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Denise Riguera[I]

Paulo Afonso André[II]

Dirce Maria Trevisan Zanetta[III]

Sugar cane burning pollution and respiratory symptoms in schoolchildren in Monte Aprazível, Southeastern Brazil

ABSTRACT

OBJECTIVE: To estimate the prevalence of respiratory symptoms and to analyze associated factors as well as peak expiratory flow measurements in schoolchildren.

METHODS: This is a descriptive cross-sectional study with schoolchildren aged 10-14 from the city of Monte Aprazível (Southeastern Brazil). Questionnaires containing the asthma and rhinitis components of the International Study of Asthma and Allergies in Childhood were administered. The questionnaires also approached sociodemographic characteristics, predisposing factors, and family and personal medical history. Repeated measures of peak expiratory flow in the children, and of black carbon and particulate matter ($PM_{2,5}$) concentration levels were carried out.

RESULTS: The prevalence of asthma and rhinitis symptoms was 11% and 33.2%, respectively. Among asthmatic children, 10.6% presented four or more wheezing attacks in the past 12 months. Past family history of bronchitis and rhinitis was associated with presence of asthma ($p=0.002$ and $p<0.001$) and rhinitis ($p<0.001$ and $p<0.001$, respectively). Regarding rhinitis, there was association with presence of mold or cracks on the house ($p=0.009$). Rhinitis was most frequent from June to October, a period that matches the sugarcane harvest season. Daily prevalence of peak expiratory flow below 20% of the median of each child's measurements was higher in days with greater $PM_{2,5}$ concentration.

CONCLUSIONS: The prevalence of asthma symptoms is below and that of rhinitis is above the national average. Although within acceptable levels, pollution in the cane trash burn season may contribute to the exacerbation of asthma and rhinitis episodes.

DESCRIPTORS: Respiratory Tract Diseases, epidemiology. Smoke, adverse effects. Agricultural Cultivation. Air Pollution. Cross-Sectional Studies.

INTRODUCTION

Respiratory diseases are the second cause of hospitalization through the *Sistema Único de Saúde* (SUS – Brazil's National Health System) (13.6%): 1,541,113 hospitalizations in the entire country in 2006.[a] Asthma and rhinitis are

[a] Ministério da Saúde; Rede Interagencial de Informações para a Saúde – RIPSA. IDB 2007: indicadores de mortalidade e fatores de risco [cited 2008 Oct 27]. Available from: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?idb2007/d13.def

[I] Programa de Pós-Graduação em Ciências da Saúde. Faculdade de Medicina de São José do Rio Preto. São José do Rio Preto, SP, Brasil

[II] Departamento de Patologia. Faculdade de Medicina. Universidade de São Paulo (USP). São Paulo, SP, Brasil

[III] Departamento de Epidemiologia. Faculdade de Saúde Pública. USP. São Paulo, SP, Brasil

Correspondence:
Dirce Maria Trevisan Zanetta
Departamento de Epidemiologia
Faculdade de Saúde Pública da USP
Av. Dr Arnaldo, 715
01246-904 São Paulo, SP, Brasil
E-mail: dzanetta@usp.br

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considered the most common chronic diseases among children and adolescents, and their prevalence has been increasing significantly. Therefore, they have become a major public health problem.[17]

Epidemiological studies with children have shown great variation in their prevalence and symptoms. Differences may derive from methodological problems, like the definition of asthma symptoms, which are not specific,[17] and the diversity of the utilized clinical expressions.[21] The International Study of Asthma and Allergies in Childhood (ISAAC) was developed to standardize the methods used in epidemiological studies, enabling to compare prevalences and the severity of asthma, rhinitis and eczema across different cities and countries. The ISAAC standardized questionnaire was translated and validated to the Portuguese language,[22,25] and has been used in studies in Brazil.[23]

Environmental factors like urbanization and high population density may be considered important determinants in the prevalences of asthma and rhinitis, as well as air pollution.[19,24] Recent studies have associated exposure to air pollution with increase in asthma incidence.[11]

Among the pollutants to which the population may be exposed, the gaseous ones, such as nitrogen dioxide and ozone, and particulate matter (PM) have been associated with the increase in mortality and hospital admission due to respiratory and cardiovascular diseases, in studies that have evaluated acute and also prolonged effects of pollutants.[5,26]

