2006

Adverse health effects of air polluion [sic] on primary school children in Tehran

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ADVERSE HEALTH EFFECTS OF AIR POLLUION ON PRIMARY SCHOOL CHILDREN IN TEHRAN

A thesis is submitted in partial fulfilment of the
requirements for the award of the degree

DOCTOR OF PHILOSOPHY

From

UNIVERSITY OF WOLLONGONG

by

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School of Health Sciences

2006

Thesis Certification

I, Narges Bagheri Lankarani, hereby declare that this thesis, submitted in the partial fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Health Sciences, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualification at any other institution.

Narges Bagheri Lankarani

31 March 2006

Dedication

In the name of God

Most Gracious Most Merciful

To my beloved husband Ali asghar Faramarzian who has supported me all the way since the beginning of my study and who has been a great source of motivation and inspiration and my sons for their patience.

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Glossary

Absenteeism	Daily respiratory illness-related absences from schools when the schools were open.
APHEA	Air Pollution and Health - A European Approach
AQCC	Air Quality Control Company
BS	Black Smoke
CI	Confidence Interval
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COH	Coefficient of Haze or Soiling Index
COPD	Chronic Obstructive Pulmonary Disease
DALYs	Disability Adjusted Life Years
DOE	Department of Environment
EC	Elemental Carbon
EHI	Environmental Health Indicator
EPA	Environmental Protection Department
FEF	Forced Expiratory Flow
FEV_1	Forced Expiratory Volume
FVC	Forced vital Capacity
GAM	Generalized Additive Models
GEE	Generalized Estimating Equations
Hospitalization	Daily diagnoses on discharge data, describing emergency room visits were recorded using the International Classification of Disease version 10 (ICD_{10}).
ICD	International Classification for Disease
IRIMO	Islamic Republic of Iran Meteorological Organization
ISAAC	International Study of Asthma & Allergies in Childhood
JICA	Japan International Co-operation Agency
L/m	Litres per minute
Log	Natural logarithm
Lung function	Peak expiratory flow rate measured by mini Wright
MA	Moving Average
MEF_{25}	Maximum Expiratory Flow at 25% vital capacity
NO_2	Nitrogen dioxide
NO_X	Nitrate Oxides
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
PEF	Peak expiratory flow
PEFR	Peak expiratory flow rate measured by mini Wright
PHREG	Proportional Hazard Regression
PM_{10}	Particulate matter smaller than 10 microns per cubic metre

Poor Lung function /airway obstruction	Daily decrease in peak expiratory flow rate (PEFR) of 50 percent of expected values' and having respiratory Symptoms such as recent wheeze (in the 12 months prior to study) or whistling in the chest and coughing.
ppm	Part per million
PSI	Pollutant Standards Index
RR	Relative Risk
SAS	Statistical Analysis Software
SCI	Statistical Centre of Iran
SO_2	Sulphur dioxide
Std Dev/SD	Standard deviation
TSP	Total Suspended Particles
USEPA	U.S. Environmental Protection Department
VOCs	Volatile Organic compounds
WHO	World Health Organization

Abstract

Health effects caused by air pollutants may range from subtle biochemical or physiological signs, such as mildly reduced lung function, to difficult breathing, wheezing, coughing and exacerbation of existing respiratory conditions such as asthma, and chronic obstructive pulmonary disease (COPD). These effects can lead to school absenteeism, increased medication use, increased doctor or emergency room visits and more hospital admissions.

Lung function and respiratory symptoms have been the primary focus of most studies addressing the respiratory health effects of air pollution among children. Peak expiratory flow (PEF) has been found to be significantly lower in children exposed to air pollution. These studies have also reported higher prevalence of asthma and respiratory symptoms such as cough, phlegm and wheezing.

Most of the data collected in this study are in the form of time-series. The focus of this thesis is on relationships between time-series, but explicit 'time-series' methods for the analysis of univariate series have not been adopted. The case-crossover method is used to examine short-term effects of air pollution. In a symmetric bi-directional design, two control times are selected, e.g. two weeks before and two weeks after phenomena of interest, so as to reduce auto-correlation effects in the exposure series. In this study, dates of high respiratory related hospital admission rate, respiratory related school absenteeism rate on two consecutive days, or the occurrence in individuals of worst lung function are defined as 'case days' and two weeks after or before each date defined as 'control'. In the case definitions, either a case date or case window was used with the corresponding two control dates or windows.

Two statistical methods were used for investigating the effects of air pollution on school absenteeism, hospital admission and lung function. Poisson regression is commonly used to model responses that are counts. In this study, the response was the absenteeism or hospital admissions per day, the predictors were air pollutants concentrations, weather parameters and other related factors. Time-series methods provide a traditional analytical approach in epidemiology studies but could not be used here because of the existence of too many missing values.

For the case-crossover approach, conditional logistic regression and hazard ratios were used to investigate the relationship between absenteeism, hospital admission, poor lung function or airway obstruction and daily temperature, air pollutant concentration and other covariates such as gender and teaching shift. For both methods, SAS statistical package version 9.1 was used.

