

ENVIRONMENTAL POLLUTANTS AND ODDS OF HOSPITALIZATION FOR ASTHMA IN CHILDREN - SÃO JOSÉ DOS CAMPOS, BRAZIL, IN THE YEARS 2004-2005

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Abstract

Objective: to estimate the association between exposure to air pollutants and hospital admissions for asthma. **Methods:** this is an ecological study of time series, which included individuals from 0 to 10 years living in São José dos Campos, for the period 2004 to 2005. Data of hospitalizations for asthma were obtained from DATASUS. The data of ambient levels of particulate matter, sulfur dioxide and ozone were obtained from the Company of Technology of Environmental Sanitation (CETESB) and temperature and humidity from the Foundation for Science, Technology and Space Applications (FUNCATE). Lag models have been made from 0 to 7 days and analyzed by binary logistic regression, yielding odds ratios and their confidence intervals of 95% by SPSS 15.0. **Results:** there were 809 admissions, ranging from 0 to 7. It was possible to identify an association of the particulate matter both on the same day of exposure and the next third, fifth and sixth days with the admissions; sulfur dioxide was associated with hospitalizations in the first, second and third days after exposure and ozone on the third day after exposure to gas. Thus, this study showed an association between air pollutants and asthma hospitalization in a medium-sized city.

Key words: asthma; air pollution; particulate matter; sulfur dioxide; ozone.

INTRODUCTION

Among the environmental factors related to the pathogenesis of respiratory diseases, we can highlight air pollution, a major public health problem today. Studies have found that air pollutants, even at exposure levels below acceptable standards, can cause deleterious effects to human health¹. It is known that the lungs are the main target of attack of air pollutants, among which the primary are particulate matter (PM₁₀), sulfur dioxide (SO₂) and ozone (O₃).

The particulate matter is a mixture of liquid and solid particles suspended in the air which can reach the lower airways. It presents an important characteristic of transporting gases adsorbed on its surface to the most distal portions of the airways. The sulfur dioxide resulting from combustion of fossil elements, can be transported to distant regions of

the primary sources of emission, which increases its area. Moreover, the ozone formed from chemical reactions involving sunlight, has powerful oxidizing and cytotoxic effect².

Among respiratory diseases, bronchial asthma, one of the most common chronic diseases of childhood, has been linked to exposure to environmental pollutants in many parts of the world³⁻⁶. In Brazil, the relationship between exposure to environmental pollutants and respiratory disease has been studied mainly in large urban centers and medium-size cities^{1,7-10}.

Besides, being a disease of worldwide prevalence, asthma generates high costs, both socially and for the health system¹¹. In 2007, the financial cost due to hospitalization for asthma in children and adolescents spun around R\$ 6 million (1 US\$ H" R\$ 1.70) for the State of São Paulo and R\$ 70,000 for the city of São José dos Campos, SP¹².

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Children and elderly people with diseases of cardio-pulmonary involvement prior are the most susceptible to the adverse effects of air pollution. For children, the fact is due to greater exposure to pollutants, increased ventilation per minute and higher levels of physical activity¹³.

It is believed that the manifestations of the biological effects of air pollution have a behavior gap in relation to the individual's exposure to these pollutants¹⁴. This means that the manifestation of symptoms of acute asthma in a certain individual may be due to pollution on the days preceding or concurrent with the outcome, which is called lag.

Thus, the objective of this study was to estimate the association between exposure to air pollutants and the chance of hospitalization for bronchial asthma in children and adolescents in Sao Jose dos Campos-SP.

METHODS

It is an ecological study of time series, which used data from hospitalizations in Sao Jose dos Campos, in the periods of 01/01/04 to 12/31/05, obtained from the Department of Information and Informatics of National Health System (DATASUS) 15. All hospitalizations in subjects aged between 0 and 10 years with International Classification of Diseases 10th revision (ICD-10) referred to asthma (J45) were selected. The present study refers to the municipality of Sao Jose dos Campos, a city in the state of Sao Paulo, which is 91 km away from São Paulo, in the Paraíba Valley, with approximate population of 600,000 inhabitants. It presents itself as a regional center for industry, shopping and services in the Vale do Paraíba and southern Minas Gerais State, serving a population of approximately 2 million in habitants¹⁶.