The association between environmental pollution caused by cane trash burn [using total suspended particles or PM (PM_{10} or $PM_{2,5}$) as markers] and respiratory morbidity showed an increase in the daily number of inhalations in the Emergency Service[1] and an increase in hospitalizations due to respiratory problems.[2,6] In an experimental study conducted with rats, exposure to PM collected in a city with predominance of vehicle pollution and to sugarcane burning showed that the respiratory outcomes were similar and in the biomass there was higher presence of metals, especially iron and zinc.[16]

The aim of the present study was to estimate the prevalence of asthma and rhinitis symptoms and to analyze associated factors, as well as peak expiratory flow (PEF) measurements in schoolchildren.

METHODS

This is a cross-sectional study with 1,076 schoolchildren aged ten to 14 years, carried out in Monte Aprazível (Southeastern Brazil) in 2007. The city had 19,745 inhabitants in this year and low vehicle traffic. It has tropical climate and a dry and warm winter, with annual average temperature of 23.4ºC. Sugarcane is the basis of the economy (66% of the entire agricultural production). It is collected mainly manually, after cane trash burn, from May to the beginning of December.

In the city, there were 1,214 children in the age group of interest, of whom 1,076 were enrolled between the fifth and eighth grades in three schools (14.6% at a private school, 78.3% at a municipal school and 7.1% at a state school). Questionnaires and consent documents were distributed in the classrooms and the students were instructed to answer them together with their parents.

Of the 1,076 students, 817 returned the questionnaires, with a response rate of 75.9%. Forty-five students older than 14 years were excluded. Of the 772 analyzed questionnaires, 86.8% came from the public schools and 13.3% from the private school.

The questionnaire contained the asthma and rhinitis components of the questionnaire of the ISAAC study, validated to the Portuguese language,[22,25] as well as questions referring to sociodemographic characteristics, predisposing factors, and family and personal past history of respiratory problems. The prevalence of current asthma symptoms was estimated by the percentage of affirmative answers to the question "Have you had wheezing or whistling in the chest in the past 12 months?". The diagnosis of asthma was indirectly evaluated by the question: "Have you ever had asthma?". The prevalence of rhinitis symptoms was estimated by the frequency of affirmative answers to the question "Have you had a problem with sneezing, or a runny, or blocked nose when you did not have a cold or the flu" and allergic rhinoconjunctivitis, by the question "In the past 12 months, has this nose problem accompanied by itchy-watering eyes?".[22,23,25]

A panel study was carried out with 131 voluntary students of the municipal school, with 78% of the students in the evaluated grades, and located in the central area of the city. These students were submitted to serial measurements of peak expiratory flow (PEF). The students were sent to the test by the teachers. An average of 43 students was evaluated per day, and they were recalled to repeat the test every three days, up to ten measurements per student. The test was performed at the beginning of the morning, from October to November (period of sugarcane burning).

The PEF value was obtained by means of Mini Wright Peak Flow Meter portable devices (Clemente Clark International Ltd., London, England). The devices registered measures from 60 to 850 L/min, with variation below 5% or 10L/min (whichever was higher). Before reaching 80% of the number of measurements with calibration warranted by the manufacturer, the device was replaced by another one. Each child, in standing position and after maximum inhalation,

exhaled strongly and quickly in an individual disposable mouthpiece, under supervision. This was performed three times, and the highest value was considered (in L/min).

The daily sampling of the fine particulate matter ($PM_{2,5}$) was performed with a sampler developed by the Harvard School of Public Health, installed on the roof of the municipal school's courtyard. This device functions at a flow of 10L/min. At the initial part of the probe, an impaction system retains the particles whose aerodynamic diameter is higher than 2.5 µm (cutpoint $PM_{2,5}$), while the particles of interest, below 2.5 µm, are collected in a filter (polycarbonate membrane: 37 mm; pore: 0.8 µm, Millipore®) for laboratory analysis. Sampling started in the morning. The exposed filter was replaced by a clean one every 24 h and the process was reinitiated. In every replacement, the sampling parameters were registered (filter identification, date, time, hour meter indication, indication of the air volume totalizer and of the air flow indicator).

