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Impact of meteorological factors on the occurrence of hospitalizations for asthma in children

Impacto de los factores meteorológicos en la ocurrencia de hospitalizaciones para el asma en niños

Impacto dos fatores meteorológicos na ocorrência de hospitalizações por asma em crianças

ABSTRACT

Objectives: To characterize asthma cases and identify the impacts of meteorological factors on the occurrence of hospitalizations for asthma in children in the city of Campina Grande-PB. **Methods:** For the statistical analysis of the data, the negative binomial model was adjusted, adopting a significance level of 5%, based on the statistical platform R. **Results:** It is assumed that an increase of 81% occurs in cases of asthma with an increase in the average temperature, similarly increasing about 27% of these cases with an increase in the maximum temperature, in relation to the minimum temperature, it is expected that there is a 26% decrease in asthma cases due to the increase in asthma. A decrease of 3% in hospitalizations is also estimated as the relative humidity of the air increases. **Conclusion:** Considering the influence of climatic variables on health in the occurrence of hospitalizations for asthma, it becomes possible to plan actions and implement preventive measures.

DESCRIPTORS: Meteorological variables; Respiratory diseases; Hospitalizations; kids.

RESUMEN

Objetivo: Caracterizar casos de asma e identificar los impactos de los factores meteorológicos en la ocurrencia de hospitalizaciones por asma en niños de la ciudad de Campina Grande-PB. **Métodos:** Para el análisis estadístico de los datos se ajustó el modelo binomial negativo, adoptando un nivel de significancia del 5%, con base en la plataforma estadística R. **Resultados:** Se asume que se produce un aumento del 81% en los casos de asma con un aumento de la temperatura promedio, de igual manera aumentando alrededor del 27% de estos casos con un aumento de la temperatura máxima, en relación a la temperatura mínima, se espera que hay una disminución del 26% en los casos de asma debido al aumento de asma. También se estima una disminución del 3% en las hospitalizaciones a medida que aumenta la humedad relativa del aire. **Conclusión:** Considerando la influencia de las variables climáticas sobre la salud en la ocurrencia de hospitalizaciones por asma, se hace posible planificar acciones e implementar medidas preventivas.

DESCRIPTORES: Variables meteorológicas; Enfermedades respiratorias; Hospitalizaciones; niños.

RESUMO

Objetivos: Caracterizar os casos de asma e identificar os impactos dos fatores meteorológicos na ocorrência de hospitalizações por asma em crianças no município de Campina Grande-PB. **Métodos:** Para a análise estatística dos dados foi ajustado o modelo binomial negativo, adotando-se um nível de significância de 5%, com base na plataforma estatística R. **Resultados:** Pressupõe-se que ocorra um aumento de 81% nos casos de asma com o aumento da temperatura média, aumentando, do mesmo modo cerca de 27% desses casos com o aumento da temperatura máxima, em relação à temperatura mínima, espera-se que haja uma diminuição de 26% dos casos de asma em função do aumento dessa. Estima-se também uma diminuição de 3% das internações à medida que aumente a umidade relativa do ar. **Conclusão:** Considerando a influência das variáveis climáticas na saúde na ocorrência das hospitalizações por asma, torna-se possível planejar ações e implementar medidas preventivas.

DESCRIPTORES: Variáveis meteorológicas; Doenças respiratórias; Hospitalizações; crianças.

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INTRODUCTION

Asthma is a chronic inflammatory disease of the respiratory tract that makes the bronchi hyperresponsive to the various factors that trigger seizures. It is a respiratory disease that affects the airways or bronchi (tubes that conduct air into the lungs), not the larger bronchi, but the more delicate airways, these are the segmental bronchi and bronchioles. Because it is a genetic disease, it cannot be cured, but it can be successfully controlled when the treatment is adequate. ^(1,2)

The exact cause of asthma is not yet known, but it is believed to be caused by a number of factors: genetic (family history of respiratory allergies - asthma or rhinitis) and environmental. Several factors can trigger asthma attacks, such as viral infections, household dust, molds, strong odors, humidity, smoking, emotions and climatic variations. ^(1,3)

Asthma is a chronic inflammatory disease of the respiratory tract that makes the bronchi hyperresponsive to the various factors that trigger seizures.

