Environmental Research 132 (2014) 38–45

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Associations between personal exposure to air pollutants and lung function tests and cardiovascular indices among children with asthma living near an industrial complex and petroleum refineries

Audrey Smargiassi [a,b,*], Mark S. Goldberg [c,d], Amanda J. Wheeler [e,f], Céline Plante [g], Marie-France Valois [c,d], Gary Mallach [e], Lisa Marie Kauri [e], Robin Shutt [e], Susan Bartlett [c], Marie Raphoz [h], Ling Liu [e]

[a] Chaire sur la pollution de l'air, les changements climatiques et la santé, Département de santé environnementale et de santé au travail, Université de Montréal, Montreal, Canada
[b] Institut National de Santé Publique du Québec, Montréal, Canada
[c] Department of Medicine, McGill University, Montreal, Canada
[d] Division of Clinical Epidemiology, McGill University Health Centre, Montreal, Canada
[e] Health Canada, Ottawa, Ontario, Canada
[f] Centre for Ecosystem Management, School of Natural Sciences, Edith Cowan University, Joondalup, Australia
[g] Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal, Canada
[h] Ouranos Consortium, Montreal, Canada

ARTICLE INFO

Article history:
Received 4 October 2013
Received in revised form
28 February 2014
Accepted 12 March 2014
Available online 16 April 2014

Keywords:
Asthma
Industrial emissions
Refineries
Pulmonary functions
Air pollution

ABSTRACT

Objective: The acute cardiorespiratory effects of air quality among children living in areas with considerable heavy industry have not been well investigated. We conducted a panel study of children with asthma living in proximity to an industrial complex housing two refineries in Montreal, Quebec, in order to assess associations between their personal daily exposure to air pollutants and changes in pulmonary function and selected indicators of cardiovascular health.

Methods: Seventy-two children with asthma age 7–12 years in 2009–2010 participated in this panel study for a period of 10 consecutive days. They carried a small backpack for personal monitoring of sulphur dioxide (SO_2), benzene, fine particles ($PM_{2.5}$), nitrogen dioxide (NO_2) and polycyclic aromatic hydrocarbons (PAHs) and underwent daily spirometry and cardiovascular testing (blood pressure, pulse rate and oxygen saturation). To estimate these associations, we used mixed regression models, adjusting for within-subject serial correlation, and for the effects of a number of personal and environmental variables (e.g., medication use, ethnicity, temperature).

Results: Children with asthma involved in the study had relatively good pulmonary function test results (mean FEV_1 compared to standard values: 89.8%, mean FVC: 97.6%, mean FEF_{25-75}: 76.3%). Median diastolic, systolic blood pressures and oxygen saturation were 60/94 mm Hg and 99%, respectively. Median personal concentrations of pollutants were NO_2, 5.5 ppb; benzene, 2.1 $\mu g/m^3$; $PM_{2.5}$, 5.7 $\mu g/m^3$; and total PAH, 130 $\mu g/m^3$. Most personal concentrations of SO_2 were below the level of detection. No consistent associations were observed between cardio-pulmonary indices and personal exposure to $PM_{2.5}$, NO_2 and benzene, although there was a suggestion for a small decrease in respiratory function with total concentrations of PAHs (e.g., adjusted association with FVC: −9.9 ml per interquartile range 95%CI: −23.4, 3.7).

Conclusions: This study suggests that at low daily average levels of exposure to industrial emissions, effects on pulmonary and cardiovascular functions in children with asthma may be difficult to detect over 10 consecutive days.

© 2014 Elsevier Inc. All rights reserved.

Abbreviations: CI, confidence interval; d.f., degrees of freedom; FEV_1, forced expiratory volume in one-second; $FEF_{25-75\%}$, forced expiratory flow between 25% and 75% of the FVC; FVC, forced vital capacity; IQ, interquartile; NO_2, nitrogen dioxide; O_3, ozone; PAHs, polycyclic aromatic hydrocarbons; $PM_{2.5}$, fine particles (particles with aerodynamic diameters under 2.5 μm); PM_{10}, inhalable particles (particles with aerodynamic diameters under 10 μm); ppb, parts per billion; SD, standard deviation; SO_2, sulphur dioxide; VOCs, volatile organic compounds

* Corresponding author at: Chaire sur la pollution de l'air, les changements climatiques et la santé, 1301 Sherbrooke East, Montreal, Quebec, Canada H2L 1M3.
E-mail address: audrey.smargiassi@montreal.ca (A. Smargiassi).

http://dx.doi.org/10.1016/j.envres.2014.03.030
0013-9351/© 2014 Elsevier Inc. All rights reserved.

