

Francine Heloisa Nicolussi¹
Ana Paula Milla dos Santos^{1,II}
Sílvia Carla da Silva André^{1,III}
Tatiane Bonametti Veiga^{1,III}
Angela Maria Magosso
Takayanagui¹

Air pollution and respiratory allergic diseases in schoolchildren

ABSTRACT

Study on the prevalence of allergic respiratory diseases in schoolchildren between six and seven years old, associated with indicators of air pollution. A questionnaire based on the International Study of Asthma and Allergies in Childhood was administered to parents of students from public schools, located in urban areas with differing vehicle flows. There was a positive correlation between monthly frequency of rhinitis and concentration of pollutants, and negative with relative air humidity. Even with levels of air pollutants below that allowed by law, the prevalence of asthma, rhinitis and associated symptoms tended to be higher in the central region school, where there is heavy vehicular traffic.

DESCRIPTORS: Child. Respiratory Tract Diseases, epidemiology. Respiratory Hypersensitivity, epidemiology. Air Pollution, adverse effects. Environmental Health.

¹ Departamento de Enfermagem Materno-Infantil e Saúde Pública. Escola de Enfermagem de Ribeirão Preto. Universidade de São Paulo. Ribeirão Preto, SP, Brasil

^{II} Departamento de Engenharia Ambiental. Instituto de Ciências Tecnológicas e Exatas. Universidade Federal do Triângulo Mineiro. Uberaba, MG, Brasil

^{III} Programa de Pós-Graduação em Enfermagem em Saúde Pública. Escola de Enfermagem de Ribeirão Preto. Universidade de São Paulo. Ribeirão Preto, SP, Brasil

Correspondence:

Ana Paula Milla dos Santos
Av. Dr. Randolpho Borges Júnior, 1250
38064-200 Uberaba, MG, Brasil
E-mail: ana.santos@icte.uftm.edu.br

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INTRODUCTION

Prolonged exposure to pollutants, especially those emitted by motor vehicles, is associated with increased levels of hospitalizations for cardiorespiratory morbidities and can negatively affect children's cognitive development.² This situation is aggravated in winter due to the increase in thermal inversions which make it more difficult for primary air pollutants to disperse, provoking episodes of acute pollution.

Greater attention is paid to air pollution in cities and industrial regions; however, various epidemiological studies have revealed health consequences even when pollution levels are below the limits permitted by Brazilian legislation.⁵

Of patients diagnosed with asthma and allergic rhinitis, between 70.0% and 85.0% have some type of sensitivity to aeroallergens, making them more prone to developing atopic eczema.⁶ The prevalence of the atopic triad (eczema, rhinitis and asthma) is higher among children and adolescents, who experience onset of symptoms before six years of age, this being more evident in poorer families living in urban areas, which could increase socioeconomic costs and implications.

In this context, this study aimed to determine the prevalence of asthma, rhinitis and atopic eczema among schoolchildren aged six and seven, seeking to identify the relationship with urban region air pollution indicators.

METHODS

This research was conducted in Ribeirao Preto, SP, in 2010. The municipality is located in the northeast of the state and has a population of approximately 650 thousand inhabitants. The climate is tropical and humid, characterized by rains in summer and a dry winter.^a

Two state schools were selected for their geographic location: in the central region (school A) and in a residential neighborhood in the east of the municipality (school B); the intensity of daily vehicle traffic; and because the pupils lived near the schools.

Inclusion criteria for subjects were based on parents or guardians giving permission and on age group (between six and seven years old), as allergic diseases are aggravated in the period of starting school, when there is more exposure to respiratory infections. From school A, 78 students participated in the study, and 61 from school B.

Parents and guardians were given a questionnaire to complete regarding the children, based on the International Study of Asthma and Allergies in Childhood (ISAAC), in November 2010. The instrument consists of two parts: the first identified the child,

the respondent and the geographic location of the child's residence and daily life; the second was divided into three parts, covering information on frequency, time and intensity of asthma, allergic rhinitis and atopic eczema.

Comparison between the data for schools A and B used the Chi-square test, with a 5% level of significance (Table). Frequencies were also compared to calculate prevalence ratios (PR).

The monthly means of daily concentrations of inhalable particles (MP_{10}), nitrogen dioxide (NO_2), ozone (O_3) and the relative air humidity (RH%) were calculated for the November 2009 to October 2010 period, based on seasonal monitoring data from the State of Sao Paulo Environmental Company (Cetesb), located in school B. These data were related to the responses to the question on occurrence of rhinitis symptoms (sneezing, itching and blocked nose) not caused by colds, in the preceding 12 months, calculating using Pearson's coefficient of linear correlation and by analyzing the principal components.

