Traffic pollution and cardiovascular diseases in Greater Vancouver in association with socioeconomic status indicators

by

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Abstract

Cardiovascular diseases constitute a major health burden of modern societies. Besides eating habits, smoking or levels of physical activity, which are the most acknowledged risk factors, social determinants of health or air pollution constitute important risks in the development of cardiovascular diseases. Current knowledge about potential interactions between socioeconomic status and the effects of short- and long-term exposure to air pollution on mortality or morbidity due to cardiovascular diseases doesn't offer substantive answers regarding the effect modification of various socio-economic factors on the risk of developing cardiovascular diseases due to air pollution. These interactions were analyzed using a cohort of 346,536 subjects over 45 years of age from Greater Vancouver Area, British Columbia.

My study found significant evidence that even in areas with low levels of traffic pollution and even for healthy people, there is an increased risk of cardiovascular disease morbidity or mortality associated with exposure to traffic pollution and road proximity, especially when considering socioeconomic variables at medium-scale (neighborhood) levels of aggregation. However, I found consistent results regarding the extent to which socioeconomic indicators modify the effect of traffic pollution on health on the expected trajectory (individuals from more advantaged areas would be less subjected to the effects of traffic pollution compared with individuals living in more disadvantaged areas). At dissemination area levels, in the case of exposure to particulate matter, subjects living in areas with a higher percentage of Chinese population were at a lower risk of CCS health outcomes. Subjects living in areas with a higher proportion of university degrees were also at a lower risk of experiencing CCS in conjunction with black carbon exposure. These results would need to be studied in conjunction with analyses at individual level data to confirm that these trends are real.

Also, the results do not prove that socioeconomic covariates derived for smaller areas strengthen the association or show significance in respect with cardiovascular health outcomes and pollution, since higher levels of risk were found when using covariates at neighborhood levels of aggregation as oppose to those at dissemination area level.

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Abbreviations

$\mu g/m^3$	micrograms per cubic meter of air
μm	micrometer
95% CI	95 percent confidence interval
ACS	acute coronary syndrome
AMI	acute myocardial infarction
BC	British Columbia
CAC	coronary artery calcification
CCHS	Canadian Community Health Survey
CCS	chronic coronary syndrome
CHF	congestive heart failure
CI	confidence intervals
CO	carbon monoxide
COPD	chronic obstructive pulmonary diseases
CVD	cardiovascular diseases
D	diabetes mellitus
DA	(census) dissemination area
EA	(census) enumeration area
FSA	Forward Sortation Area (first three digits of the six digit Canadian postal codes)
GAB	Georgia Air Basin
GIS	geographic information system
HD	hypertensive diseases

ICD-9	International Classification of Diseases, 9th Edition
ICD-10	International Classification of Diseases, 10th Edition
IDW	inverse distance weighted
IHD	ischemic heart disease
LUR	land use regression
NO	nitric oxide
NO_2	nitrogen dioxide
O_3	ozone
OC	organic components
OR	odds ratio
PM	particulate matter
PM_{10}	particulate matter smaller than 10 micrometers in aerodynamic diameter
$PM_{2.5}$	particulate matter smaller than 2.5 micrometers in aerodynamic diameter
ppb	parts per billion
RR	relative risk
SE	standard error
SES	socioeconomic status
SO_2	sulfur dioxide
UFPs	ultra fine particles
US EPA	United States Environmental Protection Agency

Introduction

Cardiovascular diseases comprise a group of diseases in which both genetic and environmental factors play a causal role. Given this combination of factors, it comes as no surprise that the American Heart Association's (AHA) "Guidelines for Primary Prevention of Cardiovascular Disease and Stroke"[1] and the AHA/American College of Cardiology's (ACC) "Guidelines for Preventing Heart Attack and Death in Patients with Atherosclerotic Cardiovascular Disease"[2] emphasize the need for multi-factorial interventions in preventing CVD. They recommend intensive measures to reduce an individual's risk of cardiovascular disease, focusing on diet, drugs, exercise, weight management, complete smoking cessation, and the avoidance of second hand smoke.

The multi-factorial view on the causes of CVD has been emphasized even more by the research done in the last couple of decades regarding the potential deleterious effects of ambient air pollution on health and its relationship to heart disease and stroke. Of special interest are several environmental air pollutants that include carbon monoxide, oxides of nitrogen, sulphur dioxide, ozone, lead, and particulate matter ("thoracic particles" [PM_{10}] <10 μm in aerodynamic diameter, "fine particles" [$PM_{2.5}$] <2.5 μm, and "coarse particles" [PM_{10} to $PM_{2.5}$]). Among these pollutants, particulate matter have received the most attention, a recent review by the American Heart Association stating that "Exposure to PM <2.5 μm in diameter ($PM_{2.5}$) over a few hours to weeks can trigger cardiovascular disease–related mortality and nonfatal events; longer-term exposure (e.g., a few years) increases the risk for cardiovascular mortality to an even greater extent than exposures over a few days and reduces life expectancy within more highly exposed segments of the population by several months to a few years; reductions in PM levels are associated with decreases in cardiovascular mortality within a time frame as short as a few years; and many credible pathological mechanisms have been elucidated that lend biological plausibility to these findings. It is the opinion of the writing group that the overall evidence is consistent with a causal relationship between $PM_{2.5}$ exposure and cardiovascular morbidity and mortality. This body of evidence has grown and been strengthened substantially since the first American Heart Association scientific statement was published. Finally, $PM_{2.5}$ exposure is deemed a modifiable factor that contributes to cardiovascular morbidity and mortality."[2a]

US EPA Air Quality Criteria for Particulate Matter has confirmed the presence of an apparent linear dose-response relationship between PM and adverse events[3]. This dose-response curve, derived from data gathered from across North America, has no discernible threshold below which PM concentrations pose no health risk to the general population[3]. Approximately 40,000 deaths per year in Austria, France, and Switzerland combined have been attributed to PM[4]. Estimates based on time-series studies suggest that there are circa 5,000 excess deaths per year in Canada[5] and 6,000 cardiovascular events in the United Kingdom[6] that can be attributed to poor air quality. A study in London, England found that approximately 1 in 50 myocardial infarctions may be triggered by outdoor air pollution.[7] On a global scale, the World Health Organization has estimated that PM exposure is responsible for 800,000 deaths and the loss of 7.9 million disability-adjusted life-years annually, among which 89%, or over 712,000 deaths attributable to cardiopulmonary diseases.[8]

Besides the interest in environmental air pollution as a risk factor in the development of CVD, research was also directed at studying the impact of various social determinants of health as risk factors for CVD development. In doing so, most of epidemiological studies have used census data as proxies for individual level information on the socioeconomic status of the study subjects. Although, from a mechanistic perspective, it is difficult to relate the characteristics of whole neighbourhoods with an individual's propensity to develop cardiovascular diseases, there are convergent studies that relate CVD with stress,[9] as well as studies that relate low socioeconomic status with stress and health.[10] Moreover, from an epidemiological perspective, there is an emphasis on the impact of neighbourhoods on individuals' health.[11]

While the causal link between socioeconomic status and mortality and morbidity is not fully explained, the existence of an inverse gradient between SES and mortality and morbidity has been consistently observed. This inverse relationship is observed whether SES is measured using education, income, or occupational status, and it does not appear to be an artifact of the more physically ill individuals drifting down the SES hierarchy.[106] The SES-health gradient extends to a wide array of health problems, including heart disease, cancer, stroke, diabetes, hypertension, infant mortality, arthritis, back ailments, mental illness, kidney diseases, and many others,[107] and may predict future developments after illness is present.[108,109] For more detailed information on specific studies on SES and health, there are several excellent reviews available.[110-122] Not only have various health problems been found to have an inverse correlation with SES, but the prevalence of numerous risk factors associated with these diseases also tends to be inversely associated with SES. A recent review by Laurent et al[237] that investigated the potential interactions between socioeconomic status and the short- and long-term effects of air pollution on mortality found that studies using socioeconomic characteristics measured at coarser geographic resolutions (city- or county-wide) found no effect modification, but those using finer geographic resolutions found mixed results, and five of six studies using individually measured socioeconomic characteristics found that pollution affected disadvantaged subjects more.

There are relatively few studies that have examined the contribution of environmental exposure, such as air pollution, to observed socioeconomic health inequalities. The two mechanisms through which air pollution might create or enhance socioeconomic differences that are identified for various diseases are: (1) populations with low SES may be subjected to more frequent and/or intense exposures to air pollution (environmental inequality); (2) populations with low SES may have an increased susceptibility to air pollution as compared to populations with high SES (biological inequality).

Few studies to date have tried to bring together and analyze the relationship between air pollution and CVD by considering not only an individual's socioeconomic status, but also the characteristics of the subject's environment.[12,13] Of course, one problem can be seen from the start. This is the ecologic fallacy, in which the ambient pollution levels, or, depending on the case, neighbourhood characteristics, are assigned to an individual.[14,15] By using high-resolution air pollution exposure models and subjects' actual addresses, part of the first problem can be mitigated. However, not many of the variables available at a neighbourhood level are available at an individual level, and the more problematic variables are those inherently individual, like smoking.

Literature review

Air pollution and CVD

The majority of epidemiological studies to date have found an increase in the relative risk of CVD due to air pollution. However, for an individual, the increase in relative risk for CVD due to air pollution is small (see page 15 for risk estimates) compared to the impact of other well-established cardiovascular risk factors. Although this risk appears minor, given the fact that people must breathe to live, conservative risk estimates yield a substantial increase in mortality within the population when air pollution is factored in.

The epidemiology of ambient air pollution is well documented; the association between high levels of air pollutants and human illness has been known for more than half a century. There are several hundred published epidemiological studies that link air pollution with human illnesses and a number of extensive reviews on this topic are also available.[6,16-27] During the past 15 years, the magnitude of evidence and the number of studies linking air pollution to cardiovascular diseases has grown substantially.[6,16-27]

Air pollutants are comprised of an extensive variety of substances. However, the most investigated ones are particulate matter, carbon monoxide, sulphur dioxide, nitrogen oxide and nitrogen dioxide, and ozone. Although many pollutants may cause disease individually or in combination (e.g., O_3, SO_2, and NO_2),[28] over the past decade, PM has become a major focus of research. The particles believed to be most deleterious to health are those with an aerodynamic diameter of less than 10 μm (PM_{10}), but most recently the focus has been on the fine and ultra fine component ($PM_{2.5}$ and $PM_{0.1}$), which can penetrate deep into the gas exchange region of human lungs.

Acute effects of air pollution on health

There is a wealth of time series studies and case cross-over studies that link short-term exposure to various pollutants (PM-PM_{10}, $PM_{2.5}$, ultrafine particles; ozone, SO_2, NO_2, CO) with adverse cardiovascular health effects (Table 1).

Some of these studies controlled for certain cyclical variables that could possibly influence mortality, like temperature, presence of influenza outbreaks, etc. while the analyses were sometimes stratified by age. The age factor (usually a cut-off value is used for subjects over and under 65 years) does not play a consistent role in the sense that, for some pollutants, significant adverse effects are found for subjects over 65 years, while for other pollutants, significant effects are found for subjects under 65 years.[47,48] Temperature was not found to affect the estimates for pollutants[60], while smoking status was a major modifier confounder in those studies that used this information. Co-morbidities such as hypertension, diabetes, COPD, and pre-existing cardiac diseases were found to increase the risk of an adverse cardiovascular event by up to 2-3 times.[59] A Vancouver, Canada based study [12] that employed socioeconomic indicators found that, for NO_2, CO, and SO_2, the estimated percent change in daily cardiovascular mortality was more pronounced among those in the low and middle categories of SES. Similar conclusions can be drawn from data on hospital admissions for cardiovascular disease (Table 2).[66-78]

Table 1. Short term analyses of pollutants causing adverse cardiovascular health effects

Study	Geographic area	Cohort size	Type of study	Pollutants	Results
Wichmann 1989[29]	West Germany 1985	Population based study -12 million (high vs. low exposed areas)	Natural study	SO_2 TSP	8% ↑ mortality during smog 6% ↑ CVS mortality (15% q admissions)
Katsouyanni 1990[31]	Athens 1975–1982	25,138 deaths 3 x 199days	Case/control 1:2	SO_2, Black smoke	Higher respiratory and CVD mortality on polluted days
Schwartz 1990[30]	London 1958–1972	Total, Respiratory and cardiovascular deaths in London btw. 1958-1972	time series, autoregressive analysis	Black smoke, SO_2	Significant predictors of all cause daily mortality
Kinney 1991[32]	Los Angeles County 1970–1979	Total, respiratory and cardiovascular deaths	time series, autoregressive analysis	Particles, Ox CO, SO_2 NO_2	Strongly associated with daily CVS mortality
Schwartz 1992[33]	Philadelphia 1973–1980	Total, respiratory and cardiovascular deaths	time series, logistic analysis	SO_2 TSP	5% ↑ mortality/100 μg ↑ 7% ↑ mortality/100 μg q,10% ↑ CVS mortality
Schwartz 1994[34]	Philadelphia 1973–1980	Deaths in 5% high (7,915) and 5% low (7,337)pollution days	time series, logistic analysis	TSP	RR death = 1.08 on high v low pollution day, ↑ heart disease and stroke deaths
Schwartz 1994[35]	Meta-analysis 13 Studies	Total deaths		TSP	RR death = 1.06 for 100 μg ↑
Anderson 1996[36]	London 1987–1992	Respiratory and cardiovascular deaths	time series – Poisson analysis	Black smoke SO_2 Ozone	2.5% ↑ daily mortality/7–19 μg/m3 ↑ SO_2 also significant 3.6% ↑ CVS mortality/7–36 PB ↑
Ponka 1998[37]	Helsinki 1987–1993	Cardiovascular deaths	time series	PM_{10} Ozone NO_2	4.1% ↑ CVS mortality/10 μg/m3 ↑ 9.9% ↑ CVS mortality/20 μg/m3 ↑ Additive effect with PM10 and ozone
Zmirou 1998[38]	10 European cities	Respiratory and cardiovascular deaths	time series	Black smoke SO_2	RR CVS mortality 1.02/50 μg/m3 ↑ RR CVS mortality 1.04/50 μg/m3 ↑
Ostro 1999[39]	Bangkok 1992–1995	Total, respiratory and cardiovascular deaths	time series	PM_{10}	2% ↑ CVS mortality/10 μg/m3 ↑
Rossi 1999[40]	Milan 1980–1989	Respiratory and cardiovascular deaths	time series	TSP	7% ↑ heart failure deaths/100 μg/m3 ↑, 10% ↑ myocardial infarction mortality/100 mg/m3 ↑
Checkoway 2000[42]	King County, WA 1988-1994	362 SCA cases	case-crossover analysis	PM_{10}	RR SCA 0.893/ IQR ↑ PM10 lag1
Peters 2000[43]	Massachusetts 1995-1997	100 subjects with defibrillators – prospective cohort	logistic analysis	NO_2	OR 1.8 (1.1 – 2.9) increased defibrillator interventions lag2 / 26 ppb ↑
Samet 2000[41]	20 US cities 1987–1994	Respiratory and cardiovascular deaths	time series	PM_{10} SO_2 ,CO, Ozone, NO_2	↑ Rate of CVS/respiratory mortality, 0.68% for each ↑ PM10 of 10 μg/m3 Weak associations
Braga 2001[49]	10 US Cities 1986 – 1993	Deaths due to COPD, CVD, MI in 10 U.S. cities between 1986-1993;	Time series - GAM	PM_{10}	1% ↑ total cardiovascular disease deaths/ 10 μg/m3 ↑ in 7 days mean; 0.7% ↑myocardial infarction deaths/ 10 μg/m3 ↑ in 2 days mean;
Goldberg 2001[47]	Montreal 1984-1993	All deaths btw 1984-1993	Time series - GAM	ozone	2.5% ↑ total cardiovascular deaths/IQR ↑
Goldberg 2001[48]	Montreal 1986-1993	All deaths btw 1984-1993	Time series - GAM	$PM_{2.5}$, COH, Sutton sulfate sulfate mass	Consistent association with coronary artery disease and cardiovascular disease deaths for subjects > 65 years
Katsouyanni 2001[45]	29 European cities (APHEA 2)	43 million population; all deaths	Time series - GAM	PM_{10}	↑ Rate of CVS/respiratory mortality 0.6% for each ↑ PM10 of 10 μg/m3, effect size greater in elderly, with high NO2, or in cold climates
Kwon 2001[44]	Seoul 1994–1998	1,807 deaths	case-crossover and GAM (time series)	PM_{10},SO_2, CO, Ozone NO_2	RR mortality 1.014/IQR ↑ PM_{10} RR mortality 1.020/IQR ↑ CO Effect 2.5–4.1% higher in CCF
Peters 2001[46]	Boston 1995-1996	772 patients with MI	case-crossover analysis	$PM_{2.5}$	OR 1.48 MI 25 μg/m3 ↑ 2 h prior MI onset OR 1.69 MI 20 μg/m3 ↑ 24 h prior MI onset
Hong 2002[50]	Seoul 1991-1997	Stroke mortality in Seoul between 1991-1997;	Time series - GAM	TSP SO_2 NO_2 CO Ozone	RR ischemic stroke mortality 1.03/IQR ↑ same day RR ischemic stroke mortality 1.04/IQR ↑ same day RR ischemic stroke mortality 1.04/IQR ↑ 1-day lag RR ischemic stroke mortality 1.06/IQR ↑ 1-day lag RR ischemic stroke mortality 1.06/IQR ↑ 3-day lag
D'Ippoliti 2003[51]	Rome 1995-1997	6531 with AMI	case-crossover	TSP	OR 1.028 AMI//10 μg/m3 ↑ 0 to 2 day lag
Dominici 2003[53]	88 metropolitan areas in US 1987-1994	NMMPS database: 88 cities between 1987-1994	2 stage Bayes hierarchical log-linear regression of daily mortality	PM_{10}	0.31% ↑ cardiovascular & respiratory mortality/ 10 μg/m3 ↑
Sullivan 2003[52]	Washington State, US 1985-1994	1206 with cardiac arrest	case-crossover	$PM_{2.5}$	OR 0.94 out-of-hospital cardiac arrests/13.8 μg/m3 ↑ 0 to 2 days lag

APHEA, Air Pollution and Health: a European approach; NMMPS, National Morbidity Mortality Air Pollution Study; CCF, congestive cardiac failure; CVS, cardiovascular system; IQR, inter-quartile range; RR; relative risk; TSP, total suspended particles; COH, coefficient of haze; SCA, sudden cardiac arrest; MI, myocardial infarction; GAM, general additive models; ↑ (increase)

Table 1. Short term analyses of pollutants causing adverse cardiovascular health effects

Study	Geographic area	Cohort size	Type of study	Pollutants	Results
Villeneuve 2003[12]	Vancouver 1986-1999	550,000 cohort	time series	$PM_{10-2.5}$	5.9% ↑ cardiovascular mortality/diff btw 10-90th percentile
Bateson 2004[54]	Cook County, Illinois, US 1988-1991	65,180 subjects with heart or lung disease	case-crossover	PM_{10}	0.74% ↑ mortality for subjects with cardiovascular & respiratory co-morbidities/ 10 µg/m3 ↑
Bell 2004[57]	US	39 studies + NMMAPS	Meta-analysis	Ozone	0.83% ↑ total mortality / 10 ppb ↑
Daniels 2004[56]	US	20 largest cities in US (NMMAPS)	different time series analyses	PM_{10}	No threshold for cardiovascular-respiratory mortality for a 10 µg/m^3 increase (↑) in PM_{10}
Schwartz 2004[58]	14 US cities 1986-1993	Non-accidental deaths in 14 US cities	case-crossover analysis	PM_{10}	0.36% ↑ deaths from internal causes/ 10 µg/m3 ↑
Forastiere 2005[59]	Rome 1998-2000	5144 non hospital cardiac deaths;	case-crossover analysis	Ultrafine particles	7.6% ↑ out-of-hospital coronary deaths/IQR ↑ with effect modification for subjects with hypertension and COPD
Ruidavets 2005[61]	Toulouse 1997-1999	Cohort of ~ 1.1 mil	case-crossover	Ozone	RR 1.05 acute myocardial infarction / 5 µg/m3 ↑
Schwartz 2005[60]	14 US cities 1986-1993	Non-accidental deaths in 14 US cities	case-crossover analysis	Ozone	0.23% ↑ deaths from internal causes/ 10 ppb ↑
Zeka 2005[62]	US 20 Cities 1989-2000	Mortality in 20 US cities between 1989-2000	case-crossover	PM_{10}	0.30% ↑ deaths heart diseases/ 10 µg/m3 ↑ lag1 0.37% ↑ deaths heart diseases/ 10 µg/m3 ↑ lag2
Analitis 2006[65]	29 European cities APHEA 2	43 million population; all deaths;	time series	PM_{10} Black smoke	0.76% ↑ cardiovascular deaths/ 10 µg/m3 ↑ lag0-1 0.762% ↑ cardiovascular deaths/ 10 µg/m3 ↑ lag0-1
Martins 2006[64]	Sao Paolo 1996-2001	people over 64 years in São Paulo 1996 to 2001;	GAM – time series	PM_{10} SO_2	3.17% ↑ congestive heart failure/IQR ↑ 0.89% ↑ total cardiovascular disease/IQR ↑
Murakami 2006[63]	Tokyo 1990-1994	14,950 deaths;	retrospective analysis	TSP	↑ RR of Myocardial Infarction deaths within hours after reaching high concentration of TSP

APHEA, Air Pollution and Health: a European approach; NMMPS, National Morbidity Mortality Air Pollution Study; CCF, congestive cardiac failure; CVS, cardiovascular system; IQR, inter-quartile range; RR; relative risk; TSP, total suspended particles; COH, coefficient of haze; SCA, sudden cardiac arrest; MI, myocardial infarction; GAM, general additive models; ↑ (increase)

Table 2. Hospital admissions for cardiovascular disease

Study	Geographic area	Cohort size	Type of study	Pollutants	Results
Schwartz 1995[66]	Michigan 1986–1989	520,000 (over 65 years)	time series Poisson regression	PM_{10}, CO	↑ Ischemic heart disease admissions (RR 1.018 IQR ↑ PM10) and with heart failure (RR 1.024 /IQR ↑ PM10 and 1.022/ IQR ↑ CO)
Burnett 1995[67]	Ontario 1983–1988	The Toronto-Hamilton corridor	time series analyses	Particulate sulphates	2.8% ↑ CVS admission/13 µg/m3 ↑
Morris 1995[68]	7 US cities 1986–1989	Hospital admissions >=65 years and older	time series analysis;	CO	↑ Heart failure admissions (RR 1.10–1.37/10 ppm ↑)
Wordley 1997[69]	Birmingham 1992–1994	Hospital admissions	time series on an ecological retrospective cohort	PM_{10}	↑ Risk of respiratory (2.4%) or cerebrovascular (2.1%) admission for 10 µg/m3 ↑
Schwartz 1997[70]	Tucson 1997	Subjects >= 65yeras	time series analysis	PM_{10} CO Ozone/SO_2	2.75% ↑ CVS admission/IQR ↑ 2.79% ↑ CVS admission/IQR ↑ Little association
Burnett 1997[71]	10 Canadian cities 1981–1991	Congestive heart failures in subjects >=65	time series analysis	CO	RR heart failure admission 1.065/IQR ↑
Burnett 1997[72]	Toronto 1970–1994	Mortality in Toronto between 1970-1990	time series analyses	Ozone, NO_2, SO_2	13% ↑ CVS admissions/IQR ↑ gaseous pollutants
Poloniecki 1997[73]	London 1987–1994	373,556 hospital admissions	time series analysis	Black smoke NO_2	2.5% myocardial infarction admissions attributable, associated with angina admissions Associated with arrhythmia admissions
Schwartz 1999[74]	Eight US counties 1988–1990	Cardiovascular hospital admissions	time series analysis	PM_{10} CO	2.48% ↑ CVS admission/IQR ↑ 2.79% ↑ CVS admission/IQR ↑
Wong 2002[75]	Hong Kong (1995-97) London (1992-94)	Daily cardiac admissions	time series analyses	NO_2 PM_{10} SO_2	RR 0.6/0.7 cardiac admissions / 10 µg/m3 ↑ 0-1 day lag RR 0.5/0.9 cardiac admissions / 10 µg/m3 ↑ 0-1 day lag RR 0.1/1.7 cardiac admissions / 10 µg/m3 ↑ 0-1 day lag
Jordi 2003[76]	7 European areas (APHEA-2)	Hospital admissions for CVD	time series analyses	SO_2 PM_{10}	0.7% ↑ CVS admission/10 µg/m3 ↑ subjects < 65 years 1.3% ↑ CVS admission/10 µg/m3 ↑ subjects > 65 years
Zanobetti 2005[77]	21 US Cities 1985-1999	> 300,000 MI	case-crossover analysis	PM_{10}	0.65% ↑ MI admission/10 µg/m3 ↑ with effect modification for subjects with pneumonia or COPD
Symons 2006[78]	Baltimore 2002	125 subjects (135 cases)	case-crossover analyses	$PM_{2.5}$	OR 1.09 of congestive heart failure admissions/IQR ↑

APHEA, Air Pollution and Health: a European approach; CCF, congestive cardiac failure; CVS, cardiovascular system; IQR, inter-quartile range; RR; relative risk; TSP, total suspended particles; COH, coefficient of haze; SCA, sudden cardiac arrest; MI, myocardial infarction; CVD, cardiovascular diseases; MI, myocardial infarction; ↑ (increase)

It can be seen from both tables 1 and 2 that the magnitude of CVD outcomes varies greatly, from less than 1% to 13% between studies. However, meta-analyses of the time series data suggest that an increase in mean 24-hour fine particulate pollution of 10 $\mu g/m^3$ increases the relative risk for daily cardiovascular mortality by approximately 0.4% to 1.0%.[2c] The excess number of deaths due to air pollution reported by various studies[3-8] was confirmed by several large scale interventions or natural experiments, as described in more detail below.

A study regarding Dublin's ban on coal sales in 1990 showed that a reduction in black smoke concentration by 35.6 $\mu g/m^3$ was associated with a 10.3% decrease in annual cardiovascular mortality.[79] In a similar intervention study, a 50% reduction in sulphur dioxide concentrations following legal restrictions on fuel oil sulphur in Hong Kong was immediately followed by a 2.4% reduction in cardiovascular deaths.[80]

Chronic exposure to air pollution and health

The first large, prospective cohort study that demonstrated the adverse health impact of long-term air pollution exposure was the Harvard Six Cities study[82] This study showed that chronic exposure to air pollutants is independently related to cardiovascular mortality. The adjusted overall mortality rate ratio for the most-polluted city versus the least-polluted city was 1.26 (95% CI 1.08 to 1.47). Adjustment for a variety of individual-level risk factors that included tobacco smoking, gender, body mass index, educational attainment, occupational exposures, hypertension, and diabetes did not significantly alter the relationship. Cardiovascular deaths accounted for the largest single category of the increased mortality. Among air pollutants, elevations of $PM_{2.5}$ and sulphates showed the strongest associations with disease. A follow-up study on the Harvard Six Cities initial project has found that improved overall mortality was associated with decreased mean $PM_{2.5}$ (10 $\mu g/m^3$) between the initial study and the follow-up study (RR, 0.73).

Similar observations were reported by the first analysis of air pollution in relation to mortality in the ACS Cancer Prevention II study population.[83] A follow-up of the original ACS cohort by Pope et al.,[84,85] based on additional subject mortality and ambient pollutant data, has provided the largest study of the long-term health effects of air pollution. In a cohort of approximately 500,000 adults residing in all 50 U.S. states, chronic exposure to multiple air pollutants was linked to mortality statistics for a 16-year period. The ACS follow-up study increased the degree of control for confounding variables such as diet. The primary results showed that each 10 $\mu g/m^3$ increase in annual $PM_{2.5}$ mean concentration, based on a number of different averaging periods, was associated with increases in all-cause, cardiopulmonary, and lung cancer mortality of 4%, 6%, and 8%, respectively. The relationship between $PM_{2.5}$ and adverse health effects was linear and without a discernible lower "safe" threshold. This corresponds with findings in other studies.[3,56] Mortality was strongly associated with $PM_{2.5}$, sulphate particles, and SO_2. There also appeared to be an association between cardiopulmonary mortality and summertime O_3, when based on mean summer O_3 levels from 1982 to 1998. Educational level was a modifier of the risks estimated for PM-associated mortality. However, the increased risks were restricted only to those subjects with no more than a high school education. This suggests that some other unaccounted-for factors, such as intra-urban geographic location or socioeconomic status, may be important determinants of health risk.

A recent Norwegian study[86] that followed a cohort of 16,209 men 40–49 years of age living in Oslo, Norway from 1974 to 1998 found that the adjusted risk ratio for dying was 1.08 [95% confidence interval (CI), 1.06–1.11] for a 10-μg/m^3 increase in average exposure to nitrogen oxides (NO_X) after controlling for a number of potential confounders. Corresponding adjusted risk ratios for dying from a respiratory disease other than lung cancer were 1.16 (95% CI, 1.06–1.26); from lung cancer, 1.11 (95% CI, 1.03–1.19); from ischemic heart diseases, 1.08 (95% CI, 1.03–1.12); and from cerebrovascular diseases, 1.04 (95% CI, 0.94–1.15).

A study[87a] from Los Angeles for a cohort consisting of 22,905 subjects from the American Cancer Society cohort for the period 1982–2000 (5,856 deaths) looked at the association between mortality due to different causes and ambient $PM_{2.5}$ and O_3. After controlling for 44 individual covariates, for $PM_{2.5}$, ischemic heart disease mortality was elevated (in the range of 1.24 –1.6, depending on the model used).

A recent US study[88] on a cohort of 65,893 postmenopausal women without previous cardiovascular disease in 36 U.S. metropolitan areas from 1994 to 1998, with a median follow-up of 6 years, has also found a relation between $PM_{2.5}$ and cardiovascular adverse events. Hazard ratios were adjusted for age, race or ethnic group, smoking status, educational level, household income, body-mass index, and presence or absence of diabetes, hypertension, or hypercholesterolemia. Each increase of 10 μg/m^3 was associated with a 24% increase in the risk of a cardiovascular event (HR, 1.24; 95% CI, 1.09 to 1.41) and a 76% increase in the risk of death from cardiovascular disease (HR, 1.76; 95% CI, 1.25 to 2.47). For cardiovascular events, the between-city effect appeared to be smaller than the within-city effect. The risk of cerebrovascular events was also associated with increased levels of $PM_{2.5}$ (HR, 1.35; 95% CI, 1.08 to 1.68).

A study focused on women[88a] between 50 and 59 years of age based in the Ruhr area of Germany has studied the long term relation between ambient air pollution (NO_2 and PM_{10}) and cardiopulmonary mortality. The cohort comprised 4,874 women followed in the 1980s and 1990s to monitor health status and migration. One-year and five-year average exposure levels were found to be associated with cardiopulmonary mortality. The adjusted relative risk for the one-year average NO_2 exposure was 1.57 (1.23–2.00), while for the five-year NO_2 average, the relative risk was 1.74 (1.29–2.33). The adjusted relative risk for the one-year average PM_{10} exposure was 1.34 (1.06–1.71), while for the five-year PM_{10} average, the relative risk was 1.59 (1.23–2.04). The adjustment was done considering smoking status, body mass index, education level of the subject and her partner, as well as existent co-morbidities.

The above studies focusing on women, which found an increase risk of cardiovascular events associated with ambient exposure to particulates or nitrogen oxides, are complemented by a study[88c] conducted in California that followed a cohort of 3,239 subjects for 22 years, between 1977 and 1989, to investigate the effect of long-term ambient particulate matter on the risk of fatal coronary heart disease. Monthly concentrations of ambient air pollutants (PM_{10}, $PM_{2.5}$, ozone, sulphur dioxide, nitrogen dioxide) were used in the analyses as exposure variables. All participants had information on environmental tobacco smoke and other personal sources of air pollution, and all subjects with prevalent CHD, stroke, or diabetes at baseline (1976) were excluded. The analyses were also controlled for a number of potential confounders, including lifestyle. In females, the relative risk for fatal CHD with each 10 μg/m^3 increase in $PM_{2.5}$ was

1.42 (95% CI, 1.06–1.90) in the single pollutant model and 2.00 (95% CI, 1.51–2.64) in the two-pollutant model with O_3. Corresponding RRs for a 10 $\mu g/m^3$ increase in $PM_{10-2.5}$ and PM_{10} were 1.62 and 1.45 respectively in all females, and 1.85 and 1.52 respectively in postmenopausal females. No associations were found in males. Thus, a positive association with fatal CHD was found with all three PM fractions in females but not in males. The risk estimates were strengthened when adjusting for gaseous pollutants, especially O_3, and were highest for $PM_{2.5}$.

Traffic air pollution studies

A European study[4] that looked at the association between PM_{10} and hospitalizations has found an overall relative risk of 1.013 (CI 1.007-1.019) for cardiovascular hospital admissions for the assessments done in Austria, France and Switzerland. The study found that the traffic-related proportion of the total cases attributable to air pollution corresponded to the traffic-related fraction of PM_{10}, amounting to 43% in Austria, 56% in France, and 53% in Switzerland.

A Dutch study[88b], based on an ongoing cohort study on diet and cancer (NLCS-AIR study), with 120,852 subjects followed from 1987 to 1996, investigated the association between the exposure to black smoke, nitrogen dioxide, sulphur dioxide, particulate matter $\leq$ 2.5 µm ($PM_{2.5}$), and various variables related to traffic and mortality from all causes and for specific causes, including cardiovascular diseases. Hazard ratios were adjusted for age, sex, smoking status, and several socioeconomic indicators at area level. Although there was an increased risk for all mortality cases, none of the ambient pollutants investigated or traffic-related variables were significantly greater than 1 for cardiovascular mortality.

A Dutch study[89] looked at personal and home outdoor NO_2 concentrations for 241 children from six different primary schools in the Netherlands. The study found that personal and outdoor NO_2 concentrations differed significantly among children attending schools in areas with different degrees of urbanization (the difference among average classroom concentrations in the very urban and non-urban school was 12.2 $\mu g/m^3$) and among children attending schools in areas close to highways with different traffic densities (an estimated annual difference of 8.2 $\mu g/m^3$ (SE 1.8) in personal NO_2 exposure between the school with the highest traffic density and the school with the lowest traffic density). For the children living near highways, personal and outdoor NO_2 concentrations also significantly decreased with increasing distance of the home address to the highway. This study has shown that personal and outdoor NO_2 concentrations are influenced significantly by the degree of urbanization of the city district and by the traffic density of and distance to a nearby highway.

The importance of within-city residential variations as a risk factor for mortality due to air pollution was confirmed by Hoek et al.[90] It was found that the exposure to traffic-related air pollutants was more highly related to mortality than were citywide background pollution levels. Of different metrics used in the analysis, an indicator variable for living near a major road was most strongly associated with cardiopulmonary mortality (RR 1.95, 95% CI 1.09 to 3.52). This study suggests that an individual's exposure to the toxic components of air pollution may vary as much within a single city as across different cities.

A different approach to looking at traffic exposure was taken by Peters et al.[91] Theirs was a case–crossover study in which cases of myocardial infarction were identified with the use of data from the Health Research Cooperative in the Region of Augsburg Myocardial Infarction Registry in Augsburg, southern Germany, for the period from February 1999 to July 2001. For the 691 subjects, an association was found between exposure to traffic and the onset of a myocardial infarction within one hour afterward (OR 2.92; CI 2.22 to 3.83). The time the subjects spent in cars, on public transportation, or on motorcycles or bicycles was consistently linked with an increase in the risk of myocardial infarction.

A Canadian study conducted by Finkelstein[92] investigated the rate advancement periods associated with traffic pollution exposures. The mortality from all natural causes during 1992–2001 was modeled in relation to lung function; body mass index; a diagnosis of chronic pulmonary disease, chronic ischemic heart disease, or diabetes mellitus; household income; and residence within 50 m of a major urban road or within 100 m of a highway. The study found that subjects living close to a major road had an increased risk of mortality (RR 1.18; CI 1.02-1.38). The mortality rate advancement period associated with residence near a major road was 2.5 years (CI 0.2-4.8). The rate advancement period attributable to chronic ischemic heart disease was 3.1 years.

