RESPIRATORY DISEASES – RELATIONS TO CLIMATE PARAMETERS

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Abstract : The research aims to analyze the relations between the urban space and the respiratory diseases in the city of Chapecó located in the south region of Brazil, in the subtropical climate. The methodological procedures involved collection of hospitalization and weather data, statistic tests, and data collection and mapping from the Brazilian Postal Addressing Code (CEP). Results show that pneumonia was the most common disease observed in winter. Although the largest neighbourhoods show the highest absolute number of hospitalization cases, the neighbourhoods that were identified by their socioeconomic differentiation (suburban and impoverished areas) were the ones that proportionally showed the highest number of hospital admission cases.

Keywords: Climate and health; Pneumonia; Mapping

Résumé : La recherche vise à analyser les relations entre l'espace urbain et les maladies respiratoires dans la ville de Chapecó située dans la région sud du Brésil de climat subtropical. Les procédures méthodologiques impliquaient la collecte de données d'hospitalisation et de données météorologiques, des tests statistiques, ainsi que la collecte et la cartographie de données à partir du code postal brésilien (CEP). Les résultats montrent que la pneumonie est la maladie la plus fréquemment observée en hiver. Bien que les quartiers les plus grands affichent le nombre absolu le plus élevé de cas d'hospitalisations, les quartiers suburbains qui ont été identifiés comme défavorisées socio-économiquement sont ceux qui ont proportionnellement enregistrés le plus grand nombre de cas d'hospitalisations.

Mots clés : Climat et santé ; Pneumonie ; Cartographie

Introduction

Humans are in constant contact with climate elements that get altered due to modifications resulting from the alterations and changes in geographic space. The relations between climate, health and human diseases have been addressed specifically since changes in the environment can have consequences in human daily life and as a result in human health. From there, these relations can have repercussions on health system with, for example, increase in hospital admissions (SILVA *et al*., 2016).

Diseases of the respiratory system (DRS) represent the highest percentage of hospitalizations in Brazil, corresponding to about 11.4% in the period from 2008 to 2019. It is the second largest cause of hospitalizations, behind only hospitalizations for pregnancy, childbirth, and puerperium with 20.9% (BRASIL, 2020). Respiratory diseases can be caused by the lifestyle of human beings or by natural factors exposed in the atmosphere which affect the lungs and breathing capacity. Among the anthropogenic influences, we can highlight air pollution, smoking, chemicals, etc. (NOGUEIRA *et al*., 2011; BAKONYI *et al*., 2004; MARTINS *et al*., 2002) and among the environmental influences, we can mention climate change, dust, pollens, etc. (MOTA, 2009; MURARA; AMORIM, 2010).

We selected the city of Chapecó, located in the southern region of Brazil (**Figure 1**) in the subtropical climate to apply this study and understand the relations between the city (neighborhoods) and the spatialization of the respiratory diseases. Chapecó is a city with just over 220 thousand inhabitants, characterized as urban (91.6% of the population lives in the city and 8.4% in the rural area). Since the 50s, it is strongly influenced by the facilities of agro-industrie with agricultural and livestock production and large companies such as BRF and Cooperativa Aurora.

Materials and methods

The methodological procedure involved data collection of hospitalization register from the Informatics Department of the Brazilian Unified Health System (Departamento de Informática do Sistema Único de Saúde - DATASUS), National Ministry Health of Brazil. It also includes collection of meteorological data from the National Meteorological Institute (INMET): rainfall, minimum and maximum temperatures, and humidity. We used the period starting January 2008 until December 2019 (monthly data) for making the statistical tests (normality test of Shapiro-Wilk; Spearman correlations) between hospitalization and weather data.

