbá, onde os pardos são maiores. Quanto às internações por doenças respiratórias, houve diferença entre os pardos dos municípios de Campo Grande, Três Lagoas e Corumbá. Em Dourados e Ponta Porã, os indígenas são os mais afetados. Conclusão: Observou-se que os brancos são a maioria, exceto em Corumbá, onde o número de pardos é mais significativo. As taxas de internação variaram conforme a opção de autodeclaração de cada município e as faixas etárias. Observou-se que os indígenas apresentam maiores percentuais de internações, principalmente entre as crianças de 0 a 5 anos.

**Keywords**: Doenças respiratórias, auto-decaração, temperatura.

## 1. INTRODUCTION

Environmental conditions can play an essential role in the occurrence of respiratory diseases, increasing morbidity rates and the demand for health services. Among the environmental variables that affect respiratory health, meteorological conditions stand out, including temperature, relative humidity, rainfall and wind speed, among others (CACHO *et al.*, 2020; JAVADINEJAD; DARA; JAFARY, 2020; STEPHENS; CHERNYAVSKIY; BRUNS, 2021; XAVIER *et al.*, 2019). Low temperatures have been associated with several causes of death, including cerebrovascular diseases, diabetes mellitus, ischemic heart disease and respiratory system diseases (RODRIGUES, 2023).

Air pollution is a known risk factor for cardiovascular, respiratory and neurological diseases (DANESH YAZDI *et al.*, 2021; MARCHETTI *et al.*, 2023; WANG *et al.*, 2023; WARD-CAVINESS *et al.*, 2021). Wang (2023) points out domestic air pollution can also pose a significant environmental risk to respiratory health. However, few studies explore this association with the decline in lung function and respiratory diseases. The association between prolonged exposure to air pollution causes an increased risk of rhinitis, a chronic respiratory disease with a higher prevalence in the general population (MARCHETTI *et al.*, 2023). Increased levels of air pollution are associated with increased mortality rates from respiratory and general illnesses and a higher prevalence of respiratory diseases, including asthma, lung cancer and COVID-19 infections (DANESH YAZDI *et al.*, 2023).

Among hospitalizations for respiratory diseases, pneumonia is the main cause of hospitalization in Brazil and worldwide (BERRA *et al.*, 2020; PERISELNERIS; BROWN; JOSÉ, 2020). Pneumonia is an acute respiratory infection that affects the lung alveoli and can be caused by viruses or bacteria. Despite advances in treatment, pneumonia still represents a significant public health burden. The main types of pneumonia are viral, caused by a virus that settles in the lungs, and bacterial, which can be caused by bacteria inhaled or present in parts of the body, such as the throat, mouth, nose and digestive system (BERRA *et al.*, 2020; PERISELNERIS; BROWN; JOSÉ, 2020).

In addition to the respiratory diseases that have affected several people in recent decades, the year 2020 was highlighted by the COVID-19 pandemic, considered the most severe respiratory virus since the H1N1 influenza pandemic of 1918 (FERGUSON *et al.*, 2020). COVID-19 is a highly transmissible viral infection caused by Severe Acute

Respiratory Syndrome (SARS-CoV-2), which has adversely impacted global health systems and all aspects of humans (NICOLA *et al.*, 2020; SHEREEN *et al.*, 2020).

This study aims to analyze hospitalizations due to respiratory diseases in the five most populous municipalities in Mato Grosso do Sul (MS) from 2013 to 2021. The climatic variable of average temperature will be considered, as well as other environmental conditions, better to understand trends in respiratory disease in these regions. The proposal aims to improve the understanding of the trends of these diseases in these regions and provide information that can contribute to public health.

## 2. MATERIALS AND METHODS

The study in question adopts a qualitative and quantitative approach, using data collected on hospitalizations for respiratory diseases and average temperature between the years 2013 to 2021 from the DATASUS and INMET databases (DATASUS, 2022; INMET, 2022). In order to obtain information on hospitalizations due to respiratory diseases, the Hospitalization Authorizations (AIH) of patients of all age groups residing in the study area, who were hospitalized for respiratory diseases between 2013 and 2021, were used. Hospitalizations were analyzed according to the International Classification of Diseases (ICD-10), between ICD J00 and J99, which include diseases such as nasopharyngitis, sinusitis, influenza, pneumonia, bronchitis, rhinitis, laryngitis, among others (INMET, 2022).