Asthmatic children are more susceptible to the effects of environmental factors, as there is an increase in bronchial hyperresponsiveness and sensitivity to environmental agents. This fact can be explained by the immaturity of the immune system, which can be further repressed in the winter, temperatures promote spasms of the respiratory tract and ischemia due to capillary contraction in children, resulting in weakened ciliary movement and consequently difficulty in removing viruses and bacteria in the respiratory epithelium. ^(4,5)

However, the effects of climatic factors at birth decrease over time, as the child grows, being compatible with the development of the immune system and the increase in the diameter of the airways in the first years of life. ⁽⁶⁾

Several studies around the world have correlated climatic conditions with morbidity and mortality, due to different di-

seasons. Some climatic variables, such as: air temperature, relative humidity and rainfall, have been shown to interfere with the occurrence of respiratory diseases.⁽⁷⁾

Given the above, it is clear that oscillations in meteorological variables effectively contribute to the occurrence of respiratory diseases in humans, especially in children. The objective of this research was to characterize asthma cases in children under nine years old and to identify the impacts of meteorological factors on the occurrence of hospitalizations in the city of Campina Grande-PB. The study period ranged from January 1998 to December 2017.

METHODS

Study area and period - This research was carried out with data related to the municipality of Campina Grande, located in the State of Paraíba (PB), from January 1998 to December 2017, equivalent for twenty years. The municipality of Campina Grande is at an average altitude of 555 meters above sea level, distant 120 km from the State Capital, João Pessoa. The area of the municipality of Campina Grande covers 593.026 Km², with an esti-

mated population of 407.754 inhabitants, according to data from the Brazilian Institute of Geography and Statistics, it has a climate with more moderate temperatures, considered Tropical with a dry season. The rainy season begins in May and ends in September, and may extend until October (IBGE, 2018).

The current research used a cross-sectional study with a quantitative and descriptive approach. The data were from a secondary source, relative to the series of meteorological data obtained at the National Institute of Meteorology (INMET - Instituto Nacional de Meteorologia) and the number of hospitalizations for asthma. Epidemiological data were collected at the SUS-DATASUS IT Department, through the Hospital Information System (SIH - Sistema de Informações Hospitalares). The research is in accordance with Resolution No. 510/16 of the National Health Council, which provides for research that uses publicly available information, optimizes the evaluation procedures, which exempt the need for prior approval by the CEP/ CONEP system. These being, administrative data obtained from official public domain documentation, referral to the Ethics and Scientific Research Committee (CEP

- Comitê de Ética e Pesquisa Científica) was waived. Therefore, the current research used administrative data obtained from official public domain documentation. These data were used exclusively for the purpose of this research and the information prepared collectively in such a way that no result referred to a nominal individual, nor did it imply what losses to the people or institutions involved.

The meteorological data were organized in spreadsheets of the Excel software, together with the records of hospital admissions for asthma in children from 0 to 9 years old, and worked by the statistical software R (R CORE TEAM, 2018), which were treated and analyzed.

Then, since it is counting data, after adjusting the Poisson regression model, it was necessary to adjust the negative binomial regression model, which is more suitable for treating data with variance higher than the conditional average, it was elaborated with the addition of a new parameter that reflects the unobserved heterogeneity.