1. Introduction

Daily variations in urban ambient concentrations of air pollutants such as ozone (O_3), fine particles (particles with aerodynamic diameters under 2.5 μm, $PM_{2.5}$) and nitrogen and sulphur dioxides (NO_2, SO_2), have been associated with short-term increases in hospitalization and emergency department visits for asthma in children (e.g., Barnett et al., 2005; Villeneuve et al., 2007; Smargiassi et al., 2009; Mar and Koenig, 2009; Halonen et al., 2010; Strickland et al., 2010).

Results of panel studies performed in children with asthma suggest that a daily increase in ambient concentrations of particles (i.e., $PM_{2.5}$, and inhalable particles, PM_{10}) measured at fixed-site monitoring stations are associated with acute detrimental effects on lung function (e.g., Dales et al., 2009; Liu et al., 2009; Delfino et al., 2004, 2008; Moshammer et al., 2006; Lewis et al., 2005; Aekplakorn et al., 2003, 2004). The few studies of associations with personal exposures to fine particles reported similar results (Trenga et al., 2006; Delfino et al., 2008). Associations with lung function were also found with increased concentrations of ozone and oxides of nitrogen and sulphur (e.g., Weinmayr et al., 2010; Dales et al., 2009; Liu et al., 2009; O'Connor et al., 2008; Just et al., 2002; Mortimer et al., 2002; Romieu et al., 2002).

Exposure to $PM_{2.5}$ has been found to be associated with cardiovascular mortality and morbidity and with preclinical measures of cardiovascular health like measures of atherosclerosis and of oxygen saturation in adults (e.g., Nuvolone et al., 2011; Atkinson et al., 2010; Brook et al., 2010; Silverman et al., 2010; Bhaskaran et al., 2009; Goldberg et al., 2008, 2001; Wellenius et al., 2006). While associations with measures of cardiovascular health may also occur in children, to our knowledge these outcomes in children have not been investigated.

Most panel studies of children with asthma have been performed in urban areas where road traffic is the main source of air pollution and the cardiorespiratory effects from exposure to emissions from industrial sources, such as petroleum refinery emissions, have rarely been assessed. Emissions from oil refineries comprise mixtures of pollutants (SO_2 and volatile organic compounds (VOCs), such as benzene (EC, Environment Canada, 2012) that are different from the typical urban air mixture and the effects on asthmatics may differ from the ones reported that are driven mostly from internal combustion engines.

We conducted a panel study in 2009 and 2010 among children with asthma living in an urban industrial area of Montreal, Canada, that is in proximity to two oil refineries and that is also characterized by high volumes of traffic. The purpose of the present paper is to report associations between changes in selected cardiovascular parameters and pulmonary function tests with daily, personal exposure to $PM_{2.5}$, NO_2, SO_2, benzene and polycyclic aromatic hydrocarbons (PAHs). Concentrations of ozone were not measured as they were expected to be very low for personal measurements, mainly because the children spent most of their time indoors (65% in the present study) and for children who participated in the study in the winter, ambient concentrations of ozone are very low.

2. Material and methods

2.1. The study area

Fig. 1 shows the area under study in the east-end of Montreal. This area comprised a large number of major industries, including two oil refineries, and major roads and highways. The two refineries contributed more than 75% of all industrial emissions of SO_2, $PM_{2.5}$, NO_2 and benzene (EC, Environment Canada, 2012). Ambient concentrations of SO_2 and benzene in the study area were higher than in other parts of the city and other Canadian cities (Smargiassi et al., 2009).