Temperature information was collected from the National Institute of Meteorology (INMET) database. In the case of null information, records from NASA The Power Project were used as complementary support (NASA, 2021). This gap-filling method has already been used in other studies, such as in a study on the performance of gap-filling methods about evapotranspiration data for the western region of Paraná (GIOVANELLA et al., 2021) and to estimate daily data of solar radiation for the mainland United States (WHITE et al., 2011).

The five most populous municipalities in Mato Grosso do Sul, which had a meteorological station, were selected as study sites: Campo Grande (20°28′53″S, 54°36′58″W) with a population density of 97.22 inhab/ km², Dourados (22°13′15″S, 54°48′21″W) with a population density of 47.97hab/km², Corumbá (19°0′32″S,57°39′10″W) with density population density of 1.60hab/km², Três Lagoas (20°45′4″S, 51°40′42″W) with a population density of 22.43hab/km² and Ponta Porã (22°32′9″S, 55° 43′33″W) with a population density of 14.61 inhabitants/km² (IBGE, 2010).

The analysis of the results was performed using Excel 365® and R software. The calculation of hospitalization rates for respiratory diseases used the population of each municipality in the base year of 2021 and the equation (Eq. 1), as shown below:

$$Index = \frac{JoinHospitalizationsX}{PopulationX} \quad \text{(Eq. 1)}$$

Where:

*X:* variable that represents people who declare themselves: white, black, brown, white, yellow and indigenous.

*JoinHospitalizations:* total number of hospitalizations due to respiratory diseases for the set chosen in variable X.

*Population:* the total population of the chosen set, in variable X, in the base year of 2021.

*Index:* index of hospitalizations due to respiratory diseases for the group of people chosen in variable X. Result of the total number of hospitalizations due to respiratory diseases for the group of people, divided by the total population of the group of people in the municipality.

## 3. RESULTS AND DISCUSSION

Based on IBGE data, it is possible to observe in Figure 1 the population percentages obtained through self-declaration in the municipalities studied (IBGE, 2010). White people are generally the majority in the municipalities, except Corumbá, where brown people are superior to white people. Next, we have brown people, followed by black people in the third position.

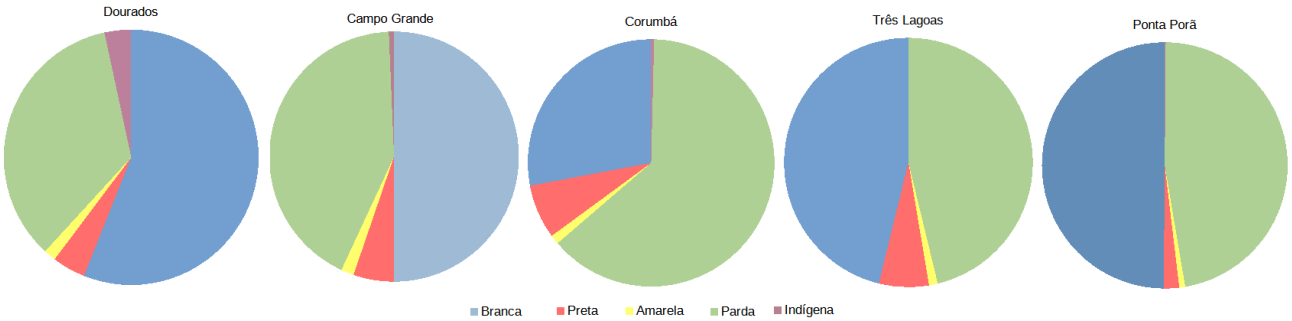


**Figure 1:** Percentages of the self-declared white, black, brown, yellow and indigenous population in the municipalities studied.