In most of the studies concerning the effect of air pollution on various health outcomes, the exposure is usually determined using only community average concentrations. This may lead to measurement error that lowers the estimates of the health burden attributable to poor air quality because, theoretically, classic exposure measurement error induced by central monitors may bias results toward the null. Jerrett et al.[13] modeled the association between air pollution and mortality using small-area exposure measures in Los Angeles, California. A sub-cohort of 22,905 subjects extracted from the American Cancer Society cohort for the period 1982–2000 (5,856 deaths) was linked with pollution exposures interpolated from 23 fine particle ($PM_{2.5}$) and 42 ozone (O_3) fixed-site monitors. Proximity to expressways was tested as a measure of traffic pollution. The impact of traffic was assessed by assigning buffers that included zip code-area centroids within either 500 or 1000 meters of a freeway. All-cause mortality had a relative risk of 1.17 (CI 1.05–1.30) for an increase of 10 $\mu g/m^3$ $PM_{2.5}$ and a RR of 1.11 (CI 0.99 –1.25) with maximal control for both individual and contextual confounders. The RRs for mortality resulting from ischemic heart disease and lung cancer deaths were elevated, in the range of 1.24 –1.6, depending on the model used. However, in their models, distance to freeways did not have a significant impact, the RR for being under 500 m from a freeway was 0.90 (0.71-1.14) while the RR for being within 1000 m of a freeway was 1.05 (0.89-1.24).

In the study conducted by Gehring et al. (2006),[88a] already mentioned under chronic effects of air pollution, the authors also investigated the relation between proximity to roads as a proxy for traffic pollution and mortality due to various causes. For cardiopulmonary mortality, the adjusted relative risk of living under 50 m from roads versus living more than 50 m from roads was 1.70 (1.02–2.81).

The NLCS-AIR study[88b] mentioned earlier also investigated the relation between traffic-related air pollution and mortality due to various causes. Thus, traffic intensity on the nearest road was found to be independently associated with mortality. Relative risk for a 10-$\mu g/m^3$ increase in black smoke concentrations (10-$\mu g/m^3$ representing the difference between the 5th and 95th percentile) were 1.04 (0.95–1.13) for cardiovascular mortality. Results were similar for NO_2 and $PM_{2.5}$, but no associations were found for SO_2.

A study[93b] conducted in the U.S. in greater Worcester, Massachusetts, consisted of 1,389 patients hospitalized with acute heart failure (HF) in 2000. These patients were followed for survival through December 2005. Daily traffic information for the roads found within 100 m and 300 m buffers of participants' residences as well as the distance from their residences to major roadways and bus routes were used as proxies for residential exposure to traffic-related air pollution. Mortality risk for the exposure variables was assessed using Cox proportional hazards models adjusted for prognostic factors. The inter-quartile range increase in daily traffic within 100 m of the home was associated with a mortality hazard ratio (HR) of 1.15 (1.05–1.25), whereas for traffic within 300 m this association was 1.09 (1.01–1.19). The mortality risk decreased with increasing distance to bus routes (HR = 0.88; 95% CI, 0.81–0.96) and was larger for those living within 100 m of a major roadway or 50 m of a bus route (1.30; 1.13–1.49).

In the Worchester Heart Attack Study involving 5,049 subjects with AMI, Tonne et al.[93d] used cumulative traffic within 100 m of subjects' residences and distance from major roadway as proxies for exposure to traffic-related air pollution in order to investigate the association of traffic pollution and occurrence of AMI. They estimated the relationship between exposure to traffic and occurrence of AMI using case-control logistic regression, with adjustment for age, sex, section of the study area, point sources emissions of particulate matter with aerodynamic diameter < 2.5 μm, area socioeconomic characteristics, and percentage of open space. The researchers found that an increase in cumulative traffic near the home was associated with a 4% increase in the odds of AMI per inter-quartile range (95% CI, 2–7%), whereas living near a major roadway was associated with a 5% increase in the odds of AMI per kilometre (95% CI, 3–6%).

In a follow-up of the Worchester Heart Attack Study based in Worchester, Massachusetts, Tonne et al.[93c] employed a case-control analysis of subjects diagnosed with AMI between 1995 and 2003 and controls taken from the same area. Traffic pollution represented by NO_2 and $PM_{2.5}$ was modelled using a semi-parametric latent variable regression model with samples collected at 36 locations in the area. The authors found that the inter-quartile range increase in modelled traffic particles was associated with a 10% (4% to 16%) increase in the odds of AMI. When accounting for spatial dependence at the census tract, but not block group, it was found that scale substantially attenuated this association. Although the results provide some support for an association between long-term exposure to traffic particles and risk of AMI, they were sensitive to the scale selected for the analysis of spatial dependence. The latent variable model captured variation in exposure, although on a relatively large spatial scale.

In the same study that looked at chronic ambient exposure to $PM_{2.5}$ and ozone, Jerret et al.[87a] investigated the association between mortality due to ischemic heart diseases and proximity to traffic. Thus, subjects living within 500 m from the freeway had a relative risk of dying of IHD of 0.90 (0.71–1.14), while subjects living within 1000 m from freeways had a relative risk of 0.92 (0.77–1.08).

A large study conducted by Rosenlund et al.[87b] in Rome, comprising all residents of Rome aged 35–84 years during the period 1998–2000, assessed the association between residential NO_2 exposure due to traffic pollution (derived by a land-use regression model) and coronary events. The study focused on the 6,513 survivors of cardiac events that were followed for 4.0 –7.5 years for readmission or mortality, starting 28 days from the date of the first event. Relative risks per 10 $\mu g/m^3$ of NO_2 exposure, adjusted for age, sex, and socioeconomic status, were calculated by Poisson regression and Cox regression. The relative risk for incidence in coronary events per 10 $\mu g/m^3$ of NO_2 was 1.03 (1.00 –1.07). Stronger associations were found for fatal cases (1.07; 1.02–1.12) and out-of-hospital deaths (1.08; 1.02–1.13). Using NO_2 exposure at the time of the first event, there was no association between air pollution exposure and either subsequent hospital readmission or mortality among survivors of the first coronary event.

Besides considering cardiovascular mortality or morbidity in relation with ambient and traffic pollution, some researchers have focused on cardiovascular disease progression or indicators. Thus, a 2005 study[87] from Los Angeles found that for a cross-sectional exposure contrast of 10 $\mu g/m^3$ $PM_{2.5}$, carotid intima-media thickness (CIMT) increased by 5.9% (95% CI, 1–11%). Adjustment for age reduced the coefficients, but further adjustment for covariates indicated robust estimates in the range of 3.9–4.3%. Among older subjects ($\geq$ 60 years of age), women, never smokers, and those reporting lipid-lowering treatment at baseline, the associations of $PM_{2.5}$ and CIMT were larger, with the strongest associations in women $\geq$ 60 years of age (15.7%, 5.7–26.6%).

In a more recent study in Los Angeles area[87c], data from five double-blind randomized trials that assessed effects of various treatments on the change in common CIMT was reviewed. Spatial models and land-use data were used to estimate the home outdoor mean concentration of particulate matter up to 2.5 µm in diameter ($PM_{2.5}$), and to classify residence by proximity to traffic-related pollution (within 100 m of highways). $PM_{2.5}$ and traffic proximity were positively associated with CIMT progression. Adjusted coefficients were found to be larger than crude associations, not sensitive to modelling specifications, and statistically significant for highway proximity while of borderline significance for $PM_{2.5}$ ($p = 0.08$). Annual CIMT progression among those living within 100 m of a highway was accelerated (5.5 µm/yr [95%CI: 0.13–10.79; $p = 0.04$]) or more than twice the population mean progression. For $PM_{2.5}$, coefficients were positive as well, reaching statistical significance in the socially disadvantaged; in subjects reporting lipid lowering treatment at baseline; among participants receiving on-trial treatments; and among the pool of four out of the five trials.

A German study (Heinz Nixdorf Recall Study) from 2005[93] tried to assess the long-term personal traffic exposure and background air pollution by comparing 3,399 residents living within 150 m of major roads with those living further away. The principal outcome variable was clinically manifest coronary heart disease (CHD). The crude odds ratio (OR) for the prevalence of CHD with high traffic exposure was 1.62 (1.12–2.34) and rose to 1.85 (1.21–2.84) after adjusting for cardiovascular risk factors and background air pollution. Subgroup analysis showed stronger effects for men [OR 2.33 (1.44–3.78)], participants younger than 60 years [OR 2.67, (1.24–5.74)], and never-smokers [OR 2.72 (1.40–5.29)]. A larger cohort (4,494 subjects),[93a] belonging to the Heinz Nixdorf Recall Study, was used to investigate the association between the level of coronary artery calcification and the distances between residences and major roads. Compared with participants living more than 200 m away from a major road, participants living within 50, 51 to 100, and 101 to 200 m had odds ratios of 1.63 (1.14 to 2.33), 1.34 (1.00 to 1.79), and 1.08 (0.85 to 1.39), respectively, for a high CAC (CAC above the age- and gender-specific 75^{th} percentile). The study also found that a reduction in the distance between the residence and a major road by half was associated with a 7.0% (0.1 to 14.4) higher CAC.

Mechanisms of action

Epidemiological studies over the last 20 years have shown with few exceptions[42,52] that there is a relationship between air pollution (especially particulate matter) and cardiovascular diseases. The acute and chronic effects of ambient and traffic pollution were replicated by studies at various locales, and several large scale interventions that tried to control pollution were followed by a substantive decrease in cardiovascular outcomes. In parallel with these epidemiological studies, other researchers tried to look at the possible pathological mechanisms that link air pollution and various air pollution components with pathological changes in the body that lead to or precipitate heart failure or myocardial infarction. Animal and human studies that target various precursors and biomarkers of cardiovascular exacerbations were studied in relation to air pollution and several biological mechanisms of action were proposed.

The ample reviews mentioned previously[6,16-27] not only describe the accumulated epidemiological evidence linking air pollutants with health effects (especially with cardiovascular outcomes), but they review the accumulated evidence for potential biological mechanisms that link pollutants to adverse cardiovascular events. From the several hypotheses that have been proposed, evidence is accumulating in support of two possibly interlinked mechanisms by which low concentrations of particles in inspired air may have adverse cardiovascular effects. In the first pathway proposed, the inhalation and the passage of fine particles through the alveolar epithelium may provoke an inflammatory response in the lungs with the consequent release into the circulation of prothrombotic and inflammatory cytokines, impairing vascular function and accelerating atherosclerosis.[94-97] A systemic acute phase response of this nature would put people with coronary atheroma at increased risk of plaque rupture and thrombosis. This pulmonary oxidative stress/inflammation induced by inhaled pollutants represents fewer acute and chronic indirect effects.

The second, interlinked pathway suggests that direct effects may occur via agents that readily cross the pulmonary epithelium into the circulation, such as gases, and possibly ultra fine particles[98-100] along with soluble constituents of $PM_{2.5}$ (e.g., transition metals). In addition, the activation of pulmonary neural reflexes secondary to PM interactions with lung receptors may play a role. Exposure to PM may have an adverse effect on cardiac autonomic control,[101-104] leading to an increased risk of arrhythmia in susceptible patients. These direct effects of air pollution represent a plausible explanation for the occurrence of rapid (within a few hours) cardiovascular responses, such as myocardial infarctions. A general scheme illustrating potential mechanisms of the effects of PM on the cardiovascular system is shown in Figure 1.

Socioeconomic indicators and cardiovascular diseases

The number of studies that investigate the link between air pollution and health is dwarfed by the research and effort gone into assessing the relationship between socioeconomic factors and cardiovascular health outcomes health. The simplest explanation for this fact lies probably in the availability of data, with information at an individual level of these parameters being more readily available than pollution information at an individual level. Even aggregate neighbourhood socioeconomic indicators based usually on census areas or zip/postal codes have a higher resolution than most of the ambient models used in assigning air exposure to individuals.

Table 3. Neighborhood based studies of SES and cardiovascular health outcomes

Study	Geographic area	Cohort size	Type of study	Outcome	Covariates	Results
Krieger[123] 1992	N. California 1980 & 1985	14,420 subjects	Retrospective study	HBP	Job type (area) Education (area) Race (area)	1.0 (0.9,1.2) 1.3 (1.2,1.5) 1.8 (1.6,2.0)
Wing[183] 1992	US 1962 - 1978	VS mortality data for white women	Retrospective study	CVD	Job type (area) Education (area) Income (area)	All significant, visual analysis
Diez-Roux[184] 1997	4 US communities	12,601	Retrospective study	CVD prevalence (morbidity)	% adults w/o high school (area) Median income (area) Median house value (area) % adults in occ. categ II-VI (area)	1.88 (1.00 – 3.52) 1.61 (1.11 – 2.87) 2.17 (1.20 – 3.94) 2.82 (1.29 – 6.16)
Sundquist[186] 1999	Sweden 1988 - 1989	9,240	Retrospective study	BMI Physical activity smoking	Care Need Index (CNI) (area level aggregate index)	1.18 (1.02 – 1.36) 1.61 (1.34 – 1.93) 1.69 (1.42 – 2.01)
Diez-Roux[175] 2000	44 US States 1990	70,534	Hierarchical analysis	HBP Sedentarism Smoking	Robin Hood Index	1.61 (1.17 – 2.21) 2.06 (1.27 – 3.35) 0.86 (0.59- 1.26)
Diez-Roux[190] 2001	4 US communities 1987 - 1999	13,009	Prospective study	CHD	Neighbourhood aggregate factor, income, education, etc.	1.6 (1.1 – 2.2)
Villeneuve[12] 2003	Vancouver 1986 - 1999	550,000	Time series study	CVD mortality	QAIPPE	Not significant
Sundquist[194] 2004	Sweden 1986 - 1993	25,319	Prospective study; Cox mod.	Incident CHD	Neighbourhood income Neighbourhood education	1.23 (1.00 – 1.52) 1.25 (1.02 – 1.54)
Mujahid[197] 2005	4 US communities 1987 - 1999	13,167	Population based study	BMI	Census based SES aggregate factor + individual SES	(-) association with income, education, neighb. SES for women; (-) association with income, education, neighb. SES for white men; (+) association with income, education, neighb. SES for white men;
McGrath[205] 2006	2 schools in Pittsburgh;	212 adolescents	Cross-sectional study; multilevel analysis	BP (SBP/DBP), HR, negative mood	Individual income, education Neighbourhood income, education, race profile	Individual income and education, and neighborhood race predicted heart rate
Mobley[202] 2006	US 2001 - 2002	2,692 women	Retrospective study	BMI 10-year CHD risk	Racial segregation land use crime rates neighbourhood income	CHD ↓ BMI ↓ 2.6 kg/m2; CHD ↓ 20% BMI ↑; CHD ↑ BMI ↓; CHD ↓
Stjarne[208] 2006	Stockholm County 1992 - 1994	2,246 incidents	population-based case–control study	MI incidence rate ratio	Median income Income distribution	Women:1.94(1.28-2.96);Men:1.51(1.15-1.89) Women:0.77(0.50-1.19));Men:1.15(0.87-1.52)
Chaix[213] 2007	Scania region, Sweden 1987 - 2002	~ 1,000,000	Longitudinal study	AMI incidence	Previous heart diseases Alone vs. cohabiting Educational attainment Occupation 20-ye averaged income Neighborhood SES position Residential stability	1.54 (1.15 – 2.03) 1.34 (1.20 – 1.49) 1.43 (1.24 – 1.66) 1.14 (1.01 – 1.30) 1.65 (1.38 – 1.97) 1.67 (1.39 – 2.03) 1.19 (1.00 – 1.41)
Lisabeth[212] 2007	Corpus Cristi, US 2000 - 2003	1,247	Cohort study; Poisson analyses	Ischemic stroke	Neighborhood SES score	90% vs. 10% RR: 1.06 (0.81–1.39)
Ross[210] 2007	Canada 2000 - 2001	131,535	Cross-sectional study	BMI	recent immigrants, density, sprawl, education, median household income	Significant for % immigrants (for men), education (men and women), and sprawl (men)

MI: myocardial infarction; CHD: coronary heart disease; HBP: high blood pressure; VS vital statistics; CVD: coronary vascular disease; BMI body mass index; BP blood pressure; SBP systolic blood pressure; DBP diastolic blood pressure; SES socio economic status; AMI acute myocardial infarction

The relation between socioeconomic status and health is a problem that has been extensively studied.[105] Research studies have shown a consistent inverse relationship between SES and morbidity and mortality rates. Morbidity and mortality rates generally decrease when moving up the SES ladder. This inverse relationship is observed whether SES is measured using education, income, or occupational status, and does not appear to be an artefact of the more physically ill individuals drifting down the SES hierarchy.[106] The SES-health gradient extends to a wide array of health problems, including heart disease, cancer, stroke, diabetes, hypertension, infant mortality, arthritis, back ailments, mental illness, kidney diseases, and many others,[107] and may predict prognosis after illness is present.[108,109] For more detailed information on specific studies on SES and health, there are several excellent reviews available.[110-122] A condensed overview of some studies that used neighbourhood characteristics in relation with various health outcomes is presented in Table 3.

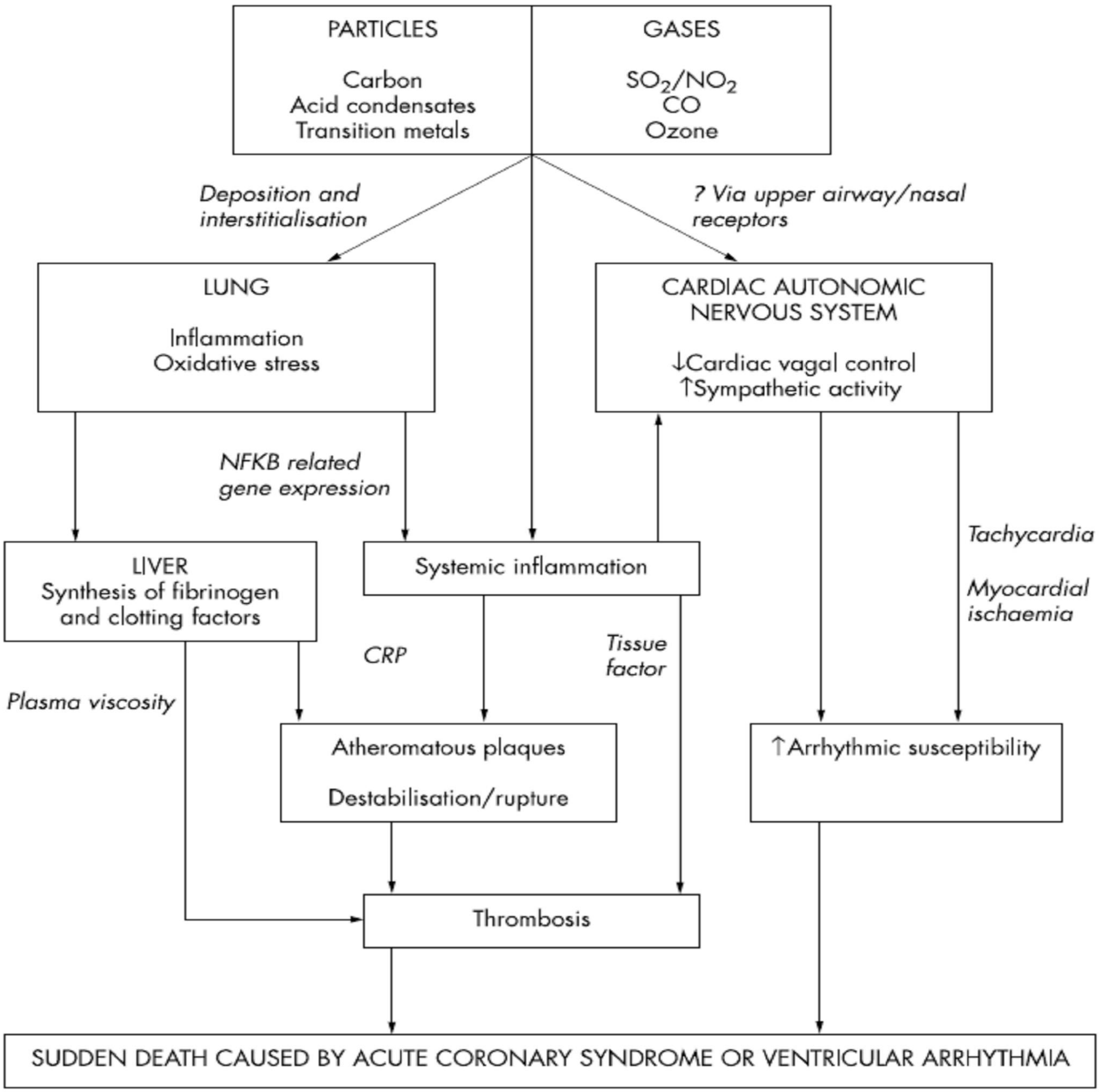

Figure 1. Mechanisms by which particulate and gaseous air pollutants may exert adverse effects on the cardiovascular system (from Routledge et al.[6]).

The effect of socioeconomic status on the relationship between atmospheric pollution and health

The previous sub-sections reviewed the research literature that investigated the relation between ambient air and traffic pollution and cardiovascular diseases as well as the relation between socioeconomic status and cardiovascular diseases. However, there are relatively few studies that have examined the contribution of various environmental exposures, such as air pollution, to socioeconomic health inequalities.[223] Some authors hypothesise that air pollution contributes to creating or accentuating the socioeconomic disparities seen in various diseases (including cancer[224], asthma,[225] and cardiovascular diseases[226]) and thus in premature death rates.[227]

As mentioned in the introductory section, two hypotheses have been suggested to explain the interplay between air pollution, SES, and health outcomes. The environmental inequality hypothesis proposes that populations with low SES may be more frequently or more intensely exposed to air pollution than those with high SES[228, 229] and in this case air pollution acts as a confounder in the causal relation between SES and health outcomes. The evidence accumulated so far to reinforce this hypothesis linking the distribution of exposure to air pollution in populations with different SES is "mixed and inconclusive"[230] according to Bowen. Other studies[231–234] support this observation. These mixed results might be explained by the great methodological diversity of these studies and the variety of their settings.[232]

The biological inequality hypothesis, which is also pursued by the present research, postulates that those populations with low SES may be more susceptible to air pollution than those with high SES.[228] This susceptibility is caused by risk factors that are more prevalent in less advantaged populations and that can act as effect modifiers of the relationship between pollution and mortality. These risk factors include poor health status (for example, diabetes, obesity, and chronic obstructive pulmonary disease),[228] addictions (including smoking),[235] and multiple pollutant exposures (passive smoking, occupational exposure); these are likely to act in addition to or in synergy with urban pollution.[235]

In Laurent et al.,[237] a review of the relevant research literature that looks at the contribution of air pollutants to socioeconomic health inequalities, the authors concentrate their research only on the published articles that deal with the second potential mechanism, arguing that the existing research that looks at the environmental inequality hypothesis has mixed and inconclusive results. Laurent's review[237] found, for both short-term and long-term studies of the effect of air pollution on mortality that those studies using socioeconomic characteristics measured at coarser geographic resolution showed no effect modification, those studies using finer geographic resolutions showed mixed results, and those studies using individually measured socioeconomic characteristics showed that pollution affected disadvantaged subjects more.

The conclusion of Laurent's[237] review is that populations of different SES levels need to be tested for a higher range of pollutant concentrations and that further research should consider the largest possible number of SES indicators (both individual and contextual at different geographic resolutions) in order to identify those that are most discriminating in terms of the relative risks of mortality or morbidity associated with pollution.

The same review found fifteen articles (time series, case-crossover, and cohort) that examined short-term effects of air pollution on mortality. Because of the variety of socioeconomic indicators studied, a formal comparison was difficult. However, the reviewers concluded that studies using socioeconomic characteristics measured at coarser geographic resolutions (city- or county-wide) found no effect modification, but those using finer geographic resolutions found mixed results. Five of six studies using individually-measured socioeconomic characteristics found that pollution affected disadvantaged subjects more. These findings from the short-term studies were complemented by the six studies (which employed cohorts of subjects) of long-term effects that the reviewers identified as suitable for inclusion in the review. The same problem, substantial methodological differences, plagued the interpretation of the long term studies, and the same general observation re-emerged. The reviewers concluded that current evidence does not provide sufficient and definitive evidence that socioeconomic characteristics modify the effects of air pollution on mortality. However, the results so far, by their tendency to show greater effects among the more deprived, emphasise the need for further investigation of this topic.

A recent study[238] conducted by Dragano investigated whether the association between traffic exposure and sub-clinical cardiovascular disease is modified by socioeconomic characteristics of individuals and neighbourhoods. The cohort used in the study was mentioned previously[93,93a] as being used to investigate the relationship between traffic pollution and cardiovascular health outcomes. However, in this particular study, the cohort (2,264 women and 2,037 men aged 45–75 years) was used to investigate the associations between high traffic and coronary artery calcification within strata of SES to determine effect modification. The researchers found that high traffic and low SES were both associated with higher amounts of calcification (>75th age-specific percentile). Although a higher number of participants with low SES were found to live close to major roads, the stratified analyses did not indicate higher susceptibility in low SES groups. However, the study found that participants with low SES and exposure to high traffic had the highest levels of CAC. When considering individual level of education, better-educated men with low traffic exposure had a prevalence of high calcification of 23.9%, but it was 37.7% in lower-educated men with high traffic exposure (women: 22.0% vs. 28.1%). For neighbourhood levels of unemployment, it was found that men living in neighbourhoods with low unemployment rates and within 50 m of roads had a prevalence of high calcification of 25%, while men living in neighbourhoods with high unemployment rates and within 50 m from roads had a prevalence of high calcification of 50% (29.2 % vs. 42.1% for women). The authors conclude that high traffic exposure was associated with coronary calcification in all social groups, but because low SES individuals had higher calcification in general and were also more exposed to traffic, the existing inequalities could be further shaped by traffic exposure.

A very recent study by Ren et al.[238b] looked at the socioeconomic modifiers of short-term effects of ozone on mortality in eastern Massachusetts. In this study, the authors used a case-crossover design to examine whether impacts of ozone on mortality were modified by socioeconomic status coded at the tract level or characteristics at an individual level in eastern Massachusetts, US for the period between May 1995 and September 2002. The authors looked at 157,197 non-accidental deaths among those aged 35 years or older and used moving averages of maximal 8-hour concentrations of ozone monitored at 8 stationary stations as personal exposure. They found that a 10 ppb increase in the four-day moving average of maximal 8-hour ozone was associated with non-significant changes in cardiovascular diseases, heart diseases, acute myocardial infarction, and stroke respectively (0.44% (95% CI: -1.45%, 2.37%), -0.83% (95% CI: -2.94%, 1.32%), -1.09% (95% CI: -4.27%, 2.19%) and 6.5% (95% CI:1.74%, 11.49%)), and concluded that there was no evidence that the associations were significantly modified by socioeconomic status or individual characteristics, although small differences of estimates across subpopulations were demonstrated.

Summary of literature review

Epidemiological evidence has consistently shown that various air pollutants, especially particulate matter, are aggravating risk factors in the triggering, progression, and full manifestation of various cardiovascular events[2a]. This was demonstrated when considering exposures at large scales and small scales as well as proximity to roads. Meta analyses of the time series data suggest that an increase in fine particulate pollution of 10 $\mu g/m^3$ is associated with an increase in total mortality of 1.8% and cardiovascular mortality of about 1.4%.[6] Hospitalization analyses indicate similar results. The excess number of deaths due to air pollution reported by various studies[3-8] was confirmed by several large scale interventions. There is a confirmed presence of an apparent linear dose-response relationship between PM and adverse health events, relationship that has no discernible threshold below which PM concentrations pose no health risk to the general population[3].The adverse cardiovascular outcomes in the general population are seen at levels at or below existing air quality standards. Pathophysiological studies on animals and humans have shown that several biological mechanisms can explain the interaction between the human body and particulate matter and/or various gases that lead to a cardiac event.[94-104]

Epidemiological and sociological studies have shown the correlation between lower socioeconomic status and health, considering individual and neighbourhood characteristics. Income, wealth, education, and personal support, are all important indicators of health. A lack of them is associated with higher stress levels that have been shown to be a mechanism for the onset of coronary heart disease.[9, 182] Access to health care,[180,200] better food,[200] recreational facilities,[201] social support, better housing conditions,[140,156] and public transportation,[160-195] with an absence of violence, and an environment away for sources of pollution,[170] are all important factors in preserving a healthy life. Neighbourhoods that are lacking in such amenities are more inductive to unhealthy life styles and stress, and ultimately to poorer health for their inhabitants.[132,145-147,148,150,158,159]

It is apparent that the number of factors involved in the final health outcome of an individual can be quite large. For instance, Jerrett et al.[13] used an excess of 44 individual potential confounders identified in earlier ACS studies[84] of air pollution health effects to which he added some neighbourhood identifiers. These variables include lifestyle, dietary, demographic, occupational, and educational factors that may confound the association between air pollution and mortality.

While there is compelling evidence of the effects of air pollution on health and of the impact of SES on health, there is less evidence and understanding of the mechanisms and the magnitude through which SES modifies the effect of air pollution on health, and this research tries to address this particular knowledge gap.

Objectives

It is evident from the array of studies conducted to date that the environment plays a significant role in the onset of CVD. Air pollution and socioeconomic factors (among others) contribute to the relative risk of CVD outcomes. The objective of this project was to analyze, in a combined framework, the risk of CVD relative to traffic air pollution, taking into account the socioeconomic status of subjects' neighbourhoods. The study will use two levels of aggregation of SES variables. One level of aggregation is at a large scale, using Statistics Canada Dissemination Areas, while the other level of aggregation is represented by actual geographical neighbourhoods as defined by their residents. These two levels will be used in separate analysis to check the assumption that aggregate socioeconomic variables at a finer grained resolution are capable of producing more significant results than those based on coarser level of aggregation. This study will consider chronic exposure to air pollution and will assess several SES indicators at the two levels of aggregation as potential effect modifiers for the risk of cardiovascular morbidity due to long-term exposure to traffic air pollution in a large population cohort. To summarize, the two main questions that this study tried to address were: (1) is increased air pollution (road proximity) associated with increased CVD outcomes? and (2) is there effect modification by socioeconomic status? This study is relevant first by exploring the impact of lower levels of traffic pollution than usual and road proximity in a large cohort with excellent residential history. Also, this study will provide maybe for the first time a consistent assessment on the way the joint effects of socio-economic status and pollution are impacting cardiovascular health outcomes.

Hypotheses

Two main hypotheses will be investigated:

1. that increased traffic pollution and closer proximity to main roads are associated with an increased incidence of CVD outcomes.
2. that although increased air pollution levels affect people indiscriminately, people living in neighbourhoods with higher socio-economic status will be less affected by air pollution than those living in neighbourhoods with lower socio-economic status.

Methods

Study population

The study population consisted of all residents of greater Vancouver metropolitan region who were 45 to 84 years of age as of January 1st, 1999, had lived in the area for the 5 years prior to 1999 (1994-1998), were alive as of December 31st, 1998, and did not have a diagnosis of cardiovascular diseases or diseases considered as a risk factor for developing cardiovascular diseases prior to January 1, 1999. The study cohort[1] was assembled by extracting data from a series of linked administrative datasets obtained from the British Columbia Ministry of Health Services and British Columbia Vital Statistics Agency.

Several criteria were applied in order to define the cohort subset eligible for the analysis and to establish the end of follow-up for each of the subjects. All subjects had to be registered continuously, with registration gaps of a maximum of 6 months (183 days) being permitted between April 1st, 1994 and December 31st, 1998 and onward until Dec 31st, 2002 or the end of the registration in the provincial universal medical plan, whichever was earliest (April 1st was chosen instead of January 1st because the registration dates are related to the financial year rather than the calendar year, and also because the three-month gap at the beginning would satisfy the condition that there should not be registration gaps greater than 183 days). The follow up period for the study's subjects is from January 1st, 1999 to December 31st, 2002. For subjects that died in the follow-up period (between January 1st, 1999 and December 31st, 2002), the registration end date was set to be at the end of the month of death, if the actual registration end date was later than the last calendar date of the month of death.

All subjects had to continuously reside in the study area (Greater Vancouver metropolitan area) between January 1st, 1994 and December 31st, 1998. The end of residential history for subjects with continuous residence in the area between January 1st, 1994 and December 31st, 1998 was considered to be the date when they left the area after December 31st, 1998, or Dec 31st, 2002, whichever date occurred first. Thus, the end date of the follow-up for a subject for a particular outcome of interest was considered to be the earliest date between December 31st, 2002, the date of death (if the subject died in the follow-up period), the end of registration in the provincial universal medical plan, the end of residence in the study area, or the date when the outcome of interest occurred (if there was an outcome of interest).

From the original 876,473 subjects living in Georgia Air Basin, only 534,856 were found to have lived continuously in the Greater Vancouver metropolitan area from January 1, 1994 to the end of follow-up period (stretching from January 1, 1999 to December 31st, 2002). Out of this number, 6,471 subjects were excluded from the study because there were gaps in the registration history that were greater than 183 days. Also, 3 additional subjects were found to be included as a consequence of erroneous linkage between the several administrative

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[1] The original cohort was extracted from a larger area, namely the Georgia Air Basin, and consisted of 876,473 subjects identified as satisfying the age eligibility criteria. However, because the traffic exposure assessment was available only for the greater Vancouver metropolitan region, the number of subjects retained was substantially smaller.

databases used. Thus, a total of 528,382 subjects with complete medical and residential history were available for analyses in the Greater Vancouver metropolitan area.

By considering the eligibility criteria (the non-presence of any cardiovascular health outcomes and health outcomes considered as risk factors for cardiovascular diseases), only 356,893 subjects were further retained from those with a full residential history in the Greater Vancouver metropolitan area. The cardiovascular health outcomes and the health outcomes considered as risk factors for cardiovascular diseases prior to the start of the follow-up period were:

- acute coronary syndrome (ACS), defined as either acute myocardial infarction, unstable angina or other acute forms of ischemic heart disease (ICD9 = 410 or 411 or ICD-10 = I20.0, I21, I22 or I24.9);
- chronic coronary syndrome (CCS), defined as stable angina pectoris, other chronic forms of ischemic heart disease, or atherosclerotic cardiovascular disease (ICD9 = 413, 414, 429.2 or ICD-10 I20.1, I20.8, I20.9, I25.0, I25.1, I25.9, or I51.6);
- congestive heart failure (CHF) (ICD9= 428 or ICD-10 = I50);
- hypertensive disease (HTN) (ICD9 = 401-405 or ICD-10 = I10-I15);
- chronic obstructive pulmonary diseases (COPD) (ICD9=466, 490-492, 496 or ICD-10 = J41-J44);
- diabetes mellitus (DM) (ICD9= 250 or ICD10= E10-E14).

In order to determine if a person had one of these pre-disposing conditions, one hospital diagnostic (principal or primary) or two (in case of HD, three) out-patient diagnostics per year were required as a case definition.

Subsequent linkages with the socioeconomic indicators from the Canadian Census further diminished the number of subjects. A total of 346,536 subjects with full census, demographic, and residential data were retained for analyses. Additional subjects were excluded from pollutant specific analyses if traffic pollution measurements were not available: between 304 and 18,246 subjects did not have exposure data for various traffic-related pollutants (NO: 304, NO_2: 326, $PM_{2.5}$: 18,246, and black carbon - B.C.: 1,519).

Residential history

Three sets of data were used to reconstitute the residential history[2] of each individual at postal code level. These files are:

- BC Ministry of Health Services Registration (BC MoHS) & Premium Billing (R&PB) files
- BC's health services utilization files:
  - Medical Services Plan (MSP) Payment Information
  - Discharge Abstract Database - DAD (Hospital Separations)

[2] Because personal information (i.e. full six digit postal code address) was not directly available, the residential history was reconstituted under the privacy screen by an analyst at CHSPR.

These data files provided the set of postal code 'observations' for the cohort, including associated dates. Only records with postal codes were retained. Although the three data sources are not necessarily independent, due to BC MoHS Client Registry input into MSP and Hospital records, the MSP and Hospital files may reflect updated postal codes more quickly than the R&PB file, as the latter relies only on R&PB file. The creation of residential history for each subject in the cohort required a substantial amount of processing due to the inherent messiness of the data with issues like multiple postal codes recorded on the same service date, invalid postal codes, non-residential postal codes, etc.

The problem of the substantial amount of potentially spurious or uninformative data was resolved by retaining only postal codes that had a minimum of two observations (encounters with the medical system) at least one month apart. By applying this rule, many non-residential postal codes were removed from the data. Many inconsistencies in residential history were resolved by eliminating spurious and non-residential postal codes. The remaining inconsistencies were resolved by removing postal codes ending before 1994 and by comparing attributes of postal codes in terms of spanned overlap (e.g., if postal code B was observed only a couple of times, but postal code A spanned the length of the data, then A was set as the address throughout; if multiple reasonable postal codes overlapped, then they were all accepted and transition dates were set to remove overlaps). Also, hospital address postal codes were retained when they were consistent with a nursing home address (and if appeared last in the data).