Then, we classified data from the Brazilian Postal Addressing Code (CEP) to understand how the structuring and changes made to the urban site can affect the health and well-being of the population.
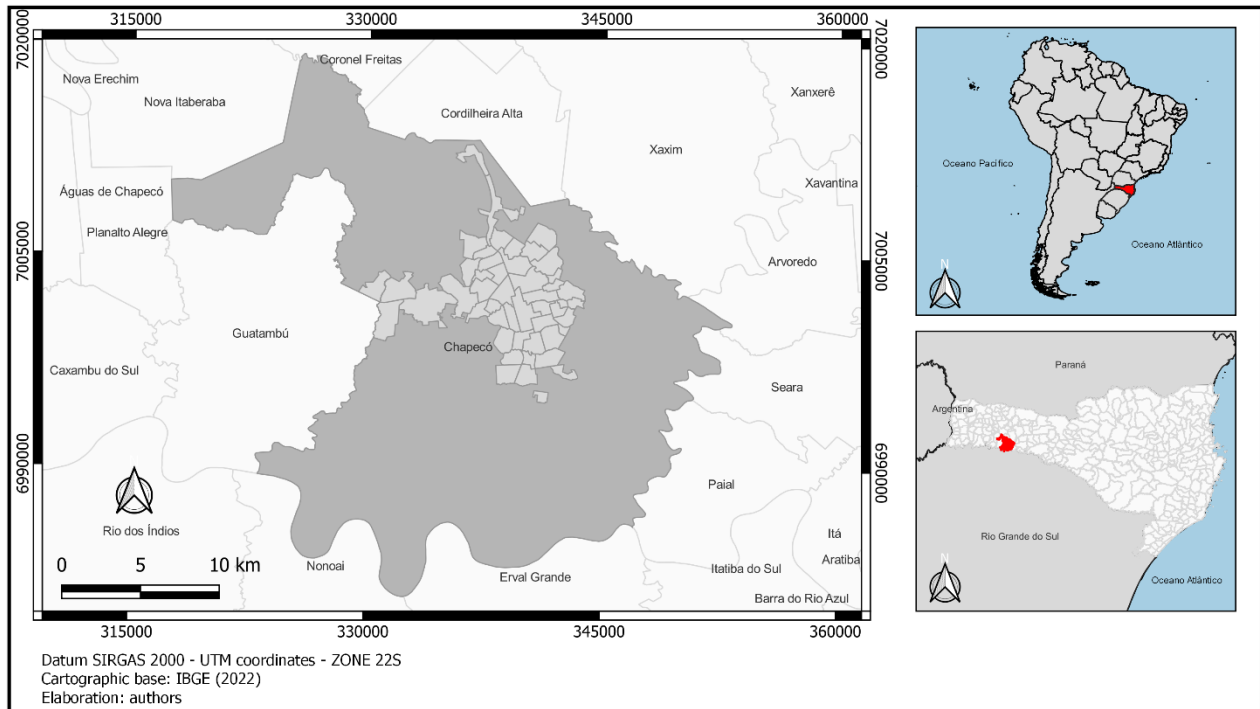
figure 1. Location of the study area – Chapecó-SC, Brazil.

For the elaboration of the maps, the ArcGis - ArcMap platform was used. The data and shapefile of the city taken from Chapecó's city hall were inserted into the platform. For the map, the frequency of each number and variation of non-uniform data was used. For the population, breaks were used for frequency. For the hospitalization rate, the following formula was used: (number of hospitalizations / population of the neighbourhood) x 1000.

For the mapping and differentiation of the neighborhoods, we used Nascimento (2014) which presents a spatial pattern of downtown vs periphery based on the socioeconomic (monthly income of the head of the family), profile of the city resident population, and the levels of infrastructure and services in the neighborhoods.

Results and discussion

According to the survey of respiratory disease data, 17,827 hospitalizations were registered from 2008 to 2019, corresponding to 12.3% of the total hospitalizations occurred by residents of Chapecó during that same period. The winter season (July, August, and September) has the highest records of hospitalizations and is also the period with the lowest temperatures (**Figure 2**). During the summer period (January, February, and March), a decrease in hospitalization records is observed which may be associated with higher temperatures when compared to winter.

With a percentage of 34.2%, the highest records of hospitalizations by age group occurred within the elderly population (60 years and over), and occurred during the winter period. The elderly population is the most sensitive to low temperatures as seen with the highest rate of hospitalization for respiratory diseases (MOTA, 2009; NOGUEIRA *et al*., 2011; PANET *et al*., 2015; PONTES *et al*., 2016;) and, therefore, constitutes a risk group.