Yellow people have similar percentages in all municipalities. On the other hand, indigenous people are more expressive in Dourados, followed by Campo Grande and Corumbá. In fourth place, we have Ponta Porã, followed by Três Lagoas. Except for

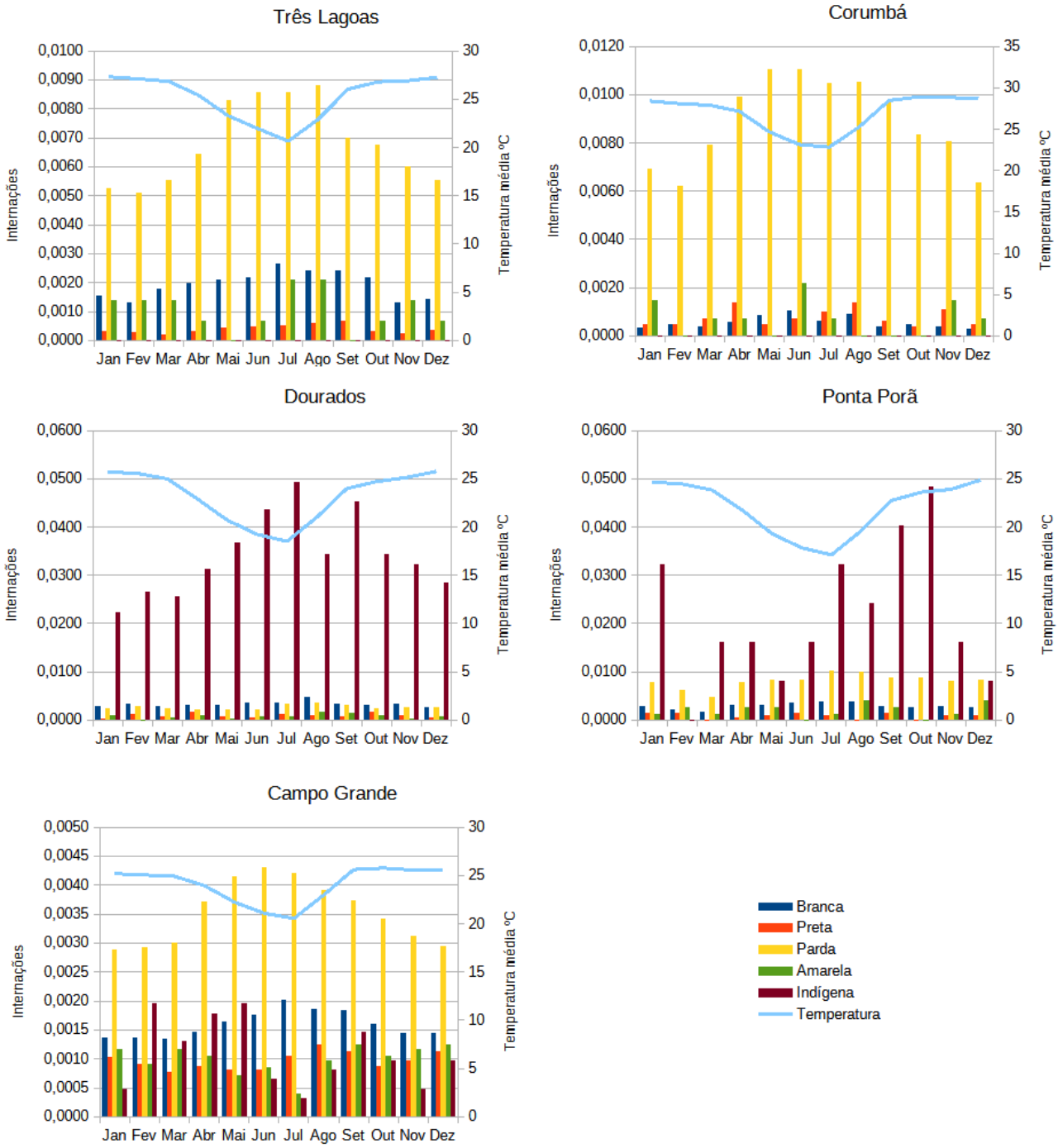


**Figure 2:** Index of hospitalizations for respiratory diseases between the years 2013 to 2021 separated by population group that self-declared: white, black, brown, yellow and indigenous. The blue line represents the average monthly temperature during the period.