The daily mean concentration of $PM_{2,5}$ was obtained through a gravimetric method, with sampled mass, by the difference in the filter's weight before and after sampling, divided by the total volume of sampled air. The weighing of the filter was performed at a laboratory with control of temperature (22°C) and relative humidity (45%), in an ultra-sensitive Mettler Toledo scale, model UMX2, with accuracy of 1 µg, using a portal for the elimination of electrostatic charge. Black carbon concentration was estimated in each filter by reflectance in a reflectometer with a tungsten lamp, model Smoke Stain Reflectometer, M43D Diffusion System, with the aid of a calibration curve.

The laboratory analysis and the processing of the calculations of $PM_{2,5}$ and black carbon concentration were conducted in the facilities of the Experimental Air Pollution Laboratory of the School of Medicine of *Universidade de São Paulo* (USP), which is jointly run with the Astronomy, Geophysics and Air Sciences Institute of USP. The daily temperature and humidity were measured with the portable device Digital Thermohygrometer, model 970, Kiltler.

Descriptive statistics of the data included number of measurements, frequencies, means and standard deviation (SD), median, minimum and maximum, for the environmental variables and for the questions of the questionnaire. To each child, the median of his/her PEF measures was calculated. The variation of the daily measurement was calculated considering the median of the child's measures as reference (the individual median was subtracted from the PEF measure on that day and the difference was divided by the median). The daily prevalence of children with a PEF reduction of at least 20% in relation to the median was calculated with the number of children with PEF decrease divided by the total number of children evaluated on that day.[13] The association between the daily $PM_{2,5}$ concentrations and the daily prevalences of PEF decreases was evaluated. These prevalences were categorized as zero prevalence (no child on that day with PEF decrease), from 0.1% to 4.9% and equal to or higher than 5%. The comparisons of the results were made with chi-square, Fisher, t-test, Mann-Whitney or ANOVA. The limit for statistical significance that was considered was $p < 0.01$ due to the multiple comparisons.

The statistical analysis used the computer application SPSS version 15.

The study was approved by the Research Ethics Committee of the School of Medicine of São José do Rio Preto (Process no. 5303/2007).

RESULTS

Of the 772 participants, 53.3% were males, with mean age of 12.9 years (SD = 1.11), 48.6% were between 13 and 14 years of age and 92.5% lived in the urban zone.

Symptoms of active asthma had a prevalence of 11%. There was no difference in the prevalences of wheezing ever in life and symptoms of active asthma between genders (Table 1).

Higher frequencies of history of another respiratory disease (47.5% vs. 16.7%, $p < 0.001$) and of hospitalization due to respiratory problems (30.2% vs. 10.8%, $p < 0.001$) were observed in children with asthma symptoms. No association was observed between asthma and the studied predisposing factors (Table 2). Presence of bronchitis ($p = 0.002$) or rhinitis ($p < 0.001$) in the family presented association with asthma in the child.

The prevalence of symptoms of current rhinitis (sneezes, runny nose or nasal obstruction with no cold or flu in the past 12 months) was of 33.2%. There was no statistically significant difference between rhinitis symptoms or its previous diagnosis and gender (Table 1). Figure 1 shows the prevalence of rhinitis symptoms reported per month, in the past 12 months, in the studied population. It achieved the highest value from June to September. Rhinitis was associated with the presence of cracks or mold on the walls ($p = 0.009$) and with the presence of bronchitis ($p < 0.001$), rhinitis ($p < 0.001$) or asthma ($p = 0.008$) in the family (Table 2).

The 131 students who performed the PEF measurements were, on average, 12.7 years old (SD = 0.94), 51.8% were males and 94.5% lived in the urban zone. The comparison with the 641 students who did not participate in the panel study did not show differences between these characteristics or between the prevalences of the symptoms of asthma and rhinitis or of risk factors.

Table 1. Prevalence of symptoms of asthma and rhinitis and in relation to gender in schoolchildren. Monte Aprazível, Southeastern Brazil, 2007.