By applying all these strategies, 46% of subjects retained a single postal code after the deletion of inconsistent postal codes and non-residential addresses. An additional 27% of subjects had more than one postal code, without overlaps. About 7% of subjects had a complete overlap of a postal code with relatively more observations over another postal code with relatively fewer observations that left a consistent residential history after being deleted. About 12% of subjects had a partial overlap that was resolved when transition dates were set. Another 2% of subjects had a shortfall of less than a year in coverage at the beginning and end of follow-up due to the way the dates were originally set. By extending the first and last postal code of a subject by up to one year to match the dates of subject registration, this problem was resolved. Thus 6% of the subjects had no usable residential information and they were not considered for analyses (2% of subjects were unresolved due to urban PO Box addresses and 4% of subjects had relocated postal codes or other non-residential postal codes, or too few observations).

In order to test the validity of the residential history derived from administrative databases, the Canadian Community Health Survey (v. 2001) (CCHS) was used as a benchmark. The first three digits of the postal codes (indicating the Forward Sortation Area – FSA) from the CCHS dataset were compared with the administratively-derived FSAs of the subjects, and the FSAs were recorded in the same time interval in which the CCHS survey was conducted.

Health outcomes

Health data are available from the British Columbia Linked Health Database (BCLHD) for research purposes, through an approved process governed by a data access agreement[3] between the researchers and the data stewards. Medical services and hospitalization data were provided and governed by the Ministry of Health, Government of British Columbia, and vital statistics data by the British Columbia Vital Statistics Agency. The research database was constructed by merging vital statistics death records (for cohort enumeration according to residential postal codes) with outpatient medical services billing records and inpatient hospital discharge records, for identification of cases for the period of 1999–2002 (and all co-morbidities between 1991 and 2002). Socioeconomic indicators for education, income, and other attributes were available from Statistics Canada census data. The research database was provided to the research team with all personal identifiers removed and replaced by anonymous study identifiers. The identifiers were unique to each individual and enabled identification of the same individuals across data sources. The study protocol was approved by the Behavioral Research Ethics Board of The University of British Columbia.

The health outcomes of interest were separated into three broad categories:

- acute coronary syndrome (ACS), defined as either acute myocardial infarction, unstable angina or other acute forms of ischemic heart disease (ICD9 = 410 or 411 or ICD-10 = I20.0, I21, I22 or I24.9);
- **chronic coronary syndrome (CCS)**, defined as stable angina pectoris, other chronic forms of ischemic heart disease, or atherosclerotic cardiovascular disease (ICD9 = 413, 414, 429.2 or ICD-10 I20.1, I20.8, I20.9, I25.0, I25.1, I25.9, or I51.6);
- congestive heart failure (CHF) (ICD9= 428 or ICD-10 = I50)

Because the focus of this study was to investigate the health effects of chronic exposure to traffic, the most relevant cardiovascular health outcome for long term traffic pollution exposure is represented by the diseases grouped under the chronic coronary syndrome. Thus the results chapter will focus only on the CCS outcomes while the analyses pertaining with ACS and CHF will be presented in the appendix.

The follow-up period was between January 1st, 1999 and December 31st, 2002. A subject in the cohort was considered to have one of these health outcomes if there was a hospital admission with a principal diagnosis (from the Hospitalization Discharge File) or a death (from BC Vital Statistics deaths file) due to one of these health outcomes.

The diagram in Figure 2 depicts the overlay between the time frame for which co-morbidity data was available and considered for analysis, the chronic exposure data, the residential history data, census data, and the follow-up period for which the health outcomes of interest (**CCS**, ACS and CHF) were assessed.

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[3] Chamberlayne R, Green B, Barer ML, Hertzman C, Lawrence WJ, Sheps SB. Creating a population-based linked health database: a new resource for health services research. Can J Public Health. 1998;89(4):270–273

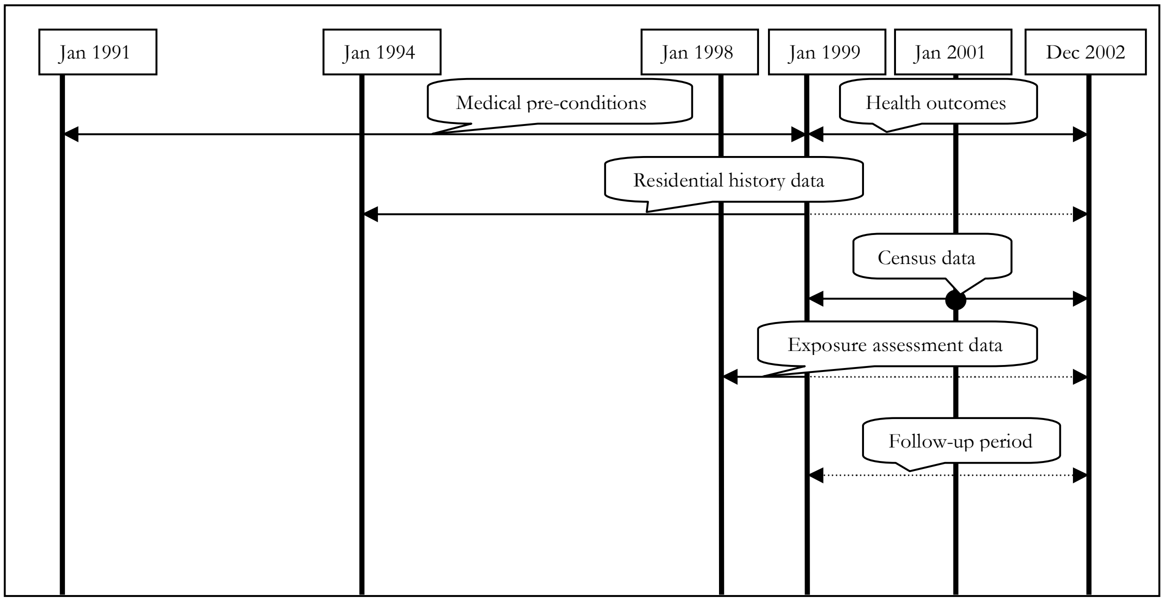

Figure 2. Time periods and data availability

Individual and small-scale socioeconomic covariates

Only sex, age, postal codes, and health outcomes were available at the individual level from the existing administrative data sources. Statistics Canada 2001 Census data were used to assign socioeconomic information to each subject based on their residence at the Census Dissemination Area resolution level. Dissemination areas are the smallest geographic areas for which Canadian Census data are aggregated, are randomly derived, and they correspond to one or more neighboring blocks with target populations of 400 to 700 persons.[215]

Residential postal codes were allocated to their corresponding DA using DMTIs CanMap multiple enhanced Postal Code, 2005 files. Also, using the compiled residential history, each subject in the cohort was merged with the SES variables dataset, with the SES values corresponding to the most extended residential location in terms of time spent there between 1999 and 2002 for each individual.

Hundreds of socioeconomic variables were available from Stats Canada 2001 Census data. However, based on the literature review performed prior to the analyses, about 25 variables were initially chosen to act as socioeconomic covariates at DA level, number that ulterior, in the end, was reduced to ten variables. These variables are: the average individual and family income, the percentage of people with a university degree, the percentage of people from China or of Chinese descent, the proportion of people that used bikes, public transit, or walking to commute to work, the coefficient of income variation, the percentage of home ownership, the percentage of people working in management jobs, the proportion of people with low income, and the rate of employment for the. These ten socioeconomic variables used at DA level can be broadly classified in five categories of variables. These categories are:

Racial/Cultural

The *racial/cultural* category is represented by the percentage of Chinese minority variable. The percentage of immigrants[210] and time since moving to the neighborhood[213] were variables found to have an impact on health outcomes. A Canadian study[210] showed a relationship between racial characteristics and obesity in females and although the individual subjects in the study do not have a racial profile available (except for the native status), the percentage of population of Chinese origin or descent is available at DA/EA. A recently released Canadian study[272] investigating cardiovascular risk profiles among people living in Ontario found that the risk profiles (smoking, hypertension, obesity, and diabetes mellitus) among blacks, whites, Chinese, and South East Asians varied considerably. There are many studies available that link obesity with socioeconomic status and with cardiovascular diseases.[197,199,202] Most of the studies in the U.S. use a racial indicator in their analyses because income in U.S. is well correlated with race.[129,137, 139,155,202,205] Although this might not be the case in Canada, the introduction of a variable describing the racial composition of individual DAs can be useful from other standpoints, such as the one mentioned before, or from broader standpoints, such as culture.[119, 151-153]

The variable representing the percentage of visible minorities of Chinese descent in the DA was considered to be used as a variable representing Chinese cultural values and broader East-Asian cultural values and norms. The decision to use this variable was made after investigating the correlation between the variable representing the percentage of total visible minorities, the variable representing the percentage of Chinese visible minorities, the variable representing the percentage of Asian visible minorities (Chinese, Japanese, Korean, Filipino), and the variable representing the percentage of visible minorities of South Asian (Indian) descent.

Income and wealth
This category of socioeconomic variables includes the average personal income variable, the average family income variable, the percentage of people with low income, the income variation variable, and the percentage of occupied dwellings that are owner-occupied variable. The coefficient of variation for income gives an idea of the range of values around the mean income for each DA.[188,208] Dwelling value and ownership gives an indication of the wealth of a person[147] which is considered to be a supplementary indicator that might be linked with stress, with higher accumulated wealth being potentially associated with lower levels of stress.

Education
This group consists in only one variable, the percentage of total population with any university degree.

Labour
This group includes the employment rate variable and percentage of people working in management variable. The type of work performed,[110,117,119,134,140,156,173] was another variable of significance in relation to health.

Transportation means
This category consists of the percentage of people biking, walking, or using public transit in their daily commute to work variable. The variable representing the percentage of people that used biking, public transit, and walking to commute to work was used because it was found that commuting and the way it is done might impact cardiovascular health outcomes (Peters et al. 2004)[91]. Also it was assumed that people walking or biking to work are exposed

to more traffic pollution than car users because they are just beside traffic without the protection of a car's interior. Also, the stress in traffic,[195] was another variable of significance in relation to health.

All these SES variables were included in the analyses as categorical variables, after being partitioned in quintiles. There were a total of 6,572 DAs in the Greater Vancouver metropolitan area, but for some of them not all of the variables of interest were available, thus subjects living in these DAs were discarded from the analyses.

Medium scale socioeconomic covariates

Statistics Canada Dissemination Areas are statistical units designed for collecting and presenting census information, and do not necessarily have any relation with neighborhoods as people actually perceive them. To avoid this drawback of census-defined areas and also to employ socioeconomic variables at a different level of aggregation, I employed the neighborhoods defined by the B.C. Atlas of Child Development.[216] In the Atlas, school districts were used as a blueprint for more refined neighborhoods. Communities and volunteers participating in the Early Development Initiative were involved in determining neighborhood boundaries that more accurately reflect the lived experience of a diverse range of people that reside in the area. Local representatives were invited to draw lines on maps of their area to signal the presence of perceived divides in their community. While some opted to maintain the Census or another existing boundary system, others opted for totally different configurations.

For the creation of the Atlas, the study team worked with Statistics Canada to amalgamate SES indicators at the neighborhood level. Statistics Canada used the 2001 census information collected at the block face level and aggregated it according to the boundaries defined in the Atlas. Although the reported SES variables created for the Atlas do not entirely match those available at the DA level, most of them can still be used. There were ten variables at the neighborhood level that were selected to be used in the analyses.

The average individual and family income, the percentage of home ownership, the incidence of low income, and the percentage of people with a university degree variable from the B.C Atlas of Child Development matched entirely the variables at the DA level. The rate of employment at the DA level is related with the rate of unemployment at the neighborhood level. The variable representing the percentage of visible Chinese minorities from DA has a clear relationship with the variable representing the percentage of total population whose home language is neither English nor French and with the variable representing the percentage of total population without knowledge of English or French from the Atlas. The stress variable from the Atlas, which represents the percentage of families spending 30% or more of income on shelter costs, was also considered relevant. All the variables retained for the analyses were transformed in categorical variables by being partitioned in quintiles.

Using the B.C. Atlas of Child Development and the GIS boundary layers employed by the Human Early Learning Partnership (HELP) Institute to produce the B.C. Atlas of Child Development, there were a total of 321 neighborhoods identified in GAB, of which 5 neighborhoods were not surveyed and did not have aggregate census variables calculated. Table 4 presents a synopsis of the variables selected at dissemination area and neighbourhood levels, while Figure 3 presents an outlay of dissemination areas and neighbourhoods in Vancouver, which is included in the Lower Mainland.

Table 4. SES variable to be used in statistical analyses

Category of variables	SES variable at DA level	SES variable at Neighbourhood level	Expected behaviour
Cultural/Racial	Percent of visible minorities from China	Foreign Home Language: % of total population whose home language is neither English nor French	Areas with high levels of minorities will have lower CVD HRs
		Linguistic Isolation: % of total population without knowledge of English or French	
Education	Percent of people over 15 with university education	University Education: % of total population (>=20 years of age) with any university degree	Areas with high levels of university education will experience lower CVD HRs
Income and wealth	Average 2000 total income $ in population over 15 years	Average Employment Income: average annual employment income in dollars	Areas with high levels of personal income will experience lower CVD HRs
	Average 2000 family income $	Median Family Income: median annual family income in dollars	Areas with high levels of family income will experience lower CVD HRs
	Coefficient of variation of income in population over 15 years	Income from Government Transfers: % of aggregate neighbourhood income from any government transfer	Areas with high levels of CV will experience lower CVD HRs; Areas with high levels of gov transfers will experience higher CVD HRs
	Incidence of low income in 2000 %	Persons Below LICO: % of persons in households below the low-income cut-off (LICO)	Areas with high levels of low income will experience higher CVD HRs
	Percent of owned dwellings	Homeownership Rate: % of occupied dwellings that are owner-occupied	Areas with high levels of home ownership will experience lower CVD HRs
		Housing Stress Index: % of families spending 30% or more of income on shelter costs	Areas with high levels of housing stress index will experience higher CVD HRs
Labour	Percent of people employed in population over 25 years	Unemployment Rate: seasonally adjusted unemployment rate among persons aged 25 years and over	Areas with high levels of employment will experience lower CVD HRs
	Percent of people in labour working in management		Areas with high levels of management workers will experience lower CVD HRs
Transportation	Percent of working people that uses transit, bikes or walks to work		Areas with high levels of usage of transit, biking, walking will experience high CVD HRs

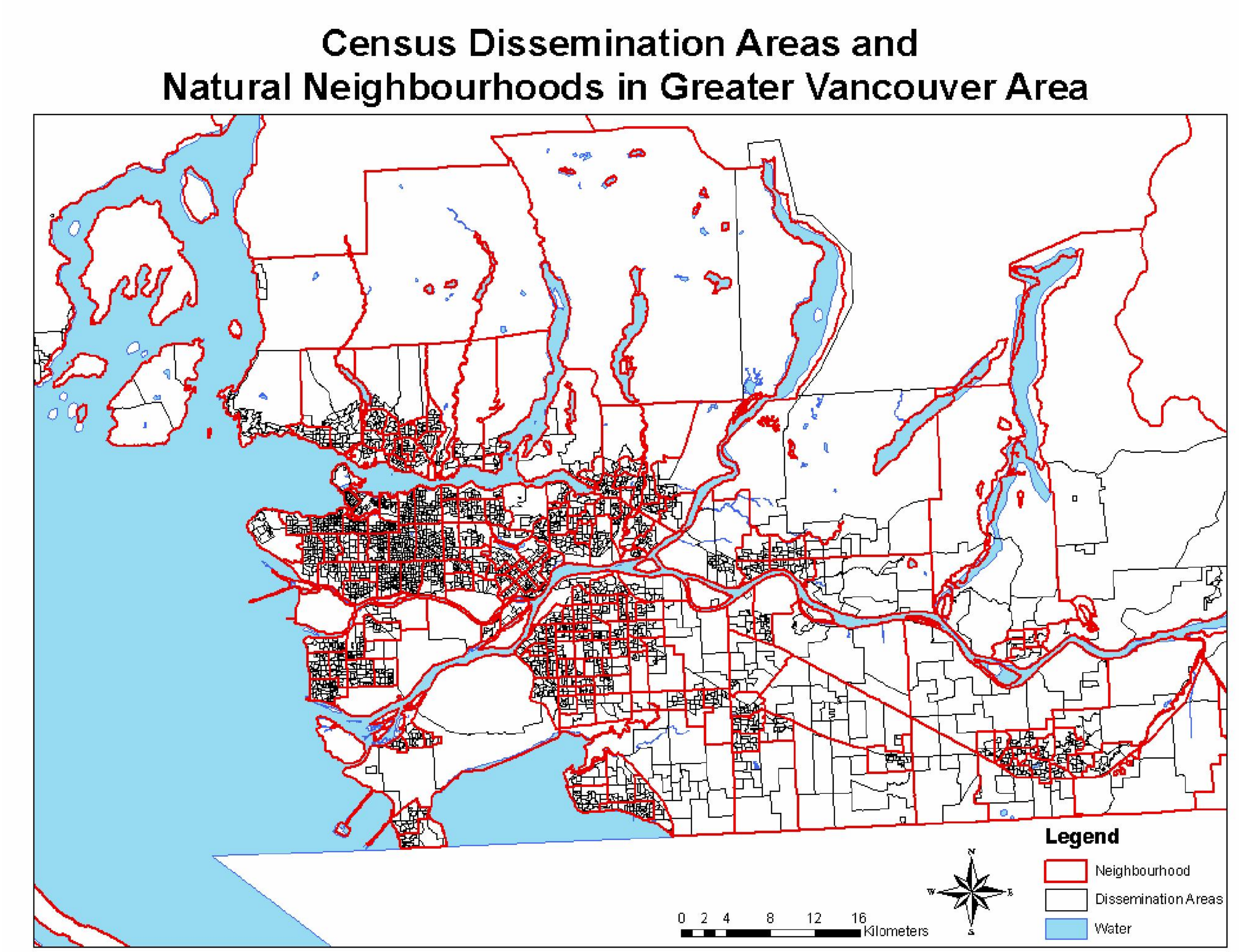

Figure 3. Dissemination Areas, Neighbourhoods and forward Sortation Areas in Vancouver

Air pollution exposure assessment

Land use regression

The land use regression models used in this study were previously developed for the study region by Henderson[217] and colleagues in 2007 to provide improved local spatial resolution. Pollution data was considered a time-dependent covariate in the Cox proportional hazards model employed in the analyses. For each month in the follow-up period (January 1st, 1999 – December 31st, 2002) the average exposure of the previous year was calculated using the residential history and the land use regression model. Thus, each subject had up to 48 months of exposure information.

The land use regression model was built by assessing the association between variables describing land use and traffic information and the NO and NO_2 concentration measured at 116 sites in the study area over two 14-day periods. The mean concentrations during these two periods closely approximated annual averages from regulatory monitoring network data, and were highly correlated with these averages. The $PM_{2.5}$ model was developed using data from a subset of 25 locations during a 2-month sampling period.

For a subset of 36 sites, particle absorbance (Black Carbon) was measured using a Particle Soot Absorption Photometer (Radiance Research, Seattle WA) in a mobile monitoring platform. These measurements were then adjusted for temporal variation based upon repeated measurements at a centrally-located site. For NO, the model had an R^2 of 0.62 and included the number of major roads within 100-m and 1,000-m radius circular buffers around the measurement sites, the number of secondary roads within a 100-m buffer, the population density within a 2,500-m radius, and elevation. For NO_2, the model ($R^2 = 0.56$) included the same variables as well as the amount of commercial land use within 750 m. For $PM_{2.5}$ the model ($R^2 = 0.52$) included the amount of commercial and industrial land use within 300 m, the amount of residential land use within 750 m, and elevation. For black carbon, the model ($R^2 = 0.56$) included the number of secondary roads within a 100-m buffer, the distance to the nearest highway, and the amount of industrial land use within 750 m (Brauer et al. 2008).[216a]

The model output consisted of yearly exposure averages based on the measurements done in 2003 for a 10 m^2 grid for the study area. Ambient monitoring data obtained from the local monitoring network was used to identify the long-term trends in NO, NO_2, and particulate pollution, and the coefficients obtained from these trend analyses (performed using the Times Series Forecasting System from SAS v 9.1.2) were used to adjust the land use regression yearly averages in order to obtain the average exposures of the previous year for each month in the follow-up period.

Proximity to roads

Road proximity for home postal codes of all cohort members was calculated by the author as a proxy for traffic exposure. Road classifications (DMTI ArcView street file dataset for British Columbia, Canmap Streetfiles, v2006.3, 2006) were used to determine whether a home postal code was within 50 m of an expressway or primary highway (R-I), between 50 m and 150 m of an expressway or primary highway (R-II), within 50 m of a secondary highway or major road/arterial road (R-III), between 50 m to 150 m of a secondary highway or major road/arterial road (R-IV)or within 150 m of a secondary highway or major road, or within 50 m of an expressway or primary highway (R-V). The R-I and R-II road categories and R-III and R-IV road categories are mutually exclusive but this not preclude a subject living within 50 m of an expressway or highway to also live within 50 m or within 150 m of a primary road or a major road. This is why the sum of subject living in the proximity of R-I, R-II, and R-III will be less than the number of subjects found for R-V category.

Statistical analysis

The initial analyses performed consisted in validating the administrative databases and especially the health outcomes derived from the administrative databases with data derived from the 2001 Canadian Community Health Survey (CCHS). The information from the CCHS was also use to investigate the effect of smoking on the CVD outcomes as well as the correlation between the individual level variables and census SES and pollution variables.

There are two main sets of statistical analyses that were performed for this study. For the first set of analyses, Cox proportional hazard analysis (using SAS v 9.1.2) was used to investigate the effect of air pollution on cardiovascular health outcomes adjusting for age, gender, and SES at the DA and neighbourhood levels. Pollution exposure (yearly average of traffic pollution exposure prior to the event) and road proximity variables were treated as time-dependent variables.

The second set of statistical analyses followed the methodology suggested by Laurent et al.[237] for investigating the modifying effect of SES on the relationship between traffic pollution and cardiovascular health outcomes. Figure 4 illustrates a fictitious example suggested by Laurent:[237] the slope of a dose–response curve corresponding to a population with low SES might be stronger than that of a population with high SES for some concentration ranges (between x1 and x2), and lower for a range of higher concentrations (between x3 and x4). The slopes of these curves may be considered equivalent to a hazard ratio or relative risk. This shows the importance of taking into account the range of pollutant concentrations tested for which SES might be an effect modifier.

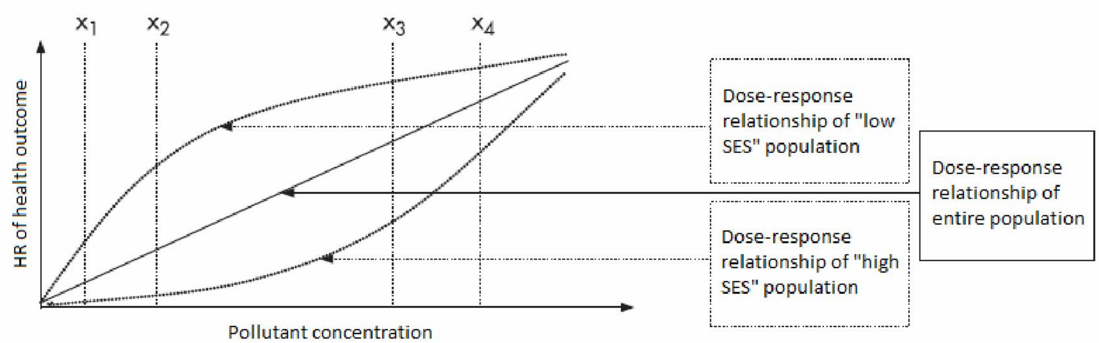

Figure 4. Fictitious example of dose-response relationship in low and high SES populations (from Laurent et al. 2007)[237]

In order to follow this methodological approach, all SES variables retained for analyses, regardless of their level of aggregation, were ranked and classified by quintiles. Stratified Cox proportional hazard analyses were run (using SAS v 9.1.2) for the lowest and highest quintiles for each of the SES variables and for all four traffic pollutants available. Pollution levels were ranked and classified by quartiles and were used in the analyses as time-dependent variables.

Results

Validation of the administrative database with the Canadian Community Health Survey information

CCHS data summary

A pilot validation study containing subjects from the Border Air Quality Study that participated in the 2001 Canadian Community Health Survey was performed. A dataset with a total of 2,824 subjects was obtained form CHSPR. One subject with duplicate Study ID was eliminated and another subject was also eliminated because it had two different ages. Thus, the final number of subjects from CCHS found in the BAQ Study is 2,821. Out of these, 1,470 subjects were matched to the study cohort.

The proportion of CCHS subjects with full data in the study area, out of the total CCHS survey data with full information (2,752) was only 53% which indicates that there might be some underlying problems that led to a greater reduction in the CCHS/GVRDplus sub-cohort compared with the GAB/ GVRDplus population.

One thing to consider is that the CCHS surveys people between 12 and 74 years old while the BAQ Study looked only at people over 45 years of age as of January 1st 2009. Another cause of the difference might reside in the different sampling intensities that Statistics Canada uses for different regions. For this reasons we compared the sampling weights of the subjects from CCHS in the GVRDplus area with the sampling weights of the subjects that are outside this area. The results are presented in Table 5.

Table 5. Comparison between the sampling weights of subjects from GVRDplus area and subjects outside GVRDplus

Area	N	Mean	Std Dev	Minimum	Maximum
GVRD plus	1,470	237.55	171.89	25.27	1946.85
Outside GVRD plus	1,279	175.26	115.83	15.09	938.25

It can be seen from Table 1 that there are major differences between the two sub-cohorts in terms of the sampling intensity used by Statistics Canada. Assuming that subjects with smaller weights demanded a higher sampling intensity, it appears that CCHS survey over sampled in areas with smaller population. The CCHS survey data was also used to check the validity of the administratively derived demographical, medical, and residential medical history data.

Residential history check

The first three digits of the postal code (indicating the Forward Sortation Area) from the CCHS dataset were compared with the FSAs of the subjects recorded on the same time interval the CCHS survey was conducted. Thus from the 1470 subjects from GVRDplus in CCHS, one has left the GVRDplus area prior to the date of the survey so it does not appear in the residential history during that time frame. However, out of the remaining 1469 subjects from the greater Vancouver metropolitan area in CCHS, only 144 (9.80%) showed differences between their declared residence in the CCHS and the residence obtained from the residential history file compiled using the medical data files. When no time restriction (postal code address from the 2001 CCHS survey had to match the postal code of residence derived from the administrative databases for the same time interval the CCHS was conducted) was applied to the postal codes in the residential history file, an even smaller discrepancy with CCHS addresses was noted.

Demographic check

Gender

There was a misclassification of gender when comparing the BAQ study information with the CCHS information. Thus, 7 males (according with CCHS) were reported as females by the BAQ Study data. These subjects were not included in any further analyses.

Age

There were differences in age among the 1469 subjects from CCHS in GVRDplus when comparing the BAQ Study derived age with the CCHS derived age. A total of 109 subjects differed in their age when comparing CCHS year and month of birth with registry year and month of birth. However, there were only 65 subjects that differed in their year of birth. Out of these 65, 32 subjects had a difference of 1 year, 4 subjects had a difference of 2 years, and for 4 subjects there seems to be juxtaposition or misreading in the year. Thus, only 25 subjects were discarded. After removing the 7 subjects that did not have similar genders in the two databases, only 1,442 subjects were left for future analyses. A cross-check was done on the 25 subjects considered as being problematic in respect with the year of birth, to see if the CCHS address matches the BAQ study address from residential history. Only 4 subjects out of 25 had different residential histories

Health history check

The subjects in the CCHS survey were asked several questions regarding their health status in respect with several diseases. A general variable defines the health status of the subjects in respect with heart diseases while other variables are more specific in respect with what type of heart disease one has. The health status of CCHS subjects in respect with hypertension (has high blood pressure), COPD (has emphysema, COPD or chronic bronchitis), and diabetes (has diabetes) is represented by individual Yes/No variables.

The variables indicating the presence/absence of heart diseases, hypertension, diabetes and COPD were compared with the MSP and hospitalization health outcomes obtained from the respective files. A relatively low level of matching could be noted across all health outcomes studied. Table 6 shows the proportion of subjects in the CCHS (1,442 subjects) that had declared that they have one of the three health outcomes of interest and were found from the MSP and hospital discharge files that they actually have those health outcomes. One caveat regarding the health outcomes from administrative data is that only data from 1991 to 2003 was available for creating a health history for any individual, which might explain the low level of concordance between the CCHS answers and the administrative health data.

The summaries from Table 6 indicate that there is a relatively high level of concordance between the health status reported in the CCHS and the administrative databases used to extract and define the health status for the subjects in the cohort. Thus, there was a 93,3%

match regarding ACS status, 89% match regarding CCS status, and 95.4% regarding CHF status.

Table 6. CCHS health outcomes vs. Administrative health data

CCHS Health Status	Administrative health data							
	All Heart Diseases		ACS		CCS		CHF	
	No	Yes	No	Yes	No	Yes	No	Yes
No	1160 (80.44%)	109 (7.56%)	1321 (91.61%)	54 (3.74%)	1229 (85.23%)	145 (10.06%)	1361 (94.38%)	46 (3.19%)
Yes	48 (3.33%)	125 (8.67%)	28 (1.94%)	39 (2.70%)	15 (1.04%)	53 (3.68%)	21 (1.46%)	14 (0.97%)

Smoking status in the CCHS sub-cohort

CCHS provided relevant information regarding the smoking status of the surveyed subjects making possible to calculate the number of pack-years. In order to do that, the variable SMKADSTY (Type of smoker – derived variable) was used as a start point. This variable classifies people in 7 non overlapping categories: (1) daily smoker, (2) occasional smoker (former daily smoker), (3) always an occasional smoker, (4) former daily smoker, (5) former occasional smoker, (6) never smoked, (7) not stated. For each of these categories (except for people that did not state their status), a different algorithm was used to determine the number of pack-years. Also, to simplify the analysis and to create classes of smokers with sufficient number of subjects, a new categorical variable was created with the purpose of analyzing the correlation between road proximity, a categorical variable, and smoking. The new categorical variable (SMOKING) has three classes: (1) current smokers (current daily smokers, always occasional smokers and occasional smokers – former daily smokers), (2) former smokers (former daily smokers and former occasional smokers), and (3) subjects that never smoked. In Table 7 are presented the overall summary statistics for the number of pack years and also the summary statistics grouped by SMOKING class.

Table 7. Summary statistics regarding the number of pack years

Category	N	N Miss	5th Ptcl.	Lower quartile	Mean	Median	Upper quartile	95th Ptcl.	Std Dev
Missing	1	1	0	0	0	0	0	0	.
Current smokers	226	0	1.75	17.50	30.98	27.87	44.10	66.00	20.74
Former smokers	760	0	1.82	1.82	27.28	18.87	40.25	85.95	30.54
Non smokers	454	0	0	0	0	0	0	0	0
Overall	1442	1	0.00	0.00	19.24	6.50	31.00	66.00	27.05

Analysis of the relationship between smoking status and health outcomes

Because for the main analyses there wasn't available information at individual level on the smoking status that could be used to better assess the effects of traffic pollution on health, an analysis was conducted using the CCHS data to see the impact of smoking on the CVD outcomes on the population of this survey.

Proc FREQ was used to analyze the relation between the declared health status for several health outcomes (ACS, CCS, and CHF) and smoking status (ever smoked/never smoked).

Table 8 presents the odds ratios of being sick (self reported and administratively derived health outcomes), for the subjects that ever smoke as opposed to subjects that never smoked.

Another analysis using Proc FREQ was done to determine weather or not there is a trend of having some of the health outcomes of interest present when comparing non-smokers with occasional smokers and daily smokers. Tables 9 and 10 depict for every one of the health outcomes of interest (self reported and derived from administrative data) the trend in the proportion of adverse effects due to increase in the smoking levels, Somers' D C|R statistics' 95% CI (Somers' D C|R statistic measures the association treating the column variable (Health outcome) as the response and the row variable (Smoking frequency) as a predictor.

A strong positive association exists when the asymptotic 95% confidence limits do not contain zero.), and the Cochran-Armitage test (The small left-sided p-values for the Cochran-Armitage test indicate that the probability of the Column 1 level (Health outcome='No') decreases as smoking frequency increases or, equivalently, that the probability of the Column 2 level (Health outcome='Yes') increases as smoking frequency increases. The two-sided p-value tests against either an increasing or decreasing alternative. This is an appropriate hypothesis when one wants to determine whether the tested treatment has progressive effects on the probability of adverse effects but the direction is unknown.

Although the tests were not significant for any of the three health outcomes, a more consistent trend, at least for non-smokers and occasional smokers emerged for the administratively derived health outcomes. The inconsistency in the trend for current smokers might be due to the much smaller number of current smokers.

Table 8. Estimates of odds ratio of having a self reported/administratively derived health outcome for subjects that ever/never smoked

Health outcome	Odds ratio & 95% CI	
	Self reported health outcome	**Administratively derived health outcome**
Acute Coronary Syndrome	1.34 (0.77 – 2.36)	1.83 (1.09 – 3.07)
Chronic Coronary Syndrome	0.88 (0.52 – 1.47)	1.15 (0.83 – 1.60)
Congestive Heart Failure	0.77 (0.39 – 1.55)	1.37 (0.75 – 2.48)

Table 9. Trend analysis of having a self reported health outcome for subjects with different levels of smoking

Health outcome	Proportion of adverse effects for non-smokers, occasional smokers and daily smokers	Somers' D C|R statistics' 95% CI	Cochran-Armitage test (one sided/two sided)
ACS	3.74%, 5.92%, 1.77%	-0.0183 – 0.0129	0.3509 / 0.6392
CCS	5.07%, 4.87%, 3.10%	-0.0275 – 0.0089	0.1802 / 0.3498
CHF	2.86%, 2.76%, 0.44%	-0.0232 – 0.0012	0.0624 / 0.1240

Table 10. Trend analysis of having an administratively derived health outcome for subjects with different levels of smoking

Health outcome	Proportion of adverse effects for non-smokers, occasional smokers and daily smokers	Somers' D C|R statistics' 95% CI	Cochran-Armitage test (one sided/two sided)
ACS	4.19%, 8.82%, 2.65%	-0.0113 - 0.0237	0.4306 / 0.8094
CCS	12.56%, 15.92%, 8.41%	-0.0374 - 0.0195	0.2351 / 0.4563
CHF	3.30%, 5.13%, 2.21%	-0.0150 - 0.0156	0.46890 / 0.9211

Correlations between individual CCHS variables and census SES and pollution related variables

Pearson correlations were calculated between the continuous CCHS and Census SES variables while Spearman correlations were calculated between the categorical CCHS and traffic quartiles of exposure as well as with the road proximity data (0/1). Spearman correlations were also calculated between the above mentioned categorical CCHS variables and the quintiles of Census SES variables.

Correlations with traffic pollution and road proximity

Traffic pollution

Although there were several statistically significant correlations between traffic pollution data and CCHS variables, the highest correlation coefficient in absolute value was only 0.1454, while the majority of coefficient of correlations were in the 10^{-2} order of magnitude. This indicates that there are no correlations between traffic pollution and individual CCHS variables. The greater correlations were found between individual and family income variables and traffic generated pollutants, and these were found to be inverse correlations.

Road proximity

Although there were several statistically significant correlations between road proximity data and CCHS variables, the majority of correlation coefficients were in the 10^{-2} order of magnitude with some coefficients being in the 10^{-3} order of magnitude. This indicates that there are no correlations between traffic pollution and individual CCHS variables.

Correlations with dissemination area level SES

While the expectation for the pollution and CCHS variables was that there will be little or no correlation, the expectation was that the CCHS individual data and Census SES data were correlated, not only between similar variables (i.e. CCHS personal income/Census SES personal income), but also between smoking, drinking, BMI, physical activity index and some of the Census SES variables.

This expectation was not confirmed by the correlation analyses performed with the continuous and categorical data. The highest correlation was found to be 0.3097, between CCHS family income and Census SES family income. There was little or no correlation found between smoking, physical activity, drinking and eating habits and any of the Census SES variables.

While these results preclude the use of some of the Census SES variables as proxies for lifestyle indicators, it is important to remark that the correlation analysis between the individual CCHS variables indicated that there is no correlation between smoking, drinking, eating and activity habits and income or education for instance.