Information on the daily levels of pollutants particulate matter, sulfur dioxide and ozone were obtained from the Agency of Environmental Sanitation Technology (CETESB)¹⁷, which has a monitoring station in Sao Jose dos Campos, located in the central region. For all pollutants, data collection was started in the first hour of the day, for 24 hours and were quantified in mg/m³. We considered the daily averages of each pollutant. The technique to quantitate the PM₁₀ was Beta monitor for the technique of coulometry SO₂ and O₃

chemiluminescence. The interpolation of missing data of pollutants was not performed because these data have no deterministic behavior, but chaotic.

Data on temperature and humidity were obtained from the Foundation for Science, Technology and Space Applications (FUNCATE)¹⁸. To estimate the relationship between exposure to environmental pollutants and hospital admissions for asthma, both on the same day as the previous days, we constructed models of lags distributed from zero to seven days prior to exposure (lag).

The asthma hospitalization variables were then recoded, with zero referring to absence of a hospital admission and 1 for one or more admissions daily. Then, we analyzed the relationship between exposure to pollutants, which were analyzed as continuous variable, in a unipollutant model adjusted for minimum temperature and humidity, and hospitalizations for asthma with lags from zero to seven days, making use of SPSS 15.0. To estimate this association, binary logistic regression was made and odds ratios obtained with their respective confidence intervals of 95%.

RESULTS

There were 809 hospitalizations of children aged between zero to 10 years for asthma in Sao Jose dos Campos during the study period. The mean was 1.11 hospitalizations (SD = 1.24), with daily ranges 0-7. April, May and June are the months with the highest numbers of admissions in both years of study.

Forty-nine data on humidity, maximum temperature, minimum temperature and average temperature were not obtained. This period of failure refers to the first day of January 2004 until the eighteenth day of February 2004.

There was no information regarding the 31 days of average daily particulate matter (4.2% missing data), 20 days of sulfur dioxide (2.7%) and 26 days ozone (3.6%), irregularly distributed in study period. The admission data were obtained on all days of the study period.

Mean values of hospital admissions, environmental pollutants concentrations, humidity and minimum temperature with respective standard deviations and minimum and maximum values, as well as the number of days that did not have this information, are shown in Table 1.

Table 1: Descriptive analysis of hospital admissions and environmental variables. São José dos Campos, Brazil, 2004-2005

	Mean (sd)	Mínimum - máximo
Hospital admission (0) [#]	1,15 (1,26)	0 - 7
PM ₁₀ in mg/m ³ (31)	25,24 (13,42)	6 - 100
SO ₂ in mg/m ³ (20)	4,6 (3,21)	1 - 31
Ozone in mg/m ³ (26)	74,27 (32,39)	9 - 232
Umidity in % (49)	79,6 (6,8)	54,0 - 99,3
Temperature °C (49)	15,4 (2,7)	7,4 - 20,5

[#] missing records

The distribution of the daily levels of environmental pollutants are shown in Figure 1.