Dourados, the percentages of indigenous people in Campo Grande, Corumbá, Três Lagoas and Ponta Porã are smaller, below 1%.

Figure 2 shows the average hospitalization rates of people who declared themselves white, brown, black, yellow and indigenous and the average monthly temperature between the years 2013 to 2021. The average monthly temperatures were observed to follow a similar pattern in the municipalities studied. The months between September and March had the highest temperatures, while the lowest temperatures marked the months between April and August.

The municipality of Ponta Porã had the lowest monthly averages, varying between 17.1 ºC minimum and 28.8 ºC maximum (Figure 2). This pattern can be influenced by the geographical position of the municipality, which is located further south in Mato Grosso do Sul. In Corumbá, located in the state's western region and with land in the Pantanal biome, the highest monthly temperatures were recorded, with a variation between 22.8 ºC minimum and 28.9 ºC maximum.

When analyzing the annual temperature averages, it was found that in all the municipalities studied, 2016 and 2020 had the lowest temperatures. This slight drop may be related to the La Niña phenomenon, which is part of an oceanic, atmospheric phenomenon in the Equatorial Pacific Ocean. This change in the temperature of the Equatorial Pacific Ocean could affect temperatures and precipitation globally (CPTEC/INPE, 2023).

As of March 2020, the World Health Organization (WHO) has declared a COVID-19 pandemic (LOTFI; REZAEI, 2020). This fact may have contributed to reduced hospitalizations for respiratory diseases during this period. The COVID-19 pandemic has been associated with changes in respiratory virus infections worldwide, which differed across virus types. Reductions in respiratory virus infections, including influenza and respiratory syncytial, were most notable early in the COVID-19 pandemic and continued to varying degrees during subsequent waves of SARS-CoV-2 infections (CHOW; UYEKI; CHU, 2023). In addition, some studies investigate whether climate variables and high concentrations of air pollution can influence cases of COVID-19. These studies indicate that climatic factors such as temperature, humidity and altitude correlate with SARS-CoV-2 activity (CACHO *et al.*, 2020; LIN *et al.*, 2020; STEPHENS; CHERNYAVSKIY; BRUNS, 2021).

Regarding hospitalizations for respiratory diseases, it was found that there was a difference between brown people in the municipalities of Campo Grande, Três Lagoas and Corumbá. In Campo Grande, the white population ranks second in terms of hospitalizations. In Três Lagoas, the black population is the second most affected, while in Corumbá, this second place is occupied by yellow people (Figure 2).

In Dourados and Ponta Porã, indigenous people are the most affected by respiratory diseases, while brown people rank second in both municipalities (Figure 2). It is worth mentioning that, despite the distance of 100 km between them, Dourados and Ponta Porã show similar patterns in terms of hospitalizations for respiratory diseases by people who declared themselves white, black, brown, yellow and indigenous, in addition to being located in the southernmost portion of the state.

Another issue observed is to the values of the indices of the group of people who were in the first place. There was a difference of approximately 0.044 between the highest values of indigenous people and those of brown people. This indicates that the rates of hospitalizations among the indigenous people of Dourados and Ponta Porã are considerably higher than the rates of the largest hospitalizations for brown people in the municipalities of Corumbá, Campo Grande and Três Lagoas (Figure 2).

In all the municipalities studied, the rates of respiratory disease hospitalizations were higher from April to August, corresponding to the lower average temperatures (Figure 2). However, there was an exception in Dourados in August, where hospitalizations for indigenous people were lower compared to September. Environmental factors, such as temperature, relative humidity, rainfall, atmospheric pressure and wind speed, influence the manifestation of morbidities, especially respiratory diseases (XAVIER *et al.*, 2019).