Additional analyses

Exposure data and smoking & drinking

Although the correlation analyses have shown that there is little or no correlation between traffic pollutants and road proximity and the individual level variables from CCHS dataset (i.e. smoking status, income, alcohol consumption), additional analyses were performed to ascertain this lack of relation. Two additional analyses were thus carried: one consisted in performing analyses of variance and comparing the exposure means to various pollutants between various smoking categories; the other method consisted in producing box plots for exposure by categories of smoking.

All ANOVA analyses (done using PROC GLM in SAS 9.1 - to account for potential unbalanced data) were not significant (including tests for mean differences). A similar ANOVA analysis was performed for drinking category and almost similar results were obtained for most of the pollutants with the exception of ambient PM_{10}, where differences were detected between people that never drank and regular drinkers in terms of ambient PM_{10} exposures. Also differences were found between former drinkers and regular drinkers in terms of traffic generated black carbon and $PM_{2.5}$ exposures.

Cohort summary statistics

There were 346,536 residents of the greater Vancouver metropolitan area in the cohort. The sex and age characteristics of the cohort and the number of cases in each stratum are presented in Table 11.

Table 11. Age, sex and health outcome summaries

Age by 10 years classes	SEX		Total freq. (%)	Health outcome rates (per 1000)		
	Female freq. (%)	Male freq. (%)		ACS	CCS	CHF
75 and over	18,092 (5.2)	11,385 (3.3)	29,477 (8.5)	29.3	21.6	13.5
65 - 74	30,757 (8.9)	25,192 (7.3)	55,949 (16.1)	18.1	19.9	4.3
55 - 64	49,859 (14.4)	46,024 (13.3)	95,883 (27.7)	9.9	12.7	1.1
45 -54	86,560 (25.0)	78,667 (22.7)	165,227 (47.7)	4.7	5.5	0.3
Total	185,268 (53.5)	161,268 (46.5)	346,536 100.0)	10.4	11.2	2.3

In the greater Vancouver metropolitan area baseline cohort during the follow-up period, the total number of hospitalizations or deaths for each of the three health outcomes of interest was: ACS – 3,588; CCS – 3,878; CHF – 794. From the total number of health outcomes of interest, the deaths due to one of the three health outcomes of interest were as follows: ACS – 594; CCS – 475; CHF – 80.

Tables 12 and 13 present the cohort summaries for the socioeconomic variables at the DA and neighborhood levels that are used in the two sets of Cox proportional hazards analyses. These summaries give an idea of the distribution of each of the variables describing the cohort. It can be seen from the two tables that, at least for the common variables between the levels, there is attenuation in the magnitude of the statistics from the DA level to the neighborhood level. Also Tables 12 and 13 present the summaries for each of the 20 SES variables (10 at the DA level and 10 at the neighborhood level). In both sets of analyses performed in this study, the SES variables are categorized by quintiles and these categories were actually used in the analyses. Particularly in the second set of analyses, only the lower and higher strata of each variable were used to compare the effects of pollution on the cardiovascular health outcomes. As was the case for the overall numbers pertaining to each SES variable in both sets of analyses, the summary statistics for quintiles for DA-level variables have a smaller minimum and a greater maximum than the quintiles of the variables at the neighborhood level of aggregation. However, the number of subjects corresponding to each quintile for the similar variables at the DA and neighborhood levels of aggregation was very similar.

Table 12. Summary statistics for the DA-SES variables form Stats Canada 2001 Census used in the Cox model

SES Indicator (Stats Can Variable)	Count	Mean	Maximum	Minimum	Std Dev
Percentage of Chinese visible minorities (VIS_CHINESE)	346,536	16	89	0	19
Average 2000 total personal income ($) (INCOME)	346,536	33,020	187,691	9,087	13,304
Percent of people with university degree (UNIVERSITY)	346,536	33	99	0	15
Percent of people that use transit, walk or bike for work (TRANSPORTATION)	346,536	9	48	0	7
Coefficient of variation of income in population over 15 years (INCOME_VAR)	346,536	9	47	0	4
Percent of owned dwellings (OWNED_HOMES)	346,536	69	100	0	24
Average 2000 family income ($) (FAM_INCOME)	346,536	74,122	543,603	0	33,716
Employment rate (%) (EMPLOYMENT)	346,536	63	95	3	12
% people in labor working in management (MANAGEMENT)	346,536	12	67	0	7
Incidence of low income in 2000 % (LOW_INCOME)	346,536	18	94	0	13

Table 13. Summary statistics for the Neighbourhood SES variables from the B.C. Atlas of Child Development in the Cox Model

VARIABLE	Count	Mean	Maximum	Minimum	Std Dev
% of total population whose home language is neither English nor French (OTHLANG)	346,536	13	49	0	10
% of total population without knowledge of English or French (LINGISOL)	346,536	4	26	0	4
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	346,536	22	70	5	11
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	346,536	6	21	2	3
Median annual family income ($) (FAM_INCOME)	346,536	60,740	102,951	26,971	14,534
Average annual employment income ($) (INCOME)	346,536	34,792	69,604	19,730	8,569
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	346,536	10	41	4	4
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	346,536	19	65	4	9
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	346,536	66	92	9	18
% of families spending 30% or more of income on shelter costs (STRESS)	346,536	29	54	16	6

Exposure related summaries

Traffic exposure

All correlations between traffic pollutants were positive, with a relatively high correlation between NO and NO_2 ($r = 0.54$). There was a weak correlation between $PM_{2.5}$ and all the other pollutants, while the correlations between black carbon and NO and NO_2 were moderately high. From a longitudinal perspective, in all pollutants there was a weaker correlation between the more distant monthly windows of exposure and the more proximal ones.

Table 14. Traffic pollutants: summary statistics

Pollutant	Mean	Minimum	Maximum	STD	Inter-quartile range
Traffic NO ($\mu g/m^3$)	30.90	0.4	206.6	19.09	23.2
Traffic NO_2 ($\mu g/m^3$)	31.11	0.6	66.8	9.44	10.2
Traffic $PM_{2.5}$ ($\mu g/m^3$)	4.05	0.0	12.2	1.81	1.8
Traffic Black Carbon (B.C.) (10^{-5}/m filter absorbance)	1.51	0.0	6.2	1.24	0.8

Table 15. Correlations between traffic pollutants

Variable	NO	NO_2	$PM_{2.5}$	B.C
NO	1.0000			
NO_2	**0.54**	1.0000		
	<0.0001			
$PM_{2.5}$	**0.09**	**0.40**	1.0000	
	<0.0001	<0.0001		
B.C.	**0.30**	**0.19**	**0.16**	1.0000
	<0.0001	<0.0001	<0.0001	

Road proximity

Table 16 presents a summary of the total numbers of subjects living in the proximity of each of the five road types. It is necessary to mention that the number of subjects living in the proximity of roads was derived only from the first month of follow-up, namely January 1999, while the health outcomes were derived for the whole follow-up period. In the analysis, road proximity is a time-dependent variable.

Table 16. Percentage of subjects in the CVD cohort living in the proximity to roads

Road proximity type	In Road proximity
Subjects living within 50 m from expressways and primary highways	1.73%
Subjects living between 50 and 150 m from expressways and primary highways	4.92%
Subjects living within 50 m from secondary highways and major roads	10.62%
Subjects living between 50 and 150 m from secondary highways and major roads	21.78%
Subjects living within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads	16.93%

Table 17. Traffic exposure and relative risk for CCS health outcomes

Traffic exposure	RR of health outcome for subjects in the 4^{th} vs. 1^{st} quartiles of traffic pollution exposure
NO	0.90 (0.82 – 0.92)
NO_2	0.86 (0.78 – 0.94)
Black Carbon	1.10 (1.00 – 1.20)
$PM_{2.5}$	0.92 (0.84 – 1.01)

* Note: exposure is determined based on the first month of follow-up, January 1999

Table 18. Road proximity* and relative risk for CCS health outcomes

Road proximity	RR of health outcome for subjects in road proximity vs. subjects not in road proximity
Subjects living within 50 m from expressways and primary highways (R-I)	1.21 (0.97 – 1.51)
Subjects living between 50 and 150 m from expressways and primary highways (R-II)	1.06 (0.92 – 1.22)
Subjects living within 50 m from secondary highways and major roads (R-III)	1.01 (0.92 – 1.12)
Subjects living between 50 and 150 m from secondary highways and major roads (R-IV)	1.05 (0.98 – 1.13)
Subjects living within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (R-V)	1.05 (0.96 – 1.14)

* Note: exposure is determined based on the first month of follow-up, January 1999

The main analysis employed to assess the effect of pollution on different cardiovascular morbidities and mortality was done using Cox proportional hazards regression, with pollution as a time-dependent covariate (thus varying on a monthly basis over the four years of the follow-up period, between January 1999 and December 2002). However, Table 17 only shows the distribution of the events in the CCS morbidities and mortalities that occurred during the whole follow-up period for the four traffic pollutants, when considering only the first month of follow-up, January 1999. This exposure represents the yearly average pollution exposure that a person in the cohort was subjected to between January 1998 and December 1998.

In Table 17, the crude relative risk on the occurrence of morbidity or mortality of CCS for subjects in the 4th versus 1st quartile of particular traffic pollutants are presented. For NO, NO_2, and $PM_{2.5}$, the relative risk is smaller than one (between 0.86 and 0.92). However, the relative risk of CCS was larger than one in the case of black carbon [1.10 (CI: 1.00 – 1.20].

In Table 18, the crude relative risk was calculated comparing subjects that were in the proximity of a certain road type and those who were not. Relative risks were higher than one for all five road type categories in the case of CCS health outcomes but none was significantly higher than one. However, the crude relative risk of experiencing CCS for the subjects living within 50m of expressways and highways was high (1.21) and only marginally non-significant [CI: 0.97 - 1.51]. All these relative risk values give only an indication of what the calculated risk would be, because we have to also take in account the effect of age, gender and different SES covariates that will be used in the analyses. Tables 30 and 31 in the Appendix show the crude RRs for ACS and CHF health outcomes in relation with traffic pollution and road proximity.

Tables 37 to 50 in Appendix I present the counts for censored subjects (those without any morbidity or mortality due to one of the three cardiovascular health outcomes of interest) and those that experienced such an outcome (event) during the follow-up period for each of the health outcomes of interest and the covariates at two levels of aggregation used in the analyses for all traffic pollutants as well as for road proximity analyses. The values for the four traffic pollutants differ slightly because there were differences in the number of total subjects that had available exposure information for a particular pollutant, while for road proximity, all numbers are the same regardless of the road type because all subjects had information regarding their residential address (which was all that was required for calculating the distance to a particular road type).

Cox analysis

Table 19 provides the results for the crude hazard ratio estimates for CCS health outcomes in relation with traffic exposure while Table 32 in the Appendix provides the results for the crude hazard ratio estimates for the ACS and CHF health outcomes in relation with traffic exposure. There are only few instances of a linear descending or ascending trend for any of the estimates. The hazard ratios start to be higher than one for black carbon and especially for $PM_{2.5}$. For NO, NO_2, and black carbon the results were non-significant and mostly without any particular trend, or with the opposite trend than expected. In the case of $PM_{2.5}$ the hazard ratios for the CCS outcomes and all quartiles of exposure were greater than one. There is also a noticeable increasing trend in HRs for $PM_{2.5}$ that goes from non –significant for the second and third quartiles and becomes significant for the forth quartile.

Table 20 provides the results for the adjusted hazard ratio estimates for the three health outcomes of interest in relation with traffic exposure. The two sets of results are for the analyses using the DA level covariates plus age and gender and for the neighborhood level covariates plus age and gender respectively, all in relation with traffic pollution exposure.

For the analyses done using DA level SES covariates (Table 20), all hazard ratio estimates are non significant and there were no striking patterns. The hazard ratio estimates for the analyses performed using neighborhood level SES covariates were almost all greater than the corresponding estimates obtained adjusting with the DA level covariates. This was opposite to what was expected, given some of the results in the literature (Laurent et al[237]) but somewhat explained by other arguments that refer though to higher levels of aggregation (Wilkinson and Pickett[122], see Discussion Chapter) For NO, NO_2, and $PM_{2.5}$ there was an increasing linear trend in the hazard ratio estimates for CCS, trend that is better depicted in Figure 5.

Table 19. Crude hazard ratios for traffic pollutants in relation with CCS outcomes

Pollutant	Crude HR and 95% CI			
	1st	2nd	3rd	4th
NO	1.00	0.99 (0.91 - 1.08)	0.89 (0.81 - 0.97)	0.94 (0.86 - 1.02)
NO_2	1.00	0.90 (0.83 - 0.98)	0.85 (0.78 - 0.93)	0.88 (0.80 - 0.96)
$PM_{2.5}$	1.00	1.07 (0.98 - 1.17)	1.07 (0.97 - 1.17)	**1.12 (1.02 - 1.22)**
Black Carbon	1.00	1.02 (0.93 - 1.11)	1.01 (0.93 - 1.11)	0.95 (0.86 - 1.04)

Table 20. Hazard ratios for traffic pollutants adjusted for DA and neighborhood levels SES covariates in relation with CCS outcomes

Pollutant	DA SES Adjusted[1] HR and 95% CI			Neighborhood SES Adjusted[2] HR and 95% CI		
	2nd	3rd	4th	2nd	3rd	4th
NO	1.04 (0.95 - 1.13)	0.97 (0.88 - 1.07)	1.05 (0.95 - 1.16)	1.06 (0.97 - 1.16)	1.04 (0.94 - 1.15)	**1.12 (1.01 - 1.24)**
NO_2	0.96 (0.88 - 1.05)	1.01 (0.91 - 1.12)	0.99 (0.89 - 1.10)	**1.00 (0.91 - 1.10)**	**1.11 (1.00 - 1.24)**	**1.13 (1.01 - 1.25)**
$PM_{2.5}$	1.03 (0.95 - 1.13)	1.04 (0.95 - 1.14)	1.05 (0.96 - 1.15)	1.05 (0.96 - 1.16)	1.08 (0.98 - 1.20)	**1.10 (1.00 - 1.21)**
Black Carbon	1.05 (0.95 - 1.15)	1.08 (0.98 - 1.19)	1.03 (0.93 - 1.14)	1.05 (0.96 - 1.16)	1.11 (1.00 - 1.22)	1.05 (0.95 - 1.16)

[1] The adjustment was done for sex, age class, and 10 DA level SES covariates; [2] The adjustment was done for sex, age class, and 10 Neighborhood level SES covariates; SES variables grouped in quintiles

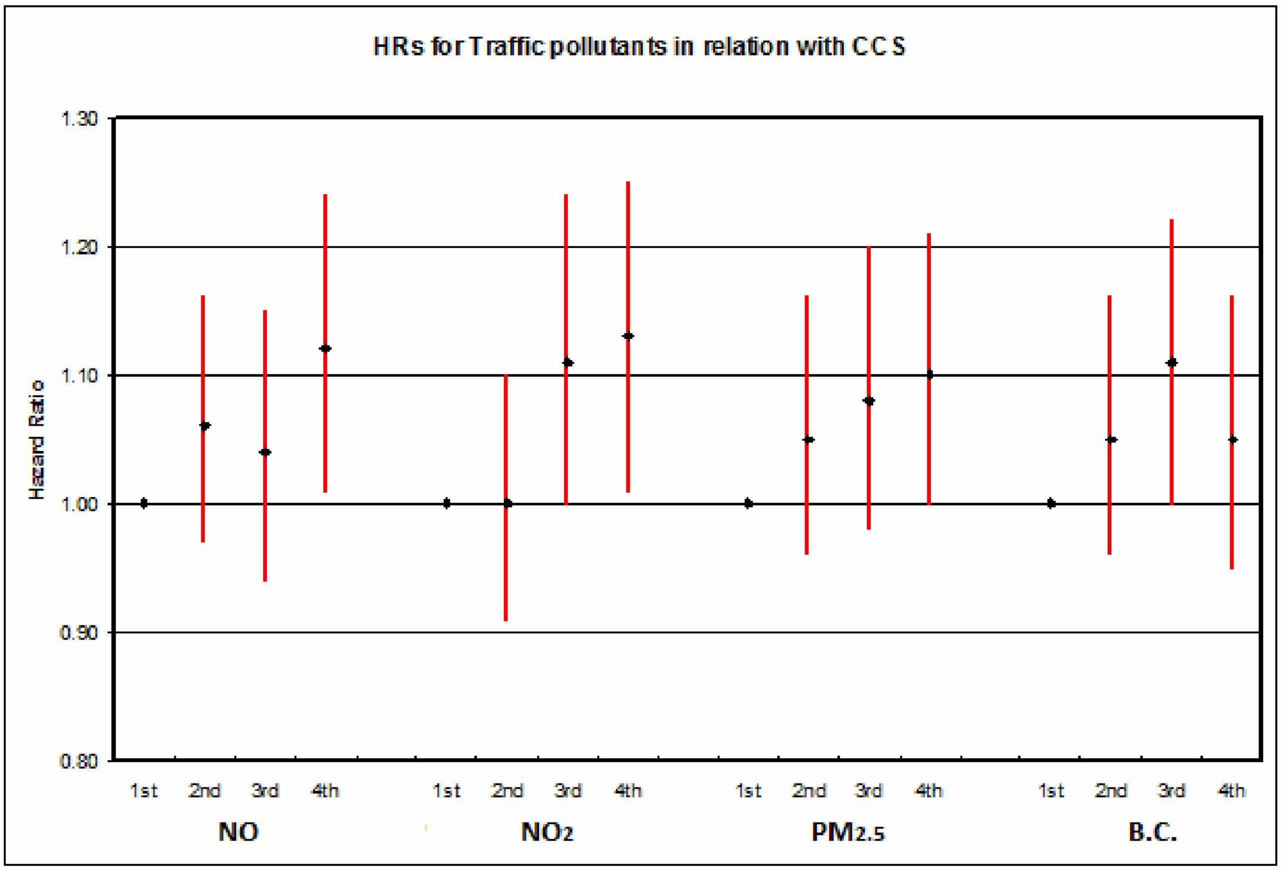

Figure 5. Adjusted hazard ratios for traffic pollutants and CCS in conjunction with neighborhood level SES

Table 21 presents the crude and adjusted (with both DA level and neighborhood level SES covariates) hazard ratio estimates for CCS health outcomes due to proximity to different road types. As was suggested by the relative risk estimates in Table 20, all hazard ratio estimates (crude and adjusted) for the CCS outcomes due to proximity to roads are greater than one, with many significantly so. Also, as for the HR estimates from traffic pollution analyses, the estimates derived by employing neighborhood level SES covariates are larger than when employing DA level SES covariates.

The HR estimates for CCS health outcomes show a definite decreasing trend from subjects living in the closer proximity of expressways (R-I: within 50 m from expressways and primary highways) towards subjects living further away from secondary roads (R-IV: between 50 and 150 m from secondary highways and major roads) only when employing neighborhood level SES covariates. In the case of DA level covariates there are no significant HRs and no clear trend from close proximity/high traffic roads to further away/less traffic roads.

The hazard ratios for traffic pollutants adjusted for DA and neighborhood level covariates in relation with ACS and CHF health outcomes are found in table 33 in the Appendix while the crude and adjusted (for DA and neighborhood level covariates) hazard ratios for road proximity in relation with ACS and CHF health outcomes are found in table 34 in the Appendix.

Table 21. Crude and adjusted hazard ratios for road proximity adjustment done using SES covariates at different levels of aggregation

Pollutant	Analyses HR and 95% CI		
	Crude HR	DA SES Adjusted[1] HR	Neighborhood SES Adjusted[2] HR
Within 50 m from expressways and primary highways (R-I)	1.27 (1.02 - 1.57)	1.08 (0.87 - 1.34)	**1.46 (1.18 - 1.80)**
Between 50 and 150 m from expressways and primary highways (R-II)	1.07 (0.93 - 1.23)	1.04 (0.90 - 1.19)	1.12 (0.97 - 1.29)
Within 50 m from secondary highways and major roads (R-III)	1.09 (0.99 - 1.20)	1.03 (0.93 - 1.14)	**1.16 (1.05 - 1.28)**
Between 50 and 150 m from secondary highways and major roads (R-IV)	1.03 (0.96 - 1.11)	1.06 (0.98 - 1.15)	1.01 (0.93 - 1.09)
Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (R-V)	1.11 (1.03 - 1.21)	1.04 (0.96 - 1.13)	**1.20 (1.10 - 1.30)**

[1] The adjustment was done for sex, age class, and 10 DA level SES covariates; [2] The adjustment was done for sex, age class, and 10 Neighborhood level SES covariates; SES variables grouped in quintiles

Stratified Cox analyses for the low and high levels of various SES covariates

As was described in the methodology section, in order to assess the modifier effect of pollution on the SES covariates in relation to CCS, a series of stratified analyses were conducted. The Cox proportional hazards analyses were conducted for the lowest and highest quartile of subjects of each SES variable available for the study, for both levels of aggregation. Each analysis was thus adjusted for sex, age and the pollutant of interest. No other SES variable was included in the analyses in order to assess independently each SES variable and because of the significant correlation between many of the covariates.

Tables 22 to 25 present the results of these stratified analyses for CCS health outcomes, all traffic pollutants and road proximity categories and both sets of SES covariates, at DA level of aggregation and neighborhood level of aggregation respectively. These tables present the hazard ratio estimates (and their 95% confidence intervals) of experiencing CCS for different traffic exposure levels or road proximities. For these particular analyses, the main focus is not necessarily the magnitude and significance of each individual estimate, but rather the relative difference between the low level SES estimate and high level SES estimate for the same pollution level. A divergent trend with HR estimates without overlapping confidence intervals would maximally indicate the effect modification induce by traffic pollution/road proximity on the SES in conjunction with CCS morbidity and mortality.

Traffic related health outcomes

DA level covariates

Following the literature review performed on the relation between socioeconomic factors and cardiovascular diseases and prior to the start of the stratified analyses for low/high levels of the socioeconomic variables, assumptions were made regarding the behaviour of the HRs for each of the variable investigated. Thus, for the percentage of Chinese minority population, university education, employment, family and personal income, home ownership, and for the percentage of people working in management, the assumption was that the HRs will be higher for the low levels of these variables compared with the high levels. Opposite to this assumption, the assumption for the transportation means variable, low levels of income, and income variation variable was that at higher levels there will be larger HRs compared with the low levels of these variables.

Table 22 presents the comparison between HR estimates for CCS outcomes in conjunction with traffic pollution for the low and high levels of the ten available SES variables at DA level of aggregation. Appendix II also presents in a graphic format the results from Table 22 as well as the results for ACS and CHF health outcomes derived from Tables 31 and 33 in the Appendix. The expectation was that the results will be similar for ACS and CCS, but this was not necessarily the case. Similar results were obtained only for the education variable (for B.C.), for family income (for NO), for transportation (for $PM_{2.5}$), for low income (for NO and B.C.), for home ownership (for B.C.), income variation (for B.C.), and for the work type variable (for NO). There were few circumstances where the HR estimates were significantly higher than unity, and although not many, there were definitely more than for ACS outcomes. For the analyses done based on the percentage of Chinese population in the DA of residence grouping, almost all HR estimates were smaller than the unit. Only for black carbon and particulate matter traffic pollution exposure the HR estimates are clearly and consistently higher for the group of subjects living in areas with a low percentage of Chinese minorities compared with the subjects living in DAs with a higher percentage of Chinese people.

The analyses showed that for each of these variables, at least for one of the traffic pollutants investigated, but in many cases for three or all four of them, there were differences between the low and high levels of the covariates. However, the expected behaviour of the HRs for the low/high levels of the SES covariates did not always matched actual results.

Table 22. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering CCS health outcomes

Health Outcome			CCS			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Chinese population	NO	Low	1.00	0.97 (0.83 - 1.14)	0.91 (0.76 - 1.09)	0.90 (0.73 - 1.11)
		High	1.00	0.88 (0.64 - 1.19)	0.78 (0.58 - 1.05)	0.98 (0.74 - 1.29)
	NO_2	Low	1.00	0.87 (0.74 - 1.01)	0.98 (0.81 - 1.19)	0.74 (0.59 - 0.92)
		High	1.00	0.86 (0.6 - 1.23)	0.92 (0.67 - 1.27)	0.90 (0.64 - 1.25)
	Black Carbon	Low	**1.00**	**1.05 (0.88 - 1.25)**	**0.96 (0.79 - 1.16)**	**1.10 (0.92 - 1.32)**
		High	**1.00**	**0.93 (0.73 - 1.18)**	**0.92 (0.73 - 1.17)**	**0.99 (0.79 - 1.24)**
	$PM_{2.5}$	Low	**1.00**	**0.97 (0.81 - 1.16)**	**1.02 (0.85 - 1.22)**	**0.94 (0.77 - 1.15)**
		High	**1.00**	**0.83 (0.63 - 1.10)**	**0.77 (0.59 - 1.00)**	**0.92 (0.71 - 1.18)**
University	NO	Low	1.00	0.98 (0.84 - 1.16)	1.03 (0.87 - 1.23)	0.93 (0.76 - 1.14)
		High	1.00	1.11 (0.88 - 1.39)	0.97 (0.77 - 1.22)	1.18 (0.96 - 1.47)
	NO_2	Low	1.00	0.85 (0.72 - 1.00)	0.94 (0.78 - 1.14)	0.94 (0.78 - 1.12)
		High	1.00	0.85 (0.67 - 1.09)	0.96 (0.77 - 1.20)	1.01 (0.80 - 1.26)
	Black Carbon	Low	**1.00**	**1.10 (0.90 - 1.33)**	**1.06 (0.87 - 1.29)**	**1.17 (0.97 - 1.42)**
		High	**1.00**	**0.87 (0.69 - 1.09)**	**0.97 (0.79 - 1.20)**	**1.10 (0.90 - 1.35)**
	$PM_{2.5}$	Low	1.00	0.89 (0.72 - 1.08)	1.02 (0.84 - 1.23)	1.02 (0.83 - 1.24)
		High	1.00	1.02 (0.81 - 1.29)	1.20 (0.98 - 1.48)	0.91 (0.74 - 1.13)
Employment	NO	Low	**1.00**	**0.88 (0.72 - 1.08)**	**0.83 (0.68 - 1.01)**	**0.80 (0.66 - 0.98)**
		High	**1.00**	**1.13 (0.93 - 1.37)**	**1.05 (0.86 - 1.28)**	**0.96 (0.78 - 1.18)**
	NO_2	Low	**1.00**	**0.82 (0.67 - 1.00)**	**0.73 (0.6 - 0.88)**	**0.69 (0.58 - 0.84)**
		High	**1.00**	**1.03 (0.86 - 1.24)**	**1.05 (0.86 - 1.29)**	**0.94 (0.77 - 1.16)**
	Black Carbon	Low	1.00	0.96 (0.78 - 1.18)	0.96 (0.78 - 1.17)	1.02 (0.84 - 1.25)
		High	1.00	1.05 (0.86 - 1.27)	0.98 (0.80 - 1.20)	1.00 (0.81 - 1.23)
	$PM_{2.5}$	Low	**1.00**	**0.94 (0.76 - 1.16)**	**0.92 (0.75 - 1.14)**	**0.90 (0.74 - 1.11)**
		High	**1.00**	**1.12 (0.92 - 1.37)**	**1.12 (0.91 - 1.37)**	**0.99 (0.80 - 1.23)**
Family income	NO	Low	**1.00**	**0.80 (0.65 - 0.98)**	**0.67 (0.55 - 0.82)**	**0.72 (0.60 - 0.88)**
		High	**1.00**	**1.05 (0.86 - 1.29)**	**1.15 (0.94 - 1.40)**	**1.12 (0.90 - 1.40)**
	NO_2	Low	**1.00**	**0.86 (0.70 - 1.07)**	**0.64 (0.52 - 0.79)**	**0.71 (0.59 - 0.85)**
		High	**1.00**	**0.93 (0.77 - 1.13)**	**0.95 (0.77 - 1.15)**	**0.92 (0.72 - 1.18)**
	Black Carbon	Low	1.00	0.96 (0.76 - 1.21)	0.94 (0.75 - 1.17)	0.95 (0.77 - 1.18)
		High	1.00	0.94 (0.78 - 1.14)	0.91 (0.73 - 1.12)	1.03 (0.84 - 1.27)
	$PM_{2.5}$	Low	1.00	0.83 (0.65 - 1.04)	0.84 (0.67 - 1.05)	0.80 (0.64 - 1.00)
		High	1.00	0.96 (0.79 - 1.17)	1.09 (0.90 - 1.33)	0.80 (0.63 - 1.01)
Personal income	NO	Low	**1.00**	**0.82 (0.66 - 1.02)**	**0.64 (0.52 - 0.80)**	**0.72 (0.59 - 0.88)**
		High	**1.00**	**1.02 (0.83 - 1.26)**	**1.05 (0.85 - 1.29)**	**1.24 (1.01 - 1.52)**
	NO_2	Low	**1.00**	**0.78 (0.62 - 0.98)**	**0.61 (0.49 - 0.75)**	**0.65 (0.53 - 0.80)**
		High	**1.00**	**0.94 (0.77 - 1.14)**	**0.99 (0.81 - 1.21)**	**1.08 (0.86 - 1.35)**
	Black Carbon	Low	1.00	0.92 (0.73 - 1.17)	0.94 (0.76 - 1.17)	0.94 (0.76 - 1.16)
		High	1.00	0.98 (0.81 - 1.20)	0.95 (0.77 - 1.18)	1.12 (0.92 - 1.37)
	$PM_{2.5}$	Low	1.00	0.88 (0.68 - 1.14)	0.85 (0.66 - 1.10)	0.91 (0.71 - 1.17)
		High	1.00	0.94 (0.77 - 1.15)	1.16 (0.95 - 1.41)	0.91 (0.73 - 1.14)

Table 22. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering CCS health outcomes (cont.)

Health Outcome			CCS			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Transportation	NO	Low	1.00	0.99 (0.83 - 1.17)	1.06 (0.88 - 1.28)	0.95 (0.78 - 1.16)
		High	1.00	1.30 (0.91 - 1.85)	0.98 (0.69 - 1.38)	1.18 (0.85 - 1.65)
	NO_2	Low	**1.00**	**0.88 (0.75 - 1.04)**	**0.86 (0.69 - 1.06)**	**1.05 (0.84 - 1.32)**
		High	**1.00**	**1.18 (0.73 - 1.90)**	**1.01 (0.65 - 1.59)**	**1.11 (0.71 - 1.72)**
	Black Carbon	Low	1.00	0.96 (0.81 - 1.15)	1.11 (0.92 - 1.36)	1.10 (0.91 - 1.33)
		High	1.00	1.11 (0.82 - 1.50)	1.11 (0.84 - 1.47)	1.14 (0.87 - 1.51)
	$PM_{2.5}$	Low	**1.00**	**1.25 (1.04 - 1.50)**	**1.15 (0.94 - 1.40)**	**1.35 (1.10 - 1.65)**
		High	**1.00**	**1.02 (0.78 - 1.32)**	**1.02 (0.79 - 1.33)**	**0.81 (0.63 - 1.05)**
Low income	NO	Low	**1.00**	**1.09 (0.91 - 1.30)**	**1.14 (0.95 - 1.38)**	**1.12 (0.91 - 1.38)**
		High	**1.00**	**0.74 (0.59 - 0.93)**	**0.65 (0.52 - 0.81)**	**0.72 (0.59 - 0.88)**
	NO_2	Low	**1.00**	**1.00 (0.85 - 1.18)**	**1.18 (0.97 - 1.44)**	**0.85 (0.65 - 1.10)**
		High	**1.00**	**0.72 (0.56 - 0.93)**	**0.62 (0.49 - 0.78)**	**0.69 (0.56 - 0.87)**
	Black Carbon	Low	**1.00**	**1.19 (1.00 - 1.42)**	**1.11 (0.90 - 1.36)**	**1.06 (0.87 - 1.30)**
		High	**1.00**	**0.89 (0.69 - 1.14)**	**0.95 (0.76 - 1.18)**	**0.98 (0.79 - 1.22)**
	$PM_{2.5}$	Low	**1.00**	**1.08 (0.90 - 1.29)**	**1.11 (0.92 - 1.35)**	**1.02 (0.81 - 1.29)**
		High	**1.00**	**0.94 (0.73 - 1.21)**	**1.01 (0.79 - 1.29)**	**0.92 (0.73 - 1.17)**
Home ownership	NO	Low	1.00	0.94 (0.73 - 1.21)	0.69 (0.54 - 0.89)	0.80 (0.64 - 1.01)
		High	1.00	0.97 (0.81 - 1.15)	1.02 (0.85 - 1.23)	0.98 (0.80 - 1.20)
	NO_2	Low	1.00	0.71 (0.53 - 0.95)	0.65 (0.51 - 0.84)	0.71 (0.56 - 0.90)
		High	1.00	0.85 (0.72 - 1.00)	0.99 (0.82 - 1.20)	0.84 (0.66 - 1.07)
	Black Carbon	Low	**1.00**	**0.92 (0.71 - 1.20)**	**0.84 (0.67 - 1.07)**	**0.88 (0.70 - 1.11)**
		High	**1.00**	**1.24 (1.05 - 1.48)**	**1.13 (0.92 - 1.38)**	**1.31 (1.08 - 1.60)**
	$PM_{2.5}$	Low	**1.00**	**0.83 (0.65 - 1.07)**	**1.01 (0.80 - 1.27)**	**0.82 (0.65 - 1.03)**
		High	**1.00**	**1.03 (0.86 - 1.23)**	**1.13 (0.93 - 1.37)**	**1.09 (0.89 - 1.35)**
Income variation	NO	Low	1.00	1.02 (0.85 - 1.22)	0.93 (0.77 - 1.13)	0.92 (0.77 - 1.10)
		High	1.00	0.90 (0.73 - 1.11)	0.94 (0.76 - 1.16)	1.02 (0.83 - 1.26)
	NO_2	Low	1.00	0.93 (0.77 - 1.13)	1.01 (0.83 - 1.22)	0.85 (0.71 - 1.01)
		High	1.00	0.78 (0.63 - 0.95)	0.81 (0.66 - 0.99)	0.84 (0.67 - 1.05)
	Black Carbon	Low	**1.00**	**1.23 (1.00 - 1.51)**	**1.08 (0.88 - 1.32)**	**1.23 (1.01 - 1.49)**
		High	**1.00**	**0.85 (0.69 - 1.03)**	**0.92 (0.75 - 1.13)**	**0.87 (0.71 - 1.07)**
	$PM_{2.5}$	Low	1.00	1.23 (1.00 - 1.51)	1.25 (1.01 - 1.54)	1.07 (0.88 - 1.32)
		High	1.00	0.96 (0.78 - 1.18)	1.04 (0.84 - 1.27)	0.96 (0.77 - 1.19)
Management	NO	Low	**1.00**	**0.76 (0.63 - 0.92)**	**0.67 (0.55 - 0.81)**	**0.64 (0.52 - 0.78)**
		High	**1.00**	**1.09 (0.90 - 1.33)**	**0.92 (0.75 - 1.13)**	**1.19 (0.98 - 1.44)**
	NO_2	Low	1.00	0.73 (0.60 - 0.89)	0.66 (0.54 - 0.80)	0.66 (0.55 - 0.80)
		High	1.00	0.86 (0.71 - 1.04)	0.95 (0.78 - 1.16)	0.94 (0.76 - 1.16)
	Black Carbon	Low	**1.00**	**0.98 (0.80 - 1.21)**	**1.00 (0.81 - 1.22)**	**0.86 (0.70 - 1.06)**
		High	**1.00**	**1.10 (0.90 - 1.33)**	**1.16 (0.95 - 1.42)**	**1.18 (0.97 - 1.43)**
	$PM_{2.5}$	Low	**1.00**	**0.98 (0.79 - 1.21)**	**0.93 (0.75 - 1.15)**	**0.89 (0.71 - 1.11)**
		High	**1.00**	**1.33 (1.10 - 1.61)**	**1.33 (1.09 - 1.62)**	**1.01 (0.82 - 1.25)**

Thus, for the variable representing the percentage of Chinese origin people, the expected differences between the low/high levels of the variable materialized only for black carbon and $PM_{2.5}$ (low level corresponding to higher HR). These results were in spite of the fact that a larger proportion of subjects living in areas with a high percentage of Chinese population were expose to higher levels of pollution (Appendix I, Table 47 – e.g. for NO, 9,280 subjects in areas with a low percentage of Chinese population and high levels of pollution versus 26,781 subjects living in areas with a high percentage of Chinese population and high levels of pollution).