This study was approved by the Research Ethics Committee of the Ribeirao Preto Nursing School, *Universidade de São Paulo* (Protocol 1171/2010), and was authorized by the Regional Director of Education.

RESULTS

According to the responses, the majority of the 139 pupils were seven years old (72.7%), 51.8% were male and 61.8% did not live with smokers.

Diagnosis of asthma was reported by 18.0% of pupils in school A, almost double the frequency found in school B (PR = 1.8). The frequency of nocturnal coughing, considered one of the symptoms of active asthma, together with wheezing after exercise, was higher in schools A (PR = 1.4; $\chi^2 = 4.9$; $p \leq 0.05$) (Table).

Both the prevalence of diagnosed allergic rhinitis and associated symptoms (having experienced sneezing and itching at some point in life, sneezing and itching in the preceding 12 months and ocular symptoms) were more frequent in pupils in school A (PR = 1.4; 1.1 and 1.2, respectively). The frequency of ocular symptoms was 1.7 times higher in school A ($\chi^2 = 4.4$; $p \leq 0.05$) and, according to the responses, 37.1% of the pupils in this school also found their daily activities a little or very affected by nasal discomfort ($\chi^2 = 4.1$; $p \leq 0.05$), almost double that of school B (PR = 1.8) (Table).

There was no significant difference in diagnosed atopic eczema or associated symptoms between pupils at the two schools (Table).

^a Instituto Brasileiro de Geografia e Estatística. Cidades [cited 2013 Nov 12]. Available from: <http://www.ibge.gov.br/cidadesat/topwindow.htm?>

Table. Frequency of affirmative responses to diagnoses of asthma, allergic rhinitis, atopic eczema and associated respiratory symptoms in six- and seven-year old pupils in public schools in Ribeirao Preto, SP, Southeastern Brazil, 2010. (N = 139)

Question	School A (n = 78) %	School B (n = 61) %
Diagnosis of asthma	17.9	9.8
Wheezing at any point in life	69.2	65.6
Wheezing in preceding 12 months	33.3	29.5
Wheezing after exercise	9.0	8.2
Nocturnal dry cough	61.5 ^a	42.6
Diagnosis of allergic rhinitis	48.7	36.1
Sneezing and itching at any point in life	60.3	52.5
Sneezing and itching in preceding 12 months	53.8	44.3
Ocular symptoms	39.7 ^a	23.0
Effect on daily activities		
Never	24.4	32.8
A little	33.3 ^a	18.0
A lot	3.8	3.3
Diagnosis of atopic eczema	24.4	29.5
Marks on the skin at any point in life	20.5	19.7
Marks on the skin in preceding 12 months	16.7	16.4
Age at which marks appeared		
< 2 years old	5.1	6.6
2 to 4 years old	9.0	8.2
≥ 5 years old	6.4	6.6
Complete disappearance of marks in the preceding 12 months	19.2	16.4

^a $p \leq 0.05$

Presence of the atopic triad (eczema, rhinitis and asthma) was reported by only 3.6% of pupils participating in this study. Of the three diseases studied, allergic rhinitis was the most frequent, in pupils from both schools, reported by 43.2% of all respondents, with diagnosed atopic eczema reported by 26.6% and asthma by 14.4%.

Symptoms of allergic rhinitis (sneezing, itching, blocked nose, not caused by a cold) were more frequent in the third trimester of 2010, coinciding with increased levels of MP_{10} and NO_2 , and with the driest period of the year. Analysis of the data showed a strong negative correlation between symptoms of rhinitis and RH% ($r = -0.91$) and a positive correlation with MP_{10} and NO_2 ($r = 0.89$ and 0.88 , respectively) (Figure).

DISCUSSION

A higher prevalence of medical diagnoses of asthma, rhinitis and associated symptoms was found among pupils at the school in the central region (school A),

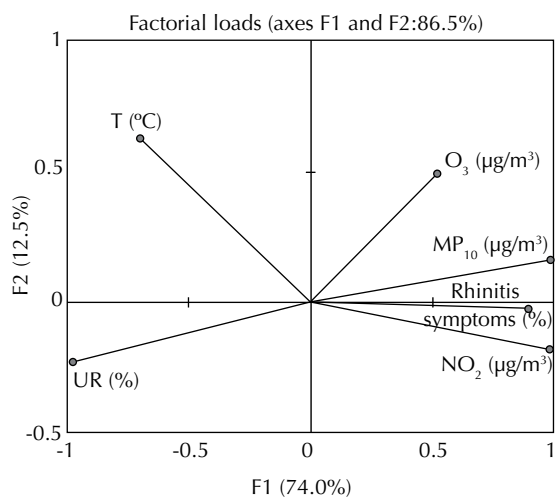


Figure. Analysis of the main components for environmental variables and symptoms of allergic rhinitis in six- and seven-year old pupils in public schools in Ribeirao Preto, SP, Southeastern Brazil, between November 2009 and October 2010.

