

# Original Article

## Climate variations and health services use for the treatment of asthmatic children under five years of age: an ecological study\*

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### ABSTRACT

**Objective:** To study variations in climate (dry or rainy periods) and health services use for the treatment of asthma in children under five years of age. **Methods:** An ecological study was conducted and involved analysis of the medical charts of all children under the age of five that were diagnosed with asthma and treated in the Municipal Emergency Room of the city of Cuiabá, located in the state of Mato Grosso, Brazil. In accordance with the geographic location of Cuiabá, two climatic periods were identified: a dry season (from May to October) and a rainy season (from November to April). **Results:** The percentage of children treated that were diagnosed with asthma was 12.2% (3140/25,802), with no gender-based difference. Children from 3 to 5 years of age were most often affected. The overall asthma hospitalization rate was 1.3% (336/25,802), rising to 10.7% (336/3140) among the asthmatic children treated in the emergency room. In the rainy season, the percentage of outpatients seeking treatment for asthma was higher than in the dry season: 39.1% (1228/3140) versus 60.9% (1912/3140). However, during the dry season, a greater proportion of such patients were hospitalized: 52.3% (176/336) versus 47.7% (160/336). These differences were statistically significant ( $p < 0.05$ ). **Conclusions:** The dry season, which was correlated with higher asthma hospitalization rates, seems to be related to more severe cases of asthma in children under five years of age.

**Keywords:** Asthma/prevention & control; Allergens/adverse effects; Respiratory hypersensitivity; Environmental monitoring; Climate; Child

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## INTRODUCTION

Environmental factors affect the dynamics of asthma, increasing its severity and morbidity rates. Of note among these factors is the presence air pollutants (both indoor and outdoor) and the meteorological conditions of the locale, including temperature, relative humidity and wind speed, which may increase the duration of exposure to pollutants, as well as preventing pollutants from dissipating.<sup>(1-3)</sup>

Among the climatic variables, wind speed and relative humidity (when interacting with air pollution) have been correlated with an increase in the incidence of asthma exacerbations. In corroboration of this fact, a study describing the distribution of asthma attacks in relation to local meteorological factors (temperature, relative humidity and rainfall) revealed that relative humidity was correlated with bronchial asthma in adults.<sup>(4)</sup>

Another important fact is that the concentration of airborne fungal spores, which account for most of the biological material in suspension in the atmosphere, as well as that of several other substances found in the air, depends on environmental variables, such as temperature, rainfall, wind and relative humidity.<sup>(5)</sup> The effect of climatic variables on asthmatic individuals may be didactically summarized as follows: direct irritating action of cold and humidity on the respiratory mucosa; effect on the autonomic system of body temperature regulation (varying the level of reactivity of the organism, thereby favoring hypersensitivity and, consequently, asthma attacks); creation of an environment conducive to respiratory infections; increase in the amount of mold or fungi as well as in the population of mites, thereby making house dust much more allergenic; change in living conditions, especially among children, to the detriment of practicing sports and engaging in outdoor activities, which makes them spend more time at home, bundled up and in close contact with house dust.<sup>(6)</sup>

In this context, possibly in places where there is a high concentration of respiratory pollutants or where the weather conditions do not favor their dispersion, which would minimize their effects, individuals predisposed to respiratory diseases such as asthma experience a worsening of symptoms.

The city of Cuiabá is located in the geomorphologic unit known as the Depressão

Cuiabana (Cuiabá Depression) in the state of Mato Grosso and has a predominantly tropical climate, alternately dry and humid. In general, this type of climate presents one climatic period that is classified as dry (when the tropical continental air mass is stationary over the region), with high temperatures (rising to over 40°C) and low relative humidity (below 30%) on most days. During this period, there are some days on which there is a thermal inversion, with the temperature drops to between 10°C and 15°C. In conjunction with the climatic characteristics of this period, there are controlled burns of both scrublands and domestic garbage, which release large quantities of particulate matter into the atmosphere. The climatic period that is classified as wet (when the equatorial continental air mass is predominant over the state), which lasts from November to April, is characterized by heavy rains and higher relative humidity, with an annual mean temperature of approximately 28°C.<sup>(7)</sup> This period favors an increase in allergenic substances in homes due to the higher reproduction/growth rates of some species of dust mites and fungi.