Other studies also point out that climatic variables influence the increase in cases of pneumonia. Some studies report that dry air due to low precipitation increases the incidences of pneumonia, while the temperature during periods of the day can increase morbidities (GALVÃO; FERONI; SILVEIRA, 2020; SOUZA; SANTOS, 2020). Furthermore, a study showed a positive correlation between wind and the increase in pneumonia due to the dispersion of pollutants and particulate matter (XAVIER *et al.*, 2019). The meteorological wind variable was investigated for biological materials associated with airborne dust. Results drive research into the spatiotemporal distribution of airborne microbes and their implications for overall health (AL SALAMEEN *et al.*, 2020).

When analyzing hospitalizations by age group in the municipalities studied, we observed that the highest rates of hospitalizations occur among children aged 0 to 5 years and older adults over 70 in many municipalities. However, there are differences when analyzing the level of a group of self-declared people. In percentage terms, the age groups with the highest rates of hospitalizations vary significantly between the municipalities studied. For example, children aged 0 to 5 years represent 1.2% of total admissions in Campo Grande, 5.1% in Dourados, 9.6% in Três Lagoas, 12.6% in Corumbá and 15.6% in Ponta Porã. Older adults over 70 represent 2.4% of total hospitalizations in Campo Grande, 12.5% in Dourados, 16.8% in Três Lagoas, 25.4% in Corumbá and 26.6% in Ponta Porã (Table 1).

**Table 1.** Percentages of hospitalizations for respiratory diseases in relation to the total population of the municipalities, grouped by age groups.

| Age group | Campo Grande (%) | Dourados (%) | Corumbá (%) | Ponta Porã (%) | Três Lagoas (%) |
|---|---|---|---|---|---|
| 0 to 5 | 1,3 | 5,1 | 12,6 | 15,6 | 9,6 |
| 6 to 10 | 1,2 | 5,7 | 12,5 | 15,9 | 9,7 |
| 11 to 20 | 1,2 | 25,4 | 12,9 | 15,0 | 9,3 |
| 21 to 30 | 1,2 | 5,4 | 121,5 | 15,6 | 9,4 |
| 31 to 40 | 1,3 | 5,6 | 13,1 | 154,5 | 9,6 |
| 41 to 50 | 1,2 | 5,8 | 13,3 | 14,0 | 99,7 |
| 51 to 60 | 7,5 | 6,0 | 13,0 | 14,1 | 9,0 |
| 61 to 70 | 1,2 | 6,3 | 13,2 | 13,6 | 9,1 |
| 71 to 80 | 1,2 | 6,2 | 12,7 | 13,3 | 8,3 |
| Over 80 | 1,2 | 6,1 | 12,8 | 13,2 | 8,5 |

In Campo Grande, the highest rates of hospitalizations by age group among white and brown people are similar to the general behavior of the municipality. In contrast, for yellow and black people, the highest hospitalizations occur mainly in the population over 31 years of age. The percentages of hospitalizations in Campo Grande for children aged 0 to 5 years among whites and browns are 8% and 7%, respectively. Black and yellow people have the highest percentages of hospitalizations in the 21 to 30-year-olds, with 18% for blacks and 17% for yellows, and 16% for blacks and 14% for yellows in the 31 to 40 years old range (Table 2).

On the other hand, in Três Lagoas and Corumbá, there were no hospitalizations for indigenous people during the period studied (Figure 3). For black people, the highest rates of hospitalizations occurred mainly from the age of 51. In contrast, white and brown people had higher hospitalizations among children aged 0 to 5 years and elderly people over 71

years. In percentage terms, in Três Lagoas, the age group with the highest number of hospitalizations among black people was 21 to 30 years old, with 17% with the total population of black people in the municipality with this age group (Table 2). And in Corumbá, the age group from 21 to 30 years had the highest percentage of hospitalizations, with 18%.

