DOI: 10.1590/1413-81232020255.04442018

The influence of climatic conditions on hospital admissions for asthma in children and adolescents living in Belo Horizonte, Minas Gerais, Brazil

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Abstract *Limited research exists on the influence of climatic conditions on the risk of hospital admission for asthma in Minas Gerais, Brazil. The objectives of this article are: a) to evaluate the influence of climatic conditions on hospital admissions for asthma and lower respiratory tract infections (LRTIs) among children and adolescents living in Belo Horizonte during the period 2002 to 2012 and identify epidemic peaks of admissions for asthma; b) to compare local seasonal patterns of admissions for asthma and LRTIs. Using hospital admission data stratified by aged group, regression analysis was performed to determine the relationship between the variables. Epidemic peaks were identified using an ARIMA model. There was an increase in admissions for asthma with an increase in relative humidity after rainy periods; admissions for bronchiolitis were associated with low levels of maximum temperature and rainfall. Rainy periods can lead to an increase in indoor and outdoor humidity, facilitating fungal proliferation, while cold periods can lead to an increase in the spread of viruses.*
Key words *Hospital admissions for asthma, Climate, Hospital admissions for Bronchiolitis, Child and Adolescent*

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Introduction

Asthma is a multifactorial disorder characterized as a chronic inflammatory disease with bronchial hyperresponsiveness and variable airflow limitation that is often reversible, either spontaneously or through the use of bronchodilators[1,2].

In Brazil, despite a fall in the number of hospital admissions, asthma is the third biggest driver of healthcare costs in Brazil's national health system[3]. While studies have shown a decline in admissions for asthma in regions and large cities such as Minas Gerais[4] and Belo Horizonte[5], this reduction has been less pronounced among people living in areas with a high level of social vulnerability, such as slums[6], resulting in asthma inequalities.

According to the National Heart, Lung, and Blood Institute, various interacting individual, lifestyle, and environmental factors may cause asthma exacerbations, including lower respiratory tract infections (LRTIs), contact with indoor and outdoor allergens, and weather changes[2,7,8]. Moreover, these factors may be influenced by socioeconomic status[2].

Respiratory viruses have been recognized as a major factor in the sharp rise of wheezing episodes and asthma exacerbations, especially among children under two years of age. Respiratory syncytial virus is known to be one of the main causes of wheezing episodes in these children[9].

Another important factor that can trigger asthma attacks is climatic conditions. Studies conducted in different regions of the world, including Brazil, have shown a link between admissions for asthma and seasonal variations in climate[10-12]. However, the role played by climatic factors (temperature, accumulated rainfall, and relative humidity) in triggering and/or aggravating asthma remains unclear.

In winter, cold air can affect lung function in asthma patients and induce bronchospasm[13]. Furthermore, rainy spells with less sunshine hours give rise to an increase in indoor humidity, favoring fungal proliferation, and people tend to spend more time indoors in enclosed spaces with others, thereby facilitating the spread of viruses[14,15]. In addition, greenhouse gas emissions accelerate global warming, causing a rise in winter and spring temperatures and leading to earlier and prolonged pollination seasons. Spores containing allergens interact with pollutants, determining the diffusion and aggregation of gases in the atmosphere[7], leading to an increase in human exposure to these gases and thereby increasing the risk of asthma attack and asthma susceptibility[15].

Given that the interaction between urban climate and health is setting specific, understanding local seasonal patterns and environmental triggers of asthma is vital, especially in areas lacking longitudinal studies over long periods.

In view of the above, the objectives of this study were: a) to evaluate the influence of climatic conditions (minimum and maximum temperature, accumulated rainfall, and relative humidity) on hospital admissions for asthma and LRTIs among children and adolescents living in an urban settings between 2002 and 2012 and identify epidemic peaks of admissions for asthma; and b) to compare local seasonal patterns of admissions for asthma and LRTIs.

The findings of this study can contribute to asthma management, prevention, and treatment and improve healthcare delivery and the allocation of resources during epidemic peaks.

Furthermore, the inclusion of LRTIs, such as viral bronchiolitis, enables the analysis of the patterns of this disease associated with climate change in children aged 0-4 years, helping to clarify diagnosis in this age group.