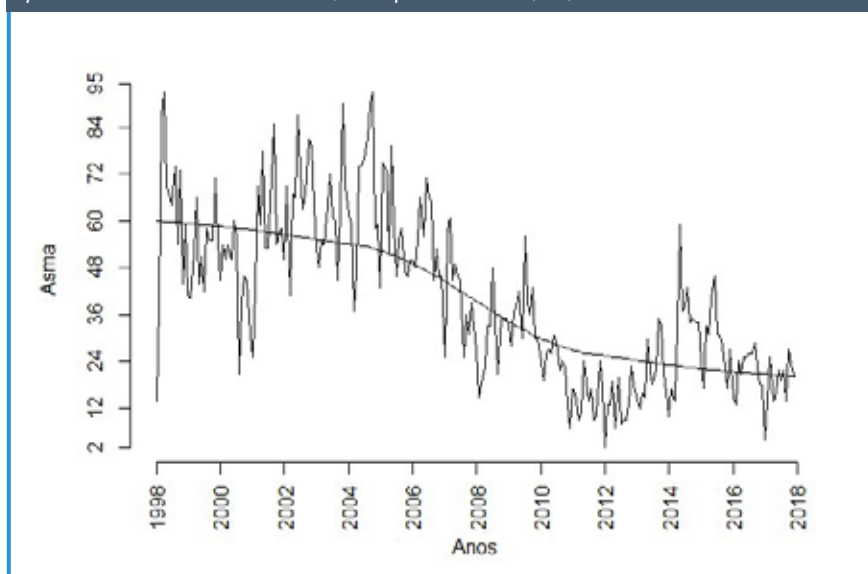
RESULTS

To assess the relationship between meteorological variables and the occurrence of asthma, the increase in cases due to seasonality was initially observed. Asthma cases in the city of Campina Grande-PB, related to data from the Hospitalization System of the Unified Health System (SIH/SUS). Between 1998 and 2017, a total of 9,701 hospitalizations were recorded, 1,588 in the age group between 0 and 12 months (16,3%), 5,690 in the age group between 1 and 4 years (58,6%) and 2,423 in the age group between 5 to 9 years (24,9%).

Regarding asthma records, the largest number of hospitalizations occurred in the years 2002 and 2010, with a total of 807 and 810 records, respectively. The age group that had the highest number of hospitalizations was between 1 and 4 years in both years, whereas the months with the highest records were May and June. And the year with the lowest record was 2011 with 187 cases.

In 1998, there were 737 asthma cases

Figure 1 - Distribution of the number of asthma cases in children under 9 years old from 1998 to 2017, Campina Grande (PB).



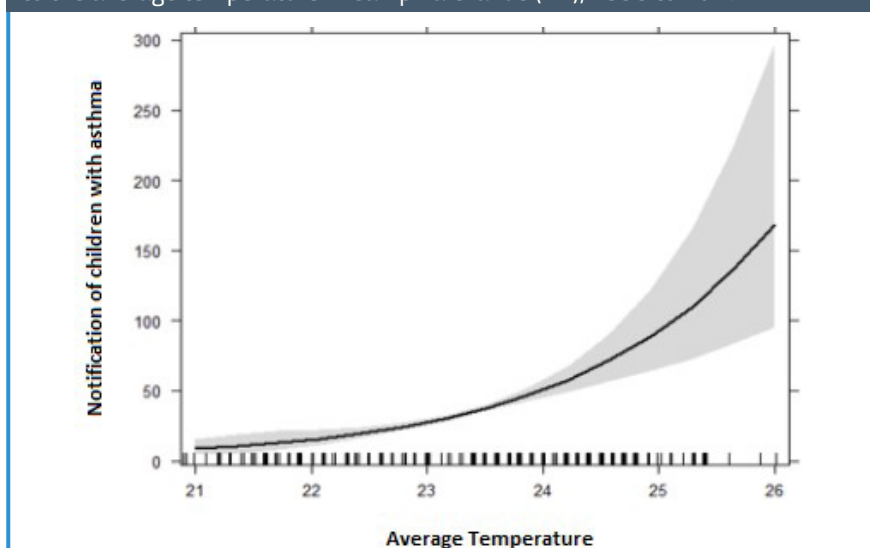
Source: Research data, 2019.