**Table 2.** Percentages of hospitalizations for respiratory diseases in municipalities of Mato Grosso do Sul, grouped by age group, in relation to the sets of self-declared population of municipalities.

| Age group | White (%) | Black (%) | Yellow (%) | Brown (%) | Indigenous (%) |
|---|---|---|---|---|---|
| | | | **Campo Grande** | | |
| 0 to 5 | 8,2 | 4,2 | 5,0 | 7,0 | 9,1 |
| 6 to 10 | 6,2 | 4,8 | 5,1 | 6,8 | 6,5 |
| 11 to 20 | 14,0 | 14,1 | 13,4 | 16,1 | 17,1 |
| 21 to 30 | 16,1 | 18,5 | 16,5 | 15,7 | 18,7 |
| 31 to 40 | 13,3 | 16,2 | 13,6 | 13,7 | 15,2 |
| 41 to 50 | 11,7 | 13,6 | 12,7 | 10,9 | 12,4 |
| 51 to 60 | 8,6 | 8,8 | 10,3 | 7,3 | 8,0 |
| 61 to 70 | 4,9 | 4,5 | 7,6 | 4,0 | 5,6 |
| 71 to 80 | 2,7 | 2,3 | 4,8 | 1,9 | 2,5 |
| Over 80 | 1,2 | 0,9 | 1,9 | 0,7 | 1,0 |
| | | | **Dourados** | | |
| 0 to 5 | 8,5 | 3,5 | 5,1 | 7,1 | 16,0 |
| 6 to 10 | 6,6 | 4,3 | 4,0 | 7,1 | 13,9 |
| 11 to 20 | 14,6 | 13,2 | 11,1 | 16,9 | 22,1 |
| 21 to 30 | 16,1 | 16,2 | 13,5 | 16,5 | 14,5 |
| 31 to 40 | 12,9 | 15,2 | 12,5 | 14,0 | 9,7 |
| 41 to 50 | 11,4 | 12,7 | 11,4 | 11,4 | 5,3 |
| 51 to 60 | 7,9 | 8,1 | 8,9 | 7,7 | 3,7 |
| 61 to 70 | 4,4 | 4,6 | 8,6 | 3,8 | 2,1 |
| 71 to 80 | 2,3 | 2,0 | 4,9 | 2,0 | 0,8 |
| Over 80 | 0,9 | 0,9 | 2,0 | 0,7 | 0,6 |
| | | | **Corumbá** | | |
| 0 to 5 | 11,5 | 4,8 | 7,9 | 9,0 | 7,7 |
| 6 to 10 | 8,9 | 5,7 | 10,0 | 9,0 | 8,9 |
| 11 to 20 | 16,8 | 16,2 | 15,0 | 18,8 | 22,0 |
| 21 to 30 | 16,1 | 18,0 | 16,1 | 15,9 | 15,9 |
| 31 to 40 | 13,4 | 16,2 | 14,6 | 12,8 | 13,8 |
| 41 to 50 | 11,4 | 12,5 | 11,1 | 10,7 | 9,6 |
| 51 to 60 | 7,6 | 9,0 | 6,6 | 7,4 | 5,8 |
| 61 to 70 | 5,3 | 5,1 | 4,4 | 4,3 | 5,4 |
| 71 to 80 | 2,7 | 2,5 | 2,3 | 2,1 | 2,6 |
| Over 80 | 1,3 | 1,1 | 0,7 | 0,7 | 1,4 |
| | | | **Ponta Porã** | | |
| 0 to 5 | 10,1 | 3,4 | 4,7 | 8,0 | 31,5 |