Materials and method

A time series study covering the period 2002 to 2012 was conducted in Belo Horizonte, Brazil (latitude 19.9°S and longitude 43.9°W). Belo Horizonte is the capital of the State of Minas Gerais, has a population of 2,375,151 inhabitants, an area of 331.4 km^2, and population density of 7,167.02 people/km^2.[16]

The climate is subtropical with a wet season (summer) and dry season (winter). The average monthly temperature is 23°C in the summer (December to March) and 19°C in the winter (June to September). Temperature inversions are common in the winter months. Annual rainfall is around 1,450 mm and the prevailing wind direction is east-northeast[16].

Admissions for asthma

Data on admissions for asthma was obtained from hospital admission authorization forms provided by the Belo Horizonte City Department of Health. The study included all admissions to public services of children and adolescents aged 0 to 14 years living in Belo Horizonte registered

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in the database of the *Projeto BH-Viva* (implemented by the Urban Health Observatory at the Federal University of Minas Gerais) where the primary diagnosis was asthma (International Classification of Diseases – ICD 10, J45 to J46). The admissions were categorized into the following age groups: 0-4, 5-9, and 10-14 years.

Lower respiratory tract infections (LRTI)

Data on admissions to public services for bronchiolitis (ICD 10 J21, J21.0, J21.8, and J21.9) in children aged 0 to 4 years living in Belo Horizonte was obtained from the same source mentioned above. The age group was limited to 0 to 4 years because it is known that during the study period 98% of registered admissions for bronchiolitis occurred in children in this group.

Asthma and bronchiolitis hospitalization rate

To calculate the annual hospitalization rate, the population figures were adjusted to take account of omissions in the 2010 Census conducted by the Brazilian Institute of Geography and Statistics (IBGE)[16]. A correction factor of 14.6% was used based on omission rates of 15 and 16%, respectively, for boys and girls under five years of age, and 13% for the five to nine years age group.

In addition, we calculated the annual population growth rate based on demographic changes in delimited areas such as the "formal city" and slums. The cohort growth rate during the period between censuses was estimated based on the comparison between the base population in 2010 and population in 2000[17]. The rate of admissions for asthma and bronchiolitis were calculated for each age group based on the number of admissions per month and per year.

Climate data

Data on mean monthly minimum and maximum temperature (°C), relative humidity (%), and accumulated rainfall (mm) was obtained from the Conventional Station of Belo Horizonte (World Meteorological Organization - WMO: 83587), belonging to the National Institute of Meteorology, was provided by the Climatology Laboratory at the Pontifical Catholic University of Minas Gerais and Belo Horizonte City Council[18].

Data was obtained for all months (132 months) during the 11 years. The study used the monthly average of these data, for all years.

Statistical analysis

Descriptive statistics

The annual rates and monthly admissions for asthma and bronchiolitis were stratified by age group and analyzed against the climate data and number of hospitalizations by asthma (0-14 years) and bronchiolitis (0-4 years) happened in Belo Horizonte, between 2002 and 2012.

Correlation and regression analysis

The relationship between the rates of admissions for asthma and bronchiolitis and the climate variables was determined using Pearson's correlation coefficient. The effects of each climate variable were analyzed using Poisson regression, where the dependent variables were rate of admissions for asthma among the 0-14 and 0-4 years age groups and rate of admissions for bronchiolitis among children aged between 0-4 years. To determine whether there was a delayed response of hospitalization rates to climatic conditions, the climate variables were lagged by one and two months before the date of hospitalization.

Time series

An Auto-Regressive Integrated Moving Average (ARIMA) model[19] was used to capture seasonal patterns in the variables over time from past values. We used the seasonal model ARIMA (p,d,q) x (P,D,Q)[S], where p is the order of the autoregression (AR), q is the order of the moving average part (MA), d is the number of times the series is differenced, P is the order of the seasonal-AR process, Q is the order of the seasonal-MR process, and D is the degree of seasonal difference[19]. Trends in the number of admissions in the years 2013, 2014, and 2015 were analyzed together with their confidence intervals. The differences between the orders d and D are applied to remove trends and seasonal effects to make the time series data stationary.