Variable	Total			13 to 14 years			Male			Female			p*
	N	n	%	N	n	%	N	n	%	N	n	%	
Asthma module													
Wheezing ever in life	757	254	33.6	367	124	33.8	353	120	34.0	404	134	33.2	0.81
Wheezing in the last 12 months	755	83	11.0	367	33	9.0	352	33	9.4	403	50	12.4	0.18
More than 4 wheezing attacks in the last 12 months	754	80	10.6	367	32	8.7	351	31	8.8	403	49	12.2	0.13
Sleep disturbed more than one night per week	754	23	3.1	367	12	3.3	352	9	2.6	402	14	3.5	0.46
Speech limitation due to wheezing	753	8	1.1	366	5	1.4	350	3	0.9	401	5	1.2	0.60
Previous asthma diagnosis	762	119	15.6	369	66	17.9	354	59	16.7	408	60	14.7	0.45
Wheezing after physical exercises	739	49	6.6	354	22	6.2	336	20	6.0	403	29	7.2	0.49
Dry cough at night without flu or respiratory infection	744	272	36.6	357	121	33.9	341	131	38.4	403	141	35.0	0.33
Rhinitis module													
Sneezes, runny nose or blocked nose without flu or cold ever in life	741	294	39.7	357	143	40.1	339	138	40.7	402	156	38.8	0.59
Sneezes, runny nose or blocked nose in the past 12 months	741	246	33.2	357	116	32.5	339	111	32.7	402	135	33.6	0.80
Itchy-watering eyes	738	135	18.3	355	61	17.2	339	54	15.9	399	81	20.3	0.12
Previous rhinitis diagnosis	750	174	23.2	361	80	22.2	350	85	24.3	400	89	22.3	0.51
Activities disturbed by the nasal problem	745	41	5.5	358	21	5.9	340	16	4.7	405	25	6.2	0.38

* p-value for comparison between the male and female sex

The PEF measurements were performed in 25 school days, as there were many holidays in this period. The students performed an average of 9.9 measurements (SD = 0.38), with a minimum of seven and a maximum of ten. The PEF mean was 295 (SD = 54) L/min, varying from 200 to 498 L/min.

The daily mean prevalence of PEF measure at least 20% lower than the median of the results of each student was 2.1%, varying from 0 to 6.5% in the diverse days of the study.

Among the children who had at least one PEF measure with a decrease of at least 20% of the value of its

Table 2. Environmental predisposing factors, personal and family history in children with and without asthma and rhinitis symptoms. Monte Aprazível, Southeastern Brazil, 2007.

Variable	Asthma N = 83[a] %	Non asthma N = 672[a] %	p*	Rhinitis N = 246[a] %	Non rhinitis N = 495[a] %	p**
Rug, curtain or carpet	59.0	60.3	0.82	59.3	61.3	0.60
Cracks or mold	20.7	14.8	0.16	20.5	13.1	0.009
Bad ventilation at home	8.4	8.7	0.95	11.0	7.3	0.09
Use of insecticide	25.6	26.5	0.85	29.9	23.8	0.07
Furry animals	73.5	73.3	0.97	72.0	74.3	0.48
Passive smoking	29.9	20.2	0.57	20.3	20.4	0.98
Breastfeeding	84.3	79.7	0.31	83.1	79.4	0.23
Bronchitis in the family	58.0	39.7	0.002	52.9	36.8	< 0.001
Rhinitis in the family	58.5	35.7	<0.001	50.6	31.6	< 0.001
Asthma in the family	21.3	14.6	0.12	20.3	12.9	0.008

[a] In the asthma column, the analyzed variables had from 0 to 3 missing values; in the Non asthma column, from 0 to 13; in the Rhinitis column, from 0 to 5 and in the Non rhinitis column, from 0 to 8.
* p-value for comparison between Asthma and Non asthma
** p-value for comparison between Rhinitis and Non rhinitis