For the variable representing the percentage of university degrees in the area the expected differences between the low/high levels of the variable materialized only for black carbon (low level corresponding to higher HR). Although smaller in magnitude, a similar distribution was found for the subjects living in areas with high levels of university graduates and high pollution levels (Appendix I, Table 47 – e.g. for NO 20,684) versus subjects living in areas with low levels of university graduates and high pollution levels (Appendix I, Table 47 – e.g. for NO 10,405).

The variable representing income variation in the area showed also the expected results for NO_2 particulate matter and black carbon, low levels of income variation corresponding to higher HR. In the case of this variable, the distribution of subjects on low/high levels of variable and pollutants was more in accord with the results, a smaller proportion of subjects living in areas with low income variation and high pollution (Appendix I, Table 47 – e.g. for NO 19,718) versus subjects living in areas with high income variation and high pollution (Appendix I, Table 47 – e.g. for NO 16,660). The only other result that confirmed the expectations was for the transportation variable and that only for nitrogen dioxide exposure (low level corresponding to low HRs). In the case of this variable, the distribution of subjects on low/high levels of variable and pollutants was also more in accord with the results, a smaller proportion of subjects living in areas with high usage of public transportation, etc. and high pollution (Appendix I, Table 47 – e.g. for NO_2 35,389) versus subjects living in areas with low usage of public transportation, etc. and high pollution (Appendix I, Table 47 – e.g. for NO_2 7,798).

Contrary to the assumptions made prior to the stratified analyses, the results for the rest of the variables showed opposite trends than expected. Thus, for the variables representing family and personal income as well as for the variable representing the percent of employment in the area, the results showed that for nitrogen oxides and particulate matter low level of family and personal income as well as low level of employment correspond to lower HR. All the above results were despite the fact that more subjects were from areas with low income (personal, family) or low employment and high levels of pollution as opposed to subjects from areas with high income (personal, family) or high employment and high levels of pollution.

For the variables representing percentage of home ownership in the area and the percentage of people working in management the results showed, contrary to the expectations, that for all four traffic pollutants the HRs corresponding to lower levels of these two variables were smaller than the HRs for the high levels of these two SES indicators. All the above results were despite the fact that more subjects were from areas with low home ownership or low management workers and high levels of pollution as opposed to subjects from areas with high home ownership or high percentage of workers in management and high levels of pollution. Also, for all four traffic pollutants investigated, low levels of low income were associated with high HRs compared with subjects from areas with high levels, which in turn were associated with lower HRs.

The variable representing transportation by bus, bike, and walk was the only variable that had inconsistent results across pollutants, showing, as was described before, expected results for nitrogen dioxide, while for particulate matter HRs were found to be higher for subjects from areas with low percentages of people that used public transit, walked or biked to work.

Neighborhood level covariates

As for the DA-level covariates, assumptions were made regarding the behaviour of the HRs for each of the neighborhood level variable investigated. Thus, for the percentage of people with a second language at home, linguistic isolation, university education, family and personal income, and home ownership, the assumption was that the HRs will be higher for the low levels of these variables compared with the high levels. Opposite to this assumption, the assumption for the unemployment variable, low levels of income, governmental transfers variable and neighborhood stress variable was that at higher levels there will be larger HRs compared with the low levels of these variables.

Table 23 presents the HR estimates for the four traffic exposure pollutants stratified by the low and high strata of the ten available SES variables defined at neighborhood levels of aggregation. Appendix III also presents in a graphic format the results from Table 23 as well as the results for ACS and CHF health outcomes from Tables 32 and 34 in Appendix I. As opposed to the results at DA-level, there was more commonality between the results for CCS and ACS at neighbourhood level, with all variables showing comparative results at least for one of the traffic pollutants.

The analyses showed that for each of these variables, at least for one of the traffic pollutants investigated, but in many cases for three or all four of them, there were differences between the low and high levels of the covariates. However, the expected behaviour of the HRs for the low/high levels of the SES covariates did not always matched actual results.

Thus, the expected differences between the low/high levels of the variable materialized for all of the four traffic pollutants (low level corresponding to higher HR) only for the variables representing the use of a second language at home other than French or English and for the linguistic isolation variable. For the variable representing the percentage of university degrees in the area the results were inconclusive for all four traffic pollutants and thus the expected differences between the low/high levels of the variable could not be verified.

Contrary to the assumptions made prior to the stratified analyses, the results for the rest of the neighborhood level variables showed opposite trends than expected. Thus, for the variables representing family and personal income, the results showed that for all four traffic pollutants, low level of family and personal correspond to lower HR. Also for all four pollutants, the variable representing the percent of unemployment in the area showed opposite results than expected, lower levels of unemployment being associated higher HRs. These results are perfectly consistent with the results from the corresponding DA level

Table 23. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering CCS health outcomes

Health Outcome			CCS			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Other language	NO	Low	1.00	1.12 (0.95 - 1.33)	1.00 (0.84 - 1.19)	0.91 (0.75 - 1.11)
		High	1.00	0.82 (0.61 - 1.10)	0.53 (0.40 - 0.71)	0.76 (0.58 - 1.00)
	NO_2	Low	1.00	1.06 (0.91 - 1.23)	1.05 (0.86 - 1.29)	0.74 (0.59 - 0.93)
		High	1.00	0.61 (0.44 - 0.85)	0.54 (0.41 - 0.72)	0.66 (0.50 - 0.87)
	Black Carbon	Low	1.00	**1.21 (1.02 - 1.45)**	**1.28 (1.05 - 1.55)**	**1.14 (0.95 - 1.36)**
		High	1.00	**0.79 (0.63 - 1.00)**	**0.77 (0.62 - 0.96)**	**0.82 (0.67 - 1.01)**
	$PM_{2.5}$	Low	1.00	**1.11 (0.93 - 1.33)**	**1.28 (1.07 - 1.55)**	**1.03 (0.85 - 1.24)**
		High	1.00	**0.77 (0.59 - 1.01)**	**0.66 (0.51 - 0.85)**	**0.86 (0.68 - 1.10)**
Linguistic isolation	NO	Low	1.00	1.11 (0.93 - 1.33)	1.05 (0.88 - 1.25)	0.97 (0.79 - 1.17)
		High	1.00	0.75 (0.55 - 1.02)	0.50 (0.37 - 0.68)	0.67 (0.51 - 0.89)
	NO_2	Low	1.00	1.00 (0.85 - 1.18)	1.10 (0.91 - 1.33)	0.72 (0.58 - 0.90)
		High	1.00	0.59 (0.42 - 0.81)	0.50 (0.38 - 0.66)	0.58 (0.44 - 0.77)
	Black Carbon	Low	1.00	**1.05 (0.87 - 1.27)**	**1.16 (0.96 - 1.41)**	**1.13 (0.95 - 1.35)**
		High	1.00	**0.87 (0.68 - 1.11)**	**0.82 (0.64 - 1.04)**	**0.81 (0.64 - 1.03)**
	$PM_{2.5}$	Low	1.00	**1.15 (0.96 - 1.37)**	**1.27 (1.05 - 1.54)**	**1.08 (0.89 - 1.31)**
		High	1.00	**0.77 (0.59 - 1.01)**	**0.62 (0.48 - 0.80)**	**0.75 (0.59 - 0.96)**
University	NO	Low	1.00	0.98 (0.85 - 1.13)	0.99 (0.83 - 1.18)	0.86 (0.69 - 1.08)
		High	1.00	1.02 (0.81 - 1.29)	0.90 (0.72 - 1.13)	1.13 (0.92 - 1.39)
	NO_2	Low	1.00	0.94 (0.81 - 1.08)	1.05 (0.84 - 1.31)	0.84 (0.69 - 1.04)
		High	1.00	0.87 (0.67 - 1.11)	0.92 (0.73 - 1.16)	1.02 (0.82 - 1.28)
	Black Carbon	Low	1.00	1.14 (0.96 - 1.36)	1.02 (0.84 - 1.23)	1.04 (0.87 - 1.25)
		High	1.00	0.95 (0.75 - 1.20)	0.98 (0.79 - 1.21)	1.15 (0.94 - 1.41)
	$PM_{2.5}$	Low	1.00	0.98 (0.81 - 1.18)	1.09 (0.90 - 1.31)	1.02 (0.84 - 1.24)
		High	1.00	1.03 (0.82 - 1.30)	1.20 (0.98 - 1.46)	0.80 (0.65 - 0.99)
Unemployment	NO	Low	**1.00**	**1.03 (0.86 - 1.24)**	**1.16 (0.97 - 1.39)**	**1.21 (1.00 - 1.47)**
		High	**1.00**	**0.91 (0.74 - 1.13)**	**0.65 (0.52 - 0.81)**	**0.76 (0.62 - 0.95)**
	NO_2	Low	**1.00**	**1.04 (0.88 - 1.22)**	**1.31 (1.09 - 1.59)**	**0.95 (0.75 - 1.19)**
		High	**1.00**	**0.74 (0.59 - 0.94)**	**0.57 (0.46 - 0.72)**	**0.75 (0.62 - 0.91)**
	Black Carbon	Low	**1.00**	**1.00 (0.83 - 1.21)**	**1.24 (1.03 - 1.49)**	**1.10 (0.91 - 1.33)**
		High	**1.00**	**0.91 (0.72 - 1.15)**	**0.85 (0.68 - 1.07)**	**0.89 (0.71 - 1.12)**
	$PM_{2.5}$	Low	**1.00**	**1.15 (0.97 - 1.36)**	**1.18 (0.99 - 1.42)**	**1.13 (0.91 - 1.40)**
		High	**1.00**	**1.08 (0.85 - 1.37)**	**0.90 (0.70 - 1.14)**	**0.87 (0.68 - 1.12)**
Family income	NO	Low	**1.00**	**0.83 (0.66 - 1.05)**	**0.54 (0.43 - 0.68)**	**0.67 (0.54 - 0.84)**
		High	**1.00**	**1.07 (0.89 - 1.30)**	**1.10 (0.91 - 1.34)**	**1.14 (0.92 - 1.42)**
	NO_2	Low	**1.00**	**0.85 (0.66 - 1.10)**	**0.55 (0.43 - 0.69)**	**0.71 (0.58 - 0.88)**
		High	**1.00**	**0.96 (0.80 - 1.15)**	**1.11 (0.92 - 1.35)**	**0.99 (0.77 - 1.27)**
	Black Carbon	Low	**1.00**	**0.94 (0.72 - 1.21)**	**0.92 (0.72 - 1.18)**	**0.89 (0.69 - 1.14)**
		High	**1.00**	**1.01 (0.84 - 1.23)**	**1.09 (0.89 - 1.34)**	**1.03 (0.84 - 1.26)**
	$PM_{2.5}$	Low	**1.00**	**0.87 (0.66 - 1.15)**	**0.75 (0.57 - 0.98)**	**0.78 (0.60 - 1.03)**
		High	**1.00**	**1.06 (0.87 - 1.29)**	**1.16 (0.96 - 1.41)**	**0.95 (0.75 - 1.21)**

Table 23. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering CCS health outcomes (cont.)

Health Outcome			CCS			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Personal income	NO	Low	**1.00**	**0.77 (0.62 - 0.94)**	**0.53 (0.43 - 0.66)**	**0.58 (0.47 - 0.72)**
		High	**1.00**	**1.12 (0.90 - 1.38)**	**1.12 (0.91 - 1.38)**	**1.07 (0.86 - 1.33)**
	NO_2	Low	1.00	0.78 (0.63 - 0.97)	0.49 (0.40 - 0.61)	0.63 (0.52 - 0.77)
		High	1.00	0.85 (0.69 - 1.05)	0.95 (0.78 - 1.17)	0.86 (0.69 - 1.07)
	Black Carbon	Low	1.00	0.90 (0.71 - 1.13)	0.79 (0.62 - 1.00)	0.82 (0.65 - 1.03)
		High	1.00	0.95 (0.76 - 1.18)	0.98 (0.80 - 1.20)	1.08 (0.89 - 1.30)
	$PM_{2.5}$	Low	1.00	0.91 (0.71 - 1.18)	0.76 (0.59 - 0.97)	0.74 (0.57 - 0.96)
		High	1.00	1.11 (0.90 - 1.38)	1.26 (1.03 - 1.53)	0.88 (0.70 - 1.09)
Governmental transfers	NO	Low	1.00	0.97 (0.80 - 1.17)	0.97 (0.80 - 1.18)	0.83 (0.66 - 1.04)
		High	1.00	0.88 (0.72 - 1.07)	0.73 (0.60 - 0.89)	0.69 (0.56 - 0.85)
	NO_2	Low	1.00	0.82 (0.68 - 0.99)	0.98 (0.80 - 1.19)	0.71 (0.55 - 0.90)
		High	1.00	0.84 (0.69 - 1.03)	0.59 (0.48 - 0.72)	0.68 (0.56 - 0.82)
	Black Carbon	Low	1.00	1.14 (0.94 - 1.38)	1.01 (0.82 - 1.25)	1.07 (0.87 - 1.31)
		High	1.00	1.03 (0.79 - 1.33)	1.00 (0.78 - 1.28)	0.94 (0.73 - 1.21)
	$PM_{2.5}$	Low	1.00	1.09 (0.89 - 1.34)	1.13 (0.93 - 1.39)	0.81 (0.64 - 1.01)
		High	1.00	0.91 (0.72 - 1.14)	0.78 (0.62 - 0.98)	0.83 (0.66 - 1.05)
Low income	NO	Low	**1.00**	**1.04 (0.88 - 1.24)**	**1.24 (1.04 - 1.48)**	**1.12 (0.91 - 1.38)**
		High	**1.00**	**0.99 (0.72 - 1.36)**	**0.73 (0.54 - 0.99)**	**0.95 (0.71 - 1.26)**
	NO_2	Low	1.00	0.95 (0.81 - 1.11)	1.37 (1.11 - 1.69)	0.90 (0.68 - 1.19)
		High	1.00	1.11 (0.73 - 1.70)	0.84 (0.57 - 1.24)	1.10 (0.76 - 1.61)
	Black Carbon	Low	**1.00**	**1.19 (1.00 - 1.40)**	**1.17 (0.96 - 1.43)**	**1.14 (0.95 - 1.37)**
		High	**1.00**	**0.98 (0.75 - 1.28)**	**0.96 (0.75 - 1.23)**	**1.08 (0.84 - 1.38)**
	$PM_{2.5}$	Low	**1.00**	**1.13 (0.96 - 1.33)**	**1.21 (1.00 - 1.45)**	**1.21 (0.97 - 1.51)**
		High	**1.00**	**0.79 (0.61 - 1.03)**	**0.78 (0.61 - 1.00)**	**0.77 (0.61 - 0.99)**
Home ownership	NO	Low	1.00	0.98 (0.77 - 1.26)	0.80 (0.64 - 1.00)	0.91 (0.74 - 1.13)
		High	1.00	0.93 (0.79 - 1.10)	1.01 (0.83 - 1.23)	1.03 (0.82 - 1.30)
	NO_2	Low	1.00	0.89 (0.66 - 1.19)	0.80 (0.61 - 1.03)	0.90 (0.71 - 1.14)
		High	1.00	0.86 (0.74 - 1.01)	1.29 (1.03 - 1.62)	0.74 (0.54 - 1.01)
	Black Carbon	Low	1.00	1.07 (0.80 - 1.42)	1.03 (0.80 - 1.34)	1.06 (0.82 - 1.38)
		High	1.00	1.13 (0.96 - 1.34)	1.08 (0.88 - 1.33)	0.95 (0.78 - 1.16)
	$PM_{2.5}$	Low	**1.00**	**0.91 (0.72 - 1.15)**	**1.04 (0.82 - 1.31)**	**0.80 (0.64 - 1.00)**
		High	**1.00**	**1.05 (0.88 - 1.25)**	**1.26 (1.04 - 1.52)**	**1.26 (1.00 - 1.58)**
Neighborhood stress	NO	Low	1.00	1.06 (0.88 - 1.28)	1.18 (0.98 - 1.42)	0.90 (0.73 - 1.11)
		High	1.00	0.90 (0.72 - 1.14)	0.69 (0.55 - 0.87)	0.82 (0.66 - 1.01)
	NO_2	Low	1.00	0.92 (0.78 - 1.08)	1.08 (0.89 - 1.31)	0.72 (0.54 - 0.96)
		High	1.00	0.83 (0.64 - 1.08)	0.67 (0.52 - 0.87)	0.85 (0.68 - 1.06)
	Black Carbon	Low	**1.00**	**1.28 (1.07 - 1.52)**	**1.24 (1.01 - 1.52)**	**1.12 (0.91 - 1.37)**
		High	**1.00**	**0.90 (0.70 - 1.16)**	**0.91 (0.72 - 1.14)**	**0.95 (0.75 - 1.19)**
	$PM_{2.5}$	Low	**1.00**	**1.17 (0.98 - 1.40)**	**1.15 (0.94 - 1.40)**	**1.01 (0.82 - 1.26)**
		High	**1.00**	**0.89 (0.69 - 1.14)**	**0.98 (0.77 - 1.25)**	**0.86 (0.68 - 1.08)**

variables. For the variables representing percentage of home ownership in the area, contrary to the expectations, for particulate matter, the HRs corresponding to lower levels of this variable were smaller than the HRs for the high levels of this indicator. For the other three pollutants the results were inconclusive.

Also contrary to expectations, for nitrogen oxide, black carbon and particulate matter, low levels of low income, governmental transfer and neighborhood stress were associated with high HRs compared with subjects from areas with high levels for these three variables, which in turn were associated with lower HRs. These results were also consistent with the results for the corresponding variables at DA level.

The distribution of subjects on high/low classes of neighborhood level variables and high levels of pollution matched the distribution of the subjects for the similar variables at the DA-level.

Overall, the results were more distinct when using variables at neighborhood levels compared with the results at DA level, and by distinct I mean clearer (greater) differences between the two strata at all levels of pollution (excluding the benchmark, of course) and more pollutants exhibiting these differences.

Road proximity related health outcomes

<u>CCS health outcomes considering DA level SES variables</u>

Table 24 presents the comparison between HR estimates for CCS morbidity and mortality outcomes in conjunction with road proximity for the low and high levels of the ten available SES variables at DA level of aggregation. Appendix IV also presents in a graphic format the results from Table 24 as well as the results for the ACS and CHF health outcomes from Table 35 in the Appendix. The graphs presented in Appendices IV and V refer only at road proximity type I (subjects living within 50 m from expressways and primary highways), road proximity type IV (between 50 and 150 m from secondary highways and major roads), and road proximity type V (within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads). This choice of only three road proximity types was made in order to create a better contrast between the road type I, considered as the road proximity with the highest levels of traffic exposures and road type IV, which can be considered the proximity with the lowest levels of traffic exposures. Road proximity type V was used as an intermediary between proximity I and proximity IV.

More variables show differences in the CCS health outcomes in conjunction with road proximity type compared with the ACS health outcomes. While for the percentage of people with university education, family income, employment rates, and income variation variables the results are mixed and inconclusive, certain trends are evident for the rest of the DA level variables. Thus, for subjects from areas with a low proportion of Chinese minorities as well as subjects from areas with low levels of low income are at higher risk of developing ACS in relation to traffic proximity. For Chinese minority variable, there is even a protective effect, especially if leaving within 50 m of expressways and highways. Otherwise, the manifested trends are decreasing from road proximity type I to road proximity type V and IV.

Table 24. Comparison between HR of different road proximity categories for low and high levels of DA-SES variables, when considering health outcomes

DA-level SES	Pollutant	SES Level	Health Outcomes CCS
Chinese population	Within 50 m from expressways and primary highways (I)	Low	1.44 (1.04 - 2.00)
		High	0.71 (0.29 - 1.70)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.30 (0.97 - 1.74)
		High	0.87 (0.62 - 1.24)
	Within 50 m from secondary highways and major roads (III)	Low	0.99 (0.80 - 1.21)
		High	1.08 (0.84 - 1.39)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.05 (0.89 - 1.24)
		High	0.98 (0.81 - 1.18)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.17 (1.00 - 1.37)
		High	0.97 (0.78 - 1.20)
University	Within 50 m from expressways and primary highways (I)	Low	1.15 (0.83 - 1.60)
		High	1.16 (0.60 - 2.24)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.89 (0.68 - 1.17)
		High	1.05 (0.75 - 1.46)
	Within 50 m from secondary highways and major roads (III)	Low	1.19 (0.99 - 1.44)
		High	1.04 (0.82 - 1.33)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.02 (0.86 - 1.21)
		High	1.21 (1.02 - 1.42)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.14 (0.98 - 1.33)
		High	1.03 (0.84 - 1.27)
Employment	Within 50 m from expressways and primary highways (I)	Low	1.22 (0.85 - 1.76)
		High	1.15 (0.63 - 2.08)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.88 (0.67 - 1.17)
		High	1.22 (0.88 - 1.68)
	Within 50 m from secondary highways and major roads (III)	Low	1.04 (0.86 - 1.26)
		High	1.02 (0.80 - 1.30)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.85 (0.72 - 1.00)
		High	1.06 (0.89 - 1.26)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.87 - 1.19)
		High	1.09 (0.89 - 1.32)
Family income	Within 50 m from expressways and primary highways (I)	Low	1.01 (0.71 - 1.42)
		High	1.29 (0.67 - 2.48)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.89 (0.70 - 1.14)
		High	0.95 (0.65 - 1.40)
	Within 50 m from secondary highways and major roads (III)	Low	1.17 (0.96 - 1.41)
		High	0.97 (0.75 - 1.25)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.98 (0.84 - 1.15)
		High	1.08 (0.91 - 1.29)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.06 (0.91 - 1.23)
		High	0.96 (0.77 - 1.19)
Personal income	Within 50 m from expressways and primary highways (I)	Low	1.19 (0.84 - 1.70)
		High	1.28 (0.70 - 2.32)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.82 (0.62 - 1.08)
		High	1.00 (0.70 - 1.44)
	Within 50 m from secondary highways and major roads (III)	Low	1.06 (0.86 - 1.31)
		High	1.09 (0.85 - 1.39)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.86 (0.72 - 1.02)
		High	1.14 (0.97 - 1.35)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.86 - 1.20)
		High	1.05 (0.86 - 1.29)

Table 24. Comparison between HR of different road proximity categories for low and high levels of DA-SES variables, when considering health outcomes (cont.)

DA-level SES	Pollutant	Level	Health Outcomes
			CCS
Transportation	Within 50 m from expressways and primary highways (I)	Low	0.97 (0.57 - 1.65)
		High	1.33 (0.93 - 1.89)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.02 (0.72 - 1.45)
		High	0.96 (0.74 - 1.25)
	Within 50 m from secondary highways and major roads (III)	Low	1.03 (0.83 - 1.28)
		High	1.09 (0.89 - 1.35)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.04 (0.86 - 1.24)
		High	1.10 (0.94 - 1.29)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.04 (0.86 - 1.25)
		High	1.07 (0.90 - 1.26)
Low income	Within 50 m from expressways and primary highways (I)	Low	1.60 (1.01 - 2.52)
		High	0.97 (0.66 - 1.44)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.85 (0.57 - 1.28)
		High	0.89 (0.68 - 1.17)
	Within 50 m from secondary highways and major roads (III)	Low	0.96 (0.76 - 1.21)
		High	1.04 (0.84 - 1.28)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.10 (0.92 - 1.31)
		High	1.00 (0.85 - 1.17)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.00 (0.82 - 1.21)
		High	0.99 (0.83 - 1.17)
Home ownership	Within 50 m from expressways and primary highways (I)	Low	0.93 (0.63 - 1.36)
		High	1.46 (0.93 - 2.30)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.94 (0.73 - 1.21)
		High	1.12 (0.80 - 1.57)
	Within 50 m from secondary highways and major roads (III)	Low	1.10 (0.91 - 1.33)
		High	1.10 (0.88 - 1.38)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.02 (0.87 - 1.18)
		High	1.00 (0.83 - 1.20)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.87 - 1.19)
		High	1.16 (0.97 - 1.40)
Income variation	Within 50 m from expressways and primary highways (I)	Low	1.24 (0.87 - 1.78)
		High	1.06 (0.50 - 2.24)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.07 (0.83 - 1.39)
		High	1.09 (0.77 - 1.54)
	Within 50 m from secondary highways and major roads (III)	Low	1.05 (0.86 - 1.28)
		High	0.89 (0.70 - 1.14)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.02 (0.86 - 1.21)
		High	1.12 (0.95 - 1.33)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.08 (0.92 - 1.26)
		High	0.94 (0.76 - 1.16)
Management	Within 50 m from expressways and primary highways (I)	Low	1.19 (0.82 - 1.73)
		High	1.46 (0.90 - 2.36)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.92 (0.70 - 1.22)
		High	0.98 (0.72 - 1.34)
	Within 50 m from secondary highways and major roads (III)	Low	1.07 (0.86 - 1.32)
		High	1.13 (0.90 - 1.41)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.90 (0.76 - 1.07)
		High	1.15 (0.98 - 1.36)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.03 (0.87 - 1.22)
		High	1.10 (0.91 - 1.32)

The transportation and home ownership variables have a similar behaviour, the subjects living in the areas with a low proportion of transit or biking usage or walking, or areas with low levels of home ownership being at a low risk of experiencing CCS while subjects from the high level categories are at increasing risk, especially if living within 50 m of expressways or highways. Similar differences can be seen for personal income variable, where the biggest discrepancy between the low/high classes is for subjects living between 50 and 150 m from secondary highways and major roads, while for the management variable the trends are parallel, with subjects from areas with a higher proportion of people working in management being at increased risk of experiencing CCS.

The same assumptions on the behaviour of SES variables that were considered for the traffic pollution were also considered in the case of road proximity. However, these assumptions were checked overall, along the gradient of exposure to traffic represented by the different categories of road proximity and also only for R-I, for subjects living within 50 m of expressways and highways.

When assessing the behaviour of SES variables overall, several of the indicators showed conclusive differences between the low and high levels of the variables and also along the exposure gradient. These variables were the percentage of Chinese population, personal income, transportation, low income, home ownership and the management variable. However, the assumptions posited for each of these variables were met only by the variable representing the percentage of Chinese population and the variable representing the percentage of people that use public transit, walk or bike to work. For the other four variables that showed conclusive differences between the low and high levels the actual results were contrary to the expected results. When looking only at subjects living within 50 m from expressways and highways (R-I), two more variables showed clear differences between the low/high levels. One variable was the family income, but in this case the expected result of high HRs for the low level category did not materialized while for the second variable, income variation, the actual differences matched the expected result, that is low income variation was associated with higher HRs compared with the high levels of income variation.

Table 49 in the Appendix presents the distribution of subjects by the two levels of socioeconomic indicators at DA-level of aggregation and the five road proximity categories. It can be seen from Table 49 that for the variables that showed clear differences between the low/high levels and were in agreement with the *a priori* assumptions made regarding their behaviour, the distribution of subjects by high/low SES levels and road proximity justify the results, while that is not the case for the variables that had opposite results than expected.

CCS health outcomes considering neighborhood level SES variables

Table 25 presents the comparison between HR estimates for all cardiovascular morbidity and mortality outcomes in conjunction with road proximity for the low and high levels of the ten available SES variables at neighborhood level of aggregation. Appendix V also presents in a graphic format the results from Table 31 for CCS health outcomes as well as the results for ACS and CHF health outcomes presented in Table 36 in the Appendix.
The results for unemployment rates, governmental transfers, home ownership and neighborhood stress are inconclusive. For a second language used at home, linguistic isolation and low income, subjects living in areas belonging to the lower classes of these covariates experience higher risks of CCS, especially if they live within 50 m of expressways and highways (for the low income covariate the trend lines are though parallel). The situation is reversed for university education, family and personal income where subject living in areas with high levels of university graduates or family and personal income experience increased

risks of CCS outcomes, especially for subjects living between 50 and 150 m from secondary highways and major roads.

Table 25. Comparison between HR of different road proximity categories for low and high levels of Neighborhood-SES variables, when considering health outcomes

Neighborhood-level SES	Pollutant	Level	Health Outcomes CCS
Other language	Within 50 m from expressways and primary highways (I)	Low	1.16 (0.78 - 1.71)
		High	1.08 (0.63 - 1.83)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.16 (0.85 - 1.58)
		High	0.79 (0.56 - 1.12)
	Within 50 m from secondary highways and major roads (III)	Low	1.02 (0.83 - 1.24)
		High	0.95 (0.74 - 1.21)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.00 (0.85 - 1.19)
		High	0.91 (0.76 - 1.09)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.09 (0.92 - 1.28)
		High	0.86 (0.70 - 1.06)
Linguistic isolation	Within 50 m from expressways and primary highways (I)	Low	1.18 (0.79 - 1.78)
		High	0.80 (0.41 - 1.54)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.18 (0.86 - 1.62)
		High	0.90 (0.65 - 1.25)
	Within 50 m from secondary highways and major roads (III)	Low	1.07 (0.87 - 1.31)
		High	0.88 (0.68 - 1.13)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.02 (0.87 - 1.21)
		High	0.92 (0.77 - 1.09)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.16 (0.98 - 1.37)
		High	0.84 (0.68 - 1.03)
University	Within 50 m from expressways and primary highways (I)	Low	0.97 (0.68 - 1.39)
		High	1.35 (0.82 - 2.21)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.97 (0.71 - 1.33)
		High	0.98 (0.72 - 1.32)
	Within 50 m from secondary highways and major roads (III)	Low	1.15 (0.95 - 1.38)
		High	1.07 (0.86 - 1.34)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.03 (0.87 - 1.23)
		High	1.17 (1.00 - 1.37)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.09 (0.94 - 1.28)
		High	1.06 (0.88 - 1.27)
Unemployment	Within 50 m from expressways and primary highways (I)	Low	1.15 (0.72 - 1.83)
		High	1.35 (0.95 - 1.93)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.14 (0.83 - 1.57)
		High	0.90 (0.67 - 1.21)
	Within 50 m from secondary highways and major roads (III)	Low	1.02 (0.82 - 1.25)
		High	1.21 (0.98 - 1.50)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.11 (0.94 - 1.31)
		High	0.84 (0.7 - 1.00)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.07 (0.90 - 1.28)
		High	1.13 (0.95 - 1.34)
Family income	Within 50 m from expressways and primary highways (I)	Low	1.17 (0.76 - 1.79)
		High	1.25 (0.72 - 2.16)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.81 (0.60 - 1.10)
		High	1.14 (0.81 - 1.60)
	Within 50 m from secondary highways and major roads (III)	Low	1.17 (0.94 - 1.46)
		High	0.93 (0.73 - 1.19)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.83 (0.69 - 0.99)
		High	1.21 (1.03 - 1.43)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.01 (0.84 - 1.21)
		High	1.01 (0.83 - 1.23)

Table 25. Comparison between HR of different road proximity categories for low and high levels of Neighborhood -SES variables, when considering health outcomes (cont.)

Neighborhood-level SES	Pollutant	Level	Health Outcomes
			CCS
Personal income	Within 50 m from expressways and primary highways (I)	Low	1.18 (0.80 - 1.74)
		High	1.27 (0.73 - 2.20)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.79 (0.58 - 1.08)
		High	1.00 (0.73 - 1.38)
	Within 50 m from secondary highways and major roads (III)	Low	1.16 (0.92 - 1.45)
		High	1.04 (0.83 - 1.31)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.82 (0.68 - 0.98)
		High	1.14 (0.97 - 1.34)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.85 - 1.22)
		High	1.05 (0.87 - 1.27)
Governmental transfers	Within 50 m from expressways and primary highways (I)	Low	0.60 (0.19 - 1.88)
		High	1.11 (0.76 - 1.62)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.09 (0.72 - 1.63)
		High	0.83 (0.63 - 1.09)
	Within 50 m from secondary highways and major roads (III)	Low	0.96 (0.74 - 1.25)
		High	1.14 (0.94 - 1.39)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.17 (0.98 - 1.39)
		High	0.79 (0.66 - 0.94)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.00 (0.80 - 1.25)
		High	1.05 (0.89 - 1.24)
Low income	Within 50 m from expressways and primary highways (I)	Low	1.32 (0.90 - 1.96)
		High	1.31 (0.86 - 2.01)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.14 (0.81 - 1.59)
		High	0.91 (0.68 - 1.23)
	Within 50 m from secondary highways and major roads (III)	Low	1.05 (0.86 - 1.29)
		High	1.17 (0.94 - 1.45)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.03 (0.86 - 1.23)
		High	0.99 (0.84 - 1.18)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.13 (0.95 - 1.33)
		High	1.05 (0.88 - 1.26)
Home ownership	Within 50 m from expressways and primary highways (I)	Low	1.35 (0.94 - 1.93)
		High	1.40 (0.92 - 2.14)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.90 (0.69 - 1.18)
		High	1.09 (0.73 - 1.63)
	Within 50 m from secondary highways and major roads (III)	Low	1.13 (0.92 - 1.39)
		High	1.01 (0.80 - 1.27)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.09 (0.93 - 1.28)
		High	1.00 (0.83 - 1.21)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.06 (0.90 - 1.26)
		High	1.07 (0.89 - 1.30)
Neighborhood stress	Within 50 m from expressways and primary highways (I)	Low	0.98 (0.47 - 2.06)
		High	1.32 (0.93 - 1.89)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.19 (0.85 - 1.69)
		High	0.90 (0.68 - 1.19)
	Within 50 m from secondary highways and major roads (III)	Low	0.88 (0.69 - 1.13)
		High	1.14 (0.93 - 1.39)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.17 (0.99 - 1.39)
		High	1.00 (0.85 - 1.17)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	0.99 (0.81 - 1.21)
		High	1.04 (0.88 - 1.23)

The same assumptions on the behaviour of neighborhood level SES variables that were considered for the traffic pollution were also considered in the case of road proximity. These assumptions were checked overall, along the gradient of exposure to traffic represented by the different categories of road proximity as well as only for R-I, for subjects living within 50 m of expressways and highways.

When assessing the behaviour of neighborhood level SES variables overall, several of the indicators showed conclusive differences between the low and high levels of the variables and also along the exposure gradient. These variables were the percentage of subjects speaking a second language at home, other than French or English, linguistic isolation, and family and personal income variables. However, the assumptions posited for each of these variables were met only by the variable representing the percentage of subjects speaking a second language at home, other than French or English, and the variable representing linguistic isolation. For the other two variables that showed conclusive differences between the low and high levels the actual results were contrary to the expected results. When looking only at subjects living within 50 m from expressways and highways (R-I), three more variables showed clear differences between the low/high levels. One variable was university education, but in this case the expected result of high HRs for the low level category did not materialized while for the other two variables, governmental transfers and neighborhood stress, the actual differences matched the expected result, that is high levels of governmental transfers or neighborhood stress were associated with higher HRs compared with the low levels for these two variables.

Table 50 in the Appendix presents the distribution of subjects by the two levels of socioeconomic indicators at neighborhood level of aggregation and the five road proximity categories. It can be seen from Table 50 that for the variables that showed clear differences between the low/high levels and were in agreement with the *a priori* assumptions made regarding their behaviour, the distribution of subjects by high/low SES levels and road proximity justify the results, while that is not the case for the variables that had opposite results than expected.

Discussion

The results of this study indicates that residential traffic related air pollution exposure increases the risk of chronic coronary syndrome, even in a region with relatively lower levels of traffic and ambient pollution in a cohort of subjects with no co-morbidities associated with cardiovascular diseases. Even more compelling evidence of the increased risk posed by traffic is produced by the analyses considering road proximity as a surrogate for traffic pollution. My study also looks at the impact of using socioeconomic covariates aggregated at different geographical levels and my results show stronger traffic pollution or road proximity effects when using covariates at medium levels of aggregation provided by the neighbourhood of residence as opposed to a smaller level of aggregation derived from census dissemination areas.

My analyses also found that there is a certain effect modification due to socioeconomic status for several of the available variables on the relationship between some or all of the traffic pollutants investigated and road proximity and chronic coronary syndrome morbidity and mortality. However, for the majority of the variables that showed differences between their low and high levels, these differences were contrary to what was originally expected.