The model was validated by forecasting the number of admissions for asthma for 2011 and 2012 using the ARIMA model without these trends and seasonal effects. Predictive capacity was measured using mean absolute error (MAE), a common measure of forecast error calculated using the following equation:

$$\mathrm{MAE} = \frac{\sum_{i=1}^{n} |y_{iobs} - \hat{y}_i|}{n}$$

where y_{iobs} is the number of observed admissions, $\hat{y}$ is the number of admissions forecasted by the adjusted ARIMA model, and *n* is the number of forecasted observations, which in this specific case corresponds to 24 observations.

Data processing and analysis was performed using the statistical software packages R and STATA adopting a significance level of 5% used to assess the statistical significance of the hypothesis tests performed.

The study was approved by the Research Ethics Committee at the Federal University of Minas Gerais.

Results

Rate of admissions for asthma and bronchiolitis

There were 32,978 admissions of children and adolescents (0-14 years) for asthma during the study period, 18,962 (57.5%) of which were males and 14,016 (42.5%) female. Hospitalization rates according to age group are shown in Table 1.

Table 1 shows that the rate was highest in the 0-4 years group (25,926), followed by the 5-9 (5,817) and 10-14 (1,235) years age groups.

The rate of admissions for asthma fell during the study period across all age groups, whereas the rate of admissions for bronchiolitis increased (Table 1).

The peak months for admissions for asthma and admissions for bronchiolitis were March, April, and May, and May, June, and July, respectively (Table 2). The Pearson's correlation coefficient showed a positive significant association between the numbers of admissions for asthma and the numbers of admissions for bronchiolitis in the 0-4 years age group (0.30, p = 0.001).

Table 2 shows that there are two well-defined seasons: a rainy season, characterized by an increase in temperature and humidity; and a dry season, characterized by lower relative humidity. Temperatures vary slightly between seasons.

As expected, the Pearson's correlation coefficients show a significant correlation (5% of significance) between maximum and minimum temperature ($r = 0.83$, $p < 0.01$), relative humidity and accumulated rainfall ($r = 0.68$, $p < 0.01$), accumulated rainfall and minimum temperature ($r = 0.55$, $p < 0.01$), relative humidity and minimum temperature ($r = 0.45$, $p < 0.01$), and accumulated rainfall and maximum temperature ($r = 0.28$, $p < 0.01$), and a very weak negative nonsignificant association between maximum temperature and relative humidity (-0.03, p = 0.76).

The Poisson regression analysis of the association between rates of admissions for asthma and climate variables showed that there was a 1% decrease in the monthly admissions rate for every 1mm increase in rainfall and a 5% rise in the admissions rate for every 1% increase in relative humidity in both age groups (Table 3). These associations were significant (5% of significance).

With regard to bronchiolitis, the results showed that there was a 1% decrease in the monthly admissions rate for every 1mm increase in rainfall and a 21% decrease in the monthly admissions rate for every 1ºC increase in maximum temperature (5% of significance) (Table 3).

To determine whether there was a delayed response of rate of admissions for asthma to climatic conditions, we analyzed the correlation between rate of admissions for asthma and climate variables lagged by one and two months. The results show a significant correlation (5% of significance) between rate of admissions for asthma and relative humidity and higher minimum temperature both one and two months before hospitalization ($r = 0.41$ and 0.50, respectively, $p < 0.01$ and $r = 0.36$ and 0.48, respectively, $p < 0.00$), suggesting a possible delayed response.

Poisson regression was used to test the effect of exposure to variations in climatic conditions one and two months before hospital admissions. The results showed an association between admission rates and mean minimum and maximum temperatures, relative humidity, and accumulated rainfall both one and two months before admission. Given that the values for minimum temperature depend on the values for maximum temperature, the analysis was performed adding the variable *temperature range*, which refers to the difference between monthly maximum and minimum temperatures.

The results of the final model with climate variables lagged by one month showed that there was a 1% decrease in the rate of admissions for asthma for every 1mm increase in rainfall and a 4% rise in rates of admissions for each 1% increase in relative humidity for both the 0-14 and 0-4 years age groups. With regard to bronchiolitis, there was a 1% decrease in the rate of admissions for every 1mm increase in rainfall and a 24% decrease in rates of admission for each 1ºC increase in temperature range (Table 4). These associations were statistically significant (5% of significance).

Table 1. Annual rate of hospital admissions for asthma and bronchiolitis in the period 2002 to 2012 stratified by age group. Belo Horizonte, Brazil.

