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# Pre-harvest cane burning and health: the association between school absences and burning sugarcane fields

## Queimadas e saúde: relação entre faltas escolares e incidência das queimadas da cana-de-açúcar

### ABSTRACT

The objective of this study was to investigate an association between pre-harvest sugarcane burning and respiratory diseases in children under five years of age. The following data were collected in five schools in the city of Araraquara, SP, Southeastern Brazil, between March and June 2009: daily records of absences and the reasons stated for these absences, total concentration of suspended particulate matter ( $\mu\text{g}/\text{m}^3$ ), and air humidity. The relationship between the percentage of school absences due to respiratory problems and the concentration of particulate matter in March and from April to June presented a distinct behavior: absences increased alongside the increase in particulate matter concentration. The use of school absences as indicators of this relationship is an innovative approach.

**DESCRIPTORS:** Preschool. Absenteeism. Respiratory Diseases, epidemiology. Smoke, adverse effects. *Saccharum*. Air Pollution. Particulate Matter.

### RESUMO

Este estudo teve como objetivo analisar se queimadas estão relacionadas a doenças respiratórias em crianças menores de cinco anos. Os dados foram coletados em cinco escolas do município de Araraquara, SP, entre março a junho de 2009, abordando: controle diário das faltas escolares, razões alegadas, concentração total de partículas em suspensão ( $\mu\text{g}/\text{m}^3$ ) e umidade do ar. A relação entre o percentual de faltas por motivo respiratório e concentração de material particulado no mês de março e no período de abril a junho apresentou comportamento distinto: aumento das faltas com o aumento da concentração do material particulado. A utilização das faltas escolares como indicadores desta relação representa recorte inovador.

**DESCRIPTORES:** Pré-Escolar. Absenteísmo. Doenças Respiratórias, epidemiologia. Fumaça, efeitos adversos. *Saccharum*. Poluição do Ar. Material Particulado.

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## INTRODUCTION

Previous studies have demonstrated the relationship between air pollution and cardiorespiratory morbidity and mortality,<sup>4,5</sup> indicating that the most susceptible groups to the effects of pollution are children, older adults, and individuals with prior cardiorespiratory diseases.<sup>8</sup>

Children have a higher susceptibility to pollutants due to their greater minute ventilation, accelerated basal metabolism, and intense physical activity. Additionally, their immune system, which is not yet fully developed, is more susceptible to respiratory infections.<sup>2</sup>

Studies in sugarcane-growing regions in the state of Sao Paulo have demonstrated that variations in the concentration of particulate matter during pre-harvest burning of sugarcane are linked to increased inhalations in emergency services and increased hospitalizations of adults and older adults resulting from asthma and hypertension.<sup>7</sup>

However, no studies have evaluated the influence of particulate matter emitted during the period when sugarcane is burned before harvest on respiratory morbidity in children aged up to 5 years.

This study aimed to examine whether pre-harvest burning of sugarcane is associated with respiratory diseases in children under the age of five years.

## METHODS

This study was conducted in the city of Araraquara, which is located in the central region of the state of Sao Paulo, Southeastern Brazil, 273 km west of the state capital and encompasses an area of 1,312 km<sup>2</sup>. The region is severely affected by pre-harvest burning of sugarcane (urban fires), according to a study conducted by Arbex (2002).<sup>a</sup>

The following data were collected daily between March and June 2009: school absences, concentration of suspended particulates, and air humidity. The total concentration of suspended particulate matter ( $\mu\text{g}/\text{m}^3$ ) was measured daily during the same period that school absences were assessed, using the Handy-Vol device (*Energética do Brasil*) with fiberglass filters and a flow rate of 3 L/min. The device was placed in downtown Araraquara and was protected from the rain by a canopy. The filters were weighed before and after each 24h period for data collection. To ensure data reliability, the filter on the device was replaced every day at 7:00 a.m. The total concentration of suspended

particulate matter was estimated using the following equation, as described by Arbex et al<sup>1</sup>:

$$PC = \Delta m / TV_{24h}$$

where PC is the total concentration of suspended particulate matter ( $\mu\text{g}/\text{m}^3$ ) under standard conditions for temperature and pressure,  $\Delta m$  is the difference in the mass of the filter (g) before and after use, and  $TV_{24h}$  is the volume of air sampled ( $\text{m}^3$ ) during each 24h period.

The Bartolomeu de Gusmão airport of the city of Araraquara provided the data on temperature and air humidity for the period of March to June 2009. Data were collected at only one point in the city, based on a study conducted by Arbex<sup>1</sup> in the urban and rural areas of Araraquara, which showed no significant difference in relation to the concentration of suspended particulate matter between the two regions studied. The near-perfect correlation found between both measuring points indicated a homogeneous deposition of soot in the city of Araraquara.