Traffic pollution related results

I had available[217] land-use regression derived exposure for NO, NO_2, $PM_{2.5}$, and black carbon for metro Vancouver area. The adjusted R^2 values for the models ranged from 0.39 to 0.62 and were similar across traffic metrics. Also, the distribution of NO was found to be more heterogeneous than that of NO_2, a fact that supports the usefulness of this approach in assessing spatial patterns of traffic-related pollution. Another impetus for using traffic related pollution derived with land-use regression was the fact that the available ambient data was not at a finer enough scale while land use regression derived exposure was derived on a 10 m^2 grid and thus had the potential to minimize exposure misclassification. Also, the ambient particulate matter data was collected only on fewer stations and for a shorter period of time and there wasn't any data collected on ultra fine particles. Furthermore, a recent study conducted by Zanobetti et al.[239] found that $PM_{2.5}$ mass higher in Ni, As, and Cr, as well as Br and OC, which indicate a combustion source from either industrial activities or traffic, significantly increased hospital admissions. This result suggests that particles from industrial combustion sources and traffic may, on average, have greater toxicity and that focusing on the effects of traffic related pollution on cardiovascular diseases might constitute a more focused approach than considering ambient pollution.

Brauer suggested[217] that traffic exposure estimates using land use regression may be more appropriate for primary pollutants, such as NO and black carbon, that vary the most spatially, whereas monitor-based estimates are more appropriate for secondary pollutants such as NO_2 and $PM_{2.5}$ that display less spatial heterogeneity. Nevertheless, my study used LUR estimates for all these four pollutants. Knowing that despite their improved spatial resolution of land use regression-based exposure estimates, they lack the more precise temporal information characteristic to exposures determined from ambient monitors[244], I tried to improve the yearly average LUR exposure estimates by superimposing the monthly trend derived for the four pollutants (same trend was used for $PM_{2.5}$ as for black carbon) from ambient data for the period between 1998 - 2003. Originally, it was found that exposure estimates from land use regression and monitoring network data for the same pollutant were only moderately correlated and appeared to be somewhat independent, with each capturing different aspects of spatiotemporal variability in exposure[244].

A potential source of exposure misclassification comes from the assignment of residential home exposure as the overall exposure, since people also spent time at work or commuting. Nevertheless, a Canadian study[245] on time activity pattern, which corroborates its results with a larger U.S. study, shows that people spend most of their time in or around home, and our restriction of exposure assessment to residential address captures the most relevant part of exposure. As was already mentioned, NO_2 and $PM_{2.5}$ generally display spatially homogeneous distributions across small areas such as dissemination areas and blocks and, as a result, the ambient conditions at postal code and DA levels likely reflect the levels expected at home outdoors[246]. It is known that $PM_{2.5}$ of outdoor origin will also penetrate indoors, and it was found that the correlation between long-term outdoor particulate matter concentrations and indoor levels of particulate matter from outdoor origin is high[247]. Although people spend most of the time indoors, at home, exposures to ambient air pollution while working and during commute are a relevant source of exposure[248], even capable of inducing cardiac events[91]. Our traffic exposure models were also evaluated in conjunction with exposure data derived from ambient measurements against short-term measured personal exposures of pregnant women in Vancouver area[249]. This evaluation indicated that for NO and NO_2, especially for those women who were the least mobile, LUR models were a stronger predictor of personal exposure and better explained between-subject (spatial) variability in exposure. On the other hand, monitor-based estimates were found to better explain within-subject (temporal) variability in exposure. Also, for $PM_{2.5}$ and black carbon, monitor-based estimates of $PM_{2.5}$ were more highly correlated with personal exposures than were the LUR models. A European study by Lanki[250] with subjects recruited from Helsinki and Amsterdam looked at daily outdoor, indoor, and personal $PM_{2.5}$ and absorbance (proxy for elemental carbon) concentrations among elderly subjects with cardiovascular disease during the winter and spring of 1998–1999. In Amsterdam, the exposure to environmental tobacco smoke (ETS) indoors was a major source of between-subject variation in $PM_{2.5}$ exposures, and a strong determinant of $PM_{2.5}$ and absorbance exposures. When the days with ETS were excluded, within-subject variation accounted for 89% of the total variation in personal $PM_{2.5}$ and 97% in absorbance in Amsterdam. The respective figures were 66% and 61% in Helsinki. In both cities, outdoor levels of $PM_{2.5}$ and absorbance were major determinants of personal and indoor levels. Nevertheless, traffic was also an important determinant of absorbance: living near a major street increased exposure by 22%, and every hour spent in a motor vehicle by 13% in Amsterdam. The respective increases were 37% and 9% in Helsinki. Cooking was associated with increased levels of both absorbance and $PM_{2.5}$.

My results are largely in accordance with previous cohort studies reporting an association between long-term air pollution exposure and cardiopulmonary morbidity and/or mortality[82,83,84,85,86,87,87a,87b,88,88a,88b,88c,90]. A study in Rome[87b] that also employed NO_2 exposure estimates derived by using LUR produced rather similar results with mine for acute myocardial infarction events. In their analyses, Rosenlund[87b] and her colleagues have distinguished though between fatal and non-fatal cases of cardiovascular events and they also have results for all their cardiovascular health outcomes grouped together. In their analyses, Rosenlund and her colleagues have used similar SES covariates aggregated at approximately similar size geographical areas as the DAs employed in my study, but they also included subjects with some co-morbidities in the analyses. My study has some refinements compared with the study done in Rome, by being able to follow the residential histories of the subjects in the cohort and for being able to temporally adjust the exposure values prior and throughout the follow-up period, such that each person in the cohort had assigned the previous year average exposure for each month of the follow-up period. Despite experiencing smaller pollution levels than in Rome (Vancouver: mean = 31.1 $\mu g/m^3$, min = 0.6 $\mu g/m^3$, and max = 66.8 $\mu g/m^3$; Rome: mean = 46.8 $\mu g/m^3$, min = 24 $\mu g/m^3$, and max = 73 $\mu g/m^3$), I obtained similar ACS risk estimates for different pollution levels for the models that used SES covariates at neighbourhood level of aggregation. The ACS risk estimates were smaller when using DA-level SES, but comparable with the estimates for non-fatal acute myocardial infarction events. Also, my estimates are slightly higher than the risk estimates from a study[12] conducted in the same area that looked among other at cardiovascular mortality rates in a cohort of approximately 550,000 subjects older than 65 year due to short term exposure to ambient pollution.

Rosenlund implies from the results in the Rome study[87b] that the mechanisms related to short-term effects[6] (e.g., arrhythmia) could be of special importance despite the objective of their study being to assess long term effects of air pollution on coronary incidence. The fact that time series[70-74] studies have repeatedly reported associations between daily variations in mortality and air pollution concentrations, while cohort studies[82-88] have demonstrated increased mortality risks from annual average air pollution levels for people living in different geographic areas obscures the effects of short and long-term air pollution exposure and keeps open the question as to whether variations in air pollution with time or geography, or possibly both, are responsible for the increased mortality risks.

However, my study used something akin to time-series data on a monthly basis at residential level in a large cohort of healthy subjects and looked especially at chronic coronary syndrome group of diseases, which have a longer time frame of development. The risk estimates for chronic coronary syndrome and for three out of four pollutants show a rather consistent increasing trend with increasing levels of pollution. However, to properly disentangle the short-term from the long-term effects, the analyses had to contain lagged daily data for a period of four years, on the top of the average yearly data for the year prior to the current month of analysis. But even if I could have obtain daily coefficients for the LUR estimates for the four years of follow-up, the size of the cohort combined with the size of the exposure data for each individual was above the capacity of the PC used to manipulate the data and perform the analyses.

The general trend in ambient pollution in metro Vancouver area was decreasing for all four traffic pollutants analyzed and especially for NO and NO_2 in the period prior and during the follow-up. The fact that I used yearly averages of exposure should help disentangle the long term effect of air pollution from the short term effects. The counterargument[87b] to this claim is that residents who have high air pollution exposure are probably also those who have a large variability in short-term exposure, whereas those who live in areas with low exposure on the geographical scale are expected also to experience a lower gradient in short-term exposure. The study done by Nethery[249] in the same study area and with the same traffic exposure data does not support this claim in the sense that her study found that all pregnant women in the study experienced temporal exposure variability, fact that would bring the estimates towards the null. However, I cannot claim that my study could entirely separate the short term effects of air pollution on the risk estimates found for the long term effects. In my preliminary analyses, I have used the five year average instead of one year prior average exposure and the risk estimates, although showing similar trends, where somewhat smaller than the ones presented here.

The only individual covariates that I had available for analyses were sex and age. For ACS and CCS, there was a striking difference in estimates between males and females, with males at higher risk of experiencing a cardiovascular event compared with women. These results differ from some other studies that have found an increase risk of cardiovascular morbidity and mortality in women[88,88a,88c]. These studies have focused only on postmenopausal women and it is plausible that in older age, the risk of a cardiovascular event might increase in women as well, a possibility suggested especially by the risk estimates for CHF outcomes, for which there wasn't a major difference between men and women and there was an overall increased risk with older age groups, where the majority of subjects were women.

My study was based on medical records so no other individual risk factors were available for the subjects in the cohort, especially smoking. However, the rates of smoking for the province of British Columbia, where metro Vancouver is located, are quite low at 18.2%[251], B.C. population being ranked first in Canada in terms of combined healthy behaviours. For metro Vancouver, smoking rates are even lower than the overall B.C. rates, some local health authorities reporting rates of 11%. There is a gradient in smoking rates in metro Vancouver local heath authorities, smaller in Vancouver and increasing in the local health authorities from Fraser Valley, east of Vancouver. A calculation of cardiovascular health outcomes by forward sortation area indicated (not shown here) a relative increase in risk for FSAs in the Fraser Valley. The higher smoking rates in Fraser Valley cannot be correlated with pollution, since higher levels of pollution (ambient and LUR) are found in Vancouver. A confirmation of the fact that smoking is not correlated with pollution exposure for the subjects in this study cohort came from a pilot study performed with a subset of subjects (~1,442 subjects) from the cohort that were surveyed through the Canadian Community Health Survey (v. 2001) (CCHS) and reported their smoking habits (15.7% current smokers). Although there were several statistically significant correlations between traffic pollution data and CCHS variables, the highest correlation coefficient in absolute value was only 0.15, while the majority of the coefficients of correlation were in the 10^{-2} order of magnitude. This indicates that there are no real correlations between traffic pollution and individual CCHS variables, including smoking status. The greater correlations were between individual and family income variables and traffic generated pollutants, and these I found to be inverse correlations.

Nevertheless, similar to other studies[87b,93c,93d] that employed cohorts based on administrative data, confounding from smoking or other individual risk factors could not be properly evaluated in this study because it was based on administrative registry data. But on the other hand, the approach to employ SES covariates at two different levels of aggregation yielded different results, with risk estimates higher in the case of medium level SES.

As I mentioned previously, my cohort was constructed using administrative databases and subjects' health status was ascertained using these same databases, making the results prone to potential bias related to the quality of diagnosis. Any such bias would probably affect patients equally, regardless of their air pollution exposure, and thus contribute to an underestimation of any positive associations. From the CCHS data of those subjects in the study cohort, I had available the information on subjects' self report health status. The level of agreement between CCHS self reported data and medical records for ACS was quite high at 94.5%, while for the CCS and CHF was 85% and 95.5% respectively. One caveat regarding the health outcomes from the electronic administrative data is that only data from 1991 to 2003 was available for creating a health history for any individual, which might explain the imperfect level of concordance between the CCHS answers and the administrative health data.

The reliance on administrative databases for medical history, residential address, and residential history has the potential to bias the results, but given that I used the whole population in the metro Vancouver area it is more likely that the estimates were biased towards the null. On the other hand I had access to exposure at the residential level and I also had available the residential history of every individual in the cohort prior and during the follow-up period thus enhancing the reliability of exposure estimates and reducing the potential of misclassification. Contrary to other studies using CVD events as the outcome (incidence, mortality, or prevalence), my study focuses on the medium and long term contribution of air pollution to the underlying mechanisms that lead to cardiovascular diseases. The importance of focusing on the chronic effects of air pollution was reiterated in the literature, there being a consensus that assessments should not rely on the results of time-series studies but rather should be based on long-term follow-up in cohort studies[251a,251b]. The use of socioeconomic estimates at different levels of aggregation produced slightly different results, but maintained the trend in the estimates. It is more likely that the use of aggregate level SES has pushed the estimates towards the null, so my results, which are in line with the results from similar studies, might not in fact reveal the true magnitude of the effect of pollution on the cardiovascular health outcomes.

Road proximity related results

There are an increasing number of studies that use distance from home to major roadways or cumulative traffic intensity as proxies for exposure to traffic-related air[93,93a,93b,238]. The rationale for using distance to roads or traffic density resides on studies that have found that these measures are significant predictors of outdoor measurements of PM absorbance and NO_2 [240,241,242]. Furthermore, previous investigations have shown that concentrations of traffic-related air pollutants drop off to the local background concentration between 100 and 150 m from the roadside[243], indicating that a 150-m buffer is a reasonable size to capture local traffic-related air pollution. A recent study by Hochadel and colleagues (2006)[242], after evaluating a wide range of buffer sizes, concluded that cumulative traffic within a 100-m radius buffer was the most predictive of both measured $PM_{2.5}$ absorbance and NO_2. The model that best predicted measured $PM_{2.5}$ absorbance included both cumulative traffic within a 100-m buffer and the distance to the nearest highway. These studies support the choice of buffer size and road type (which is in fact a proxy for traffic density). More than that, with the five road proximity/traffic density combination used in my analyses, I had not only the ability to detect the most impacted subjects, but also to look at a potential gradient in the risk measures to see if there is any dose response relationship between road proximity and cardiac diseases morbidity and mortality.

The results of my large population-based study among subjects free of any cardiovascular health problems or associated co-morbidities indicate an increased risk of experiencing a cardiovascular health outcome with exposure to traffic near the patient's residence. A greater impact on morbidity and mortality I observed for exposure to traffic closer to major roads and expressways, impact that tapered off with increase distance and decrease traffic density. However, for CCS, I obtained higher risk estimates for subjects living within 50 m of secondary roads (HR = 1.46 95% CI, 1.18 - 1.80). Not as high estimates at a local scale were also obtained by Medina-Ramon et al.[93b](HR = 1.30; 95% CI, 1.13–1.49), in a recent study with a cohort or 1,389 subjects in Worchester, Mass. which they explained as due to a different composition of the pollutants mixture deriving from the two categories of roads. But this similarity might be just coincidental, since my CCS health outcomes did not figure among the health outcomes employed in the Worcester study.

Although my study looked at morbidity and mortality combined, the results are comparable with other studies that used proximity to traffic exposure as a surrogate for pollution exposure, but that looked at mortality only. It is possible that my estimates for mortality would be higher if evaluated independently, based on the results from a cohort study in Rome[83b] where estimates for mortality were higher than the overall estimates for morbidity and mortality combined. In my study, the range of resulting HR estimates for 50 m proximity to expressways and highways was between 1.09 (95% CI: 0.68 - 1.75) for CHF and 1.46 (95% CI: 1.18 - 1.80) for CCS, results that are comparable with the estimates for mortality obtained in a 10-year follow-up of Canadian subjects who underwent pulmonary function tests (HR = 1.18; 95% CI, 1.02–1.38)[90], or those obtained in a cohort study among the Dutch general population[92] (HR = 1.41; 95% CI, 0.94–2.12), where background levels of air pollution were taken into account, or those in a cohort from Worchester, Massachusetts[87b] 1.30 (95% CI, 1.13–1.49). The Dutch study, however, found larger effect estimates for cardiopulmonary mortality (HR = 1.95; 95% CI, 1.09–3.51) than for all-cause mortality, consistent with an increased susceptibility to the effects of air pollution in heart failure patients. For the subjects in my cohort residing within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads the HR estimates were 1.20 (95% CI, 1.10 - 1.30) for CCS. Overall, the effects of residential exposure to traffic in my study and the aforementioned studies were of similar magnitude but the differences attributable to varying susceptibility of populations, including the existing health status at the beginning of the follow-up period are hard to distinguish given other differences in methodology and geographic location of these studies.

While some of the studies[92,93a] that tried to link proximity to traffic and cardiovascular mortality and/or morbidity also included some background measures of air pollution (particulate matter), and then tried to explain the results partially on the difference between background pollution and the particulates generated by the traffic, difference confirmed as being more toxic[239], my study looked separately at the effects of road proximity and the combined effects of traffic generated pollutants and road proximity using LUR exposure estimates. The estimates for road proximity measures, at least for subjects living within 50 m from expressways and major highways but also for the subjects residing within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads were higher than the estimates for the highest levels of traffic pollutants derived using land use regression. It is possible that these results are just an artefact of using a binary measure (road proximity) as opposed to a measure that has four levels (quartiles of traffic pollution), but considering that LUR was also constructed considering some measures of road proximity, the highest quartile of traffic pollution should also indicate a close road proximity. These conclusions hold for both sets of analyses, the ones using SES at DA level of aggregation as well as for those using SES covariates at neighbourhood levels of aggregation.

These results seem to indicate that while traffic generated pollutants, like particulate matter, or black carbon, or nitrogen oxides play a role in the development and triggering of cardiovascular morbidity and mortality, proximity to roads might be a surrogate not only for traffic pollution but for some other cardiovascular risk factors. Other factors that can explain the difference between the two sets of analyses such as noise and the resulting psychosocial stress can also affect cardiovascular health. A recent study showed that men, exposed to sound levels of more than 70 dB(A) during the day, had a 1.3-fold increase in risk for myocardial infarction[252]. Close proximity to traffic may coincide with high traffic-related noise levels, making it difficult to separate effects of air pollution from noise effects. While other studies have tried to adjust for hypertension[93] as a means of dealing with noise confounding[253], my study included subjects that had no history of cardiovascular diseases or associated co-morbidities like hypertension, diabetes, or COPD. Another factor that might support the added impact of noise, besides that of traffic pollution, is that my study area experience sustained levels of rain all year around and anecdotal evidence suggests that noise levels are higher on wet pavement, residents of Vancouver complaining of increased traffic noise during rainy days, even when they don't live in close proximity to major roads or bus routes.

My analysis concerning long term exposure to proximity to roads suffers from the same shortcomings as the analysis based on LUR traffic pollutants, in terms of reliability of health diagnostics, lack of personal information regarding smoking status and other individual risk factors, but as I argued before, I expect that my estimates do not suffer from major non-conservative biases but are rather pulled towards the null. On the other hand, different from any of the previous studies I had reliable long term residential history information that mitigated the problem of exposure misclassification.

SES related analyses

This study is the first to thoroughly examine exposure to traffic pollution or road proximity in the context of social inequalities with an approach akin to a well developed experimental design with two factors, each factor with several levels. All the previous analyses have included, separately, socioeconomic information at two levels of aggregation. Thus, my methodological approach should not be confused with a hierarchical approach where in the same analyses the factors that are included are at different levels of aggregation (i.e. individual, neighbourhood, city, etc) and the analyses are performed taking that in consideration (i.e. random effects). Following the suggestion from Laurent et al.[237] (see Figure 4), I performed individual analyses to determine the HR estimates due to traffic pollution and road proximity for the subjects in the lowest, respectively highest of the SES quintiles of each variables available. Thus I was able to investigate the effect of the whole range of exposure values for the subjects from the lowest and highest SES quintiles respectively.

As I presented in the results section, the analyses concerning the effect modification of socioeconomic variables on the pollution related cardiovascular health outcomes included only subjects in the highest and the lowest of the five quintiles of those socioeconomic variables investigated. The number of subjects in the four distinct pollution categories (for traffic pollutants) or the two road proximity classes (in/out) varied within each socioeconomic quintile that I investigated while the number of subjects in any of these two distinct levels of socioeconomic status were approximately the same across the variables investigated. A complete summary of the distribution of subjects within the two levels of the socioeconomic variables and the four (two) levels of traffic exposure (road proximity) is presented in Tables 47 to 50 in the Appendix. Because I used the exposure (road proximity) in the analyses as a dynamic variable, the pollution classes are in fact represented in these tables by the first month of follow-up only (similar with Tables 17 and 18).

The twenty variables that I used in the analyses [2 aggregation levels – dissemination area (DA) and neighbourhood (N) – each with ten variables] can be grouped in several categories, for the ease of discussion and also for conceptual reasons. There are five broad classes (identical to those described in the methodological section) that can be construed and that I will discuss separately. These classes are:

- *Racial/Cultural*, including the percentage of Chinese minority variable (DA), percentage of people speaking a second language at home variable (N), and percentage of people experiencing linguistic isolation variable (N);
- *Income and wealth*, which includes the average personal income variable (DA, N), average family income variable (DA, N), percentage of people with low income (DA, N), income variation variable (DA), percentage of income coming from governmental transfers variable (N), percentage of families spending 30% or more of income on shelter costs variable (N), percentage of occupied dwellings that are owner-occupied variable (DA, N);
- *Education*, which consists of the percentage of total population with any university degree variable (DA, N);
- *Labour*, which includes employment rate variable (DA), seasonally adjusted unemployment rate among persons aged 25 years and over (N) variable, and percentage of people working in management variable (DA);
- *Transportation means*, which consists of the percentage of people biking, walking or using public transit in their daily commute to work variable (DA).

The Public Health Agency of British Columbia argues[254] that the Province represents a paradox when it comes to health status and social disparities. Thus, while the life expectancy in BC is one of the highest in the world and the province has the lowest rates of smoking and obesity and the highest rate of physical activity in the country, BC has the highest rates of poverty and particularly child poverty in Canada. This presents the aforementioned paradox: despite having by some measures the best overall health outcomes in Canada, BC also has the highest rate of socioeconomic disadvantage in the country. The paradox can be explained partially by looking at the range of values the averages hide, by the fact that certain trends (like high child poverty rates) are only recent, and by the time lag in the causal link between performance on the social determinants of health (including educational achievement, poverty, early childhood development, housing, etc.) and outcomes on health measures such as life expectancy. The full impact of the effects of the upstream determinants of health may not yet be fully realized or apparent from B.C.'s current population health statistics. However, these disparities in income, education, health are evident mostly at the provincial level, while my study area shows a relatively high homogeneity (except in the downtown eastside of Vancouver) in terms of the major socioeconomic indicators as well as health status, in the sense that Vancouver area has the highest levels of education and income in the province and also average outcomes on health measures.

Racial/Cultural indicators

There is a consistent amount of sociological and epidemiological research, especially in the U.S. that tries to disentangle the role of racial attributes on health outcomes. While there are probably instances that certain genetic characteristics of a particular race might constitute a risk factor, the literature shows that socioeconomic factors like income or education or class trump biological characteristics based on race in relation with health outcomes[255]. The variables chosen for my analyses as reflecting a certain racial/cultural profile of dissemination areas and neighborhoods in Metro Vancouver do not try to capture some intrinsic genetic characteristics of the population that makes them more or less susceptible to the impact of air pollution and its effects on cardiovascular health outcomes. Instead, it tries to capture material and immaterial aspects of culture as described by Eckersley[153] in his paper focused mostly on the western culture. If the variable representing the percentage of Chinese population in the DA might indeed reflect in a distinctive way the influence of a different culture than the traditional Canadian milieu, the other two variables at the neighborhood level are less defined as "cultural" variables, since they refer to the percentage of people that use at home a language that is not English or French and that can be any other language, not necessarily Chinese or to the percentage of people that do not speak either English or French and are assumed to be isolated in their neighborhood. But since the Chinese component in the ethnic make-up of Vancouver is the dominant one, the correlation between the percentage of Chinese people and the percentage of people that speak another language at home or don't speak English or French is quite high.

A relatively recent study[210] that investigated the association between body mass index (BMI) in urban Canada and different socioeconomic variables at individual, neighborhood and metropolitan levels found that there was a strong association between immigrant status and BMI for both men and women, and this association attenuated with length of time in Canada. The study also found that small incremental effects of neighborhood-level environments on the BMI of men and women in urban Canada were related primarily to two neighborhood characteristics: low education levels and the presence of immigrants (for men only). The authors suggested that it is possible to conclude from the neighborhood-level findings that recent immigrants bring with them customs and norms regarding diet or physical activity that become part of local practice and influence behaviors beyond the immigrant community. It is not sure how long this immigrant healthy effect would last since BMI has been shown to increase in Canadian adults with time since immigration[256], regardless of self-ascribed ethnicity although while about half of Whites (who constituted more than 80% of the population) were overweight (including people who were obese), East/Southeast Asians had the lowest self-reported prevalence of overweight (22%). Given the relationship between BMI and obesity in general and cardiovascular diseases[197,199,202,228], I would then expect lower rates of cardiovascular diseases in DAs and neighborhoods with a higher percentage of Chinese population, or with people speaking a second language at home, even when experiencing higher levels of pollution. In the case of linguistic isolation, the effect of isolation might be conducive to higher stress levels, but on the other hand, if there is a whole community isolated from the overall population and somewhat self-reliant, this might in fact increase the levels of community support and decrease the overall levels of stress and the risk of disease.

This was exactly the case at the dissemination area levels, where, for traffic pollution exposures, I found lower hazard ratios for all three health outcome categories in areas with a higher level of Chinese immigrant population. This was true though especially for $PM_{2.5}$ and black carbon. These results might carry even more weight due to the fact that areas with a high percentage of Chinese immigrants were also exposed to higher levels of traffic pollution (Appendix – Table 47). I obtained the same pattern of results at the neighborhood level, where, for all three health outcomes investigated, the hazard ratios for particulate matter were markedly smaller in neighborhoods with a higher percentage of a second language speakers or with people linguistically isolated, despite the fact that again, there are more people in these neighborhoods experiencing high levels of air pollution.

As I mentioned before, these differences do not reach significance, the confidence intervals of hazard ratios always intersecting. And there is the interplay between different levels of aggregation (i.e. for the variable indicating the percentage of Chinese population, the maximum value was ~90%, while at the neighborhood level we had maximums of 49 and 25% respectively for a second language and linguistic isolation), different pollutants, and different cardiovascular health outcomes. As I mentioned in the results section, the only consistent results at DA-level of aggregation are for traffic originated particulate matter and for black carbon, for which subjects living in DAs with higher levels of Chinese immigrants experienced a lower risk of developing any of the three cardiovascular health outcomes, even though there more of these people experiencing higher levels of particulate matter or ultra fine particles. For CCS at neighborhood levels (linguistic isolation, second language spoken at home) all four traffic pollutants showed distinct differences between the low/high levels of the two variables belonging to the racial/cultural group.

Similarly, areas with a high percentage of Chinese population and in close proximity to expressways and highways markedly decreased the risk of CCS. I obtained similar results when using the two variables at neighborhood levels of aggregation. These results are more in accord with the ones using the two variables at the neighborhood level of aggregation for traffic pollution. The Canadian study[210] that looked at BMI and immigration defined neighborhoods as census tract areas (CTAs), which are geostatistical areas containing about 4,000 people and thus about ten times larger than census dissemination areas and close in size with the neighbourhoods used in my study. At this level of aggregation, I found evidence that, for higher levels of particulates or in closer proximity to traffic, subjects in areas with more immigrants are experiencing lower risk levels for any of the cardiovascular health outcomes investigated. These results are replicated at the smaller level of aggregation represented by dissemination areas.

These results are reinforced by the findings of Anand[155], who found in a cohort of 1,227 subjects of different ethnical background (white, Chinese, east-Asians, aboriginal) in

Hamilton Ontario that people of Chinese origin had the lowest probability of CVD, although the Caucasian population had the lowest social disadvantage among the ethnic groups investigated. The potential healthy immigrant effect is not though reinforced by high levels of education, the correlation between the three racial/cultural variables and university education being quite low at under 0.2.

Income and wealth variables

In a review of literature[122] concerning income inequalities and health outcomes from 2006, Wilkinson and Pickett looked at 168 analyses in 155 papers reporting research findings on the association between income distribution and population health and concluded that health is less good in societies where income differences are bigger. They also suggest that the studies of income inequality are more supportive in large areas because in that context income inequality serves as a measure of the scale of social stratification, or how hierarchical a society is. Their explanation for lack of evidence in some of the studies that they analyzed rests on the fact that many studies measured inequality in areas too small to reflect the scale of social class differences in a society. Also, they noticed that a number of studies controlled for factors which, rather than being genuine confounders, were likely either to mediate between class and health or to be other reflections of the scale of social stratification. However, there are numerous studies at individual level that link lower income with an increase in negative health outcomes, including cardiovascular diseases[128,133,171,175,181]. There is also evidence that the "wealth–health gradient" in cardiovascular mortality may be partially ameliorated by more rigorous management of known risk factors among less affluent persons[257] or in systems with universal medical coverage[180,257].

The time series analysis on the short term effects of air pollution on mortality in a cohort of old people (>65 years) in Vancouver[12] found modest increases in the all-cause and cardiovascular mortality due to exposure to NO_2, CO, and SO_2 (but not in particulate matter) among individuals living in lower relative to higher socioeconomic areas. Due to the many dimensions of my analyses (multiple exposure matrices, two levels of spatial aggregation and more than ten variables, each with two classes, describing various aspects of income and wealth), my results are relatively hard to summarize. Thus, for personal and family income I found contrary to expectations, that for both aggregation levels, subjects in areas with low personal or family income had smaller HRs at higher levels of exposure or proximity to expressways and highways than subjects from areas with higher family or personal income. The results were more consistent at neighborhood level of aggregation, which showed clear differences for all four traffic pollutants These results are not explained by the fact that there were more subjects with low family or personal income in areas with high traffic pollution exposure or in proximity to expressways and highways. Similar conflicting results were available for subjects living in areas with more households below the low-income cut-off, subjects that have in a lower risk of developing a cardiovascular health outcome at higher levels of traffic pollution exposures or when in proximity of expressways or highways. Although more subjects live in areas with a higher proportion of households below the low-income cut-off that were also exposed to higher levels of traffic pollution or proximity to expressways and highways, the lower levels of personal and family income might be still above the low-income cut-off and offer sufficient material protection in absolute terms and mitigate the risk of developing CVD.

It is harder to draw an over arching conclusion regarding home ownership, because there are differences in the results at the two different levels of aggregation. My results indicate that for CCS health outcomes, the health risks were more pronounced in neighborhoods with a high proportion of home ownership for both levels of aggregation, and especially at DA-level, where the differences were manifested for all four traffic pollutants. For CCS, higher ownership rates may be associated with longer periods of stay in a particular area and if those areas were associated with higher levels of pollution, this may lead to increased rates of CVD.

It was found that the health effect of income inequality weakens when moving from higher levels of aggregation (such as nations) to lower levels (such as neighborhoods),[237,258,259] and even the direction of the effect might change[260]. The main reasons for such an effect of scale might be fundamentally political and this political effect it is more likely to be perceived at national or state level. In those nations that have great disparities within their borders there is a smaller tendency to have extensive redistributive systems and there can be found lower levels of human capital and social security investments. My analyses were conducted at small and very small levels of aggregation and it is not clear whether these units have enough political autonomy to influence the processes behind income inequality. However, while the dissemination areas were created by Statistics Canada through a process that only tried to equalize the number of people living in the proposed DAs, the neighbourhood boundaries were based upon factors of judgment that went beyond the relatively simple approach considered for the creation of dissemination areas. This fundamental difference in the way the two levels of aggregation were construed might explain the difference in the results between the DA-level and neighbourhood level, with neighbourhood level results of higher magnitude, contrary to the original hypothesis that was derived from Laurent's review[237].

While income dispersion at the regional level may be seen merely as a result of the labor market's geographic structure, within the smallest units such as neighborhoods, the direction of the association is not evident. Income inequality within a neighborhood is more likely a measure of socioeconomic heterogeneity, a manifestation of the mixture of residents with divergent social and economic characteristics. The residential composition of a neighborhood is partly a result of housing and zoning strategies but it is also driven by wider segregation processes. Furthermore, it has been suggested that economic heterogeneity in urban communities can have beneficial effects. One hypothesis is that poor people benefit from sharing neighborhoods with more affluent families and that a certain proportion of middle and upper class people in urban neighborhoods may be necessary to sustain basic institutions[261].

In a study conducted by Stjarne in Sweden[208], in the multilevel analyses that were performed, an index of neighborhood heterogeneity was used at the higher level of aggregation (individual/neighborhood) with the assumption that the level of neighborhood homogeneity has an impact on the myocardial infarct (MI) outcomes. Their expectation was that more heterogeneous neighborhoods reduce the risk of MI on the assumption that it is an advantage to society if people from different walks of life share the same neighborhood. Although the study found an increased incidence of MI in low-income neighborhoods that was not due to individual social characteristics, the socioeconomic heterogeneity within a neighborhood seemed to have less effect on MI. In my study I did not use an index of income variation that is usually employed (Gini coefficient) but just the coefficient of variation in personal income and this information was available only at the dissemination area level, which is the smaller of the two levels of aggregation that I used. Given the research in the area, I did expect to have some conclusive results on the assumption that high levels of income variation might be in fact beneficial to health and lower the risk of CVD. My results confirmed this initial assumption for traffic pollution exposure and road proximity as well. The results indicate that overall, for higher levels of exposure (proximity to major roads), there is a decreased risk in experiencing any of the three CVD analyzed, for subjects living in dissemination areas with a greater income heterogeneity

The other two remaining variables that were used to express some aspects of income, governmental transfers and neighborhood stress, are both available only at neighborhood level of aggregation. My results indicate for three out of four pollutants that higher levels of governmental transfers are associated with lower risks of CCS compared with subjects in areas with lower levels of governmental transfers. These results contradict the initial expectations. However, for proximity to expressways and highways the results indicated that subjects living in areas with high levels of governmental transfers or neighborhood stress are at a higher risk of experiencing CCS.

Education

Besides income, education level is the other socioeconomic factor that was found to be related to health status. Among the measures of SES, such as education, income and occupation, low level of education was most consistently associated with higher coronary risk[262,263] and my expectations were that subjects from areas with higher levels of university graduates would manifest a lower level of risk of CVD, at higher levels of traffic pollution or if living in proximity of major roads. My results indicated such a relation for CCS only at the DA-level and only for black carbon. In the few other circumstances (CCS-DA for nitrogen oxides and particulate matter, and CCS-N for nitrogen oxides) the risk was found to be sometimes higher for subjects living in areas with a higher proportion of university graduates but most of the time the trends for low/high levels of university degrees were intersecting, diverging and then converging. This might be due to the fact that the distribution of subjects across the levels of pollution were unbalanced, with much more subjects from areas with more university graduates being exposed to higher levels of traffic pollution (Tables 47 and 48 in the Appendix). This is similar with the distribution that was found by Hoek[90] in a cohort study in the Netherlands, where subjects living near a major road were found to have had slightly higher education, worked less frequently in blue-collar jobs, and smoked fewer cigarettes. So, even though higher levels of education might have a protective effect, just the sheer number of highly educated people exposed to higher pollution might produce an artificially higher risk. Nevertheless, for this cohort, there were fewer subjects from areas with high levels of university education living in one of the five road categories investigated as opposed to those with low levels of university education (Tables 49 and 50).

Labor and occupation

With the objective of helping employers and government to better articulate the tradeoffs between policies that affect economic outcomes of labour market experiences and policies that affect the health consequences of these experiences, Lavis[268] has developed a conceptual framework encompassing the availability and nature of work. In this conceptual framework, work availability is characterized by six important experiences. Three of these experiences represent under work: discouraged workers who have withdrawn from the labour market, unemployed workers actively seeking work, and conditions of underemployment - expressed by hours of work and skill utilization. The fourth experience represents those employment circumstances in which there is a constant fear of underemployment. The remaining two experiences in this dimension of the conceptual framework described by Lavis are the experience of full employment and of over-employment or overwork. The dimension of the nature of work has only three defined features: job characteristics, job position within a firm or society, and the organizational characteristics of the firm.

The exploratory mechanisms and pathways for work related health effects go from the material consequences of job loss, to the disruption of social ties that can lead to disturbance in physical and mental health[269] and there is a substantial body of research that have estimated the consequences of involuntary unemployment to individual physical and mental health, such that the relationship can be considered causal. A review by Lavis et al.[270] did not find studies that conclusively linked unemployment to initiation of disease, although a large body of work had consistently found unemployment associated with the risk of death following the unemployment period.

As indicated in the results section, my study found that subjects from dissemination areas with low level of employment and higher levels of pollution are at lower risk of developing CCS as opposed to subjects where employment rates are higher. Corroborating these results, at neighborhood aggregation levels, subjects from areas with low unemployment were at higher risk of CVD than subjects from areas with high unemployment, for high levels of traffic pollution. Also, subjects from areas with high/low employment/unemployment were found to be at higher risk of CVD if living within 50 m of expressways than subjects from areas with low/high employment/unemployment. It is worth noticing that there were almost double the number of subjects living in areas with high/low unemployment/employment and high pollution levels (proximity to major roads) than otherwise. This might have impacted the results. Also, the census data refer only to the situation when the Census information was collected (2000/2001) and this covers only one year of the whole follow-up period. Unemployment/employment rates are not static and change in time and might not have long lasting effects, like education levels or racial profile.