Year	Age Group							
	0-4				5-9		10-14	
	Asthma		Bronchiolitis		Asthma		Asthma	
	Nº	Rate	Nº	Rate	Nº	Rate	Nº	Rate
2002	3,716	21.45	412	2.38	683	3.67	109	0.59
2003	3,326	19.31	456	2.68	611	3.32	142	0.77
2004	3,366	19.66	508	3.03	682	3.75	127	0.70
2005	2,699	15.85	374	2.27	613	3.40	130	0.72
2006	2,214	13.08	406	2.50	480	2.69	86	0.48
2007	2,148	12.76	395	2.47	525	2.98	111	0.63
2008	1,893	11.31	604	3.84	506	2.90	102	0.58
2009	1,699	10.20	423	2.73	423	2.45	105	0.61
2010	1,773	10.70	536	3.52	469	2.74	118	0.69
2011	1,612	9.73	583	3.83	408	2.40	98	0.58
2012	1,480	8.93	911	5.98	417	2.47	107	0.64
Total	25,926		5,608		5,817		1,235	

* Hospital admissions rate per 1,000 population.

Table 2. Mean monthly climate variables and number of admissions for asthma (0-14 years) and bronchiolitis (0-4 years) between 2002 and 2012. Belo Horizonte, Brazil.

		Asthma	Bronchiolitis	Maximum temperature	Minimum temperature	Accumulated rainfall	Humidity
Wet season	OCT	188	24	29	19	109	59
	NOV	176	24	28	19	255	68
	DEC	165	22	28	20	403	71
	JAN	160	28	28	20	358	71
	FEB	270	25	29	20	176	66
	MAR	431	45	28	20	209	69
	APR	338	44	28	20	184	67
	Mean	247	30	28	20	242	67
Dry season	MAY	371	86	26	17	23	63
	JUN	260	71	25	16	11	62
	JUL	184	55	25	15	6	57
	AGU	194	32	27	16	10	53
	SEP	171	24	28	17	55	54
	Mean	236	54	26	16	21	58

In the model with variables lagged by two months, only increased relative humidity showed a statistically significant association with rate of admissions for asthma (5% of significance), with a 3% rise in rates for each 1% increase in relative humidity. With regard to bronchiolitis, there was a 19% reduction in rates for each 1% increase in temperature range, suggesting that a reduction in temperature leads to an increased risk of hospitalization (Table 4). These associations were statistically significant (5% of significance).

Time series modeling of admissions for asthma (0-14 years) showed that the best model was ARIMA (0,1,2) (2,0,2) [12], which considers a 12-month seasonal pattern.

To validate the model, the number of admissions for asthma in 2011 and 2012 were excluded and the forecasts for these years were performed

Table 3. Final model to determine the association between rate of admissions for asthma and bronchiolitis and climate variables for the period 2002 to 2012. Belo Horizonte, Brazil.

Admissions	Coefficient	SD	p- value	CI (95%)	
Asthma 0-14 years					
Rainfall	0.99	0.0003	<0.001	0.997	0.998
Humidity	1.05	0.0060	<0.001	1.037	1.063
Asthma 0-4 years					
Rainfall	0.99	0.0002	<0.001	0.997	0.998
Humidity	1.05	0.0042	<0.001	1.040	1.057
Bronchiolitis 0-4 years					
Maximum temperature	0.79	0.0486	<0.001	0.701	0.892
Rainfall	0.99	0.0005	<0.001	0.997	0.999

using the seasonal model ARIMA (0,1,2) (2,0,2) [12]. The MAE was equal to 55.67 admissions, suggesting that the model adequately predicted the occurrence of asthma within the 95% confidence interval, as can be seen in Figure 1.

The model confirms that there were seasonal patterns in the occurrence of asthma exacerbations over the study period and that downward historical trends point to a reduction in the number of admissions for asthma among children and adolescents living in Belo Horizonte in coming years.

