Brief Communication

Anthropogenic air pollution and respiratory disease-related emergency room visits in Rio Branco, Brazil - September, 2005*

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Abstract

Air pollution is a major public health problem in the Amazon forest and in large Brazilian cities. During September of 2005, high concentrations of smoke from biomass burning were observed in the city of Rio Branco. An ecological study was conducted to evaluate the relationship between daily concentrations of particulate matter < 2.5 μm ($PM_{2.5}$) and the number of respiratory disease (RD)-related emergency room visits. Daily $PM_{2.5}$ concentrations exceeded recommended air quality limits on 23 days. The incidence of RDs was higher among children < 10 years of age. There was a significant positive correlation between $PM_{2.5}$ concentrations and asthma emergency room visits.

Keywords: Air pollution/adverse effects; Fires; Respiratory tract diseases/epidemiology; Asthma; Space-time clustering.

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Introduction

Air pollution is currently one of the leading public health problems and has been shown to have various deleterious effects on the health of the population, even at levels that are considered safe in environmental legislation.[1,2] It is estimated that exposure to particulate matter (PM), a mixture of liquid and solid particles suspended in the air, which is classified according to the diameter of those particles, causes 800,000 deaths/year worldwide, 35,000 of which occur in Latin America alone. Children, elderly individuals and patients with a history of cardiorespiratory diseases, including asthma, constitute the population that is most susceptible to the effects of air pollution.[3]

Among women of reproductive age and among children, exposure to environmental pollutants is a significant cause of low birth weight, congenital malformation, intrauterine death, hospitalization and school absenteeism.[4-6] Asthma is the most common chronic disease among children and can be aggravated by, among other factors, various pollutants found in internal and external environments. Other effects of air pollution in children include mental retardation, attention deficit disorder, hyperactivity and cancer.[7] In adults, especially among the elderly, higher levels of air pollutants have been associated with increased morbidity and mortality due to respiratory and cardiovascular diseases, such as chronic obstructive pulmonary disease (COPD). In addition, high concentrations of such pollutants can cause asthma attacks, decreased pulmonary function and acute myocardial infarction.[1,8,9]

Approximately half of the global population and over 90% of the houses in the rural areas of developing countries use energy generated from biomass burning, including the burning of wood, coal, manure and agricultural residues. In closed environments, the burning of these substances produces high concentrations of air pollutants. Biomass burning of vegetation to prepare land for planting can get out of control, damaging vast areas. Worldwide, biomass burning represents the principal source of PM and of toxic gases such as carbon monoxide, nitric dioxide, sulfur dioxide and ozone.[10-12]

From September 16 to September 20 of 2005, highly concentrated smoke, the result of intense biomass burning in the Amazon region, was observed over the state of Acre, which is located in the North of Brazil. According to satellite images, the greatest concentration of smoke was seen over the city of Rio Branco, the capital of Acre, although additional foci were identified within the state and in other states (Rondônia and Mato Grosso), as well as in Bolivia, which borders. In view of this, and based on the information on hospital and outpatient visits, the Acre State Department of Health reported an outbreak of respiratory disease. The *Secretaria de Vigilância em Saúde* (SVS, Secretary for Health Surveillance) of the National Ministry of Health was asked to help carry out the epidemiological investigation.

An ecological time series was carried out in order to evaluate the daily occurrence of emergency room visits due to respiratory diseases and their relation to air pollution. We evaluated all of the patients treated at the *Hospital de Urgências e Emergências de Rio Branco* (HUERB, Rio Branco Hospital for Urgencies and Emergencies) from September 1 to September 30 of 2005, including only those who had been diagnosed with respiratory disease under one of the following conditions:

- diagnosis of asthma, bronchitis, COPD, upper respiratory tract infection (URTI) or pneumonia, in accordance with chapter X (J00-J99) of the International Statistical Classification of Diseases and Related Health Problems, tenth revision[13]; and
- Medical history of cough or dyspnea, in the absence of another diagnosis.

A standardized pretested form was used in order to collect personal data (name, age, gender, city/neighborhood of residence) and clinical data (date of symptom onset, symptoms reported and diagnosis) from the HUERB reports. Data on daily atmospheric concentrations of PM < 2.5 μm ($PM_{2.5}$) during September of 2005 were provided by the Federal University of Acre, where the monitoring station is located.