Table 1. Estimates of the model parameters for the occurrence of hospital admissions for asthma in the period from 1998 to 2017 in Campina Grande (PB).

COEFICIENTES	ESTIMATIVA	ERRO	VALOR Z	P-VALOR	
Intecepto (β_0)	7,64360	1,35070	5,659	1,52e-08	***
Tmed (β_1)	0,59868	0,11932	5,017	5,24e-07	***
Tmax (β_2)	-0,31635	0,05314	-5,953	2,63e-09	***
Tmin (β_3)	-0,30808	0,08943	-3,445	0,000571	***
UR (β_5)	-0,03464	0,00997	-3,474	0,000513	***

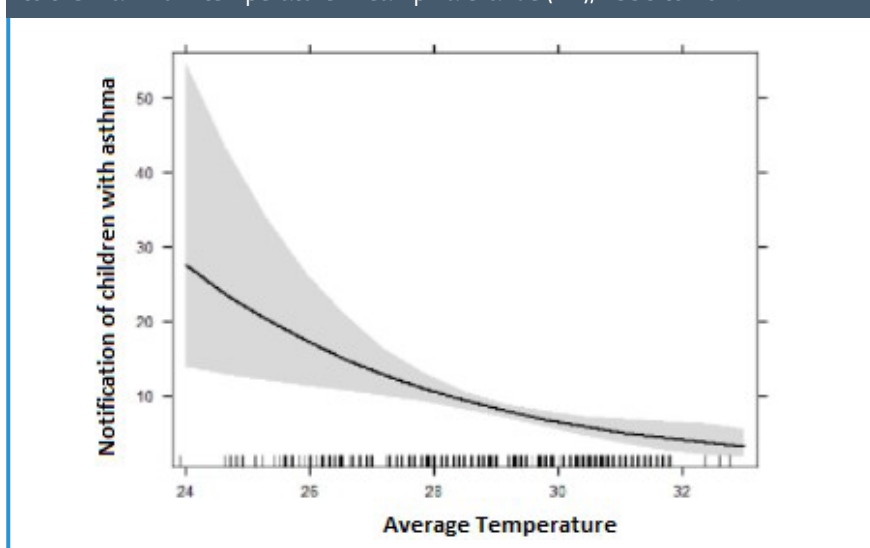
Source: Research data, 2019.

Figure 2. Behavior of asthma cases in children under 9 years of age in relation to the average temperature in Campina Grande (PB), 1998 to 2017.



Source: Research data, 2019.

Figure 3. Behavior of asthma cases in children under nine years of age in relation to the maximum temperature in Campina Grande (PB), 1998 to 2017.



Source: Research data, 2019.

and in 2017, 219 cases, thus reducing the number of asthma cases during the study period (Figure 1). There was also a seasonal effect on the number of registered cases, with the largest number of registrations between April and July.

In relation to the statistical analysis of the data, as these are counting, a negative binomial model was used, with emphasis on the relationship between the number of hospitalizations for the occurrence of asthma and the climatic variables under study. In which asthma \sim BN (μ_i, ϕ) with emphasis on the relationship between the number of hospitalizations for the occurrence of asthma and the climatic variables under study.

The results presented in Table 1 indicate that the meteorological variables: average, maximum temperature, minimum temperature and relative humidity were significant at the level of 5% probability regarding the explanation of the rate of increase/decrease in cases of hospital admissions for asthma from 1998 to 2017 in Campina Grande (PB).

The current research found a positive association between asthma cases and average temperature, whereas in relation to relative humidity, the current study found an inverse relationship, Figure 2.

In the current research, an inverse correlation was observed between the number of asthma cases and the maximum temperature variable, Figure 3.