Discussion

Climatic conditions play an important role in various atopic and infectious diseases, which are one of the leading causes of morbidity and mortality in developing countries, particularly affecting children. The main findings of the study can be summarized as follows: (1) the rate of admissions for asthma is higher among children aged 0-4 years and boys and fell over the study period. In contrast, the rate of admissions for LRTIs (based on the rate of admissions for bronchiolitis) increased over the period; (2) the peak months for admissions for asthma and bronchiolitis were March, April, and May, and May, June, and July, respectively; (3) reductions in rainfall and increases in relative humidity are significantly associated with an increase in the rate of admissions for asthma and reductions in maximum temperature and rainfall are associated with rate of admissions for LRTIs; and (4) The model confirms that there were seasonal patterns in the occurrence asthma exacerbations over the study period and that downward historical trends point to a reduction in the number of admissions for asthma among children and adolescents living in Belo Horizonte in coming years.

Asthma is the second leading cause of hospital admissions in children under 14 years in Belo Horizonte City. A study covering the period 1997 to 2000 showed high rates of admissions for asthma together with a downward trend in rates among children under five years[20]. Another study of the period 2002 to 2012 showed a continuing downward trend, indicating that actions taken to tackle asthma have had a positive impact on admissions[6].

However, it is important to stress that despite the fall in admission rates, the number of admissions is high in comparison to developed countries[21,22], suggesting that other factors influence the occurrence of asthma exacerbations.

It is also interesting to note that there was an increase in the number of admissions for bronchiolitis over the study period, corroborating the findings of studies demonstrating that there has been an increase in the circulation of multiple viruses in recent years, particularly affecting children's health[23]. In this respect, the influence of climatic conditions on the multiplication and maintenance of multiple respiratory viruses in urban settings is well-known.

However, the effect of climatic conditions is generally underestimated due to difficulties in assessing individual exposure and lack of information on patient medical history, thereby hindering the measurement of the exposure–response relationship. By understanding the influence of climatic conditions and identifying periods of severe asthma epidemic peaks based on hospital admissions, it is possible to enhance the quality of hospital care and strengthen health promotion

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Table 4. Final Poisson regression model for variations in climatic conditions one and two months before admissions for asthma and bronchiolitis in the period 2002 to 2012. Belo Horizonte, Brazil.

Admissions	Lagged by one month					Lagged by two months				
	Coeff	SD	p -value	CI		Coeff	SD	p-value	CI (95%)	
Asthma 0-14 years										
Rainfall	0.99	0.0004	<0.001	0.998	0.999	-	-	-	-	-
Humidity	1.04	0.0009	<0.001	1.031	1.057	1.04	0.001	0.000	1.034	1.038
Asthma 0-4 years										
Rainfall	0.99	0.0002	<0.001	0.998	0.999	-	-	-	-	-
Humidity	1.04	0.0040	<0.001	1.032	1.049	1.03	0.005	0.000	1.023	1.043
Bronchiolitis 0-4 years										
Rainfall	0.99	0.0004	<0.001	0.997	0.999	-	-	-	-	-
Temperature range	0.76	0.0470	<0.001	0.670	0.860	0.81	0.081	0.03	0.660	0.980

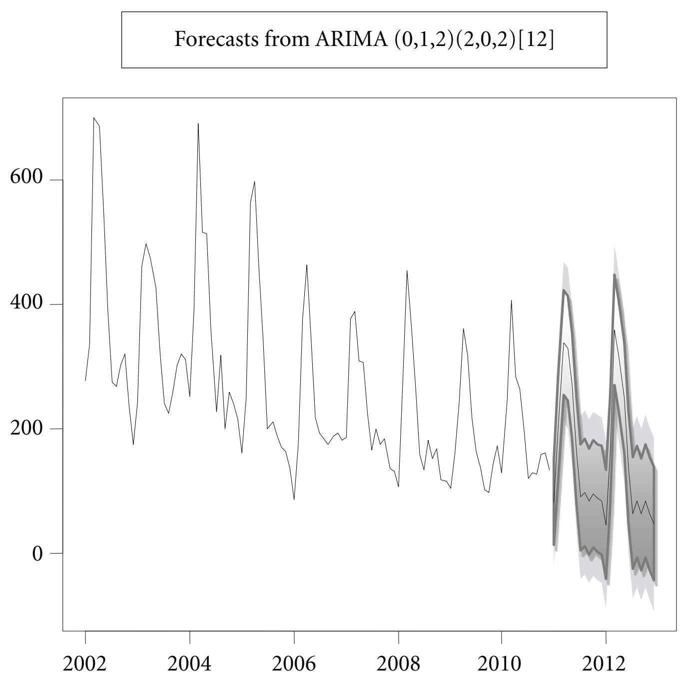

Figure 1. Time series modeling of number of admissions for asthma (0-14 years).

and asthma control programs in primary care services.