The incidence rate of respiratory disease was determined for the population residing in Rio Branco. The relationship between the $PM_{2.5}$ concentration (independent variable) and the occurrence of respiratory disease-related visits at the HUERB (dependent variable) was determined using Pearson's correlation coefficient. In this analysis, a seven-day sliding mean was employed for pollution data. A 95% confidence interval (95% CI) was adopted,

and the level of statistical significance was set at $p < 0.05$. Data were processed using the Epi Info program.[14]

According to data obtained from the Hospital Information Service of the Unified Health System, the number of hospitalizations for respiratory disease in September of 2005 was 45% higher than that determined for the same period in 2004.[15] In September of 2005, there were 19,581 emergency room visits at the HUERB, of which 2922 (15%) were for respiratory diseases. The most common diagnoses were: URTI (21%), bronchitis (15%), asthma (12%), pneumonia (10%) and COPD (2%). The number of visits by patients with a medical history of cough or dyspnea, in the absence of another diagnosis, corresponded to 40%. The clinical profile was characterized by the presence of the following signs and symptoms: cough (79%); fever (51%); dyspnea (39%); chest pain (15%); wheezing (8%); sore throat (4%); expectoration (3%); and rhinorrhea (2%). Analyzing the patients by age bracket, children (0 to 9 years of age) accounted for 48% of the visits, followed by adults (20 to 59) at 36%, adolescents (10 to 19) at 9% and elderly patients (60 or above) at 8%. Patients residing in the city of Rio Branco accounted for 97% (2830) of the respiratory disease-related visits. Within this last group, we observed a higher incidence rate among children (18.8/1000 inhabitants), followed by the elderly (12.5/1000 inhabitants), adults (6.9/1000 inhabitants) and adolescents (3.6/1000 inhabitants).

Figure 1 reveals that $PM_{2.5}$ concentrations exceeded the air quality limit of on 23 days, with values of up to 450 $\mu g/m^3$, nine times higher than the parameter established by the World Health Organization.[16] We observed a positive relationship between the seven-day sliding $PM_{2.5}$ means and the number of emergency room visits for asthma (Figure 2).

It is known that the number of respiratory disease-related emergency room visits and hospitalizations is associated with exposure to smoke resulting from the burning of woodlands.[16-19] The results presented in this study are consistent with

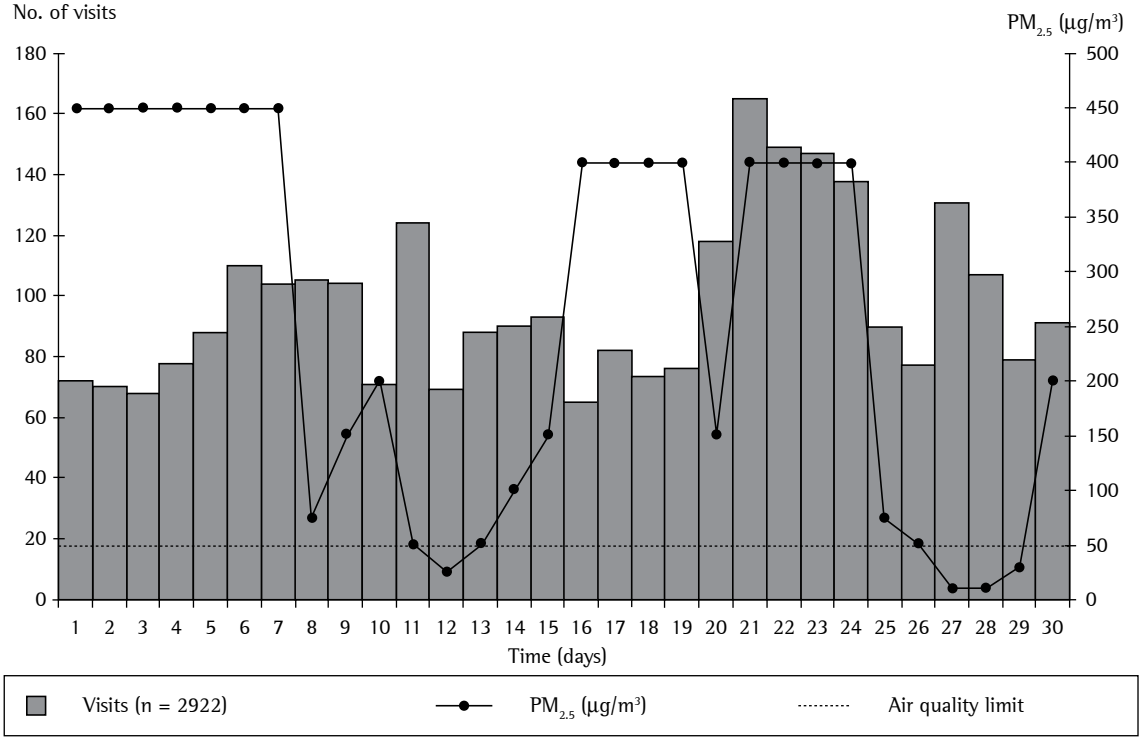

Figure 1 - Respiratory disease-related emergency room visits and *particulate matter* concentration < 2.5 µm ($PM_{2.5}$; $\mu g/m^3$). Rio Branco, Acre - September/2005.