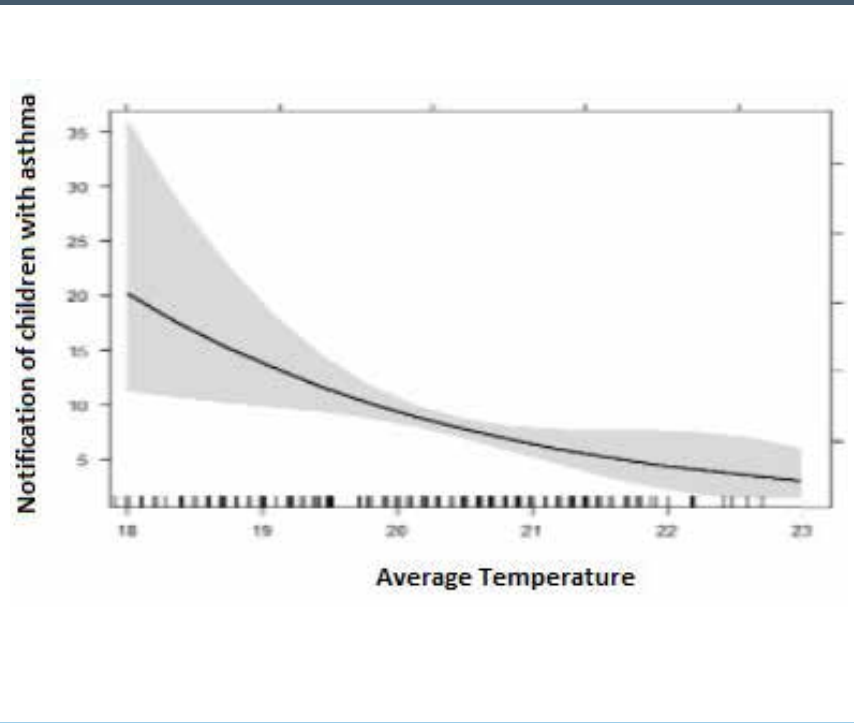
The current research found a positive relationship with the average temperature and an inverse relationship with the maximum and minimum temperature. The precipitation variable was not statistically significant.

Regarding the relative humidity variable, an inverse relationship was observed in relation to the number of hospitalizations for asthma, Figure 5.

DISCUSSION

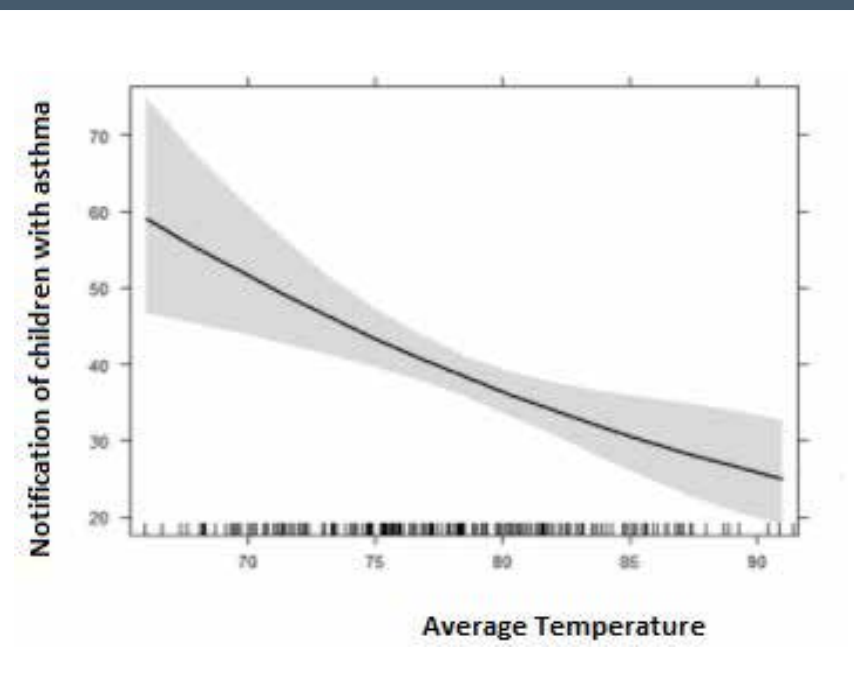
From the study it was possible to observe that part of the reduction in relation to asthma cases over the years, is due to the

Figure 4 - Behavior of asthma cases in children under nine years of age in relation to the minimum temperature in Campina Grande (PB), 1998 to 2017.