Data on school absences (date of the absence and whether it resulted from respiratory problems) were provided by the parents and recorded daily by the teachers at six municipal schools, using a validated questionnaire.

After the study was approved by the Araraquara Municipal Department of Education, five classes were selected from each preschool. Each class had an average of 25 students, who were divided into the following age groups: 0-1 year; 1-2 years; 2-3 years; 3-4 years; and 4-5 years. In total, 750 students voluntarily participated in the present study.

Descriptive statistics and graphical representations were used to assess the relationship between school absences resulting from respiratory problems, the percentage of these absences in relation to total absences, and various experimental variables, especially the concentration of particulate matter. Friedman's nonparametric test was used to assess the influence of student age on the percentage of absences resulting from respiratory problems. The degree of relationship between pairs of variables was determined by Spearman's correlation coefficient. Correlation coefficients and differences in age regarding the percentage of absences due to respiratory reasons were considered as significant when  $p < 0.05$ .

## RESULTS

In the selected schools, 21,699 absences were recorded; of these, 10,647 (49.0%) resulted from respiratory problems and 11,052 (51.0%) were for other reasons.

<sup>a</sup> Arbex MA. Avaliação dos efeitos do material particulado proveniente da queima da plantação de cana de açúcar sobre a morbidade respiratória na população de Araraquara, SP [thesis]. São Paulo (SP): Faculdade de Medicina da Universidade de São Paulo; 2002.

**Table.** Number and percentage of absences due to respiratory problems in relation to total absences, according to age. Sao Paulo, SP, Southeastern Brazil, 2012.

Month	Age (years)									
	1		2		3		4		5	
	Number of absences									
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
March	11	2 - 20	15	2 - 26	27	1 - 46	6	0 - 13	10	0 - 23
April	14	5 - 24	36	15 - 69	52	22 - 176	13	3 - 27	13	7 - 23
May	40	11 - 54	50	16 - 68	63	10 - 92	29	4 - 44	11	1 - 20
June	20	10 - 50	20	6 - 70	26	5 - 77	23	9 - 45	13	5 - 27
	Percentage of absences									
March	33	19 - 69	33	10 - 48	37	8 - 56	14	0 - 27	24	0 - 45
April	52	42 - 61	56	39 - 69	56	38 - 71	40	12 - 55	39	28 - 54
May	68	48 - 86	60	51 - 69	56	49 - 71	48	41 - 59	36	7 - 58
June	58	41 - 71	53	42 - 67	62	37 - 79	55	35 - 69	46	27 - 63

Table presents the mean, minimum, and maximum number of absences resulting from respiratory problems. Each mean was located almost in the median; the former was adopted due to its popularity. The standard deviation was not a useful measure for describing the variation of the percentages, so ranges have been presented.

## DISCUSSION

Even though this topic is difficult to quantify, this study evaluated a representative sample of municipal public schools in the city of Araraquara, SP, and the results suggest a relationship between pre-harvest burnings of sugarcane and school absences.

Friedman's test indicated significant differences each month between the percentage of absences due to respiratory problems and children's age ( $p < 0.001$ ). The mean percentage of absences for children aged up to three years was greater than or equal to the mean absences for the older children throughout the period from March to June. This result confirms the findings of Moura<sup>b</sup> (2006), who stated that younger children are more susceptible to the effects of pre-harvest sugarcane burning, corroborating several previous studies.<sup>3</sup> The mean percentages for children aged 4-5 years were less than or equal to those for the younger children, except in June, when the mean

number of absences for four year-olds increased to equal those of the younger children.

Thus, our results suggest that children less than two years of age are more vulnerable to the effects of air pollution than their older peers, indicating that susceptibility to the pollutants generated by pre-harvest sugarcane burning is inversely proportional to the child's age. This is probably because the immune system and lungs of younger children are less developed and mature.

The relationship between percentages of absences due to respiratory reasons and total particulate matter concentration exhibited a different behavior in March and in the period between April and June. In March, the percentage of absences tended to increase as a result of the increased concentration of particulate matter. From April to June, both variables increased sharply, without a strong relationship between them. More absences were also observed from the month of April onwards, when there is a greater concentration of soot in the air.

It is concluded that pre-harvest sugarcane burnings may be associated with respiratory problems in children and is reflected in school absences. Studies evaluating such an association are rare, especially those using school absences as an indicator of this association. Further studies are needed to consolidate this finding.

<sup>b</sup> Moura M. Qualidade do ar e atendimentos médicos de emergência por sintomas respiratórios em crianças residentes em Jacarepaguá, Rio de Janeiro [doctoral dissertation]. Rio de Janeiro (RJ): Instituto de Medicina Tropical da UERJ; 2006.

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The authors declare no conflict of interest.