| | | | | | |
|---|---|---|---|---|---|
| 6 to 10 | 7,8 | 4,8 | 5,5 | 8,2 | 21,0 |
| 11 to 20 | 15,4 | 15,8 | 15,1 | 17,3 | 33,1 |
| 21 to 30 | 14,2 | 18,6 | 14,4 | 13,4 | 23,4 |
| 31 to 40 | 11,7 | 17,0 | 12,7 | 11,5 | 18,5 |
| 41 to 50 | 9,8 | 14,4 | 11,4 | 9,1 | 11,3 |
| 51 to 60 | 6,9 | 9,7 | 10,8 | 6,0 | 8,1 |
| 61 to 70 | 4,1 | 6,2 | 7,4 | 3,4 | 8,1 |
| 71 to 80 | 2,2 | 2,5 | 3,6 | 1,7 | 3,2 |
| Over 80 | 1,0 | 1,0 | 1,3 | 0,7 | 2,4 |
| **Três Lagoas** | | | | | |
| 0 to 5 | 8,4 | 3,1 | 5,9 | 6,9 | 14,0 |
| 6 to 10 | 6,1 | 3,7 | 6,3 | 6,7 | 18,0 |
| 11 to 20 | 13,2 | 12,0 | 11,9 | 15,1 | 26,0 |
| 21 to 30 | 15,4 | 17,0 | 15,8 | 15,2 | 62,0 |
| 31 to 40 | 12,7 | 14,3 | 16,7 | 12,3 | 48,0 |
| 41 to 50 | 11,1 | 11,8 | 11,2 | 9,9 | 48,0 |
| 51 to 60 | 8,0 | 8,7 | 8,2 | 6,9 | 42,0 |
| 61 to 70 | 4,7 | 4,9 | 7,6 | 3,7 | 20,0 |
| 71 to 80 | 2,7 | 2,7 | 3,2 | 1,9 | 16,0 |
| Over 80 | 1,0 | 0,9 | 1,8 | 0,6 | 6,0 |

In the municipality of Dourados, there is a similarity in hospitalization rates between people who declare themselves white and brown and between yellow and black people. However, indigenous people stand out for having high rates of hospitalizations, especially among children aged 0 to 5 years (Figure 3). In percentage terms, indigenous children from 0 to 5 years old represent 16% of the total indigenous population of the municipality. In Ponta Porã, indigenous people had the highest rates of hospitalizations, with the age group from 0 to 5 years showing the highest rates (Figure 3). In percentage terms, these indexes represent 31% of the municipality's indigenous population (Table 2). These indices are much higher than other sets of people who self-declared white, who presented, on average, an index of 0.0065 for the same age group. Hospitalizations occurred similarly for almost all age groups in this population group, except for the 51 to 60 and 61 to 70 age groups.

Research indicates that there is a profile of precarious conditions of basic sanitation infrastructure in indigenous households, especially in urban areas, evidencing the vulnerability of these populations compared to other populations. In addition, the health of the indigenous population is worse than that of the general population (FERREIRA; MATSUO; SOUZA, 2011; RAUPP *et al.*, 2017; SOUSA; SCATENA; SANTOS, 2007).

Studies indicate that some diseases have higher rates among indigenous peoples than others. Pneumococcal infection caused by Streptococcus has been the subject of study in Alberta, Canada, due to the constant increase in these cases and the various diseases they can cause, such as pharyngitis, skin infections, pneumonia, septic arthritis, rheumatic fever, rheumatic heart disease, severe invasive diseases, among others. The epidemiology of these diseases varies by region, and previous studies have shown that rates of illnesses caused by Streptococcus are higher in indigenous populations than in other populations (TYRRELL *et al.*, 2021).