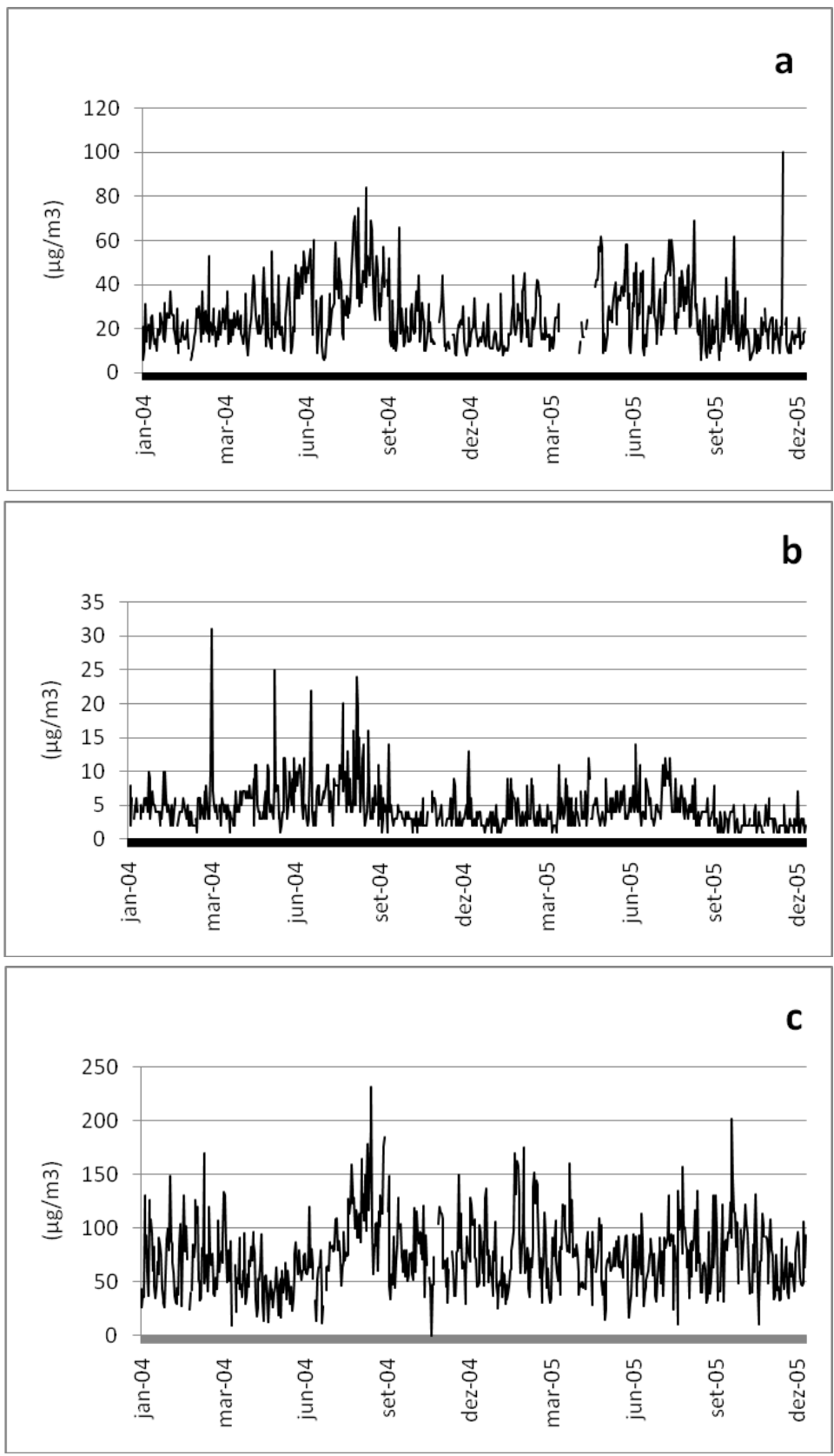


Figure 1: Pollutants values *, em ig/m³. São José dos Campos, Brazil, 2004-2005. *(a) particulate matter; (b) sulfur dioxide; (c) ozone

From the binary logistic regression, we obtained the coefficients of the odds ratios and standard errors for each pollutant in each lag structure, shown in table 2. Figure 2 shows the odds ratio obtained by relating the