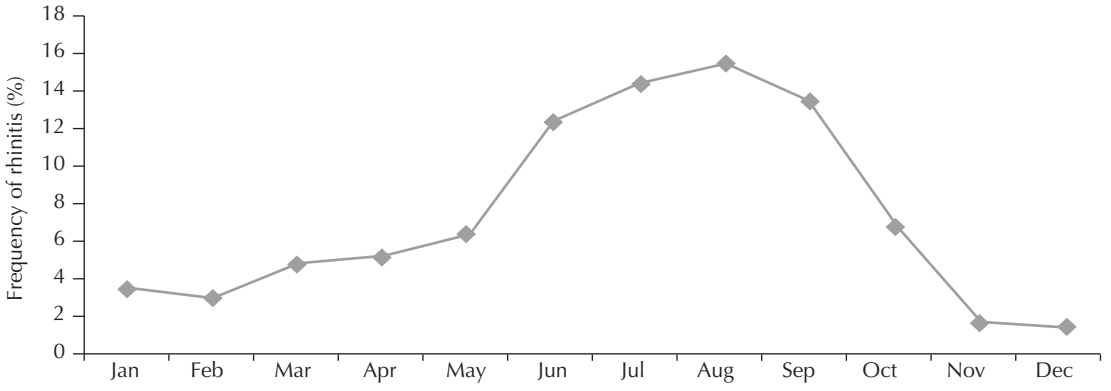


Figure 1. Rhinitis symptoms in the past 12 months in schoolchildren. Monte Aprazível, Southeastern Brazil, 2007.

median, none had current asthma and 38.1% presented rhinitis in the past 12 months.

There were problems in $PM_{2,5}$ sampling or determination in eight days due to damage to the filter or weighing flaws. The distribution of the daily mean concentration of $PM_{2,5}$ was calculated for the 34 days with valid measures. There were no losses in the measurements of the daily mean concentration of black carbon, minimum and maximum temperature and minimum and maximum relative humidity of air (Table 3).

Figure 2 shows the distribution of the mean concentration of $PM_{2,5}$ and black carbon, according to the daily prevalences of PEF decrease. The comparison of the $PM_{2,5}$ and black carbon concentrations between the three groups (zero prevalence, from 0.1% to 4.9% or equal to or higher than 5%) was not significant ($p = 0.18$ and $p = 0.053$, respectively).

Table 3. Concentration of $PM_{2,5}$ and black carbon, temperature and relative humidity of air. Monte Aprazível, Southeastern Brazil, 2007.

Variable	N (days)	Mean (SD)	Min – max
$PM_{2,5}$ ($\mu g/m^3$)[a]	34	17.1 (7.4)	8.7 – 39.2
Black carbon ($\mu g/m^3$)	42	1.44 (0.64)	0.09 – 2.98
Minimum temperature (°C)	42	20.5 (2.0)	17.0 – 24.3
Maximum temperature (°C)	42	35.1 (4.7)	28.9 – 39.8
Minimum relative humidity of air (%)	42	35.2 (17.6)	10 – 57
Maximum relative humidity of air (%)	42	62.7 (12.6)	38 – 82