It is known that, as a group, asthmatic children are more susceptible to the effects of environmental factors, which trigger increases in bronchial hyperresponsiveness and sensitivity to environmental agents.<sup>(8)</sup> Therefore, the hypothesis that climatic changes are determining factors in asthma control and in the use of health services may be justified. In view of this, the objective of the present study was to determine whether asthma control correlates with climate (dry and wet periods) in children under five years of age. To that end, we studied variations in the number of children treated for asthma in an emergency room in the city of Cuiabá between January and December of 1999.

## METHODS

We analyzed the medical charts of all children under the age of five, both male and female, who were diagnosed with asthma and treated in the Municipal Emergency Room of the city of Cuiabá between January and December of 1999. All children were residents of the city. The following procedures were followed: all medical charts of children up to five years of age were separated and grouped by the month of treatment; we separated those who were diagnosed with asthma from those

who were diagnosed with other diseases; we collected data regarding gender, age (less than one year of age; one to three years of age; three to five years of age), diagnosis (asthma or other diagnoses), number of treatments and need for hospitalization.

All children whose medical charts indicated asthma, allergic bronchitis or asthmatic bronchitis were considered asthmatic. Diseases other than asthma were referred to as other diagnoses.

Based on the climatic characteristics of the Baixada Cuiabana (Lower Cuiabá region), two periods of the year were delineated for the purpose of studying their correlation with the frequency of treatments for asthma: a dry season (from May to October) and a wet season (from November to April).<sup>(7)</sup>

The chi-square test for proportional differences, with a 95% confidence interval, was used to analyze the correlations between the covariables and the response variable. The Epi Info 6 program, version 6.04, was used for the statistical analysis.

## RESULTS

The percentage of children treated for asthma was 12.2% (3140/25,802), and its distribution by gender was 56.5% for males and 43.5% for females, a difference that was less than statistically significant ( $p = 0.05$ ). Children from 3 to 5 years of age were most often affected (36.1% and 30.7%, respectively, for males and females), a statistically significant difference ( $p < 0.05$ ).

The monthly frequency of treatments of children diagnosed with asthma ranged from 4% to 14% and is shown in Figure 1, where it can be seen that this frequency was higher in the months of March, April and May (the wet season) and lower in the months of July, August, September and October (the dry season).

The distribution of the children studied by the problem (complaint) diagnosed and by the type of treatment (hospitalization or outpatient treatment) is shown in Table 1, where it can be seen that the overall asthma hospitalization rate was 1.3% (336/25,802). Among the children diagnosed with asthma, 10.7% (336/3140) required hospitalization, compared with 7.8% (1763/22,662) of the children diagnosed with other diseases, a statistically

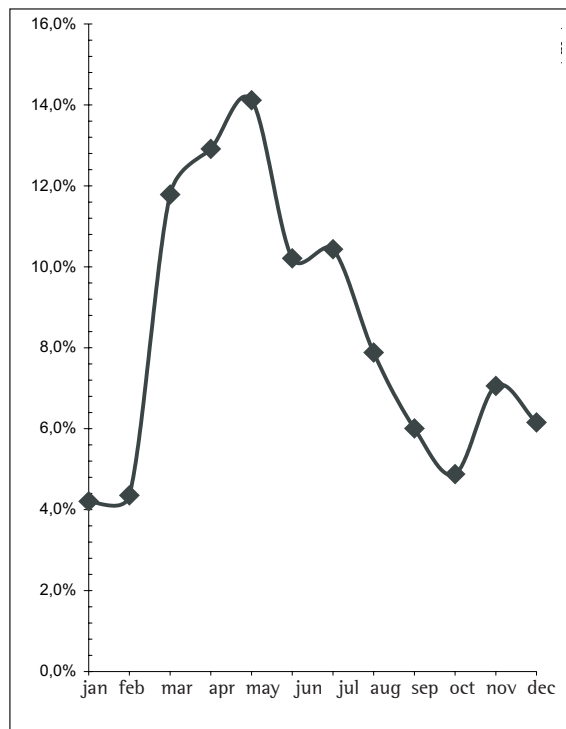


Figure 1 - Monthly frequency of outpatient treatment among children diagnosed with asthma