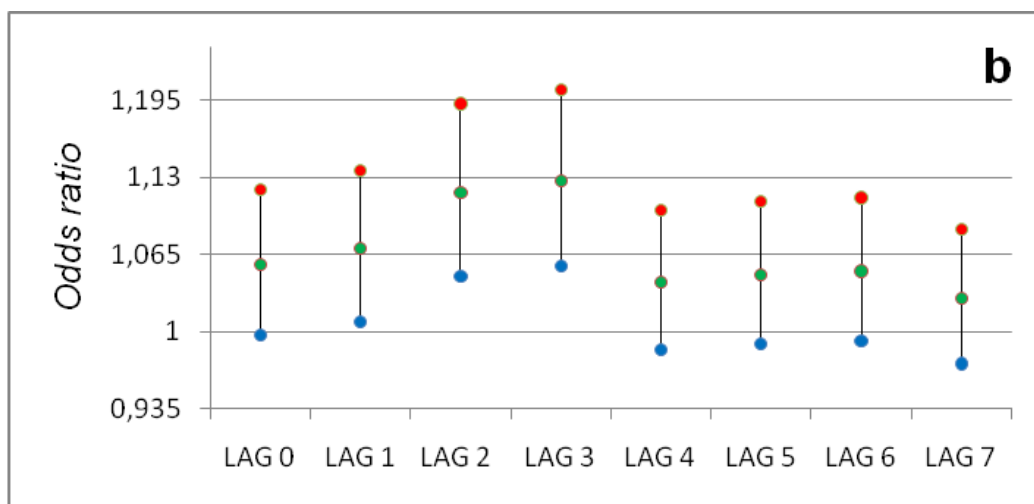
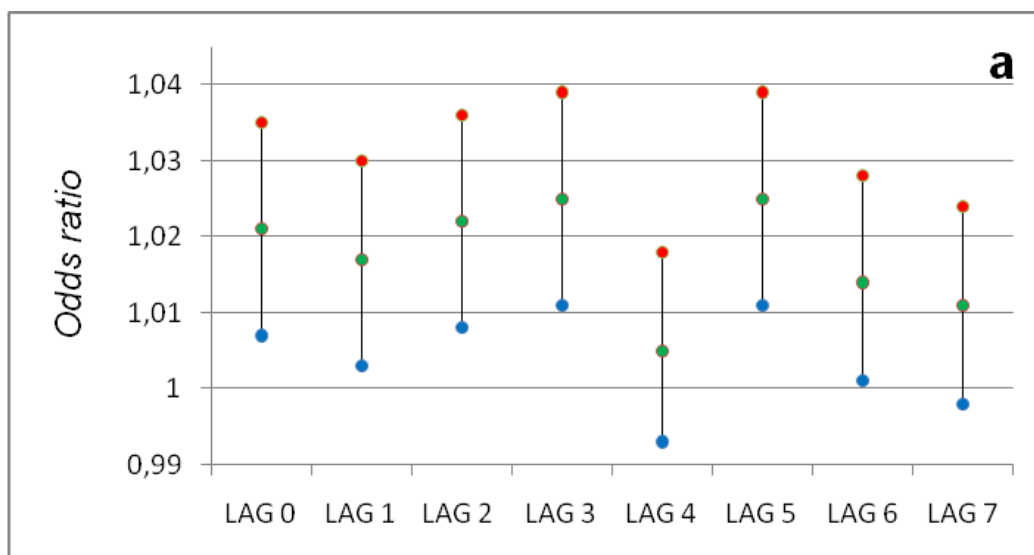
concentrations of air pollutants, adjusted for minimum temperature and humidity, and hospitalizations for asthma, with their respective 95% confidence intervals for lags from zero to seven days.

Table 2: Pollutants coefficients and standard errors (SE) of OR in respect to lag structure. São José dos Campos, Brazil, 2004-2005

	<i>PM</i> ₁₀	<i>SO</i> ₂	<i>O</i> ₃
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Lag 0	0,02 (0,007)**	0,055 (0,03)	0,002 (0,003)
Lag 1	0,017 (0,007)*	0,068 (0,03)*	0,003 (0,003)
Lag 2	0,022 (0,007)**	0,111 (0,033)**	0,000 (0,003)
Lag 3	0,025 (0,007)**	0,120 (0,034)**	0,007 (0,003)*
Lag 4	0,005 (0,007)	0,041 (0,029)	0,004 (0,003)
Lag 5	0,024 (0,007)**	0,047 (0,029)	0,002 (0,003)
Lag 6	0,014 (0,007)*	0,049 (0,029)	0,001 (0,003)
Lag 7	0,011 (0,007)	0,027 (0,028)	0,001 (0,003)