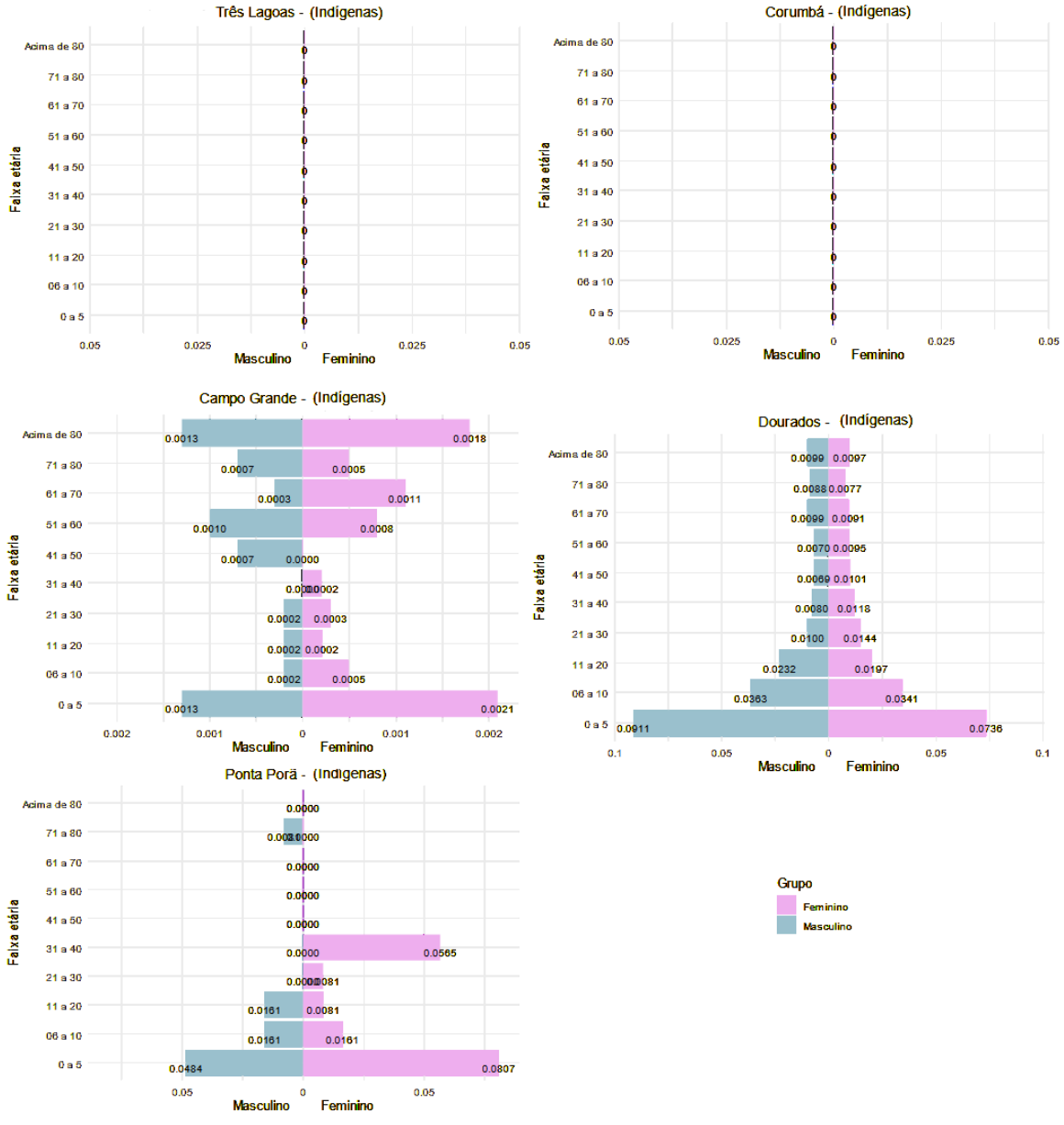


**Figure 3:** Age pyramid by hospitalization rates among Indigenous people.

## 4. FINAL CONSIDERATIONS

This study analyzes data on respiratory disease hospitalizations in different municipalities in Mato Grosso do Sul. People who declare themselves white constitute a majority group in most municipalities, except in Corumbá, where the number of people who declare themselves brown is higher. Hospitalization rates vary between different sets of self-declared people and age groups in each municipality studied.

It was noted that indigenous peoples have higher percentages of hospitalizations, especially among children aged 0 to 5 years. This may be related to primary sanitation infrastructure conditions in their homes and worse health conditions than other populations. In addition, 2016 and 2020 had the lowest temperatures in all municipalities studied, and in 2020 there was a reduction in the number of hospitalizations. These facts are possibly related to the La Niña phenomenon and the COVID-19 pandemic, which may also have contributed to the reduction in hospitalizations for respiratory diseases from 2020 onwards.

## 5. ACKNOWLEDGMENT

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