[a] Mean of 34 days, due to measurement inconsistencies in 8 days

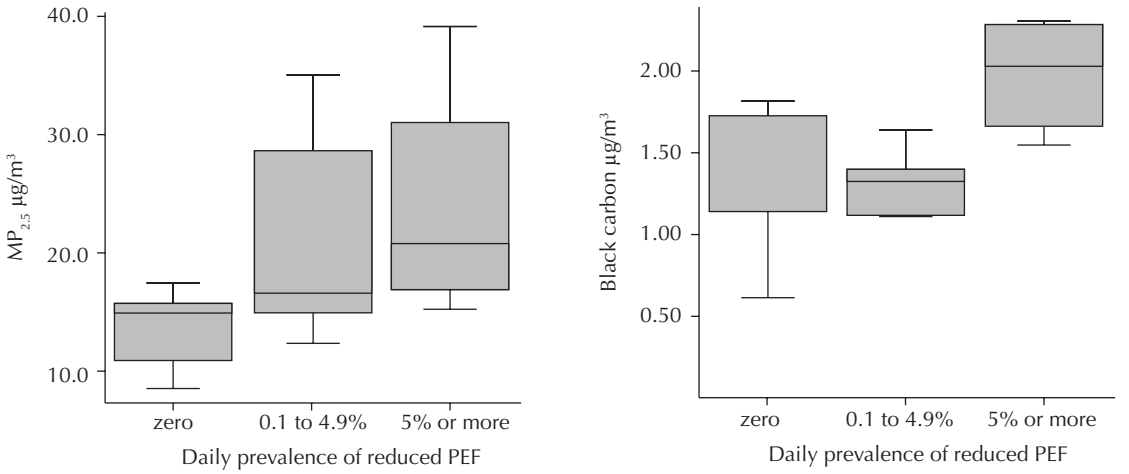
DISCUSSION

In comparison with the Brazilian national means,[23] the prevalence of symptoms of active asthma in this study was lower (11% *vs*. 19%) and that of active rhinitis was higher (33.2% *vs*. 29.6%) in adolescents aged 13 and 14 years. In phase III of ISAAC,[23] the prevalences of asthma symptoms varied from 11.8% in Nova Iguaçu (Southeastern Brazil) to 30.5% in Vitória da Conquista (Northeastern Brazil) and the rhinitis prevalences varied from 17.4% in Nova Iguaçu to 47% in Belém (Northern Brazil). The differences in these prevalences are partly explained by environmental factors (like air pollution), socioeconomic factors (like high population density and the basis of the local economy, whether agricultural or industrial), and genetic factors, like sensitivity to allergens.[11,24]

The number of children evaluated in the present study was lower than that of ISAAC (3,000 children), due to the inexistence in the city of this number of adolescents in the recommended age group. To compensate for it, the age group was amplified to 10-14 years. The results for children aged 13 and 14 were presented separately to facilitate comparison with other studies.

Measures of $PM_{2,5}$ concentration in Monte Aprazível in October and November exceeded the air quality standards established by the World Health Organization ($25 \mu g/m^3$) for daily mean in some days. A study carried out in Piracicaba[6] (Southeastern Brazil) showed mean concentration of $PM_{2,5}$ of 22.8 $\mu g/m^3$ and 10 $\mu g/m^3$ in the harvest and off-season periods, respectively. In Araraquara (Southeastern Brazil), a city which is a large sugarcane producer, data from *Companhia de Tecnologia de Saneamento Ambiental* (CETESB – Environmental Sanitation Technology Company)[b] showed an important increase in total suspended particles and of PM_{10} in the period of sugarcane harvest, compared to the off-season period.

[b] CETESB. Departamento de Qualidade Ambiental. Resumo dos estudos em locais influenciados diretamente pelas queimadas de cana [internal communication]. São Paulo; 1999.



PEF: peak expiratory flow

Figure 2. Mean concentration of $PM_{2,5}$ (a) and of black carbon (b) by daily prevalence of children with measures of peak expiratory flow at least 20% below the median. Monte Aprazível, Southeastern Brazil, 2007.

Pollution caused by biomass burn has been associated with higher number of hospital admissions due to respiratory problems in children and the elderly,[2,6] as well as vehicle pollution.[10,26]

The effect of pollution on asthma prevalence has been observed mainly with pollutants related to vehicle traffic, especially carbon monoxide and nitrogen dioxide.[12] The prevalence of symptoms of active asthma among adolescents has been directly related to air pollution in the state of Rio de Janeiro.[19] In Monte Aprazível, where there is little pollution caused by traffic, lower prevalence of symptoms of active asthma has been observed compared to other urban centers studied in Brazil.[23] In Nova Iguaçu, the prevalence of symptoms of active asthma was similar to the one obtained in Monte Aprazível.[14] Although it is the largest municipality of the region of Baixada Fluminense and the second in terms of population, with high demographic density (1,449.60 inhab/km^2), many of the researched schools were located at semi-rural areas with low vehicle traffic.[14]

Despite the fact that the prevalence of asthma symptoms in Monte Aprazível is among the lowest levels when compared to other Brazilian cities, the frequency of four or more crises in the last 12 months (10.6% overall or 8.7% in schoolchildren aged 13 to 14 years) was higher than in other studies (of up to 3%).[3,14] Even though there is no large temperature variation throughout the year in Monte Aprazível, there is evidence of greater exacerbation of asthma, which may derive from exposure to the pollution generated by sugarcane burning. Exposure to particulate matter was associated with neutrophilic inflammation in airways of healthy individuals, and was an important induction agent for asthma exacerbation. This may derive from mechanisms associated with the inflammation, by adjuvant effect of ultrafine particles.[20] Pollutants can aggravate asthma, even in relatively moderate concentrations, as reported in a bibliographic review about adverse effects of environmental pollutants.[9] In addition, the transfer of children with non-treated mild asthma from a highly polluted urban region to a rural one that is almost non-polluted showed an improvement in the inflammation of the airways after one week, evaluated by reduction in nasal eosinophils, and improvement in the lung function, evaluated by the increase in PEF.[18] The frequency of rhinoconjunctivitis in Monte Aprazível was higher than the one found in the majority of the cities evaluated in Brazil, with a mean of 14.6%,[23] and higher number of episodes during the period of sugarcane burning.