Source: Research data, 2019.

Figure 5. Behavior of asthma cases in children under nine years of age in relation to relative humidity in Campina Grande (PB), 1998 to 2017.



Source: Research data, 2019.

consolidation of the national asthma control program. In 2003, there was financing for drugs for severe asthma, but from 2005 on, there was the purchase of drugs for mild and moderate asthma (Ordinance GM 2.084). As asthma is a chronic inflammatory disease with long-term treatment, in the following year (2006), it was possible to verify the benefit of reducing exacerbations that could lead to hospitalization.^(8,9)

As for the rate of increase or decrease in cases of hospital admissions for asthma as well as in this research. Valença, Restivo e Nunes⁽¹⁰⁾ observed that asthma visits, covering children in a satellite city of Gama (DF), presented a seasonal variation, with a significant increase in cases in March and a decrease in the months of August and September. It was observed by the researchers that the acute cases of asthma increased from one to two months, after the elevation of the relative humidity of the air and two months after the increase of the pluviometric index and of the average temperature.

Regarding the positive association between asthma cases and average temperature and the inverse relationship observed in the relative humidity observed in this study, they corroborate the results obtained by González, Victora and Gonçalves,⁽¹¹⁾ who observed in their studies in Pelotas, Rio Grande do Sul effects of climate (through the variable, average temperature) in the trimester of birth and in the first six months of life on hospitalizations for asthma and pneumonia in children. Regarding hospitalizations in the first six months of life, it was found that the incidence of hospitalization for asthma was higher among children who lived the first six months exposed to low temperatures.

Studies show the association between maximum temperature and the number of asthma cases showed a moderate and weak positive correlation in the years 2011 and 2012.⁽¹²⁾ However, correlations between the environmental variables and the morbidities under study were not so significant.

According to studies by Pesce and collaborators,⁽¹³⁾ in Italian cities. It was observed in the research that the prevalence in asthma cases was significantly associated with

climatic variables (mean annual temperature, precipitation, solar radiation, with an increase in asthma cases when there was greater exposure to solar radiation and an increase in mean annual temperature and lower precipitation records).

The research by Silva et al. ⁽⁹⁾ assessed the effect of climatic seasonality on hospitalizations for asthma. The results showed an inverse relationship between maximum temperature and the number of hospitalizations for asthma, as was found in the current research. A positive relationship was also observed between maximum relative humidity and the number of hospitalizations for asthma, unlike the current study that found an inverse relationship, Figure 5.

CONCLUSIONS

The meteorological variables: average, maximum temperature, minimum temperature and relative humidity were significant, with regard to the explanation of cases of hospital admissions for asthma. These variables explained the increase and

The meteorological variables: average, maximum temperature, minimum temperature and relative humidity were significant, with regard to the explanation of cases of hospital admissions for asthma.

decrease in hospital admissions for asthma.

It is assumed that an increase of 81% occurs in cases of asthma at each degree of increase in the average temperature, similarly increasing by about 27% of these cases with the increase in the maximum temperature, in relation to the minimum temperature it is expected that there is a 26% decrease in asthma cases due to the increase in the minimum temperature. It is also estimated that there will be a 3% decrease in hospitalizations for asthma as the relative humidity increases.

Considering the influence of meteorological variables (air temperature and relative humidity) in hospital records for asthma. It is possible to assess the risk to the health of the population due to climatic data. Actions can be planned to facilitate care and preventive measures for hospitalizations for asthma in the age group under study are implemented, thus avoiding complications of the aforementioned morbidity, in periods when there is an intensity of asthma records that are in the fall and winter. ■

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