TABLE 1  
Distribution of the children studied by problem diagnosed and by type of treatment

Treatment	Problem		Total n (%)
	Asthma n (%)	Other diagnoses n (%)	
Inpatient	336 (10,7)	1.763 (7,8)	2.099 (8,1)
Outpatient	2.804 (89,3)	20.899 (92,2)	23.703 (91,9)
<b>Total</b>	<b>3.140 (100)</b>	<b>22.662 (100)</b>	<b>25.802 (100)</b>

chi-square = 50,51;  $p < 0,05$

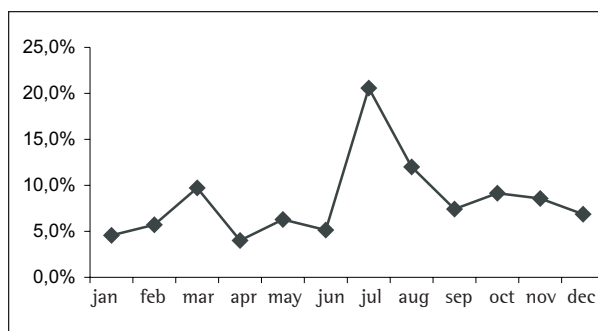


Figure 2 - Monthly frequency of hospitalizations among children diagnosed with asthma

TABLE 2  
Distribution of the children studied by problem diagnosed and by climatic period

Climatic period	Problem		Total n (%)
	Asthma n (%)	Other diagnoses n (%)	
Dry	1.228 (39,1)	11.470 (50,6)	12.698 (49,2)
Wet	1.912 (60,9)	11.192 (49,4)	13.104 (50,8)
Total	3.140 (100)	22.662 (100)	25.802 (100)

chi-square = 146,12; p < 0,05

TABLE 3  
Distribution of the children diagnosed with asthma by type of treatment and by climatic period

Climatic period	Type of treatment		Total n (%)
	Inpatient n (%)	Outpatient n (%)	
Dry	176(52,3)	1.052 (37,5)	1.228 (39,1)
Wet	160(47,8)	1.752 (62,5)	1.912 (60,9)
Total	336 (100)	2.804 (100)	3.140 (100)

chi-square = 27,31; p < 0,05

significant difference ( $p = 0.01$ ).

Figure 2 shows the monthly frequency of treatments of the children studied who were diagnosed with asthma and required hospitalization. This frequency ranged from 5% to 20% and was higher in the (dry season) months of July, August and September.

Table 2 shows the distribution of the children studied by climatic period (dry or wet) and by the problem diagnosed. We observed that 60.9% of the asthma diagnoses (1912/3140) and 49.4% of the other diagnoses (11,192/22,662) were made in the wet season, a statistically significant difference ( $p < 0.05$ ).

The distribution of the children diagnosed with asthma by type of treatment (inpatient or outpatient) is shown in Table 3. Comparing inpatient treatment with outpatient treatment, we observed that hospitalization was more common among children diagnosed with asthma during the dry season (52.5%; 176/336) than among those diagnosed during the wet season. Conversely, we observed that outpatient treatment among such children was more common during the wet season (62.5%; 1752/2804) than during the dry season (37.5%; 1052/2804), a statistically significant

difference ( $p < 0.05$ ).

## DISCUSSION

The frequency of emergency treatment for asthma in children under five years of age found during the year under study (12.2%) was probably influenced by the locale (emergency room). Asthma morbidity rates vary, especially when compared to its prevalence, which is close to nil in some regions and as high as 30% in others. The factors that are mainly responsible for this variation are the genetic differences among the various races, the local environmental characteristics, the diagnostic measures employed and differences in the interpretation of the results of the diagnostic measures.<sup>(9-10)</sup>

The distribution of the children studied by gender was as expected, with no significant gender-based difference. Various studies have demonstrated that asthma does not differ significantly between boys and girls in relation to the aspects analyzed regarding the course of the disease.<sup>(11-12)</sup> However, several other authors have stated that the prevalence of asthma is higher among boys. Nevertheless, it is not clear whether this difference is related to gender itself, the geometric differences between the airways of the two genders, the decreased bronchial resistance seen in girls, or the higher frequency of airway infections seen among boys.<sup>(13-17)</sup>

