Science of the Total Environment 646 (2019) 105–110

Contents lists available at ScienceDirect

Science of the Total Environment

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

Exposure to ambient air pollution and risk of childhood cancers: A population-based study in Tehran, Iran

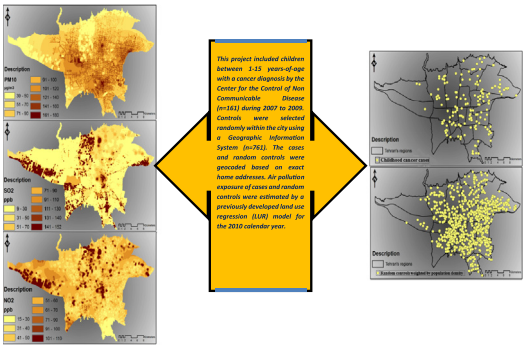
Morteza Seifi [a], Sadegh Niazi [a,b], Graham Johnson [b], Vahideh Nodehi [c], Masud Yunesian [d,e,*]

[a] Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[b] International Laboratory for Air Quality and Health, Queensland University of Technology (QUT), Brisbane, Australia
[c] Department of geography, Kharazmi University, Tehran, Iran
[d] Center for Air Pollution Research (CAPR), Institute for Environmental Research (IER), Tehran University of Medical Sciences, Tehran, Iran
[e] Department of Research Methodology and Data Analysis, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

HIGHLIGHTS

- We observed a positive association between exposures to PM_{10} with childhood cancers.
- We did, however, observe a positive, but not statistically significant association between NO_2 exposure and childhood cancer.
- We did not find a positive association between exposures to SO_2 with childhood cancers.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 26 February 2018
Received in revised form 5 July 2018
Accepted 16 July 2018
Available online xxxx

Editor: SCOTT SHERIDAN

Keywords:
Air pollution
Childhood cancer
Tehran
PM_{10}
NO_2
SO_2

ABSTRACT

The relationship between air pollution and childhood cancer is inconclusive. We investigated the associations between exposure to ambient air pollution and childhood cancers in Tehran, Iran. This project included children between 1 and 15 years-of-age with a cancer diagnosis by the Center for the Control of Non Communicable Disease (n = 161) during 2007 to 2009. Controls were selected randomly within the city using a Geographic Information System (GIS) (n = 761). The cases were geocoded based on exact home addresses. Air pollution exposure of cases and random controls were estimated by a previously developed Land Use Regression (LUR) model for the 2010 calendar year. The annual mean concentrations of Particulate Matter ≤ 10 μm (PM_{10}), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) in the locations of cancer cases were 101.97 μg/m^3, 49.42 ppb and 38.92 ppb respectively, while in the random control group, respective mean exposures were 98.63 μg/m^3, 45.98 ppb and 38.95 ppb. A logistic regression model was used to find the probability of childhood cancer per unit increase in PM_{10}, NO_2 and SO_2. We observed a positive association between exposures to PM_{10} with childhood cancers. We did, however, observe a positive, but not statistically significant association between NO_2 exposure and childhood cancer. Our study is the first to highlight an association between air pollution exposure and childhood cancer risk in Iran, however these findings require replication through future studies.

1. Introduction

There is a growing body of literature describing the risks associated with proximity to urban air pollution (Brunekreef and Holgate, 2002;

* Corresponding author at: Center for Air Pollution Research, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran.
E-mail address: yunesian@tums.ac.ir (M. Yunesian).

https://doi.org/10.1016/j.scitotenv.2018.07.219
0048-9697/

Raaschou-Nielsen and Reynolds, 2006; Forouzanfar et al., 2015). Air pollution exposure has been shown to have serious negative health consequences (Chen et al., 2016; Morawska et al., 1999). Cancer incidence and mortality rates in urban communities are far higher than in rural societies (Ziegler et al., 1993; Kunzli et al., 2000); with air pollution being recognized as one of the most important public health issues in an urban setting (Selden and Song, 1994).

Urban and industrial development and increasing economic activity tend to increase pollution levels in cities (Wheeler, 2001). In Tehran, as in many other industrial cities, the major sources of air pollutants include motor vehicles, industry and domestic sources (Asadollah-Fardi, 2008). Tehran acquires about 80–85% of its major air pollutants, which include PM_{10}, NO_2, SO_2, HC, O_3 and CO, from mobile sources (Naddafi et al., 2012).