* p<0,05

** p<0,01



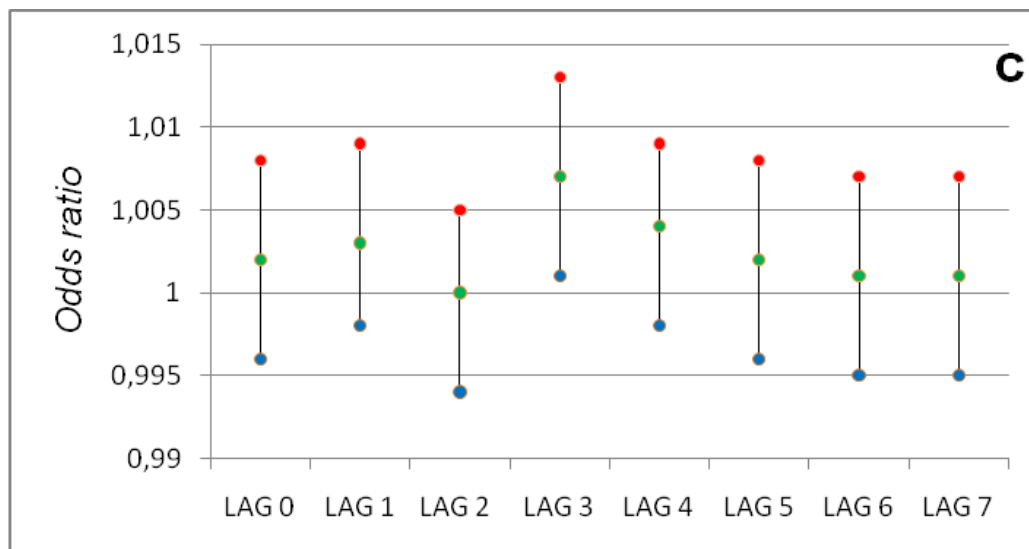


Figure 2: Odds Ratio* and the respective 95% confidence interval in respect to lags structure. São José dos Campos, Brazil, 2004-2005. *a) particulate matter; b) sulfur dioxide; c) ozone

DISCUSSION

This is the first study to estimate the association between exposure to air pollutants (PM_{10} , SO_2 and O_3) and hospitalizations for asthma in a medium-size city in Brazil, such as São José dos Campos. We chose to use logistic regression to estimate the odd of hospital admission unlike other studies in Brazil that used Poisson regression to estimate the increase in risk of hospitalization^{19,20}.

The months with higher numbers of hospital admissions for asthma in this study were April, May and June in both years of study, and this is possibly due to the lower temperatures occurring in those months.

The PM_{10} exposure is significant in the same day, the three subsequent days, in the fifth and sixth days. It is known that one of the mechanisms involved in the onset of deleterious effects from exposure to PM_{10} is the pulmonary inflammation. This pollutant also presented a greater statistical significance in the research conducted by Nascimento et al, also in children in São José dos Campos, in relation to hospitalization for pneumonia¹⁰. On the other hand, in a study conducted in Mexico, there was no significant relationship between ambient levels of PM_{10} and emergency visits for respiratory causes²¹.

Possibly, this difference in statistical findings is due to disregard of individual exposure to the pollutant, to different sampling, having this focus on young people up to 17 years, the longer period of analysis (4 years) in relation to this study and the use of a different analysis model, the Poisson regression.

In the search of Gouveia et al, carried-out in São Paulo, Brazil, it was observed that an increase of $10 \mu g/m^3$ in the level of inhalable particulate

matter is associated with an increase of 4.6% in hospital admissions for asthma in children⁸. In our study, for an increase of $10 \mu g/m^3$ of PM_{10} , the odd of hospitalization increases from 5% to lag of 3 days, and 23% for 1-day lag.