The population was potentially exposed to ambient air concentrations of SO_2 in excess of the WHO limit for 304 days in 2000, for the entire year of 2001, and for 241 days in 2002. Since, there is no limit for PM_{10} in WHO air quality standards it is compared to World Bank and other countries' limits. In the period 2000-2002, the population of Tehran was also potentially exposed to ambient air concentrations of PM_{10} in excess of the World Bank limit for 25 days in 2002 and some courtiers such as Australia, Canada, EU, Philippines and Hong Kong limits for 327 days in 2000, 352 days in 2001 and 296 days in 2002. Exposure to ambient air concentration of NO_2 was also potentially in excess of WHO standards for 132 days in 2000, 0 days in 2001 and 142 days in 2002. Potentially exposure to ambient air concentration of O_3 was also there in excess of WHO standards just for 3 days in 2002. Likewise, ambient air concentrations of CO exceeded the WHO limit for 314 days in 2000, 277 days of 2001 and 272 days in 2002.

Absenteeism data over 295 days were obtained from two schools in Tehran, and was found to be associated with some pollutants using both Poisson and case-crossover analyses. Specifically, the strongest association found in this study was equivalent to an increase in daily absenteeism of 0.8 for the Poisson model, and an odds ratio of 10 for the probability of daily absenteeism for case-crossover analysis. However, absenteeism was also negatively associated with concentration of seven-day moving average of PM_{10}, NO_2 and O_3. Such associations are not consistent with the literature.

Hospital admission data were obtained from two hospitals in Tehran over a 2-year period. After using both Poisson regression, addressing the full data set of hospital admissions, and a case-crossover analysis of the reduced set of cases and controls, the following results were found. Temperature and O_3 (same day) were the only statistically significant predictors. However, the association between ozone and hospital admission was negative, which is not consistent with the literature.

This study also assessed the results of a survey using a standard questionnaire on students at two elementary schools. This demonstrated that some respiratory prevalence

rates are higher in males than females. Around 22% of students have current wheeze, and 38% of the students who have current wheeze are passive smokers. In general, the level of exposure to known risk factors, with the exception of number of smokers at home, does not seem to be extraordinarily high in this population.

The overall prevalence rate of poor lung function (percentage of students whose lung function was less than 50% of their predicted value or best blow) found in this study is 12% using predicted value and 30% using best blow.

Lung functions of students were measured for six weeks. The lung function data were analysed using the case-crossover method, and it was found that a change between mean and maximum concentration of seven-day moving average of NO is predicted to lead an increases the probability of poor lung function (OR = 19 and OR = 80 using predicted value and personal best blow respectively. The concentrations of seven-day moving average of PM_{10} and CO were negatively associated with the probability of poor lung function, which is not consistent with the literature.

Overall, some significant negative effects of air pollution level on respiratory health were found in this study. Case-crossover analysis tended to confirm the general pattern indicated using Poisson regression. Some puzzling positive effects were found, and these are inconsistent with the literature. While there were some limitations in the quantity of data available (eg. lung function measurements which were only available for a six week period) the major limitation was of the quality of air pollution data, with many missing values as well as problematic measurements.

Acknowledgement

First, I give thanks to God, without whom I would not have had the ability or the opportunity to attempt this thesis. I express my gratitude to all those who gave me the possibility to complete this thesis. I acknowledge Associate Professor Irene Kreis and Professor David Griffiths for their supervision and advice. Without their advice, this thesis would not be prepared. I thank Professor Dennis Calvert, former Head of the former Graduate School of Public Health and Associate Professor Heather Yeatman, Interim Head of the School of Health Sciences. I thank Dr. Barnett, Dr. Chandra Gulati for his advice in statistics and Vicki Kendrick for her priceless help in use of the SAS (Statistical Analysis Software) package for the analysis. To Kay Kent for her support in creating a happy work environment for me and my peers. My special thanks go to Meeta Chatterjee, for her precious help and her advice in thesis writing styles.

My special thanks to the Iranian Ministry of Education and Iranian Ministry of Health, the statistics centres of the two hospitals (Imam Hussein and Loghman), the staff of the schools Haghighat and Shahid Shahsavari who gave me the opportunity to collect my data. I thank the parents of children, and the students of both schools who cooperated with me during data collection. To the head, Dr. Rashidi and staff of the Air Quality Control Company and Dr. Majid Azadi from the Iran Meteorological Organization who provided the meteorological data for this thesis.

To my fellow postgraduate research students, Dolly Bondarianzadeh, Chun-Min Chen (Lisa) and, Yung-Yu Su (Paul) who tried to fill the empty spot of my family being overseas and Anne-Maree Parrish and Judy Mullan for their kindness. My special thanks go to Dolly and her family for their help and sharing their especial times with me. Thank you, especially, to my best friend Hildegard Ojibway for her great help. To Shirin Dinkouh my research assistant for her help in data collection.

Last but not least, I thank my husband, without whose love, patience, and support I would never have been able to complete this thesis, and my sons who were patient with my absence from many life events. I am especially thankful to my husband and my father, who, in spite of their serious illnesses during my thesis work, kept supporting me as before.