While a number of studies have shown that there is a relationship between seasonal variations in climate and the prevalence of asthma in Brazil[12,14,24,25], few have investigated hospital admissions for asthma[26]. Furthermore, these studies present contrasting findings regarding the role climatic conditions play in respiratory exacerbations.

The present study investigated the association between climatic conditions and cases of severe asthma requiring hospital admission. It is important to highlight there is often a delay between the onset of asthma symptoms and admission to hospital, during which time the patient continues to be affected by the surrounding environment, worsening the condition. Moreover, other factors can contribute to hospital admission, such as poor or delayed access to primary healthcare services and inappropriate or inadequate medication[26]. Our findings show that there was an association between increased relative humidity after rainfall and admissions for asthma, with effects persisting for long periods of time. In general, relative humidity refers to the degree of saturation of the air and is strongly influenced by rainfall. However, the present study showed that admissions for asthma were associated with high humidity and low rainfall, suggesting that the delayed effects of rain can lead to an increase in humidity, especially indoors. Poor ventilation and exposure to the sun can lead to damp and mould and overall poor indoor air quality, contributing to an increase in respiratory diseases. The present study did not investigate the influence of heatstroke on hospital admissions, due to lack of information. Instead, maximum temperature was used as a proxy variable, considering the strong correlation between these variables. However, it is recommended that future studies include this variable.

Belo Horizonte is the most densely populated city in the State of Minas Gerais. Rapid population growth led to unplanned urban sprawl, with the occupation of areas of risk such as steep slopes and stream banks, particularly by low-income groups. Environmental degradation, poverty, and extreme geological risk may contribute to flooding of soils, leading to an increase in indoor humidity. In this respect, a study reported higher rates of admissions for asthma in vulnerable areas such as slums[6].

Studies conducted in other states in Brazil confirm the influence of humidity on respiratory diseases in regions with a tropical climate characterized by slight variations in temperature between seasons[14,24,25].

It is important to highlight that, in contrast to the problems experienced in the dry season, during the rainy season high relative humidity combined with the fact that people tend to spend more time indoors increases contact with indoor allergens and spread of viruses[8,27,28]. In this respect, exposure to indoor allergens for prolonged periods of time may partially explain why increases in humidity after rainy spells continued to influence hospital admissions for up to two months later.

Only a weak association was found between LRTIs (based on admissions for bronchiolitis) and admissions for asthma in children aged 0-4 years ($r = 30$, $p < 0.01$), suggesting that LRTIs have little influence on severe asthma. In this respect, the timing of epidemic peaks in admissions for asthma and bronchiolitis was different and the occurrence of bronchiolitis was associated with different climatic conditions to those that influence asthma.

The findings show that admissions for bronchiolitis and admissions for asthma followed different patterns. The results of Poisson regression showed a significant association between admissions for bronchiolitis and falls in maximum temperature and lower rainfall, which coincides with winter weather patterns. Studies have shown that breathing in cold air decreases the temperature of the lower airways, facilitating rhinovirus replication[29]. In addition, in colder weather people tend to spend more time indoors in enclosed spaces with others, facilitating the spread of viruses, especially in schools, crèches, and homes[8,28].

The time series model used by this study accurately predicted future epidemic peaks in admissions for asthma, making it an important tool from a public health perspective. The World Health Organization (WHO) encourages the development of models capable of predicting disease outbreaks, as they are invaluable tools for tackling and preventing epidemics[30].

Despite providing important insights about asthma, this study has limitations, notably that it was impossible to evaluate the role of pollutant concentrations. The main source of air pollution in Belo Horizonte is road traffic, since most factories are located in metropolitan regions and the use of gas heaters is limited. Pollutants may have a toxic effect not only on people with allergies, but also on susceptible individuals[31,32]. According to the state environment agency (*Fundação Estadual do Meio Ambiente* - FEAM)[33], air pollution concentrations in the city are within legal limits. Nonetheless, future studies should consider the effect of air pollutants.