2.2. Study subjects

The target population comprised children with asthma, 8–12 years of age, who lived in the study area and in a non-smoking home. To be eligible for the study, the child's parent or legal guardian had to be a French- or English-speaking adult (18 years of age and older), the family had to be non-smoking, and there was no intention of moving during the observation period.

Forty-five children were recruited using the records of a paediatric asthma clinic at a tertiary-care adult hospital (Maisonneuve–Rosemont). We made use of the records of this clinic to identify physician-diagnosed cases of asthma. In the latter half of the study, additional subjects were needed to meet the requirements of sample size. We thus enrolled 27 children from local schools where parents of children with a diagnosis of asthma by a physician were encouraged to contact the study centre. Although children from the asthma clinic were confirmed by respirologists to have asthma, subjects coming from the sample identified in the schools may not have necessarily been so diagnosed. We thus asked guardians the following questions to ensure eligibility: "Can you confirm that a doctor ever said that this child had asthma", "At about what age did his or her asthma begin? and "Does he or she still have asthma?"

Interested families were scheduled for a home visit which included an in-depth explanation of the study, an introduction to the study diaries and questionnaires, and an introduction to all instruments used to measure health outcomes and personal exposures. After fully describing the study and answering any questions from the parent/guardian and the child, the staff went through the consent form with the family and obtained consent from the parent/guardian and assent from the child to participate.

2.3. Design of the study

The study was designed as a panel study of 72 children that lasted 10 consecutive days, including weekends. Thirteen panels, each containing six or fewer children, were completed between October 2009 and April 2010; one panel of two children was also assessed in the spring 2009. Repeated daily measurements of respiratory and cardiovascular health and personal air monitoring were collected from each child. All measurements were made at the child's home, between 4 and 6 pm on each day.

During the first home visit by technicians, a parent or guardian was asked to complete baseline questionnaires for both health and housing characteristics. The health-based baseline questionnaire was administered to obtain socio-demographic information regarding participants and their families (e.g., age, sex, height, race, education of parents), current and past health status of the child, prescription drugs taken, tobacco smoking, exposure to second hand smoke, and family medical history. The housing characteristics questionnaire included information on age and type of home, heating and cooking fuels used, and presence of pets.

Each day of the study, the children carried with them a rolling backpack that contained a number of instruments for measuring personal exposure to selected air pollutants. If the child was at rest (e.g., watching television), the backpack was placed nearby on a chair. Children also completed a daily diary to capture their activities and locations, which included information on factors contributing to the child's exposure to various air pollutants (e.g., use on day of testing of air fresheners, air cleaners, windows opened on the day of testing, cigarette smoking inside the house). The research assistants reviewed the diary on a daily basis with the child and the parent and attempted to complete missing entries.

The children were also interviewed to elicit information on various health endpoints, and carried out a series of physiological and biological measurements that included spirometry, exhaled nitric oxide, exhaled breathe condensate, blood pressure, pulse rate and oxygen saturation (through pulse oximetry), and body temperature. We also made inquiries on the type and amount of medication used during the previous 24 hours.

2.4. Measurement of personal exposure to selected air pollutants

Air pollutant measurements and analytical methods have been described in detail elsewhere (Nethery et al., 2011; Wheeler et al., 2011). Briefly, the backpack for personal monitoring of exposure to air pollutants weighed 7 kg and the children were asked to keep the backpack near them at all times.

We used Ogawa samplers (Ogawa & Company, Chapel Hill, NC, USA), to measure 24-hour integrated samples of SO_2 and NO_2. The Ogawa samplers for SO_2 and NO_2 contained two alkaline or carbonate-coated filters, respectively. After sampling, filters were kept at 4 °C until analysis. Levels of SO_2 and NO_2 were measured by ion chromatography. For NO_2, the diffusion coefficients were corrected for the average temperature and relative humidity during sampling while for SO_2, a correction was only made for temperature. The average of the two readings from the duplicate filters was used. Unfortunately, the Ogawa filters were not sufficiently sensitive to measuring low concentrations of SO_2 and 94% of the values were below the level of detection (~1 ppb); thus, we will not present results for this pollutant.

Download English Version:

https://daneshyari.com/en/article/6352939

Download Persian Version:

https://daneshyari.com/article/6352939

Daneshyari.com