The Air quality guideline (ACG) of the World Health Organization (WHO), published in 2005, accepted maximum daily exposure levels for the PM_{10} up to $50 \mu g/m^3$ and annual exposure to concentrations below $20 \mu g/m^3$, being acute exposures at levels greater than $150 \mu g/m^3$ associated with the increase of mortality by 5% due to cardiorespiratory changes caused by the pollutant.

The levels of annual average concentration of PM_{10} obtained in this study exceed acceptable levels by the WHO, and annual exposure levels above $70 \mu g/m^3$ are associated with significant deleterious effects on health, leading to increased mortality by 15%¹³. This pollutant has as one of its main sources the vehicular fleet, directly interfering in their levels.

The sulfur dioxide, in turn, had a statistical significance in the second and third days of exposure, increasing the chance of at least one hospital admission between 17% and 36% for an increase of $10 \mu g/m^3$. This pollutant, in a study carried out in São Paulo by Braga et al, showed the largest contribution in hospital admissions for respiratory causes among children less than or equal to 2 years, decreasing with advancing age; when analyzed in a group of 0 to 19 years, was also found a significant increase in the hospital admissions⁷.

The maximum value of sulphur dioxide was $31 \mu g/m^3$ and its mean was $4.6 \mu g/m^3$. The maximum concentrations found in this study ($31 \mu g/m^3$) are slightly above values recommended by the WHO, which accepts $20 \mu g/m^3$ as maximum exposure level for 24 hours¹³.

Moreover, ozone was significant only in hospital admissions for asthma on the third day after exposure to the pollutant. This is according to a study by Bakonyi et al, which resulted in a statistically significant effect only in O₃ for 3 days moving mean with respect to care for respiratory diseases.

In study carried out with students in Rio de Janeiro, there was a protective effect of ozone: the increase of 10µg/m³ of O₃ would be associated, one day after exposure, to an increase of 0.2 l/min in mean lung function and on the other hand, considering the indicator of three days of lag, there was a reduction in mean lung function, though no significant⁹. This situation is known as paradoxical ozone association.

For this pollutant, WHO guideline accepts maximum levels of exposure up to 100µg/m³ eight hours a day. Levels above 240 µg/m³ are associated with significant effects on health such as decreased lung function, airway inflammation and respiratory hyperreactivity¹³. The mean of 24 hours was found to be 74.27µg/m³ during the period of 2004 to 2005 years.

In addition to acute effects such as increased hospital admissions due to respiratory diseases, a study shows a strong relationship between chronic exposure to pollutants such as NO₂ and PM₁₀, and decreased lung development in children, resulting in adulthood by decreasing lung capacity and consequently with increased morbidity and mortality. It was not observed relationship of ozone exposure with decreasing pulmonary function in this cited study⁹. These data reinforce those found by Moura et al, in a study with one year time series including children up to 12 years about the role of

PM₁₀ exposure and visits in emergency rooms in a region of Rio de Janeiro²². Unlike Lin et al, it was not possible to identify the role of ozone on asthma hospitalization²³.

It is noteworthy that, although the odds ratio values found were of small magnitude, the risk prevention can have a major economic and social impact on public health in Brazil, because of exposure to pollution is a frequent event and the high prevalence of symptoms related to asthma, has been estimated as of approximately 24% in Brazilian students (24).

Moreover, in our study, only the hospitalizations through the public health system were recorded, and may have been errors in coding of diagnoses and, also, double counting of the same patient; other situation is that only part of the survey cases that have resulted hospitalization for asthma, ignoring the crises and consultations that have not resulted in hospitalization. Individual exposures to the pollutants studied were not considered and a homogeneous atmosphere with the same level of exposure to all individuals was considered.

So, it was possible to identify an association between pollutants and hospital admissions for asthma, checking the increase of hospitalizations for asthma in according to particulate matter, sulfur dioxide and ozone exposure. This study may provide subsidies for the development of measures to reduce the health risks associated with pollution.

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