A wide range of adverse health consequences due to short and long-term exposure to air pollutants have been recorded in urban populations throughout the world (Pope III and Dockery, 2006; Naddafi et al., 2012). Globally, cancer is one of the major causes of childhood death. Childhood cancer incidence rates among white children are 120–150 diagnoses per million boys and 110–140 per million girls annually within Europe, North and South America, Australia and New Zealand, all of which routinely register cancer cases (Parkin et al., 1988). In Iran, the third highest cause of deaths is cancer incidence, after coronary heart disease and accidents (Naghavi and Jafari, 2007). Cancer is responsible for 4% of the deaths in children under 5 years-of-age and 13% of deaths in children 5–15 years-of-age in the Iranian population; contributing to a total 15% of loss of life in the under 15-years-of-age population (Mosavi-Jarrahi et al., 2007). Some epidemiological studies have shown that an increase in childhood cancer risk is related to traffic exposure (Reynolds et al., 2002; Reynolds et al., 2004; Feychting et al., 1998; Raaschou-Nielsen et al., 2001; Elliott et al., 2017). Nevertheless, the evidence for an association between our air pollutants of interest and childhood cancer is weak; few positive findings were obtained in a small number of studies which featured small sample size, unreliable exposure assessment methods and other methodological limitations (Raaschou-Nielsen and Reynolds, 2006). The etiology of childhood cancers is to a great extent unknown, but a few risk factors have been confirmed, including environmental risk factors such as air pollution, traffic and electromagnetic radiation (Heck et al., 2013). It has been shown that environmental factors play an important causal role in childhood cancer, as cases of childhood cancer stemming from genetic alterations are responsible for only a small percentage of total cases (Parkin et al., 1988; Parsons et al., 2011). The aim of this study was to investigate the associations between exposure to ambient air pollution and childhood cancer incidence in Middle Eastern City of Tehran, Iran. Further research into and greater recognition of the effects of air pollutants in childhood cancer will help bring awareness to governments, medical professionals, and the public about the dangers of these pollutants to our health and economy.

2. Methods

2.1. Study area

This study was performed in Tehran, the capital of Iran. Tehran has a population of over 10 million (http://www.amar.org.ir, 2017). Tehran is located at the foot of the Alborz Mountains (Latitude: 35° North, Longitude: 51° East), south of the Caspian Sea. Tehran suffers from higher air pollution concentrations due to motorized traffic, industry and dust. There are many bus terminals within the city. There is also a wide range of heavy and light industries across the city, including production and manufacturing of inks, metals, machinery, roofing material, plastics, detergents and pharmaceuticals. Another source of air pollution is using natural gas for cooking and heating (Amini and Taghavi-Shahri, 2013). It is reported that childhood cancer in Tehran had a moderate incidence (176.3 cases/1,000,000 children under 15 years of age) (Mosavi-Jarrahi et al., 2007; Amini, 2014). However, more recent estimates of childhood cancer incidence are required.

2.2. Characterization of cases and random controls

Records of 64, 55 and 42 childhood cancer patients were obtained from the center for Non Communicable Disease (Ministry of Health and Medical Education) for years 2007, 2008 and 2009, respectively. All cancer cases were diagnosed during the years of 2007, 2008 and 2009, while our LUR model, based on air pollutant data from 2010, was used to estimate the exposure of patients. The limited number of cancer records available for 2007 did not permit a sufficiently powerful study size, so additional cancer cases were added from diagnoses in 2008 and 2009. These cases were geo-coded within the Tehran megacity by GIS based on their exact home addresses at diagnosis (Fig. 1). The postal code of each cancer patient was determined through the Bureau of Iran's Post Office. Each 10 digit postal code represented the exact cancer patient's place of living. Table 1 shows the age, gender and breakdown of cancer cases. We included cases that were of 1 to 15 years of age at cancer diagnosis, who permanently resided at their recorded addresses. We did not consider children <1 year of age in this study. The center for Non Communicable Disease has been recording each patient's residential situation (permanent and nonpermanent) and these details were used to geocode locations in our study. Given that people spend 90% or more of their time within indoor environments (Dockery and Spengler, 1981), we have assumed that our cases spend 90% of their time in their houses or schools. Because most children were enrolled in schools located close to their homes, their exposure to air pollutants was assumed to be the same during their journey to school and while at school. We did not have access to more information regarding

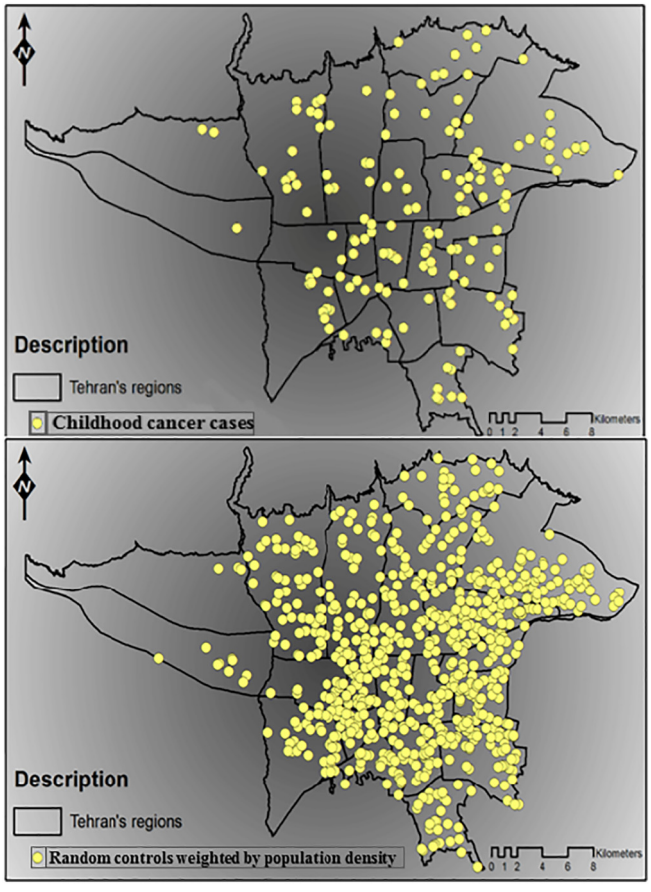


Fig. 1. Map illustrating the distribution of cancer cases and their random controls within the Tehran area.