With a percentage of 29.7%, the population of children, from 1 to 14 years old, has the second highest number of hospitalizations by age group. They present high records during the months of June, July, and October, with an equal record of hospitalizations compared to the elderly population. Pontes *et al*. (2016), who analyzed the hospitalizations due to pneumonia of children under five years old, concluded that the increase in hospitalization records is related to the decrease in temperature during the winter months. In this sense, the rainy season is possibly related to excess humidity in children's living environments, which may be in constant contact with substances that cause allergies and with the growth of fungi related to excessive humidity (OLIVEIRA *et al*., 2011).
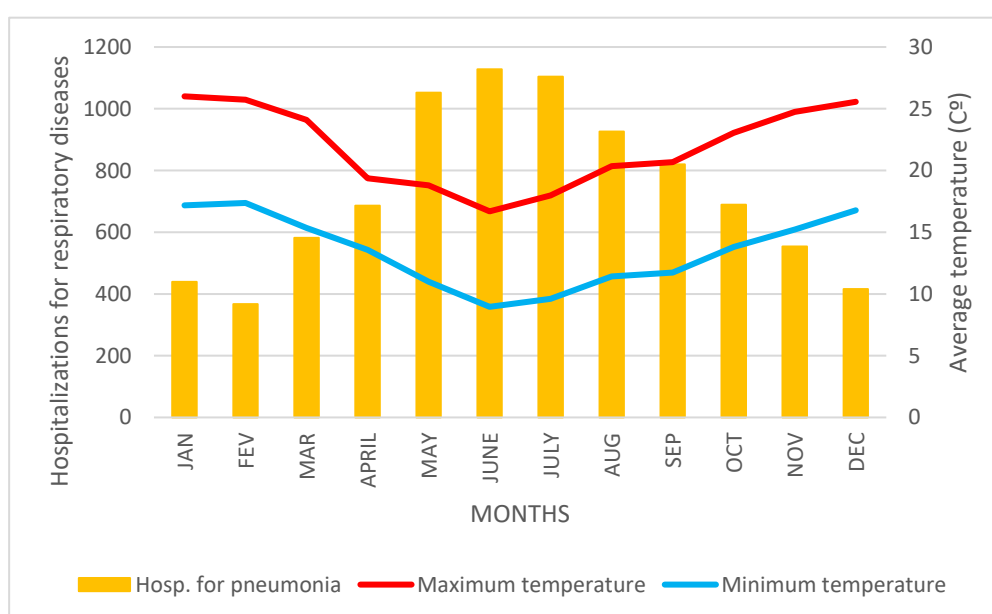
figure 2. Monthly average of hospitalizations for respiratory diseases, average temperatures in Chapecó during the period from 2008 to 2019.

The records of hospitalizations by gender showed a higher prevalence among males which accounted for 55.6% of hospitalizations recorded for respiratory diseases, while females accounted for 44.3% of hospitalizations.

Among the group of diseases of the respiratory system, it was identified that pneumonia records represent more than half (50.8%) of the hospitalization cases in Chapecó. In second place in the records of hospitalizations for respiratory system diseases are other diseases of the respiratory system (16.0%), in third, chronic diseases of the tonsils and adenoids (11.6%) and in fourth, bronchitis, emphysema and other lung diseases chronic obstructive disorders (7.8%).

In this context, and for the analyzed period, it is clear that pneumonia has great relevance in hospitalization rates during the winter season, since it accounts for more than half of the total records in the city. The statistical study revealed that the minimum temperature is the element that shows the best anticorrelation with the records of hospitalizations for respiratory diseases with a correlation coefficient of -0,27 (*p* = 0,005) (**Table 1**).

**Table 1.** Spearman correlation values for number of hospitalizations for pneumonia vs. weather parameters.

Tmax	Tmin	Rain	RH
-0,22	-0,27	-0,05	0,04

Significant at the level of p = 0,005.

Maximum temperature also shows an anticorrelation with the records of hospitalizations for respiratory diseases, though with a lower correlation coefficient (-0,22; p = 0,005). However, the average maximum temperature also showed a negative correlation with the records of hospitalizations. This result may be associated with extremes of heat and cold. Rain and relative humidity have a correlation value lower than 0.1.

These results corroborate the investigations already carried out on the impact of climate in subtropical environments on respiratory diseases, showing that low temperatures, or decreasing temperatures, have an impact on diseases. (JOHNSTON Jr., 1991; VILKMAN *et al.*, 1996; BESANCENOT, 2001; SÄYNÄJÄKANGAS *et al.*, 2001; TOYOSHIMA *et al.*, 2005; HOSSAIN *et al.*, 2019).