Asthma prevalence was highest among children from one to three years of age, followed by children from three to five years of age. These results are in accordance with those of a study reporting that 82.4% of children have their first asthma attack within the first five years of life.<sup>(12)</sup> The authors of that study determined that, in the emergency room of a public hospital, asthma was one the three leading causes of treatment-seeking for respiratory diseases and was predominant among children under three years of age.<sup>(18)</sup> It is known that bronchial hyperreactivity may appear from the fourth week of life onward. However, since asthma is a chronic disease and is easily confused with other childhood respiratory diseases, it is difficult to diagnose in children under one year of age.<sup>(16-17)</sup> It is important to emphasize that, in children, asthma may be mistaken for bronchitis, bronchiolitis or acute respiratory infection, especially in cases of asthma attacks triggered by infections.

We also found that the rate of hospitalization was highest among children from one to three years of age, followed by those from three to five years of age and by those under one year of age. Among the children studied, the overall asthma hospitalization rate was 1.3%. If we consider only the children diagnosed with asthma, this rate rises to 10.7%. Since asthma is one of the main causes of hospitalization among children under five years of age, this information is a warning to the directors of health facilities since it may either indicate that asthma is even more relevant in the treatment statistics or that the efficacy of the health facilities is low.

In Brazil, asthma hospitalization rates vary according to the locale studied and the regional environmental characteristics. The frequency of hospitalization found in the Emergency Room of the Hospital do Servidor Público de São Paulo (São Paulo Hospital for Public Employees) was 1.8%.<sup>(19)</sup> In 1996, most such hospitalizations occurred in hospitals located in rural areas of Brazil and operating under the Sistema Único de Saúde (Unified Health System). That year, asthma was the fifth leading cause of hospitalization nationwide (excluding childbirth and puerperal disorders), the third in the northeast, the fourth in the north and south, and also the fifth in the central-west and southeast regions.<sup>(9)</sup>

Other Brazilian studies have shown the significance of asthma as a cause of hospitalization. From July of 1983 to June of 1994, asthma was responsible for approximately 18.6% of all hospitalizations due to acute respiratory diseases among children under five years of age at all pediatric hospitals in the city of Porto Alegre, located in the state of Rio Grande do Sul.<sup>(20)</sup> In the city of Santo André (in the state of São Paulo), asthma attack was found to be one of the three leading causes of hospitalization among children treated in the emergency room.<sup>(21)</sup> In various locations, hospitalization due to asthma occurred more often among children under five years of age, especially in those under two years of age. Asthmatic children presenting more severe clinical profiles tend to have recurring attacks and, consequently, present multiple hospitalizations.

The influence of environmental variables on the triggering of asthma attacks has been described by several authors. In a study of asthmatic children

up to fourteen years of age, the main precipitating factors found to be potentially correlated with attacks were changes in climate (in 78% of the children studied), upper airway infections (in 65%) and exposure to house dust (in 52%).<sup>(14)</sup> In another study, climatic influences (temperature and relative humidity) were also correlated with the incidence of asthma attacks.<sup>(23)</sup> In one study, climatic changes were found to be the main triggering agents of asthma attacks and upper airway infections in the first year of the disease, regardless of gender.<sup>(12)</sup>

The influence of climatic changes, particularly sudden drops in temperature, has been found to be potentially correlated with greater dispersion of aeroallergens, leading to a higher frequency of asthma attacks.<sup>(2,17,24-25)</sup> As previously mentioned, the climate in the city of Cuiabá is divided into a dry season (from May to October) and a wet season (from November to April), and there is no winter, as traditionally defined.<sup>(7)</sup> The hypothesis of the present study is that, in the dry season, through the influence of low relative humidity and high temperatures, asthma control is affected due to an intensification of the attacks and of their severity.<sup>(26)</sup>