where there is heavy vehicle traffic and, therefore, a higher concentration of pollutants. Compromised air quality, as an exogenous component, together with other biological, economic and/or social factors, are significant aggravators of allergic diseases.⁴

Vehicular emissions are a significant source of air pollution in urban centers, due to the difficulty of direct monitoring and control. In recent years, in Ribeirao Preto, SP, there has been an accelerated increase in the number of vehicles, a trend reflected in the country as a whole. According to Denatran, there are 1.4 vehicles for every two inhabitants in the municipality.^b According to Cetesb, in Ribeirao Preto, mobile sources of air pollution, such as heavy goods vehicles and motorcycles, are responsible for the emission of around seven million tons of CO, one thousand tons of NO_x and 100 tons of particulate matter annually. This has immediate consequences for the quantity of atmospheric pollutants emitted, and indirect consequences for health, especially that of residents in the busiest neighborhoods.

The positive correlation found between symptoms of rhinitis (sneezing, itching and blocked nose) and MP_{10} and NO_2 concentrations corroborates a study conducted by Castro et al, in Rio de Janeiro, in 2009.⁴ According to these authors, a positive correlation between increased air pollutants and decreased respiratory function in children was verified.

Symptoms of allergic rhinitis were more frequent during months with low rainfall, showing negative correlation with RH%. It was also in this period that the number of fires increased, some accidental, some arson but most attributable to pre-harvest burning of sugar cane. The

^b Departamento Nacional de Trânsito. Frota de veículos. Brasília (DF); 2013 [cited 2013 Nov 12]. Available from: <http://www.denatran.gov.br/frota2013.htm>

particulates produced from burning biomass may be similar or greater than those emitted by vehicles with regards their composition of heavy metals and polycyclic aromatic hydrocarbons (PAH).³

The region studied is one of the principal sugar and ethanol sectors in the country, and burning takes place in April and December. Legislation^c provides for a gradual end to this practice in Sao Paulo by 2031, but this date was brought forward to 2014 and 2017 for mechanized and non-mechanized areas, respectively by the Agro-environmental Protocol proposed by the State Environmental Secretariat,^d in 2007. Despite increasing mechanization of harvesting sugar cane in the Ribeirao Preto region (above 70.0% in the 2012-2013 harvest), burning cane still represents an aggravating factor for air pollution, affecting the population's health, especially in months of low RH%.

According to Cetesb data, air pollution in the Ribeirao Preto region was below the limits set by national standards. However, the results show possible effects of air pollution in the central region, with heavy vehicle traffic, on children's health with regards asthma, allergic rhinitis and associated symptoms.

Thus, given the large number of studies which are revealing new knowledge of the impact of air pollution on human health at diverse stages of development, the importance of adopting more rigorous national air quality standards, based on World Health Organization (WHO) directives,^e is highlighted.

It should be considered that levels of infant morbidity from respiratory causes could be prevented if there were guaranteed changes in legal and socioeconomic aspects interacting with the implementation of public health actions.

^c São Paulo. Lei Estadual nº 11.241, de 19 de setembro de 2002. Dispõe sobre a eliminação gradativa da queima da palha da cana-de-açúcar e dá providências correlatas [cited 2014 Mar 5]. Available from: http://www.iea.sp.gov.br/out/bioenergia/legislacao/2002_Lei_Est_11241.pdf

^d Secretaria do Meio Ambiente do Estado de São Paulo; Secretaria da Agricultura e Abastecimento do Estado de São Paulo; União da Agroindústria de São Paulo. Protocolo Agro-Ambiental do Setor Sucroalcooleiro Paulista. São Paulo; 2007 [cited 2014 Mar 5]. Available from: <http://www.ambiente.sp.gov.br/etanolverde/files/2011/10/protocoloAgroindustriais.pdf>

^e World Health Organization, Regional Office for Europe. Air quality guidelines: global update 2005. Copenhagen; 2006 [cited 2014 Mar 5]. Available from: http://www.euro.who.int/_data/assets/pdf_file/0005/78638/E90038.pdf

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