THE EFFECT OF AMBIENT AIR QUALITY ON LUNG FUNCTION, RESPIRATORY SYMPTOMS AND BRONCHODILATOR USE AMONG SYMPTOMATIC CHILDREN

By

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Declaration

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution

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Abstract

Numerous overseas studies have linked both short and long-term exposures to outdoor air pollution to a range of health effects. The differences in air pollution sources, climate and geography in Australia challenged the generalisability of these overseas findings to the Australian setting. In response, the Hunter Illawarra Study of Airways and Air Pollution (HISAAP) was undertaken. The aim of Phase II of HISAAP was to assess the short-term effects of particulates on respiratory health amongst symptomatic children.

This thesis presents the results of an analysis of the 345 primary school children eligible for Phase II of the Hunter component of HISAAP. There were multiple daily diary measures on each child, different types of outcomes such as continuous, dichotomous and count variables, as well as several sources of exposure data on pollutants. Because of the complex and hierarchical nature of data, there are several possible methods of analyses that could be used. The thesis begins with a description of the sampling methods used in the study. Next, an overview of the literature on the relationship between air pollution and respiratory health, followed by a review of the methods of analyses appropriate for longitudinal diary studies of this nature. The methods and results are then presented for the analyses of the association between the three main outcomes of interest – evening peak flow, day cough and bronchodilator use – and air quality variables: particulates (PM10 and TSP), sulphur dioxide, pollens and fungi, using three modelling approaches. These include a representative of data reduction methods (Aggregate analysis), subject-specific or mixed-model methods (Korn-Whittemore analysis) and marginal methods (Generalised Estimating Equations). All estimates were adjusted for climate-related covariates and trend. The final chapter discusses the advantages and disadvantages of the various methods of analyses, and a recommendation for analytic techniques for further studies.

Glossary of abbreviations

The following key abbreviations are used in this thesis:

	Abbreviation	Description
	5-day average	average concentration over the current and previous 4 days
	6d-TSP	total suspended particulates as a daily load on a 6-day rotating basis
𝔸	AIC	Akaike's Information Criterion
	ANSTO	Australian Nuclear Science and Technology Organisation
	ASP	Aerosol Sampling Project
	APHEA	Air Pollution and Health a European Approach
	AR-1	autoregressive process of order one
𝔹	B	Beresfield
	BHP	Broken Hill Proprietary
	BHPQ	BHP Quality Program
	BS	black smoke
ℂ	CI	confidence interval
	COPD	chronic obstructive pulmonary disease
	CV	coefficient of variation
𝔻	df	degrees of freedom
𝔼	EPA	Environmental Protection Agency
	EPF	evening peak flow
𝔽	FEV_1	forced expiratory volume in one second
	FVC	forced vital capacity
	FEV_1/FVC	ratio of the forced expiratory volume in 1 second to the forced vital capacity
𝔾	GAM	generalised additive model
	GEE	generalised estimating equations
	GEE-2	second order generalised estimating equations
	GLM	generalised linear model
	GLMM	generalised linear mixed model

Glossary of abbreviations continued (H to M)

	Abbreviation	Description
ℍ	hr	hour
	H+	hydrogen ion
	H_2S	hydrogen sulphide
	H_2SO_4	sulphuric acid
	HARP	Health and Air Research Program
	HISAAP	Hunter Illawarra Study of Airways and Air Pollution
	HVRF	Hunter Valley Research Foundation
	HVS	high volume sampler
𝕀	ICC	intraclass correlation coefficient
	IQR	interquartile range
	ISAAC	International Study of Asthma and Allergies in Childhood
𝕂	KINAS	Kooragang and Inner Newcastle Airshed Study
	K-W	Korn-Whittemore
𝕃	L/min	Litres per minute
	Lag *x*	A single day lag of order *x* days (e.g. lag 1)
	LMCC	Lake Macquarie City Council
	LRT	lower respiratory tract
𝕄	$\mu g/m^3$	micrograms per cubic metre
	μm	micrometre
	M	Mayfield
	MAQS	Metropolitan Air Quality Study
	MAR	missing at random
	MCAR	missing completely at random
	MLE	maximum likelihood estimation

Glossary of abbreviations continued (N to R)

	Abbreviation	Description
ℕ	n.a.	not applicable
	NAAQS	National Ambient Air Quality Standards
	NCC	Newcastle City Council
	NCICAS	National Cooperative Inner-City Asthma Study
	NEPM	National Environment Protection Council
	NHMRC	National Health and Medical Research Council
	NLM	North Lake Macquarie
	NO	nitric oxide
	NO_2	nitrogen dioxide
	NO_x	nitrogen oxide
	NH_4	ammonium
ℚ	O_3	ozone
	OR	odds ratio
ℙ	PA	population-averaged
	PACF	partial autocorrelation function
	PDL	polynomial distributed lag
	PEACE	Pollution Effects on Asthmatic Children in Europe
	PEF(R)	peak expiratory flow (rate)
	PM	particulate matter
	PM*x*	Particulate matter less than *x* micrometres in diameter (e.g. PM2.5, PM10)
	PMS	Pasminco Metals-Sulphide
	pphm	parts per hundred million
	PQL	partial quassi-likelihood
ℝ	REML	restricted maximum likelihood
	R^2	coefficient of determination

Glossary of abbreviations continued (S to Z)

	Abbreviation	Description
S	S	Stockton
	sd	standard deviation
	SE	standard error
	SO_2	sulphur dioxide
	SO_4	sulphate
	SS	subject-specific
	SSI	size-selective inlet
T	TEOM	Tapered Element Oscillating Microbalance
	TSP	total suspended particulates
U	URT	upper respiratory tract
	UK	United Kingdom
	USA	United States of America
W	W	Wallsend
	WHO	World Health Organization

Description of study areas

This thesis was based on a study conducted in five areas in the Hunter Region of NSW, Australia. Three of these areas were close to industrial sources of air pollution, and two served as control areas. Subjects in Wave 1 completed a diary from February to October 1994 and subjects in Wave 2 completed diaries from August 1994 to April 1995.

Study area	**Exposed to industrial sources of air pollution?**	**Wave**
Stockton	Yes	1
Wallsend	No	1
Mayfield	Yes	1
Beresfield	No	2
North Lake Macquarie	Yes	2