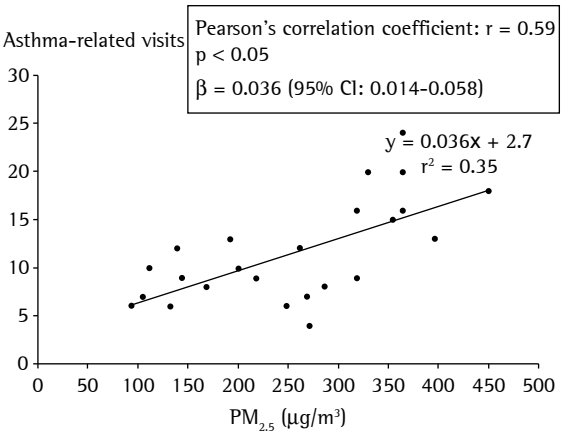

Figure 2 - *Particulate matter* concentration < 2.5 µm ($PM_{2.5}$; µg/m³)/asthma-related emergency room visits ratio. Rio Branco, Acre - September/2005. 95% CI: 95% confidence interval.

findings obtained from investigations carried out in countries where large forest fires occurred. As an example, we can mention the large forest fires in California, in the United States of America, in the 1980s and 1990s,[17,18] when the number of emergency room visits for asthma, COPD and URTI were higher than in periods when there were no burnings. In that country, the characteristics of the population affected were similar to those of the patients treated in Rio Branco. Although most of the foci of biomass burning were located outside of the state of Acre, the smoke was carried by easterly winds and accumulated over the Rio Branco region. A similar phenomenon was observed in Southeast Asia between July and October of 1997, when smoke from fires in Indonesia affected the health of the population of Singapore on the first days of November of the same year, demonstrating the influence of the wind on the long-distance dispersion of fine and ultrafine PM.[19]

According to data evaluated at the Federal University of Acre, extreme, prolonged drought-related air pollution events, possibly the greatest in over 60 years, including the impact of biomass burning, low water levels in creeks, rivers and reservoirs, as well as low relative humidity of the soil and air, were observed in the Amazon region in 2005. The existence of a database for monitoring of meteorological conditions and concentration of pollutants in Rio Branco allowed us to track the air pollution phenomenon. Although high smoke concentrations had been observed in previous years, they did not match those seen in 2005 in terms of their impact.[20]

Ecological studies have been widely used to evaluate the effects of air pollution on the health of the population.[1-3,8] Ecological time series studies have the advantage of preventing variables such as socioeconomic factors, occupation or smoking habits from confusing the relation between pollution and effects on health, since these factors do not present daily variations.[1,8] The biological manifestations of the effects of pollution on health present a behavior that shows a gap in relation to the exposure of the individual to pollutants. Therefore, the visits observed on a specific day should be related to the pollution of that day and to that observed on previous days, which justifies the use of the seven-day sliding mean.[2,8,19]

As prevention and control measures, the following steps were taken: preparation of the treatment protocol for patients with respiratory disease to be distributed to the network of public health facilities of the state of Acre; implementation of the simplified model for monitoring hospital and outpatient treatment of respiratory diseases in conjunction with the municipal health departments; structuring of the Environmental Health Surveillance in order to implement air quality surveillance activities.

Based on the results of this investigation, it is recommended that the following measures be adopted:

- Identifying and establishing partnerships with the official organs responsible for the monitoring of environmental data (air pollutants, temperature and humidity), so that air quality can be monitored according to the current legislation;
- Implementing surveillance of respiratory diseases by monitoring URTIs, together with hospitals (epidemiology hospital centers), health facilities of the Unified Health System network itself, as well as and those affiliated with it, and private health centers; and
- Improving the quality of the data from the various health information systems, so that they are adequately equipped to analyze morbidity and mortality in relation to air pollution.

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