The effect of pollution on PEF was estimated by the daily prevalence of measures below the median of each child (a decrease of at least 20%), as suggested by Hoek et al.[13] The variability of the measures of each child was evaluated by comparing with the median of their own measures. In this way, the age, anthropometric and gender effects that occur in the studied age group did not interfere in the analysis. Although with no statistical significance, probably due to the small number of evaluated days, pollution may have an acute effect on lung function, as the daily prevalence of measures with PEF reduction increased as the mean concentration of $PM_{2,5}$ and black carbon increased. The effects of the exposure to air pollutants are reported even when their levels are low and it has not been possible to establish a concentration threshold, below which there would not be a harmful effect on people's health.[5] Thus, the evaluation of daily exposure to environmental pollutant and of PEF measures showed that, even with acceptable levels of pollutants in the majority of days, PM_{10} and NO_2 were associated with reduction in the lung function in children who live in Rio de Janeiro.[8] The majority of the studies evaluates the effect of the environmental

pollution produced by traffic on health. [5,9,12,26] In an experimental study, the single and low dose exposure to environmental particles produced by traffic or by sugarcane burning induced to significant alterations in mice, and the biomass particles were at least as toxic as those produced by traffic. [16]

The prevalence of lifetime asthma is described as lower than that of current asthma.[23] This finding is interpreted as a subdiagnosis of asthma, i.e., there are some patients with asthma that is not diagnosed. In Monte Aprazível, prevalence of lifetime asthma was higher than the prevalence of symptoms of current asthma. As the present study included children aged ten to 14, the questionnaires were answered by the parents, differently from other studies with children aged 13 to 14 years. It is possible that the parents have better memory than the adolescents about previous diagnoses of asthma. However, in the validation of the questionnaire, there was a significant agreement between the answers to the ISAAC questionnaire of the adolescents and of their parents or guardians, although the parents tended to underestimate the symptoms that have little interference in the adolescents' daily activities.[22] On the other hand, there may be a difference in the diagnosis of the healthcare services in diverse cities.

Higher prevalence of asthma has been found in the female sex.[7,15] The difference observed in the present study was not significant and may have occurred due to the lower number of participants.

Asthma was not associated with predisposing factors and personal history, a result that is similar to the findings of another study.[7] On the other hand, Maia et al[15] found an association with the presence of animals. This association is difficult to detect, because the result depends on the duration and intensity of the exposure to the animal, which varies if the animal stays in or out of the house. The present study found an association between rhinitis and the presence of cracks or mold on the walls.

Asthma and rhinitis were associated with family history of bronchitis and rhinitis, which is in accordance with evidences described for genetic factors and family history of allergies in these conditions.[11]

The seasonal variation of the prevalence of rhinitis symptoms, like sneezes, runny nose or nasal obstruction, without having a cold, in the past 12 months had higher percentage in the months from June to September and the proportion of children who reported these symptoms in Monte Aprazível was higher than the one reported in other studies.[4] The increase observed in Monte Aprazível occurred during the sugarcane harvest (April to November), consequently with the occurrence of burning outbreaks, which may intensify the pollution levels in the city. This is also the period of winter, which is warm and dry in Monte Aprazível, the period of lowest rainfall index (annual mean rainfall of 113.47 mm, reaching 20 mm in July) and of low air humidity (minimum of 10% during the harvest of 2007). These factors hinder the dispersion of air pollutants and foster the emergence of respiratory diseases.

The results of the present study showed a prevalence of symptoms of asthma that is lower than and of rhinitis that is comparable to the ones found in other cities in Brazil that have vehicle pollution. Despite the small temperature variation during the year, the results suggest greater exacerbation of asthma in Monte Aprazível. The city does not have polluting factories and the traffic of vehicles is low, which suggests that the pollution generated by sugarcane burning may influence the occurrence and exacerbation of respiratory symptoms. To better evaluate its role, it is necessary to measure in a continuous way the several pollutants and to monitor the respiratory symptoms during the seasonal alterations and in the periods of sugarcane harvest and off-season.

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