



SHORT COMMUNICATION

Short terms effects of air pollution from biomass burning in mucociliary clearance of Brazilian sugarcane cutters

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Received 14 April 2011; accepted 2 August 2011

Available online 19 August 2011

KEYWORDS

Sugarcane;
Mucociliary transport;
Biomass;
Nasal epithelium

Summary

Nasal mucociliary system is the first line of defense of the upper airways and may be affected acutely by exposure to particulate matter (PM) from biomass burning. Several epidemiologic studies have demonstrated a consistent association between levels of air pollution from biomass burning with increases in hospitalization for respiratory diseases and mortality. To determine the acute effects of exposure to particulate matter from biomass burning in nasal mucociliary transport by saccharin transit time (STT) test, we studied thirty-three non-smokers and twelve light smokers sugarcane cutters in two periods: pre-harvest season and 4 h after harvest at the first day after biomass burning. Lung function, exhaled carbon monoxide (CO), nasal symptoms questionnaire and mucociliary clearance (MC) were assessed. Exhaled CO was increased in smokers compared to non-smokers but did not change significantly after harvest. In contrast, STT was similar between smokers and non-smokers and decreased significantly after harvest in both groups ($p < 0.001$). Exposure to PM from biomass burning did not influence nasal symptoms. Our results suggest that acute exposure to particulate matter from sugarcane burned affects mucociliary clearance in smokers and non-smokers workers in the absence of symptoms.

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Introduction

Nasal mucociliary system is the first line of defense of the upper airways and it's responsible for the clearance of inhaled particles, including particulate matter (PM).¹ In epidemiological studies an association of airborne PM concentration and human nasal diseases has been reported.² The nasal epithelium is similar to the respiratory epithelium in lower airway, and is an important tool to assess pathophysiologic mechanisms in the respiratory tract.³

The inflammatory response induced by inhalation of air pollutant particles is associated with up regulation of various pro-inflammatory cytokines and chemokines which could affect the ciliary beating.⁴

Sugar cane-burning emissions cause damage to the respiratory system leading to an increase in hospitalization for respiratory disease mainly in children and the elderly.⁵ Releases into the atmosphere large quantities of PM, carbon monoxide, ozone and other gases exposing millions people every year in Brazil.⁶

However, the most exposed people are the sugarcane cutters and no previous reports studied respiratory effects of PM in these individuals at the field planting. Acute exposure to concentrations of PM in areas of agglomeration may affect functions such as MC and worsen nasal symptoms.⁷ The purpose of this study was to evaluate the effects of acute exposure to PM from the sugarcane burning in the MC of sugarcane cutters.

Methods

Forty-five sugarcane cutters, men, thirty-three non-smokers, (mean age 26 ± 5 years) workers in a Sugar and Ethanol Company located in western state of Sao Paulo, Brazil, in April/2010 were included at random in this study. Each subject gave their informed written consent according to the Declaration of Helsinki and the study was approved by the Ethical Committee of Faculty of Science and Technology, University of State University of Sao Paulo, Brazil (No.15/2010).

The individuals included in this study had no history of nasal surgery or trauma, lung diseases, nasal septal deviation or recent episodes of upper airway infection. The study was carried out in the field of sugarcane planting at pre-harvest (seven days before harvest) during the manual planting season and 4 h after harvest at the first day after biomass burning. Lung function, exhaled carbon monoxide (CO), nasal symptoms questionnaire and STT test for measuring nasal MC was performed in two periods.

The spirometry was performed according to the guidelines of the American Thoracic Society and European Respiratory Society⁸ using a portable spirometer Spirobank-MIR (version 3.6., MIR, Italy) reference values were specific for the Brazilian population.⁹ Exhaled CO was measured using CO analyzer (MicroCO Meter, Cardinal Health, U.K), and the results were expressed as ppm.¹⁰ The questionnaire to assess nasal symptoms and STT test has been previously published.^{11,12} The determination of toxic metals as cadmium (Cd^{2+}), copper (Cu^{2+}) and lead (Pb^{2+}) from

passive PM sampler were performed by differential pulse polarography using a polarograph 797 VA Computrace (Metrohm).

Statistical analysis was performed using the R statistical software (version 2.13.0; R. Foundation for Statistical Computing). Analysis of variance (ANOVA) was used to investigate the differences between smokers and non-smokers at baseline and after exposure to biomass burning. For association analysis in the qualitative variables was used the Goodman test. Our results were presented as mean \pm standard deviation. Statistical significance was determined at 5%.