Although the largest neighbourhoods reflect the highest absolute number of hospitalizations, the neighbourhoods that were identified by their socioeconomic differentiation, as pointed out by Nascimento (2017) to determine the suburban and poor areas in the city of Chapecó, were the ones that, proportionally, presented higher number of hospital admissions (**Figure 3**).
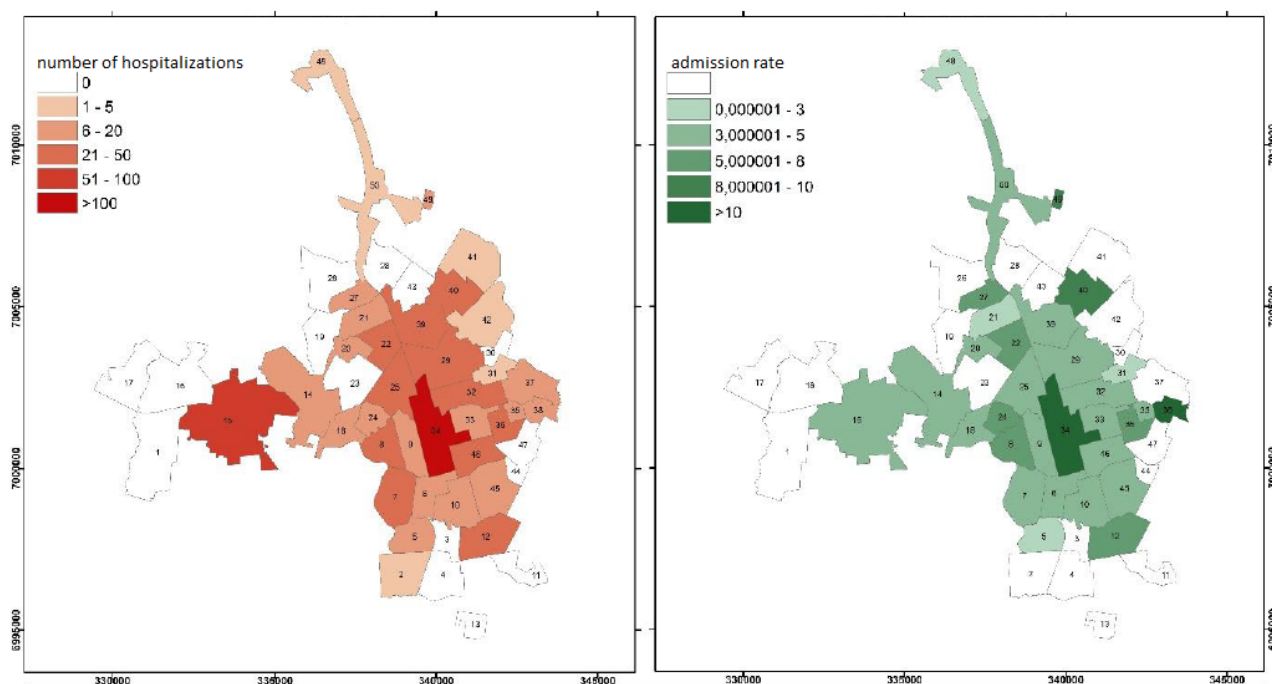
figure 3. Map of hospitalization records for pneumonia in the urban area of Chapecó, 2019

As for the spatialization of pneumonia cases, the results of the absolute numbers of hospitalizations are associated with the locations of higher density of population. However, when analysing the hospitalization rates by neighbourhoods, it can be shown (**Figure 3**, year 2019) that the highest percentages of hospitalizations occur in the more peripheral neighbourhoods that are characterized by socioeconomic inequalities (lower family income).

Conclusion

We have identified relationships between climate and health. It was possible to notice that hospitalizations are more frequent during the autumn and winter periods when temperature are lower. On the opposite, during the period of temperature increase, there are lower records of hospitalizations.

The increase of diseases of the respiratory system and pneumonia during autumn and winter months may be linked with variations in weather conditions, but also with greater occurrence of viruses and respiratory bacteria (MURARA, 2012). The urban growth in Chapecó may be related to the increase in records for peripheral neighbourhoods, following the pattern of development of medium-sized Brazilian cities (BRITO *et al.*, 2021).

Though there is a relationship between climate and the occurrence of human diseases, not all city dwellers are affected in the same way. The relationship is indeed dependant on economical situation of the inhabitants as seen from the difference of hospitalization rates between neighbourhoods with differentiated average family income.

Acknowledgement

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