Starting with the Whitehall II study conducted by Marmot[271] and his colleagues, it was shown that people that have less control and are performing highly demanding jobs experience higher mortality than people higher on the hierarchy, that have a high control on their jobs. Similar associations were found by studies that investigated the effects of air pollution and health and have controlled for work type[123,183,184,191,212]. However, my study has found that at dissemination area level, subjects living in areas with a low percentage of people working in management were less prone to develop CCS, at high levels of traffic pollution (for all four pollutants), compared with subjects living in areas with a high proportion of people working in management. The subjects in the low/high areas were in approximately similar numbers exposed to high levels of traffic pollution. The results considering road proximity were rather inconclusive for all health outcomes investigated.

Transportation

Only at dissemination area I had available information regarding the proportion of people in an area that use public transit, bike or walk in their daily commute to work. For an individual, the use of a private car for daily work commute might represent an additional stress and Gee[195] found in a cohort in Los Angeles that perceived traffic stress was associated with both general health status and depression in multivariate multilevel models, such that persons reporting traffic stress had lower health status and more depressive symptoms. The author reported also that there was an interaction between vehicular burden and traffic stress for both general health status and depression and that persons living in areas with greater vehicular burden and who reported the most traffic stress also had the lowest health status and greatest depressive symptoms. In Canada, metropolitan sprawl, which is associated with higher levels of car use, was found to be associated with higher BMI for Canadian men[210]. However, Peters[91] found that transient exposure to traffic not only as drivers but as passengers in a bus or bikers may increase the risk of myocardial infarction in susceptible persons.

The initial hypothesis that subjects using public transit, biking or walking to work are exposed to higher levels of traffic pollution, especially for the highest quartile was confirmed by the results of my analyses (Tables 47 and 49). The expected consequence of this fact was that these people will have higher rates of CVD than subjects living in areas with low levels of public transit usage or that bike or walk to work less. For subjects living within 50 m from expressways and highways, or within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads I found evidence that for all CVD health outcomes, subjects from areas with a higher percentage of daily commuters that walk, bike or use public transit to work are at higher risk of CVD than subjects from areas with a higher use of private cars. However, these results were not entirely replicated by the analyses involving exposure to particulate matter where the HRs were higher for subjects living in areas with low usage of transit, biking or walking. Nevertheless, for nitrogen dioxide exposure the results were similar with those of road proximity measures. These apparently contradictory results may be explained that the smaller number of subjects living in the proximity to major roads are exposed not only to traffic pollutants but to other factors of stress and they represent only a fraction of the larger number of subjects that although are exposed to high levels of traffic pollution, by using transit, biking or walking to work, manage to reduce their HRs of experiencing cardiovascular health outcomes.

Strengths and weaknesses of the study

My study is population-based derived from administrative databases and consisting of subjects with no history of cardiovascular diseases or associated co-morbidities. This makes the current study less sensitive to selection bias due to a differential response rate associated with area-level deprivation, or exposure differential, which can be a considerable problem in contextual studies[264]. More than that, the validity of CVD diagnosis was verified with the self declared health status of those subjects from the cohort that were also captured by the first cycle of Canadian Community Health Survey. By using the incidence of the first event of CVD is considered to be especially relevant when evaluating the etiologic implications of contextual exposures. In particular, it reduces the risk of bias from health-related selection into low-income contexts. Also, because case-fatality rates have been found to be related to neighborhood deprivation[265], the inclusion of both fatal and nonfatal cases reduces

influences from factors such as availability of acute care or distance to a hospital. However, selecting in the cohort only subjects without any previous medical conditions has the potential to overemphasize the "healthy worker effect", which may explain some of the results, especially in relation with traffic pollution.
Another strength of my study resides in the availability of information on residential mobility and previous contextual exposures, which is rare in long term studies. I had available residential information for more than 8 years prior to the start of the follow-up and for the whole duration of the follow-up and I was able to assign precise traffic exposures (that were themselves adjusted for the period of follow up and one year prior to that to reflect the existing temporal trends in the area) and especially road proximity identifiers.

There is a lot of criticism for using administrative boundaries when estimating contextual attributes. While one of the levels of aggregation used in my study is represented by purely administrative boundaries as defined by Statistics Canada for census purposes, the other level of aggregation used represents neighborhoods as defined by the people living in the respective areas[216]. For the administratively defined dissemination areas, the summary statistics indicate that they capture the spatial differentiation of socioeconomic recourses reasonably well. In fact, the variances found in the values of covariates at dissemination area level are higher then those corresponding to the neighborhood areas. This probably happens because at a higher level of aggregation, information from sometimes contrasting small residential areas is merged, which hides important contrasts between neighborhoods and causes non differential misclassification of exposures.

The main weakness of this study is the lack of individual level information besides sex and age. This would have given me the possibility to conduct hierarchical analyses. The use of area based variables as a replacement for missing individual level information has been for long criticized as the ecological fallacy and even the use of such data in the presence of individual level information and the drawing of causal inferences from the neighborhood studies so far conducted has recently been questioned[266]. In line with Diez-Roux[14,267], I would argue that it is still productive to use observational data and that the neighborhood effects are not by definition endogenous to the compositional characteristics of neighborhoods. The main question addressed in my study is whether specific aspects of the local social environment have an impact on CVD incidence, and especially how they modify the effect of traffic related pollution on the CVD. Answering this question can be regarded as a first step toward attaining the ultimate goal of understanding the causal role played by context. However, that goal is far from reached, and as Diez Roux states, "associations . . . on neighborhood health effects are what they are: measures of conditional associations under certain assumptions."[267(p.1959)] The range of covariates that I used from the available neighborhoods serve as a proxy for a range of circumstances affecting people's daily life that would have been missed if only social circumstances measured at the individual level were considered.

Conclusions

My study found significant evidence that even in areas with low levels of traffic pollution and even for healthy people, there is an increased risk of chronic coronary syndrome morbidity or mortality due to an increased exposure to traffic pollution or to living in close proximity to expressways and highways, especially when considering socioeconomic variables at medium levels of aggregation.

While the results were not always very conclusive regarding the extent to which socioeconomic indicators modify the effect of traffic pollution on health on the expected trajectory (individuals from more advantaged areas would be less subjected to the effects of traffic pollution compared with individuals living in more disadvantaged areas) several socio economic attributes stand out, especially in respect to traffic pollution exposure estimates. At dissemination area levels, in the case of exposure to particulate matter, subjects living in areas with a higher percentage of Chinese population were at a lower risk of CCS health outcomes. Subjects living in areas with a higher proportion of university degrees were also at a lower risk of experiencing CCS in conjunction with black carbon exposure. Both of these could signify an immigrant effect and or an education effect, due to immigrants having in general higher education. However, the effect modification of family and individual income in respect with all traffic exposures was inverse than expected, subjects living in areas with high levels of family or personal income being at a higher risk of experiencing CCS related morbidity and/or mortality. Similarly, a high level of home ownership was also associated with increased risk of CCS in conjunction with all traffic pollutants at DA level and with particulate matter only at neighborhood level. Subjects living in areas with a higher proportion of people working in managerial positions were at higher risk of experiencing CCS in relation with all traffic pollutants. As expected, subjects living in areas with a high proportion of people that use transit, bike or walk to work were found to be at higher risks of developing CCS in relation with NO_2 and road proximity. Also as expected, subjects living in areas with greater income variation were at a lower risk of experiencing CCS in relation with all traffic pollutants except nitrogen oxide.

A certain level of similarity was found for some of the variables derived at the neighborhood level of aggregation, when compared with the results at dissemination area. Thus, the two covariates representing the racial/cultural axis (other language used at home and linguistic isolation) indicated, as the covariate describing the percentage of Chinese population in a dissemination area, that subjects living in areas with higher percentages of people using a second language at home or higher percentages of linguistically isolated people are at a lower risk of experiencing any of the CVD investigated in conjunction with particulate matter. Also, at neighborhood level, subjects living in areas with higher family incomes were at greater risk of experiencing CVD related morbidity and/or mortality in conjunction with nitrogen oxides exposures. Same was the case for the personal income variable. Nevertheless, subjects living in areas with increased unemployment rates were at lower risk of developing any CVD in relation with the nitrogen oxides.

The results for the stratified analyses were similar for traffic pollution and road proximity. However, only for some of the variables investigated (the racial/cultural variables, education variable, transportation variable and income variation variable), the initial hypotheses regarding their behaviour were confirmed by the analyses. This was not the case for income and wealth related variables. As for the results concerning exposure and CCS outcomes, neighborhood level of aggregation produced higher HRs and clearer separation between strata in the stratified analyses for the majority of the pollutants investigated.

These results would need to be studied in conjunction with analyses at individual level data to confirm that these trends are real. Also, a more detailed analysis is required to disentangle the results obtained for ACS and CCS on one hand, and CHF on the other hand, because there were many circumstances where the behavior of the risk estimates for these two groups of CVD health outcomes was totally opposite.

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Appendix – Traffic pollution, road proximity and ACS and CHF outcomes

Table 26. Traffic exposure and relative risk for CCS health outcomes

Traffic exposure	Health Outcome	RR of health outcome for subjects in the 4th vs. 1st quartiles of traffic pollution exposure
NO	ACS	0.95 (0.87 – 1.05)
	CHF	1.08 (0.89 – 1.30)
NO_2	ACS	0.93 (0.85 – 1.01)
	CHF	1.04 (0.88 – 1.29)
Black Carbon	ACS	1.08 (0.98 – 1.18)
	CHF	1.36 (1.11 – 1.65)
$PM_{2.5}$	ACS	0.98 (0.89 – 1.07)
	CHF	1.00 (0.82 - 1.24)

* Note: exposure is determined based on the first month of follow-up, January 1999

Table 27. Road proximity* and relative risk for CVD health outcomes

Road proximity	Health Outcome	RR of health outcome for subjects in road proximity vs. subjects not in road proximity
Subjects living within 50 m from expressways and primary highways (R-I)	ACS	1.46 (1.18 – 1.80)
	CHF	1.39 (0.88 – 2.19)
Subjects living between 50 and 150 m from expressways and primary highways (R-II)	ACS	1.09 (0.94 – 1.26)
	CHF	1.19 (0.88 – 1.60)
Subjects living within 50 m from secondary highways and major roads (R-III)	ACS	1.11 (1.00 – 1.23)
	CHF	1.41 (1.16 – 1.72)
Subjects living between 50 and 150 m from secondary highways and major roads (R-IV)	ACS	1.05 (0.97 – 1.13)
	CHF	0.95 (0.80 – 1.13)
Subjects living within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (R-V)	ACS	1.15 (1.06 – 1.25)
	CHF	1.43 (1.21 – 1.69)

* Note: exposure is determined based on the first month of follow-up, January 1999

Table 28. Crude hazard ratios for traffic pollutants

Pollutant	Health Outcome	Crude HR and 95% CI			
		1st	2nd	3rd	4th
NO	ACS	1.00	1.01 (0.93 - 1.11)	0.93 (0.85 - 1.02)	0.95 (0.87 - 1.04)
	CHF	1.00	0.79 (0.64 - 0.96)	0.88 (0.73 - 1.08)	1.07 (0.89 - 1.29)
NO_2	ACS	1.00	0.96 (0.88 - 1.05)	0.80 (0.72 - 0.88)	0.94 (0.86 - 1.03)
	CHF	1.00	0.86 (0.71 - 1.05)	0.92 (0.75 - 1.12)	1.07 (0.89 - 1.30)
$PM_{2.5}$	ACS	1.00	0.99 (0.90 - 1.08)	1.02 (0.93 - 1.13)	**1.10 (1.00 - 1.20)**
	CHF	**1.00**	**1.34 (1.09 - 1.64)**	**1.28 (1.03 - 1.57)**	**1.48 (1.21 - 1.81)**
Black Carbon	ACS	1.00	1.04 (0.95 - 1.14)	0.95 (0.87 - 1.05)	1.00 (0.91 - 1.10)
	CHF	1.00	1.12 (0.91 - 1.36)	1.07 (0.87 - 1.31)	1.06 (0.86 - 1.30)

Table 29. Hazard ratios for traffic pollutants adjusted for DA and neighborhood levels SES covariates

Pollutant	Health Outcome	DA SES Adjusted[1] HR and 95% CI			Neighborhood SES Adjusted[2] HR and 95% CI		
		2nd	3rd	4th	2nd	3rd	4th
NO	ACS	1.04 (0.95 - 1.14)	0.99 (0.89 - 1.09)	1.03 (0.93 - 1.14)	1.05 (0.95 - 1.15)	1.03 (0.93 - 1.14)	1.08 (0.97 - 1.20)
	CHF	0.73 (0.59 - 0.90)	0.81 (0.66 - 1.00)	0.98 (0.79 - 1.20)	0.80 (0.64 - 0.99)	0.91 (0.73 - 1.14)	1.11 (0.89 - 1.37)
NO_2	ACS	1.00 (0.92 - 1.10)	0.91 (0.82 - 1.01)	1.01 (0.91 - 1.13)	1.01 (0.92 - 1.11)	0.93 (0.83 - 1.05)	1.09 (0.98 - 1.22)
	CHF	0.83 (0.68 - 1.02)	0.86 (0.68 - 1.07)	0.91 (0.73 - 1.15)	0.92 (0.74 - 1.15)	0.97 (0.76 - 1.24)	1.10 (0.87 - 1.40)
$PM_{2.5}$	ACS	0.94 (0.86 - 1.04)	0.97 (0.88 - 1.07)	0.99 (0.90 - 1.09)	0.96 (0.87 - 1.06)	1.02 (0.92 - 1.13)	1.06 (0.96 - 1.17)
	CHF	1.25 (1.02 - 1.54)	1.11 (0.89 - 1.38)	1.20 (0.97 - 1.48)	1.21 (0.97 - 1.50)	1.11 (0.89 - 1.40)	1.18 (0.95 - 1.47)
Black Carbon	ACS	1.06 (0.96 - 1.16)	1.01 (0.91 - 1.11)	1.07 (0.96 - 1.18)	1.07 (0.97 - 1.18)	1.03 (0.93 - 1.14)	1.09 (0.98 - 1.21)
	CHF	1.06 (0.86 - 1.3)	1.03 (0.83 - 1.27)	0.95 (0.77 - 1.18)	1.12 (0.91 - 1.38)	1.09 (0.88 - 1.36)	0.99 (0.79 - 1.24)

[1] The adjustment was done for sex, age class, and 10 DA level SES covariates; [2] The adjustment was done for sex, age class, and 10 Neighborhood level SES covariates; SES variables grouped in quintiles

Table 30. Crude and adjusted hazard ratios for road proximity adjustment done using SES covariates at different levels of aggregation

Pollutant	Health Outcome	Analyses HR and 95% CI		
		Crude HR	DA SES Adjusted[1] HR	Neighborhood SES Adjusted[2] HR
Within 50 m from expressways and primary highways (R-I)	ACS	1.46 (1.18 - 1.80)	**1.24 (1.00 - 1.53)**	**1.25 (1.02 - 1.55)**
	CHF	1.32 (0.82 - 2.10)	1.17 (0.73 - 1.87)	1.09 (0.68 - 1.75)
Between 50 and 150 m from expressways and primary highways (R-II)	ACS	1.12 (0.97 - 1.29)	1.08 (0.93 - 1.24)	1.10 (0.95 - 1.27)
	CHF	1.21 (0.90 - 1.63)	1.13 (0.83 - 1.52)	1.11 (0.82 - 1.50)
Within 50 m from secondary highways and major roads (R-III)	ACS	1.16 (1.05 - 1.28)	1.06 (0.96 - 1.17)	1.07 (0.97 - 1.19)
	CHF	1.61 (1.33 - 1.95)	**1.31 (1.09 - 1.59)**	**1.34 (1.11 - 1.62)**
Between 50 and 150 m from secondary highways and major roads (R-IV)	ACS	1.01 (0.93 - 1.09)	1.02 (0.94 - 1.11)	1.04 (0.96 - 1.13)
	CHF	0.96 (0.81 - 1.14)	0.89 (0.75 - 1.06)	0.91 (0.76 - 1.09)
Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (R-V)	ACS	1.20 (1.10 - 1.30)	**1.09 (1.01 - 1.19)**	**1.11 (1.02 - 1.21)**
	CHF	1.56 (1.33 - 1.83)	**1.31 (1.11 - 1.55)**	**1.32 (1.12 - 1.55)**

[1] The adjustment was done for sex, age class, and 10 DA level SES covariates; [2] The adjustment was done for sex, age class, and 10 Neighborhood level SES covariates; SES variables grouped in quintiles

Appendix – Traffic pollution, road proximity and ACS and CHF outcomes in relation with low/high levels of SES

Table 31. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering ACS health outcomes

Health Outcome			ACS			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Chinese population	NO	Low	1.00	1.03 (0.88 - 1.22)	1.05 (0.88 - 1.25)	0.97 (0.79 - 1.19)
		High	1.00	1.10 (0.79 - 1.53)	0.89 (0.65 - 1.22)	1.08 (0.79 - 1.46)
	NO_2	Low	1.00	1.03 (0.88 - 1.21)	1.00 (0.82 - 1.22)	0.87 (0.71 - 1.08)
		High	1.00	0.99 (0.67 - 1.44)	0.88 (0.62 - 1.25)	0.96 (0.68 - 1.37)
	Black Carbon	Low	1.00	0.93 (0.78 - 1.12)	0.97 (0.80 - 1.17)	0.92 (0.76 - 1.10)
		High	1.00	1.09 (0.85 - 1.40)	0.98 (0.76 - 1.25)	1.07 (0.84 - 1.37)
	$PM_{2.5}$	Low	**1.00**	**1.08 (0.90 - 1.29)**	**1.05 (0.87 - 1.26)**	**1.10 (0.91 - 1.34)**
		High	**1.00**	**0.96 (0.72 - 1.27)**	**0.66 (0.50 - 0.88)**	**0.84 (0.64 - 1.10)**
University	NO	Low	1.00	0.99 (0.84 - 1.18)	1.02 (0.85 - 1.23)	0.94 (0.77 - 1.16)
		High	1.00	0.90 (0.70 - 1.16)	0.89 (0.70 - 1.13)	0.94 (0.75 - 1.18)
	NO_2	Low	**1.00**	**1.07 (0.91 - 1.26)**	**0.99 (0.80 - 1.21)**	**1.08 (0.89 - 1.30)**
		High	**1.00**	**0.82 (0.63 - 1.06)**	**0.83 (0.65 - 1.06)**	**0.86 (0.68 - 1.10)**
	Black Carbon	Low	**1.00**	**1.01 (0.83 - 1.23)**	**0.95 (0.78 - 1.16)**	**1.06 (0.87 - 1.28)**
		High	**1.00**	**0.84 (0.66 - 1.08)**	**0.97 (0.77 - 1.21)**	**1.01 (0.81 - 1.27)**
	$PM_{2.5}$	Low	**1.00**	**1.16 (0.94 - 1.42)**	**1.04 (0.85 - 1.28)**	**1.19 (0.96 - 1.46)**
		High	**1.00**	**0.87 (0.67 - 1.13)**	**0.93 (0.74 - 1.18)**	**0.95 (0.76 - 1.18)**
Employment	NO	Low	1.00	0.89 (0.73 - 1.10)	0.86 (0.70 - 1.05)	0.82 (0.67 - 1.00)
		High	1.00	0.94 (0.76 - 1.16)	0.82 (0.66 - 1.02)	0.78 (0.62 - 0.98)
	NO_2	Low	1.00	0.87 (0.71 - 1.07)	0.68 (0.55 - 0.83)	0.80 (0.66 - 0.97)
		High	1.00	0.84 (0.68 - 1.03)	0.83 (0.66 - 1.04)	0.74 (0.59 - 0.92)
	Black Carbon	Low	1.00	0.91 (0.74 - 1.13)	0.87 (0.71 - 1.07)	0.98 (0.81 - 1.19)
		High	1.00	0.86 (0.69 - 1.07)	0.91 (0.73 - 1.13)	0.85 (0.68 - 1.06)
	$PM_{2.5}$	Low	1.00	0.96 (0.77 - 1.18)	0.86 (0.69 - 1.07)	0.99 (0.81 - 1.22)
		High	1.00	1.11 (0.90 - 1.37)	0.91 (0.72 - 1.14)	0.79 (0.62 - 1.00)
Family income	NO	Low	**1.00**	**0.90 (0.73 - 1.10)**	**0.75 (0.61 - 0.92)**	**0.74 (0.61 - 0.90)**
		High	**1.00**	**0.94 (0.76 - 1.16)**	**1.09 (0.89 - 1.33)**	**0.95 (0.76 - 1.20)**
	NO_2	Low	1.00	0.90 (0.73 - 1.10)	0.75 (0.61 - 0.92)	0.74 (0.61 - 0.90)
		High	1.00	0.89 (0.73 - 1.07)	0.70 (0.56 - 0.86)	0.75 (0.58 - 0.98)
	Black Carbon	Low	1.00	0.73 (0.57 - 0.93)	0.82 (0.66 - 1.02)	0.93 (0.76 - 1.14)
		High	1.00	0.79 (0.65 - 0.98)	0.87 (0.69 - 1.08)	1.03 (0.84 - 1.26)
	$PM_{2.5}$	Low	1.00	0.98 (0.77 - 1.25)	0.85 (0.67 - 1.08)	0.99 (0.78 - 1.24)
		High	1.00	0.98 (0.80 - 1.20)	0.92 (0.74 - 1.13)	0.83 (0.66 - 1.06)
Personal income	NO	Low	1.00	0.97 (0.77 - 1.22)	0.76 (0.61 - 0.95)	0.80 (0.64 - 0.99)
		High	1.00	0.90 (0.72 - 1.12)	1.06 (0.86 - 1.30)	0.96 (0.77 - 1.20)
	NO_2	Low	1.00	0.94 (0.74 - 1.19)	0.69 (0.55 - 0.87)	0.80 (0.64 - 0.99)
		High	1.00	0.87 (0.71 - 1.05)	0.75 (0.61 - 0.93)	0.75 (0.59 - 0.96)
	Black Carbon	Low	1.00	0.84 (0.66 - 1.07)	0.92 (0.73 - 1.15)	0.97 (0.78 - 1.20)
		High	1.00	0.81 (0.66 - 1.01)	0.91 (0.73 - 1.13)	1.00 (0.82 - 1.24)
	$PM_{2.5}$	Low	1.00	1.01 (0.77 - 1.32)	0.81 (0.62 - 1.06)	1.04 (0.80 - 1.34)
		High	1.00	0.89 (0.72 - 1.11)	0.97 (0.79 - 1.20)	0.85 (0.67 - 1.07)

Table 31. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering ACS health outcomes (cont.)

Health Outcome			ACS			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Transportation	NO	Low	1.00	1.00 (0.83 - 1.20)	1.12 (0.93 - 1.36)	0.92 (0.75 - 1.14)
		High	1.00	0.99 (0.71 - 1.38)	0.80 (0.58 - 1.11)	0.85 (0.62 - 1.16)
	NO_2	Low	1.00	0.92 (0.78 - 1.09)	0.72 (0.56 - 0.91)	0.92 (0.73 - 1.17)
		High	1.00	0.96 (0.59 - 1.56)	0.89 (0.57 - 1.40)	1.02 (0.66 - 1.59)
	Black Carbon	Low	1.00	0.95 (0.79 - 1.14)	1.01 (0.82 - 1.24)	0.98 (0.80 - 1.19)
		High	1.00	0.89 (0.66 - 1.20)	0.95 (0.72 - 1.26)	0.97 (0.74 - 1.28)
	$PM_{2.5}$	Low	**1.00**	**1.14 (0.95 - 1.38)**	**1.01 (0.82 - 1.24)**	**1.14 (0.92 - 1.40)**
		High	**1.00**	**1.05 (0.79 - 1.39)**	**0.96 (0.73 - 1.27)**	**1.04 (0.80 - 1.36)**
Low income	NO	Low	**1.00**	**1.00 (0.83 - 1.21)**	**1.18 (0.97 - 1.42)**	**1.21 (0.99 - 1.49)**
		High	**1.00**	**0.84 (0.66 - 1.06)**	**0.83 (0.67 - 1.04)**	**0.76 (0.61 - 0.93)**
	NO_2	Low	1.00	0.76 (0.61 - 0.93)	1.02 (0.86 - 1.21)	1.03 (0.83 - 1.27)
		High	1.00	1.02 (0.86 - 1.21)	1.03 (0.83 - 1.27)	1.00 (0.78 - 1.28)
	Black Carbon	Low	1.00	1.00 (0.84 - 1.21)	1.01 (0.81 - 1.24)	1.10 (0.91 - 1.34)
		High	1.00	0.86 (0.67 - 1.10)	0.94 (0.75 - 1.17)	1.04 (0.84 - 1.30)
	$PM_{2.5}$	Low	1.00	1.12 (0.94 - 1.33)	1.06 (0.87 - 1.29)	1.03 (0.82 - 1.30)
		High	1.00	1.02 (0.80 - 1.31)	0.92 (0.72 - 1.18)	1.00 (0.79 - 1.26)
Home ownership	NO	Low	1.00	0.95 (0.74 - 1.22)	0.74 (0.58 - 0.95)	0.68 (0.54 - 0.86)
		High	1.00	0.89 (0.74 - 1.07)	1.09 (0.90 - 1.32)	1.02 (0.82 - 1.25)
	NO_2	Low	1.00	0.94 (0.71 - 1.25)	0.65 (0.50 - 0.85)	0.76 (0.59 - 0.97)
		High	1.00	0.93 (0.79 - 1.10)	0.87 (0.70 - 1.07)	1.06 (0.83 - 1.34)
	Black Carbon	Low	**1.00**	**0.77 (0.59 - 1.01)**	**0.82 (0.65 - 1.04)**	**0.85 (0.67 - 1.06)**
		High	**1.00**	**1.17 (0.97 - 1.41)**	**1.16 (0.94 - 1.43)**	**1.31 (1.07 - 1.61)**
	$PM_{2.5}$	Low	1.00	0.99 (0.77 - 1.27)	0.91 (0.71 - 1.16)	0.99 (0.79 - 1.25)
		High	1.00	0.95 (0.79 - 1.15)	1.10 (0.90 - 1.34)	1.01 (0.81 - 1.25)
Income variation	NO	Low	1.00	1.06 (0.88 - 1.28)	0.82 (0.67 - 1.01)	0.82 (0.68 - 0.99)
		High	1.00	0.94 (0.75 - 1.18)	1.04 (0.83 - 1.30)	0.99 (0.79 - 1.24)
	NO_2	Low	**1.00**	**0.99 (0.81 - 1.20)**	**0.84 (0.68 - 1.04)**	**0.87 (0.73 - 1.04)**
		High	**1.00**	**0.80 (0.64 - 0.99)**	**0.70 (0.56 - 0.86)**	**0.78 (0.62 - 1.00)**
	Black Carbon	Low	**1.00**	**1.07 (0.87 - 1.33)**	**1.08 (0.88 - 1.32)**	**1.06 (0.87 - 1.30)**
		High	**1.00**	**0.76 (0.61 - 0.94)**	**0.85 (0.68 - 1.06)**	**0.86 (0.69 - 1.06)**
	$PM_{2.5}$	Low	1.00	1.14 (0.92 - 1.40)	1.07 (0.87 - 1.34)	0.96 (0.78 - 1.18)
		High	1.00	0.96 (0.77 - 1.19)	0.95 (0.76 - 1.19)	1.01 (0.81 - 1.27)
Management	NO	Low	**1.00**	**0.87 (0.72 - 1.05)**	**0.68 (0.55 - 0.84)**	**0.79 (0.64 - 0.96)**
		High	**1.00**	**1.07 (0.87 - 1.32)**	**0.95 (0.77 - 1.17)**	**0.94 (0.76 - 1.16)**
	NO_2	Low	1.00	0.90 (0.74 - 1.10)	0.67 (0.54 - 0.82)	0.80 (0.66 - 0.96)
		High	1.00	0.87 (0.72 - 1.05)	0.77 (0.62 - 0.95)	0.75 (0.60 - 0.94)
	Black Carbon	Low	1.00	0.86 (0.70 - 1.06)	0.79 (0.64 - 0.97)	0.90 (0.73 - 1.10)
		High	1.00	0.94 (0.77 - 1.15)	0.96 (0.78 - 1.19)	0.87 (0.71 - 1.07)
	$PM_{2.5}$	Low	1.00	1.09 (0.88 - 1.36)	0.99 (0.79 - 1.24)	1.04 (0.83 - 1.30)
		High	1.00	1.10 (0.90 - 1.34)	0.89 (0.72 - 1.11)	0.96 (0.78 - 1.19)

Table 32. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering ACS health outcomes

Health Outcome			ACS			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Other language	NO	Low	1.00	1.03 (0.85 - 1.23)	1.19 (1.00 - 1.42)	0.99 (0.81 - 1.21)
		High	1.00	0.84 (0.62 - 1.13)	0.63 (0.47 - 0.85)	0.76 (0.57 - 1.01)
	NO_2	Low	1.00	1.19 (1.01 - 1.39)	1.03 (0.83 - 1.28)	0.94 (0.76 - 1.17)
		High	1.00	0.83 (0.59 - 1.15)	0.59 (0.44 - 0.80)	0.78 (0.58 - 1.04)
	Black Carbon	Low	**1.00**	**1.01 (0.84 - 1.21)**	**1.10 (0.90 - 1.33)**	**0.96 (0.80 - 1.16)**
		High	**1.00**	**0.82 (0.65 - 1.03)**	**0.72 (0.57 - 0.90)**	**0.90 (0.74 - 1.11)**
	$PM_{2.5}$	Low	**1.00**	**1.05 (0.87 - 1.27)**	**1.19 (0.98 - 1.45)**	**1.19 (0.98 - 1.43)**
		High	**1.00**	**0.97 (0.74 - 1.27)**	**0.63 (0.48 - 0.82)**	**0.88 (0.68 - 1.12)**
Linguistic isolation	NO	Low	1.00	1.02 (0.85 - 1.24)	1.03 (0.86 - 1.24)	0.96 (0.78 - 1.17)
		High	1.00	0.86 (0.62 - 1.20)	0.64 (0.47 - 0.88)	0.79 (0.58 - 1.07)
	NO_2	Low	**1.00**	**1.14 (0.96 - 1.34)**	**0.82 (0.66 - 1.03)**	**0.81 (0.65 - 1.00)**
		High	**1.00**	**0.82 (0.58 - 1.15)**	**0.60 (0.44 - 0.81)**	**0.75 (0.55 - 1.01)**
	Black Carbon	Low	1.00	0.94 (0.77 - 1.14)	1.06 (0.87 - 1.29)	0.95 (0.79 - 1.15)
		High	1.00	0.82 (0.64 - 1.04)	0.73 (0.57 - 0.93)	0.87 (0.69 - 1.09)
	$PM_{2.5}$	Low	**1.00**	**1.03 (0.85 - 1.24)**	**1.15 (0.94 - 1.41)**	**1.10 (0.91 - 1.33)**
		High	**1.00**	**0.97 (0.75 - 1.27)**	**0.69 (0.53 - 0.90)**	**0.81 (0.63 - 1.05)**
University	NO	Low	1.00	0.90 (0.77 - 1.06)	1.08 (0.90 - 1.29)	0.81 (0.64 - 1.03)
		High	1.00	0.83 (0.65 - 1.06)	0.74 (0.59 - 0.93)	0.84 (0.67 - 1.04)
	NO_2	Low	**1.00**	**1.03 (0.88 - 1.20)**	**1.00 (0.78 - 1.27)**	**0.95 (0.77 - 1.17)**
		High	**1.00**	**0.77 (0.59 - 0.99)**	**0.70 (0.55 - 0.88)**	**0.75 (0.60 - 0.95)**
	Black Carbon	Low	1.00	1.03 (0.86 - 1.23)	1.03 (0.85 - 1.25)	0.95 (0.79 - 1.15)
		High	1.00	0.76 (0.59 - 0.98)	0.90 (0.72 - 1.13)	0.99 (0.80 - 1.23)
	$PM_{2.5}$	Low	**1.00**	**1.12 (0.92 - 1.37)**	**1.02 (0.83 - 1.24)**	**1.20 (0.98 - 1.47)**
		High	**1.00**	**0.87 (0.67 - 1.12)**	**0.92 (0.73 - 1.14)**	**0.90 (0.73 - 1.12)**
Unemployment	NO	Low	**1.00**	**0.95 (0.78 - 1.15)**	**1.15 (0.96 - 1.39)**	**1.15 (0.94 - 1.41)**
		High	**1.00**	**0.96 (0.77 - 1.18)**	**0.74 (0.59 - 0.92)**	**0.80 (0.64 - 0.99)**
	NO_2	Low	1.00	1.10 (0.93 - 1.29)	0.94 (0.76 - 1.16)	0.90 (0.71 - 1.14)
		High	1.00	1.04 (0.83 - 1.31)	0.65 (0.52 - 0.82)	0.93 (0.76 - 1.14)
	Black Carbon	Low	1.00	0.90 (0.74 - 1.09)	1.07 (0.88 - 1.30)	0.99 (0.82 - 1.20)
		High	1.00	0.92 (0.73 - 1.16)	0.87 (0.70 - 1.10)	0.94 (0.75 - 1.17)
	$PM_{2.5}$	Low	1.00	1.06 (0.89 - 1.26)	0.98 (0.81 - 1.19)	1.05 (0.84 - 1.31)
		High	1.00	1.00 (0.86 - 1.39)	0.89 (0.70 - 1.14)	1.02 (0.80 - 1.31)
Family income	NO	Low	**1.00**	**0.90 (0.71 - 1.14)**	**0.64 (0.51 - 0.80)**	**0.72 (0.57 - 0.89)**
		High	**1.00**	**0.94 (0.77 - 1.15)**	**1.07 (0.88 - 1.30)**	**1.20 (0.97 - 1.49)**
	NO_2	Low	1.00	1.09 (0.85 - 1.41)	0.63 (0.50 - 0.80)	0.88 (0.71 - 1.10)
		High	1.00	0.91 (0.75 - 1.09)	0.88 (0.72 - 1.08)	1.00 (0.78 - 1.27)
	Black Carbon	Low	1.00	0.87 (0.67 - 1.12)	0.85 (0.67 - 1.08)	0.88 (0.69 - 1.12)
		High	1.00	0.83 (0.68 - 1.02)	1.00 (0.81 - 1.24)	1.02 (0.83 - 1.24)
	$PM_{2.5}$	Low	1.00	1.02 (0.77 - 1.34)	0.80 (0.61 - 1.06)	0.93 (0.71 - 1.22)
		High	1.00	0.96 (0.78 - 1.17)	1.01 (0.83 - 1.24)	0.95 (0.75 - 1.20)

Table 32. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering ACS health outcomes (cont.)