Results

Thirty-three non-smokers (BMI 24 ± 3 kg/m² and FEV₁/CVF $98 \pm 7\%$ of predicted) and twelve smokers (BMI 26 ± 5 kg/m² and FEV₁/CVF $99 \pm 8\%$ of predicted) classified as light smoker (cigarettes/day 7 ± 6 and pack-years index 4 ± 3) were enrolled in this study. Exhaled CO was increased in smokers compared to non-smokers but did not change significantly after harvest (from 7 ± 5 to 6 ± 4 ppm in smokers and from 1.4 ± 0.9 to 1 ± 0.9 ppm in non-smokers, respectively). In contrast, STT was similar between smokers and non-smokers and decreased significantly after harvest in both groups (from 8.5 ± 3.5 and 7.3 ± 3.2 before harvest to 3.1 ± 1.3 and 4.4 ± 2.9 min after harvest in smokers and non-smokers, respectively, Fig. 1, $p < 0.001$). None of the individuals experienced nasal symptoms after harvest. The concentration of toxic metals Cd^{2+} , Cu^{2+} and Pb^{2+} were 4.8 ppm, 6.18 ppm and 4.7 ppm, respectively. Among the toxic metals studied, copper was predominant while the lead presented the lowest concentration. The low concentrations observed are attributed to the washout (precipitation) phenomenon that may be defined as the effectiveness of precipitation in removing pollutants from the atmosphere.¹³ These metals have the characteristics to accumulate in tissues and their main route of deposition is through the respiratory system.

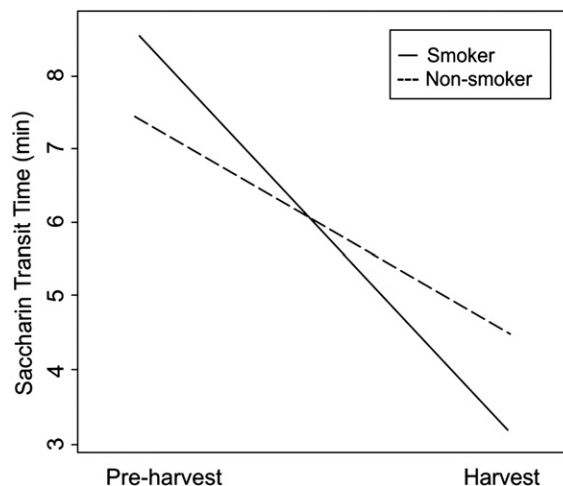


Figure 1 Nasal mucociliary clearance increased significantly after harvest in smokers and non-smokers ($p < 0.001$). Data are presented as marginal mean.

Discussion

In this study the acute exposure to PM during the sugarcane harvest increased the MC, but does not affected the nasal symptoms experienced by the workers. MC represents a major defense mechanism of nasal and bronchial epithelium and it's of central importance to clear inhaled particles from the airways.¹ The STT test used in this study has been shown to be reproducible, simple, cheap, and effective method to assessing MC and its role is widely accepted.¹¹

In the present study, the exposure to PM from biomass burning decreased STT significantly, suggesting a compensatory activation of the MC system in smokers and non-smokers workers. Interestingly, in this study the MC at pre-harvest and after acute exposure were similar between smokers and non-smokers, probably this occurred because the smokers were classified as light smokers.¹⁴ This acute effect on MC has been described earlier after exposure to dust⁷ and cigarette smoke¹⁴ however no previous reports studied respiratory effects of PM from biomass burning in sugarcane cutters at the field planting. Acute exposure to PM has been associated with enhanced production of reactive oxidative stress and nitric oxide by inflammatory cells which stimulates ciliary beat frequency (CBF).¹⁵ The stimulation on MC in the present study is probably due to the increase in CBF. Dysfunction of the mucus transport system has been observed after chronic exposure of air pollution constituents and is associated with an increased risk to acquire airway infections.⁵ We did not investigate the time course of these effects, and the acute increase in MC may be lost with repeated exposures.

We conclude that the acute exposure to PM from sugarcane burned affects MC in smokers and non-smokers workers in the absence of symptoms.

Conflict of interest statement

The authors declare that there are no current or potential conflicts of interest.

Acknowledgments

This work was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) and National Institute for Integrated Analysis of Environmental Risk (INAIRA/CNPq).

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