It is known that rain washes away pollutants, cleaning the air by removing significant amounts of suspended particulate matter. Furthermore, wet soils prevent particle resuspension. On the other hand, wind is slowed by rough surfaces and obstacles, meaning that uneven topography can affect wind speed and hinder the dispersion of pollutants and heat.

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The present study also did not evaluate the influence of heat stroke on the occurrence of hospitalizations, to test conditions against the increase in humidity. However, because it is highly correlated with the maximum temperature, the study chose to use temperature as a possible proxy for this variable in the present study, which did not show any correction between the variables.

Another limitation is the use of secondary data for admissions for asthma and bronchiolitis without confirming diagnosis and identifying the type of bronchiolitis. Because they have similar clinical characteristics, it is difficult to differentiate between viral diseases and asthma, especially in children under 2 years. However, it is important to stress that viral bronchiolitis requiring hospital admission is an acute condition and its diagnosis is eminently clinical. Patients can develop signs and symptoms that are different to those of asthma and may require a different form of treatment, especially in relation to the response to use of beta-agonists. Patterns of asthma in children under 4 years were similar to those in children aged 10 to 14 years. However, these findings are not sufficient to rule out diagnostic error.

It is important to note that the quality of information provided by health information systems in Brazil, particularly the HIC, has improved significantly in recent years and that the data shows a high level of agreement with the ICD. Studies in this area have shown that the SIH is a valuable tool for epidemiological research and its use, which is still modest considering its potential, should be encouraged. In this sense, the wide-scale dissemination of results could encourage the use of this database[34]. The dissemination of similar studies is also important so that system managers can become aware of the results and prioritize efforts to improve data quality. The results of the present study were consistent with current knowledge, reinforcing the consistency of the information.

Finally, limiting the study sample to admissions to public health services means that part of the population was excluded from the analysis. However, according to the 2013 National Health Survey, two-thirds of the Brazilian population were admitted to public hospital services, especially people under the age of 17[35], suggesting that the results of this study can be used to make inferences about a large segment of the population.

Although the findings of this study should be interpreted with caution given the methodological approach and limitations, they provide valuable insights for health, social, and environmental policy.

Conclusion

Climatic conditions play an important role in various respiratory diseases that particularly effect children. By understanding the influence of climate conditions on the occurrence of asthma and identifying severe asthma epidemic peaks based on hospital admissions, it is possible to enhance the quality of hospital care and strengthen health promotion programs in primary care services.

Interventions focused on asthma prevention, such as health education programs, correct diagnosis of signs and symptoms, and monitoring of severe cases during epidemic peaks, combined with interventions designed to promote immediate access to medication and physical therapy, interventions in and around the home environment, and improvements in socioeconomic conditions, have been shown to reduce the risk of asthma attacks and, consequently, hospital admission.

Collaborations

CS Dias participated in all the processes of writing the article, including organization of the database and statistical analysis. SA Mingoti participated in the structuring of statistical models and analysis. MAS Dias participated in the elaboration of the methodology and contribution in writing the article. APR Ceollin participated in the statistical analysis and contributed to the writing of the article. AAL Friche participated in the elaboration of the methodology and contribution in writing the article. WT Caiaffa participated in the elaboration of the methodology, in the statistical analysis and writing of the article.

Acknowledgements

The 1st phase of the BH-Viva project (creation of the Data Warehouse and qualitative study I) was partially financed by the Cooperation Agreement - BH-Rio Observatory of Fiocruz; Vice-Presidency of Environment, Attention and Health Promotion (VPAAPS); and Federal University of Minas Gerais, Urban Health Observatory of Belo Horizonte (UFMG-OSUBH), within the scope of QUALISUS, in 2011-12 and FAPEMIG projects. The 2nd phase (survey and qualitative study II) by the Ministry of Health (National Health Fund) through the Oswaldo Cruz Foundation (Fiocruz). The authors would also like to thank the team from the Urban Health Observatory of Belo Horizonte, Faculty of Medicine, Federal University of Minas Gerais (OSUBH-FM-UFMG), the invaluable team of urban planners from the Urbanizadora of Belo Horizonte (URBEL) and the National Council for Scientific and Technological Development (CNPq), for research productivity grants (WTC and AALM).

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Article submitted 24/04/2017
Approved 09/05/2019
Final version submitted 11/05/2019