Surprisingly, we found that the frequency of emergency room visits due to asthma attacks was higher in the months of March, April and May, precisely the wet season. In these months, the frequency was two to three times higher than in the dry season. It is possible that the higher rate of asthma treatment in the emergency room found in the rainy season is correlated with the excessive humidity, due to the heavy and constant rains, of the places frequented by the children, and that this could cause illness ranging from a simple cold to a more severe profile of acute respiratory infection, which are triggering factors for asthma and confounding factors in its diagnosis. In addition, the children spend most of their time at home and in contact with all of the allergenic substances present in the home environment, which are more numerous in this period due to the greater growth of fungi caused by the excessive humidity.<sup>(27)</sup>

When we analyzed the asthma hospitalization rate among the children studied and compared it with the climatic period, we found that, unlike the overall emergency room visit rate, the hospitalization rate was higher in the dry season than in the rainy season and was highest in the

months of July, August and September. In other words, the dry season was not responsible for the higher frequency of asthma attacks but was responsible for greater attack severity, as evidenced by the greater need for hospitalization among the children studied.

In corroboration of the results found for the city of Cuiabá, where emergency treatment for asthma attacks presented seasonality, the authors of another study observed that the frequency of hospitalization for asthma was higher in the months of June, August and September, coinciding with the months of greater climatic variation and greater changes in other environmental variables.<sup>(19)</sup> It was also reported that, in the national capital of Brasília (in the Federal District), more than half of all emergency room visits for asthma (63.8%) occurred between the months of December and May, a period that corresponds to the months in which rainfall is highest in that area.<sup>(28)</sup> In another study, a greater number of emergency room visits due to asthma attacks were observed in the months of May, June, July and August.<sup>(29)</sup>

With regard to the need for hospitalization of asthmatic children presenting attacks, a 20-year study was recently completed at the Hospital da Santa Casa do Rio Grande (Santa Casa Hospital of Rio Grande), in the city of Rio Grande (located in the state of Rio Grande do Sul) in order to study this tendency.<sup>(15)</sup> The authors found a higher rate of hospitalization among five-year-old children, with a slightly greater concentration between the months of March and July, the month of May presenting the highest frequency. Unlike the city of Cuiabá, where the determining climatic factor was the dry season (heat and low relative humidity), Rio Grande presents very cold months, which may have constituted a determining factor. It is known that months presenting the highest hospitalization rates correspond to those in which the demand for asthma treatment in health facilities, both inpatient and outpatient, is increased.<sup>(13, 29)</sup>

The use of secondary data collected from health facility (emergency room) medical charts may have caused some biases. Therefore, some comments regarding the method are pertinent. First, we must consider the lack of some data that could have facilitated the analysis of the study variables, as is the case for health records compiled for other purposes. Data regarding family

history of asthma or atopy, passive smoking and the nutritional state of the children, among others, were not available. This makes it difficult to understand the process as a whole since it limits the depth of the analysis of the results found, making it impossible to create study outlines in order to also measure the individual exposure of the child to the risk factors for asthma attacks.

Second, we must consider the quality of the data registered regarding the definitive diagnosis made after the clinical examination of the child in the emergency room. It is known that the margin of error increases significantly due to the type of work that the pediatrician of the emergency room faces since the demand is considerable and the job is tiring. This leads to the allocation of less time for each child, thereby favoring the occurrence of misinterpretations of the signs and symptoms presented by the child.

Third, we must discuss the way the data analysis was performed. Due to the type of data collection, data regarding morbidity obtained through the analysis of the medical charts were grouped by month, making comparison with daily variations in the climatic variables impossible and thus preventing the use of more highly recommended analytical methodologies. Therefore, we had no intention of building a predictive model that could accurately estimate the number of asthma hospitalizations by climatic period. We aimed only to show the existing correlation, taking into account the relevance of knowing the epidemiological characteristics of the disease in view of the climatic peculiarities of the region. However, despite the various limitations mentioned, the present study has significance since it demonstrates the existence of a correlation between climatic variations and asthma hospitalization, indicating the need for further studies. Such studies should employ more refined methods, carrying out a more in-depth analysis of the variables involved in order to better understand this process in the city of Cuiabá and in regions with similar climatic characteristics.

We conclude that climatic factors may affect asthma control in children, influencing asthma severity in particular. It was clear that children under five years of age are more predisposed to the complications of the asthma attacks, more often requiring hospitalization, in the dry season.

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