Health Outcome			ACS			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Personal income	NO	Low	**1.00**	**0.87 (0.71 - 1.08)**	**0.60 (0.48 - 0.74)**	**0.68 (0.55 - 0.84)**
		High	**1.00**	**0.93 (0.74 - 1.16)**	**0.93 (0.75 - 1.16)**	**0.93 (0.75 - 1.16)**
	NO_2	Low	1.00	0.97 (0.78 - 1.21)	0.55 (0.44 - 0.68)	0.78 (0.64 - 0.95)
		High	1.00	0.82 (0.66 - 1.01)	0.76 (0.61 - 0.94)	0.81 (0.65 - 1.01)
	Black Carbon	Low	1.00	0.86 (0.68 - 1.08)	0.75 (0.59 - 0.95)	0.82 (0.65 - 1.03)
		High	1.00	0.75 (0.59 - 0.95)	0.92 (0.75 - 1.14)	0.96 (0.78 - 1.16)
	$PM_{2.5}$	Low	1.00	1.13 (0.87 - 1.46)	0.81 (0.63 - 1.05)	0.87 (0.67 - 1.14)
		High	1.00	0.91 (0.72 - 1.14)	0.95 (0.77 - 1.18)	0.89 (0.72 - 1.11)
Governmental transfers	NO	Low	1.00	0.92 (0.76 - 1.13)	0.84 (0.68 - 1.04)	0.83 (0.66 - 1.04)
		High	1.00	0.89 (0.72 - 1.09)	0.75 (0.62 - 0.92)	0.71 (0.57 - 0.87)
	NO_2	Low	1.00	0.76 (0.63 - 0.92)	0.75 (0.60 - 0.93)	0.72 (0.57 - 0.92)
		High	1.00	1.11 (0.90 - 1.37)	0.67 (0.54 - 0.83)	0.88 (0.72 - 1.07)
	Black Carbon	Low	1.00	0.85 (0.68 - 1.05)	0.98 (0.79 - 1.21)	0.94 (0.76 - 1.16)
		High	1.00	0.94 (0.73 - 1.22)	0.99 (0.78 - 1.27)	0.88 (0.69 - 1.13)
	$PM_{2.5}$	Low	1.00	1.10 (0.89 - 1.36)	1.02 (0.82 - 1.27)	0.80 (0.63 - 1.01)
		High	1.00	1.05 (0.83 - 1.33)	0.79 (0.63 - 1.00)	0.97 (0.76 - 1.22)
Low income	NO	Low	**1.00**	**1.05 (0.87 - 1.26)**	**1.30 (1.08 - 1.56)**	**1.13 (0.91 - 1.41)**
		High	**1.00**	**1.06 (0.77 - 1.47)**	**0.86 (0.63 - 1.16)**	**0.86 (0.64 - 1.16)**
	NO_2	Low	1.00	1.12 (0.95 - 1.31)	1.04 (0.81 - 1.33)	1.08 (0.83 - 1.41)
		High	1.00	1.33 (0.84 - 2.09)	0.97 (0.63 - 1.49)	1.20 (0.79 - 1.81)
	Black Carbon	Low	1.00	1.02 (0.85 - 1.23)	1.12 (0.91 - 1.38)	1.04 (0.86 - 1.26)
		High	1.00	0.81 (0.62 - 1.07)	0.90 (0.70 - 1.16)	1.07 (0.84 - 1.37)
	$PM_{2.5}$	Low	1.00	1.10 (0.93 - 1.31)	1.13 (0.93 - 1.38)	1.14 (0.91 - 1.44)
		High	1.00	1.11 (0.84 - 1.47)	0.87 (0.66 - 1.15)	1.13 (0.87 - 1.47)
Home ownership	NO	Low	1.00	1.25 (0.96 - 1.61)	0.99 (0.78 - 1.27)	0.91 (0.72 - 1.15)
		High	1.00	0.93 (0.78 - 1.11)	1.05 (0.86 - 1.29)	1.02 (0.80 - 1.30)
	NO_2	Low	1.00	1.22 (0.89 - 1.66)	0.90 (0.67 - 1.20)	1.04 (0.79 - 1.35)
		High	1.00	0.92 (0.78 - 1.09)	1.00 (0.77 - 1.31)	0.93 (0.70 - 1.25)
	Black Carbon	Low	1.00	1.08 (0.78 - 1.48)	1.16 (0.87 - 1.55)	1.27 (0.95 - 1.69)
		High	1.00	0.95 (0.79 - 1.14)	1.17 (0.95 - 1.44)	0.95 (0.77 - 1.17)
	$PM_{2.5}$	Low	**1.00**	**1.00 (0.77 - 1.28)**	**0.99 (0.77 - 1.28)**	**1.02 (0.81 - 1.29)**
		High	**1.00**	**1.04 (0.87 - 1.24)**	**1.17 (0.96 - 1.43)**	**1.24 (0.97 - 1.57)**
Neighborhood stress	NO	Low	1.00	0.98 (0.81 - 1.19)	1.18 (0.97 - 1.43)	0.95 (0.77 - 1.18)
		High	1.00	1.06 (0.83 - 1.34)	0.86 (0.67 - 1.09)	0.77 (0.61 - 0.97)
	NO_2	Low	1.00	1.02 (0.86 - 1.20)	0.82 (0.66 - 1.02)	0.93 (0.71 - 1.21)
		High	1.00	1.21 (0.92 - 1.61)	0.82 (0.62 - 1.09)	1.02 (0.79 - 1.30)
	Black Carbon	Low	1.00	1.01 (0.84 - 1.22)	1.13 (0.91 - 1.39)	0.99 (0.81 - 1.22)
		High	1.00	0.86 (0.66 - 1.12)	0.93 (0.73 - 1.19)	1.03 (0.81 - 1.31)
	$PM_{2.5}$	Low	1.00	1.08 (0.90 - 1.31)	1.16 (0.95 - 1.42)	0.92 (0.73 - 1.16)
		High	1.00	1.12 (0.86 - 1.46)	1.00 (0.76 - 1.31)	1.19 (0.93 - 1.54)

Table 33. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering CHF health outcomes

Health Outcome			CHF			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Chinese population	NO	Low	1.00	0.82 (0.58 - 1.16)	0.62 (0.41 - 0.94)	0.70 (0.45 - 1.10)
		High	1.00	0.63 (0.31 - 1.27)	0.67 (0.35 - 1.27)	0.94 (0.52 - 1.73)
	NO_2	Low	1.00	0.85 (0.60 - 1.19)	0.70 (0.44 - 1.11)	0.88 (0.57 - 1.35)
		High	1.00	0.98 (0.41 - 2.33)	0.93 (0.42 - 2.05)	1.05 (0.47 - 2.32)
	Black Carbon	Low	1.00	1.75 (1.17 - 2.61)	1.37 (0.88 - 2.12)	0.90 (0.57 - 1.42)
		High	1.00	0.96 (0.53 - 1.73)	1.19 (0.69 - 2.07)	1.74 (1.04 - 2.91)
	$PM_{2.5}$	Low	**1.00**	**1.34 (0.90 - 1.99)**	**1.16 (0.76 - 1.77)**	**1.10 (0.70 - 1.72)**
		High	**1.00**	**0.88 (0.47 - 1.64)**	**0.78 (0.43 - 1.42)**	**0.92 (0.52 - 1.63)**
University	NO	Low	1.00	0.99 (0.69 - 1.42)	0.85 (0.57 - 1.26)	0.86 (0.56 - 1.32)
		High	1.00	0.64 (0.38 - 1.11)	0.70 (0.43 - 1.15)	0.97 (0.62 - 1.53)
	NO_2	Low	1.00	0.70 (0.48 - 1.01)	0.67 (0.43 - 1.06)	0.98 (0.68 - 1.43)
		High	1.00	0.64 (0.37 - 1.11)	0.65 (0.39 - 1.08)	0.94 (0.59 - 1.52)
	Black Carbon	Low	**1.00**	**1.83 (1.14 - 2.94)**	**1.53 (0.95 - 2.48)**	**1.43 (0.88 - 2.31)**
		High	**1.00**	**0.75 (0.45 - 1.23)**	**0.76 (0.48 - 1.21)**	**0.88 (0.57 - 1.37)**
	$PM_{2.5}$	Low	1.00	0.99 (0.63 - 1.55)	1.13 (0.74 - 1.74)	0.99 (0.64 - 1.56)
		High	1.00	1.29 (0.78 - 2.11)	1.05 (0.64 - 1.72)	0.95 (0.59 - 1.53)
Employment	NO	Low	1.00	0.72 (0.48 - 1.08)	0.81 (0.55 - 1.2)	0.82 (0.56 - 1.21)
		High	1.00	0.87 (0.54 - 1.38)	0.85 (0.54 - 1.36)	0.98 (0.63 - 1.53)
	NO_2	Low	1.00	0.70 (0.46 - 1.06)	0.65 (0.44 - 0.95)	0.73 (0.51 - 1.04)
		High	1.00	0.90 (0.58 - 1.4)	0.79 (0.48 - 1.3)	0.94 (0.6 - 1.46)
	Black Carbon	Low	1.00	1.21 (0.78 - 1.87)	1.04 (0.68 - 1.59)	1.33 (0.89 - 1.99)
		High	1.00	1.29 (0.81 - 2.06)	1.31 (0.81 - 2.11)	1.05 (0.64 - 1.72)
	$PM_{2.5}$	Low	1.00	0.89 (0.6 - 1.32)	0.80 (0.53 - 1.2)	0.89 (0.61 - 1.31)
		High	1.00	1.04 (0.65 - 1.67)	1.14 (0.72 - 1.81)	0.80 (0.48 - 1.32)
Family income	NO	Low	1.00	0.56 (0.35 - 0.89)	0.70 (0.47 - 1.05)	0.76 (0.52 - 1.12)
		High	1.00	0.84 (0.52 - 1.38)	1.03 (0.65 - 1.64)	1.37 (0.87 - 2.18)
	NO_2	Low	1.00	0.51 (0.32 - 0.83)	0.49 (0.32 - 0.74)	0.68 (0.47 - 0.97)
		High	1.00	0.92 (0.59 - 1.45)	1.00 (0.64 - 1.59)	1.17 (0.70 - 1.97)
	Black Carbon	Low	1.00	**1.75 (1.00 - 3.07)**	**1.35 (0.78 - 2.33)**	**1.61 (0.95 - 2.73)**
		High	1.00	**0.89 (0.58 - 1.37)**	**0.92 (0.58 - 1.46)**	**0.72 (0.44 - 1.16)**
	$PM_{2.5}$	Low	1.00	**1.06 (0.65 - 1.72)**	**0.92 (0.57 - 1.50)**	**0.95 (0.59 - 1.53)**
		High	1.00	**1.16 (0.74 - 1.83)**	**1.26 (0.80 - 1.99)**	**1.08 (0.65 - 1.79)**
Personal income	NO	Low	1.00	0.48 (0.29 - 0.78)	0.65 (0.43 - 0.98)	0.63 (0.42 - 0.95)
		High	1.00	0.70 (0.42 - 1.14)	0.72 (0.45 - 1.16)	1.03 (0.66 - 1.62)
	NO_2	Low	1.00	0.44 (0.27 - 0.73)	0.46 (0.30 - 0.71)	0.62 (0.42 - 0.92)
		High	1.00	0.65 (0.40 - 1.05)	0.83 (0.52 - 1.31)	0.97 (0.59 - 1.58)
	Black Carbon	Low	1.00	**1.66 (0.93 - 2.97)**	**1.65 (0.94 - 2.89)**	**1.76 (1.02 - 3.04)**
		High	1.00	**0.82 (0.51 - 1.29)**	**0.79 (0.49 - 1.29)**	**0.83 (0.52 - 1.31)**
	$PM_{2.5}$	Low	1.00	**1.06 (0.61 - 1.84)**	**0.78 (0.45 - 1.35)**	**1.02 (0.61 - 1.73)**
		High	1.00	**1.19 (0.74 - 1.93)**	**1.15 (0.70 - 1.90)**	**1.25 (0.76 - 2.04)**

Table 33. Comparison between traffic pollution HR for low and high levels of DA-SES variables, when considering CHF health outcomes (cont.)

Health Outcome			CHF			
DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Transportation	NO	Low	**1.00**	**0.85 (0.57 - 1.27)**	**0.82 (0.53 - 1.27)**	**0.65 (0.40 - 1.06)**
		High	**1.00**	**0.92 (0.43 - 1.96)**	**1.13 (0.56 - 2.29)**	**1.21 (0.61 - 2.42)**
	NO_2	Low	1.00	0.73 (0.49 - 1.09)	0.64 (0.38 - 1.10)	1.18 (0.74 - 1.90)
		High	1.00	1.07 (0.40 - 2.84)	0.97 (0.39 - 2.44)	1.01 (0.41 - 2.48)
	Black Carbon	Low	1.00	1.58 (1.05 - 2.40)	1.45 (0.92 - 2.30)	0.96 (0.59 - 1.58)
		High	1.00	0.61 (0.33 - 1.12)	0.83 (0.49 - 1.41)	0.98 (0.58 - 1.66)
	$PM_{2.5}$	Low	**1.00**	**1.35 (0.87 - 2.10)**	**1.44 (0.92 - 2.27)**	**1.08 (0.65 - 1.79)**
		High	**1.00**	**1.23 (0.72 - 2.11)**	**0.94 (0.54 - 1.63)**	**0.94 (0.55 - 1.58)**
Low income	NO	Low	1.00	0.73 (0.47 - 1.12)	0.61 (0.38 - 0.99)	1.11 (0.72 - 1.71)
		High	1.00	0.63 (0.37 - 1.07)	0.86 (0.54 - 1.37)	0.81 (0.52 - 1.28)
	NO_2	Low	1.00	0.65 (0.43 - 0.97)	0.89 (0.57 - 1.41)	0.72 (0.40 - 1.27)
		High	1.00	0.70 (0.40 - 1.23)	0.59 (0.35 - 0.99)	0.71 (0.44 - 1.14)
	Black Carbon	Low	**1.00**	**1.39 (0.92 - 2.08)**	**1.10 (0.68 - 1.79)**	**0.90 (0.55 - 1.47)**
		High	**1.00**	**2.58 (1.28 - 5.18)**	**2.27 (1.16 - 4.45)**	**2.69 (1.38 - 5.23)**
	$PM_{2.5}$	Low	1.00	1.24 (0.82 - 1.89)	1.24 (0.78 - 1.97)	1.04 (0.59 - 1.82)
		High	1.00	1.39 (0.78 - 2.49)	1.18 (0.66 - 2.12)	1.38 (0.80 - 2.38)
Home ownership	NO	Low	1.00	0.79 (0.47 - 1.33)	0.80 (0.49 - 1.30)	0.77 (0.49 - 1.23)
		High	1.00	0.78 (0.5 - 1.22)	0.81 (0.50 - 1.30)	0.79 (0.47 - 1.30)
	NO_2	Low	1.00	0.79 (0.46 - 1.35)	0.55 (0.34 - 0.91)	0.58 (0.37 - 0.92)
		High	1.00	0.87 (0.57 - 1.33)	0.65 (0.37 - 1.13)	1.37 (0.83 - 2.25)
	Black Carbon	Low	1.00	1.46 (0.83 - 2.57)	1.06 (0.61 - 1.82)	1.35 (0.80 - 2.27)
		High	1.00	1.51 (0.96 - 2.38)	1.28 (0.77 - 2.15)	1.26 (0.76 - 2.10)
	$PM_{2.5}$	Low	1.00	1.36 (0.80 - 2.29)	1.15 (0.68 - 1.94)	1.10 (0.67 - 1.81)
		High	1.00	1.15 (0.74 - 1.77)	1.14 (0.70 - 1.84)	0.57 (0.29 - 1.10)
Income variation	NO	Low	1.00	0.77 (0.50 - 1.17)	0.78 (0.50 - 1.20)	0.88 (0.59 - 1.30)
		High	1.00	0.74 (0.45 - 1.22)	0.90 (0.56 - 1.44)	1.28 (0.82 - 1.99)
	NO_2	Low	1.00	0.77 (0.05 - 1.18)	0.52 (0.32 - 0.87)	0.90 (0.62 - 1.30)
		High	1.00	0.91 (0.56 - 1.47)	0.96 (0.61 - 1.52)	0.99 (0.60 - 1.65)
	Black Carbon	Low	**1.00**	**1.67 (1.03 - 2.73)**	**1.43 (0.88 - 2.3)**	**1.29 (0.80 - 2.06)**
		High	**1.00**	**0.78 (0.50 - 1.2)**	**0.71 (0.45 - 1.14)**	**0.81 (0.52 - 1.27)**
	$PM_{2.5}$	Low	**1.00**	**1.28 (0.79 - 2.06)**	**1.36 (0.84 - 2.2)**	**1.07 (0.67 - 1.70)**
		High	**1.00**	**0.82 (0.52 - 1.29)**	**1.08 (0.70 - 1.67)**	**0.82 (0.51 - 1.31)**
Management	NO	Low	1.00	0.74 (0.49 - 1.13)	0.70 (0.45 - 1.08)	0.93 (0.62 - 1.39)
		High	1.00	0.89 (0.55 - 1.45)	0.99 (0.63 - 1.57)	1.08 (0.68 - 1.71)
	NO_2	Low	1.00	0.65 (0.42 - 1.01)	0.66 (0.43 - 1.01)	0.76 (0.52 - 1.13)
		High	1.00	0.80 (0.49 - 1.29)	1.13 (0.72 - 1.79)	1.16 (0.72 - 1.87)
	Black Carbon	Low	1.00	1.14 (0.71 - 1.85)	1.07 (0.67 - 1.72)	1.36 (0.86 - 2.15)
		High	1.00	1.01 (0.65 - 1.57)	0.90 (0.56 - 1.45)	0.92 (0.58 - 1.45)
	$PM_{2.5}$	Low	**1.00**	**0.76 (0.48 - 1.19)**	**0.88 (0.57 - 1.35)**	**0.74 (0.47 - 1.16)**
		High	**1.00**	**1.36 (0.87 - 2.10)**	**1.04 (0.64 - 1.69)**	**1.11 (0.70 - 1.77)**

Table 34. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering CHF health outcomes

Health Outcome			CHF			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Other language	NO	Low	1.00	0.73 (0.48 - 1.10)	0.58 (0.37 - 0.89)	0.92 (0.61 - 1.38)
		High	1.00	0.55 (0.26 - 1.14)	0.88 (0.46 - 1.70)	0.93 (0.49 - 1.77)
	NO_2	Low	1.00	0.83 (0.58 - 1.19)	0.81 (0.50 - 1.31)	0.73 (0.45 - 1.16)
		High	1.00	0.77 (0.35 - 1.67)	0.79 (0.40 - 1.55)	0.75 (0.38 - 1.46)
	Black Carbon	Low	1.00	1.38 (0.89 - 2.14)	1.48 (0.94 - 2.32)	1.19 (0.77 - 1.84)
		High	1.00	1.09 (0.65 - 1.83)	0.94 (0.57 - 1.58)	1.39 (0.89 - 2.19)
	$PM_{2.5}$	Low	**1.00**	**1.25 (0.80 - 1.95)**	**1.77 (1.13 - 2.76)**	**1.51 (0.97 - 2.33)**
		High	**1.00**	**1.10 (0.62 - 1.94)**	**0.86 (0.49 - 1.52)**	**0.97 (0.57 - 1.66)**
Linguistic isolation	NO	Low	1.00	0.54 (0.34 - 0.86)	0.58 (0.37 - 0.91)	0.99 (0.66 - 1.47)
		High	1.00	0.69 (0.30 - 1.56)	0.98 (0.47 - 2.06)	1.11 (0.53 - 2.3)
	NO_2	Low	1.00	0.62 (0.41 - 0.94)	0.80 (0.51 - 1.26)	0.70 (0.45 - 1.10)
		High	1.00	0.79 (0.35 - 1.76)	0.80 (0.40 - 1.62)	0.76 (0.38 - 1.54)
	Black Carbon	Low	1.00	1.11 (0.71 - 1.75)	1.08 (0.68 - 1.71)	1.11 (0.73 - 1.70)
		High	1.00	1.51 (0.83 - 2.76)	1.27 (0.69 - 2.35)	2.04 (1.17 - 3.56)
	$PM_{2.5}$	Low	**1.00**	**1.40 (0.89 - 2.21)**	**1.82 (1.13 - 2.91)**	**1.80 (1.14 - 2.83)**
		High	**1.00**	**1.37 (0.74 - 2.51)**	**1.10 (0.60 - 1.99)**	**1.14 (0.64 - 2.05)**
University	NO	Low	1.00	0.90 (0.65 - 1.26)	0.76 (0.51 - 1.14)	0.54 (0.30 - 0.94)
		High	1.00	0.67 (0.40 - 1.12)	0.72 (0.46 - 1.14)	1.03 (0.68 - 1.57)
	NO_2	Low	1.00	0.86 (0.62 - 1.19)	0.58 (0.31 - 1.08)	0.70 (0.43 - 1.13)
		High	1.00	0.56 (0.32 - 0.99)	0.70 (0.43 - 1.13)	0.93 (0.59 - 1.47)
	Black Carbon	Low	**1.00**	**2.10 (1.36 - 3.22)**	**1.61 (1.01 - 2.57)**	**1.19 (0.74 - 1.91)**
		High	**1.00**	**0.92 (0.57 - 1.49)**	**0.93 (0.60 - 1.45)**	**0.94 (0.61 - 1.44)**
	$PM_{2.5}$	Low	1.00	1.18 (0.77 - 1.81)	1.07 (0.69 - 1.64)	0.95 (0.60 - 1.49)
		High	1.00	1.09 (0.68 - 1.74)	1.04 (0.68 - 1.59)	0.92 (0.60 - 1.41)
Unemployment	NO	Low	1.00	0.86 (0.56 - 1.32)	0.89 (0.57 - 1.38)	1.09 (0.70 - 1.69)
		High	1.00	0.50 (0.30 - 0.82)	0.74 (0.47 - 1.14)	0.81 (0.53 - 1.24)
	NO_2	Low	1.00	0.70 (0.47 - 1.05)	0.91 (0.58 - 1.43)	0.90 (0.57 - 1.44)
		High	1.00	0.56 (0.34 - 0.93)	0.59 (0.38 - 0.91)	0.51 (0.34 - 0.78)
	Black Carbon	Low	1.00	1.21 (0.78 - 1.87)	1.05 (0.66 - 1.66)	1.04 (0.67 - 1.60)
		High	1.00	1.80 (1.00 - 3.21)	1.13 (0.62 - 2.06)	1.74 (0.98 - 3.09)
	$PM_{2.5}$	Low	**1.00**	**0.85 (0.56 - 1.29)**	**1.11 (0.73 - 1.66)**	**0.70 (0.41 - 1.22)**
		High	**1.00**	**1.67 (0.95 - 2.94)**	**1.27 (0.72 - 2.25)**	**1.23 (0.68 - 2.22)**
Family income	NO	Low	1.00	0.48 (0.27 - 0.84)	0.69 (0.44 - 1.07)	0.82 (0.53 - 1.26)
		High	1.00	0.72 (0.46 - 1.12)	0.65 (0.41 - 1.02)	1.22 (0.80 - 1.86)
	NO_2	Low	1.00	0.55 (0.31 - 0.97)	0.64 (0.41 - 1.00)	0.67 (0.44 - 1.01)
		High	1.00	0.73 (0.48 - 1.11)	0.83 (0.54 - 1.28)	1.22 (0.76 - 1.96)
	Black Carbon	Low	**1.00**	**1.54 (0.85 - 2.76)**	**1.09 (0.60 - 1.96)**	**1.53 (0.87 - 2.70)**
		High	**1.00**	**0.99 (0.66 - 1.48)**	**0.75 (0.46 - 1.23)**	**0.74 (0.48 - 1.16)**
	$PM_{2.5}$	Low	**1.00**	**1.35 (0.70 - 2.60)**	**1.27 (0.67 - 2.38)**	**1.32 (0.71 - 2.46)**
		High	**1.00**	**1.09 (0.70 - 1.68)**	**1.10 (0.71 - 1.69)**	**0.84 (0.49 - 1.42)**

Table 34. Comparison between traffic pollution HR for low and high levels of Neighborhood-SES variables, when considering CHF health outcomes (cont.)

Health Outcome			CHF			
Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Personal income	NO	Low	1.00	0.57 (0.35 - 0.92)	0.69 (0.46 - 1.06)	0.84 (0.55 - 1.26)
		High	1.00	0.70 (0.43 - 1.15)	0.87 (0.55 - 1.37)	1.14 (0.73 - 1.77)
	NO_2	Low	1.00	0.67 (0.42 - 1.08)	0.66 (0.44 - 0.99)	0.62 (0.42 - 0.93)
		High	1.00	0.82 (0.51 - 1.34)	0.86 (0.55 - 1.37)	1.16 (0.73 - 1.83)
	Black Carbon	Low	**1.00**	**1.62 (0.92 - 2.85)**	**1.07 (0.60 - 1.93)**	**1.57 (0.91 - 2.71)**
		High	**1.00**	**0.98 (0.63 - 1.52)**	**0.67 (0.41 - 1.08)**	**0.94 (0.63 - 1.41)**
	$PM_{2.5}$	Low	**1.00**	**1.91 (1.04 - 3.52)**	**1.35 (0.73 - 2.48)**	**1.47 (0.80 - 2.73)**
		High	**1.00**	**1.33 (0.83 - 2.14)**	**1.16 (0.73 - 1.84)**	**1.13 (0.72 - 1.77)**
Governmental transfers	NO	Low	1.00	0.69 (0.43 - 1.13)	0.62 (0.37 - 1.03)	0.93 (0.58 - 1.49)
		High	1.00	0.61 (0.39 - 0.97)	0.74 (0.49 - 1.11)	0.95 (0.63 - 1.42)
	NO_2	Low	1.00	0.71 (0.44 - 1.15)	0.61 (0.36 - 1.05)	1.29 (0.81 - 2.05)
		High	1.00	0.70 (0.45 - 1.10)	0.69 (0.46 - 1.04)	0.74 (0.50 - 1.09)
	Black Carbon	Low	**1.00**	**0.88 (0.54 - 1.44)**	**0.82 (0.49 - 1.37)**	**0.91 (0.57 - 1.46)**
		High	**1.00**	**1.92 (1.00 - 3.68)**	**1.42 (0.74 - 2.72)**	**1.93 (1.02 - 3.65)**
	$PM_{2.5}$	Low	**1.00**	**0.63 (0.35 - 1.14)**	**0.78 (0.46 - 1.32)**	**0.93 (0.58 - 1.49)**
		High	**1.00**	**1.44 (0.83 - 2.51)**	**1.37 (0.80 - 2.37)**	**1.63 (0.95 - 2.81)**
Low income	NO	Low	**1.00**	**0.63 (0.40 - 0.99)**	**0.84 (0.53 - 1.32)**	**1.04 (0.66 - 1.63)**
		High	**1.00**	**0.77 (0.34 - 1.73)**	**1.08 (0.52 - 2.22)**	**1.39 (0.69 - 2.77)**
	NO_2	Low	1.00	0.70 (0.47 - 1.05)	1.12 (0.68 - 1.85)	0.81 (0.44 - 1.49)
		High	1.00	0.98 (0.35 - 2.73)	1.10 (0.44 - 2.77)	1.12 (0.45 - 2.77)
	Black Carbon	Low	**1.00**	**1.38 (0.93 - 2.05)**	**0.97 (0.58 - 1.61)**	**0.89 (0.56 - 1.41)**
		High	**1.00**	**1.80 (0.91 - 3.57)**	**1.48 (0.76 - 2.88)**	**2.02 (1.06 - 3.86)**
	$PM_{2.5}$	Low	1.00	0.95 (0.62 - 1.44)	1.49 (0.98 - 2.29)	0.98 (0.55 - 1.73)
		High	1.00	1.17 (0.66 - 2.07)	0.99 (0.57 - 1.74)	0.97 (0.56 - 1.69)
Home ownership	NO	Low	1.00	0.62 (0.32 - 1.20)	1.28 (0.77 - 2.12)	1.29 (0.79 - 2.10)
		High	1.00	0.67 (0.43 - 1.05)	0.86 (0.52 - 1.42)	0.99 (0.58 - 1.70)
	NO_2	Low	1.00	1.24 (0.62 - 2.46)	0.98 (0.52 - 1.85)	1.23 (0.69 - 2.19)
		High	1.00	0.69 (0.45 - 1.07)	1.00 (0.54 - 1.84)	1.14 (0.63 - 2.06)
	Black Carbon	Low	**1.00**	**2.28 (0.95 - 5.52)**	**2.37 (1.03 - 5.49)**	**2.91 (1.26 - 6.72)**
		High	**1.00**	**1.32 (0.87 - 2.00)**	**0.95 (0.56 - 1.64)**	**0.72 (0.41 - 1.24)**
	$PM_{2.5}$	Low	**1.00**	**1.38 (0.79 - 2.43)**	**1.81 (1.04 - 3.16)**	**1.47 (0.87 - 2.50)**
		High	**1.00**	**0.81 (0.51 - 1.27)**	**1.40 (0.90 - 2.18)**	**0.73 (0.37 - 1.43)**
Neighborhood stress	NO	Low	1.00	0.58 (0.35 - 0.97)	0.80 (0.50 - 1.28)	0.98 (0.62 - 1.54)
		High	1.00	0.65 (0.37 - 1.14)	0.88 (0.53 - 1.46)	0.96 (0.61 - 1.53)
	NO_2	Low	1.00	0.74 (0.49 - 1.11)	0.91 (0.56 - 1.46)	0.60 (0.31 - 1.19)
		High	1.00	0.60 (0.33 - 1.10)	0.70 (0.42 - 1.18)	0.71 (0.44 - 1.14)
	Black Carbon	Low	**1.00**	**1.14 (0.74 - 1.75)**	**0.97 (0.57 - 1.64)**	**0.89 (0.54 - 1.46)**
		High	**1.00**	**2.37 (1.15 - 4.88)**	**1.91 (0.94 - 3.87)**	**2.30 (1.14 - 4.64)**
	$PM_{2.5}$	Low	1.00	1.11 (0.69 - 1.78)	1.70 (1.07 - 2.71)	0.90 (0.49 - 1.63)
		High	1.00	1.08 (0.63 - 1.86)	1.09 (0.64 - 1.87)	1.02 (0.61 - 1.71)

Table 35. Comparison between HR of different road proximity categories for low and high levels of DA-SES variables, when considering ACS and CHF health outcomes

DA-level SES	Pollutant	SES Level	Health Outcomes	
			ACS	CHF
Chinese population	Within 50 m from expressways and primary highways (I)	Low	1.40 (1.00 - 1.96)	0.51 (0.16 - 1.60)
		High	0.76 (0.31 - 1.82)	1.32 (0.33 - 5.32)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.56 (1.19 - 2.05)	0.81 (0.38 - 1.71)
		High	0.70 (0.47 - 1.04)	1.57 (0.88 - 2.79)
	Within 50 m from secondary highways and major roads (III)	Low	0.93 (0.75 - 1.15)	1.17 (0.78 - 1.75)
		High	1.24 (0.96 - 1.58)	1.60 (1.01 - 2.53)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.14 (0.97 - 1.34)	0.69 (0.46 - 1.04)
		High	0.97 (0.80 - 1.18)	0.87 (0.58 - 1.32)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.17 (0.99 - 1.38)	0.93 (0.65 - 1.35)
		High	1.03 (0.83 - 1.28)	1.74 (1.18 - 2.55)
University	Within 50 m from expressways and primary highways (I)	Low	1.13 (0.81 - 1.59)	0.83 (0.37 - 1.87)
		High	1.22 (0.61 - 2.46)	0.60 (0.08 - 4.29)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.99 (0.76 - 1.29)	0.54 (0.27 - 1.10)
		High	0.96 (0.66 - 1.40)	1.04 (0.51 - 2.13)
	Within 50 m from secondary highways and major roads (III)	Low	1.03 (0.84 - 1.27)	1.37 (0.93 - 2.00)
		High	1.09 (0.84 - 1.41)	1.33 (0.84 - 2.12)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.03 (0.86 - 1.22)	0.89 (0.60 - 1.32)
		High	1.03 (0.86 - 1.24)	1.09 (0.76 - 1.56)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.07 (0.91 - 1.25)	1.04 (0.74 - 1.45)
		High	1.05 (0.85 - 1.31)	1.13 (0.74 - 1.71)
Employment	Within 50 m from expressways and primary highways (I)	Low	1.25 (0.86 - 1.81)	1.58 (0.81 - 3.07)
		High	1.24 (0.66 - 2.31)	0.00 (0.00 - ∞)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.06 (0.82 - 1.38)	0.85 (0.49 - 1.49)
		High	1.22 (0.86 - 1.75)	1.09 (0.51 - 2.33)
	Within 50 m from secondary highways and major roads (III)	Low	1.10 (0.91 - 1.33)	1.32 (0.94 - 1.86)
		High	0.96 (0.74 - 1.26)	1.65 (1.06 - 2.57)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.94 (0.80 - 1.10)	0.83 (0.60 - 1.15)
		High	0.89 (0.73 - 1.10)	0.71 (0.45 - 1.12)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.14 (0.98 - 1.33)	1.28 (0.95 - 1.71)
		High	1.05 (0.85 - 1.31)	1.29 (0.86 - 1.94)
Family income	Within 50 m from expressways and primary highways (I)	Low	1.38 (1.02 - 1.87)	1.35 (0.72 - 2.56)
		High	1.23 (0.61 - 2.47)	0.66 (0.09 - 4.73)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.97 (0.76 - 1.24)	1.12 (0.70 - 1.80)
		High	1.06 (0.73 - 1.55)	0.82 (0.34 - 2.01)
	Within 50 m from secondary highways and major roads (III)	Low	1.04 (0.85 - 1.26)	1.33 (0.91 - 1.93)
		High	1.00 (0.77 - 1.3)	1.12 (0.67 - 1.86)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.01 (0.86 - 1.18)	0.69 (0.48 - 0.99)
		High	1.03 (0.86 - 1.24)	0.96 (0.65 - 1.42)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.08 (0.92 - 1.26)	1.48 (1.10 - 1.99)
		High	1.04 (0.84 - 1.29)	1.02 (0.65 - 1.59)
Personal income	Within 50 m from expressways and primary highways (I)	Low	1.44 (1.03 - 2.02)	1.72 (0.91 - 3.25)
		High	1.52 (0.86 - 2.68)	0.56 (0.08 - 4.03)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.87 (0.66 - 1.15)	0.85 (0.49 - 1.50)
		High	0.86 (0.58 - 1.29)	1.11 (0.52 - 2.38)
	Within 50 m from secondary highways and major roads (III)	Low	0.98 (0.79 - 1.22)	1.42 (0.96 - 2.10)
		High	0.94 (0.72 - 1.23)	1.05 (0.61 - 1.80)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.98 (0.83 - 1.16)	0.79 (0.55 - 1.14)
		High	1.11 (0.93 - 1.32)	1.12 (0.76 - 1.63)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.01 (0.86 - 1.20)	1.37 (1.00 - 1.89)
		High	0.97 (0.78 - 1.20)	1.04 (0.66 - 1.64)

Table 35. Comparison between HR of different road proximity categories for low and high levels of DA-SES variables, when considering ACS and CHF health outcomes (cont.)

DA-level SES	Pollutant	Level	Health Outcomes	
			ACS	CHF
Transportation	Within 50 m from expressways and primary highways (I)	Low	1.09 (0.64 - 1.85)	1.23 (0.39 - 3.84)
		High	1.44 (1.00 - 2.06)	1.48 (0.73 - 3.01)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.11 (0.79 - 1.57)	1.10 (0.54 - 2.25)
		High	1.00 (0.76 - 1.31)	1.36 (0.84 - 2.19)
	Within 50 m from secondary highways and major roads (III)	Low	1.02 (0.81 - 1.28)	0.74 (0.42 - 1.28)
		High	1.21 (0.98 - 1.50)	1.47 (1.00 - 2.16)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.99 (0.81 - 1.20)	1.02 (0.67 - 1.57)
		High	1.00 (0.85 - 1.19)	0.91 (0.65 - 1.27)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.07 (0.88 - 1.29)	0.90 (0.59 - 1.38)
		High	1.18 (0.99 - 1.40)	1.65 (1.20 - 2.27)
Low income	Within 50 m from expressways and primary highways (I)	Low	1.73 (1.11 - 2.70)	0.86 (0.21 - 3.46)
		High	1.23 (0.86 - 1.75)	1.35 (0.63 - 2.88)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.29 (0.93 - 1.80)	1.27 (0.62 - 2.59)
		High	1.02 (0.79 - 1.32)	1.45 (0.89 - 2.37)
	Within 50 m from secondary highways and major roads (III)	Low	1.03 (0.82 - 1.30)	1.30 (0.82 - 2.06)
		High	1.08 (0.88 - 1.33)	1.54 (1.05 - 2.28)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.06 (0.88 - 1.27)	0.87 (0.56 - 1.35)
		High	1.07 (0.92 - 1.25)	0.88 (0.62 - 1.24)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.17 (0.97 - 1.41)	1.21 (0.81 - 1.83)
		High	1.09 (0.93 - 1.28)	1.77 (1.29 - 2.44)
Home ownership	Within 50 m from expressways and primary highways (I)	Low	1.19 (0.84 - 1.70)	1.28 (0.63 - 2.59)
		High	1.83 (1.19 - 2.79)	1.16 (0.37 - 3.65)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.06 (0.83 - 1.36)	1.31 (0.84 - 2.07)
		High	1.13 (0.80 - 1.59)	0.63 (0.23 - 1.69)
	Within 50 m from secondary highways and major roads (III)	Low	0.99 (0.81 - 1.21)	1.31 (0.91 - 1.87)
		High	1.07 (0.84 - 1.36)	1.18 (0.70 - 2.00)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.98 (0.84 - 1.15)	0.95 (0.70 - 1.29)
		High	1.15 (0.96 - 1.39)	0.95 (0.60 - 1.52)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.87 - 1.20)	1.46 (1.09 - 1.97)
		High	1.20 (0.99 - 1.45)	1.03 (0.65 - 1.62)
Income variation	Within 50 m from expressways and primary highways (I)	Low	1.17 (0.80 - 1.72)	1.15 (0.51 - 2.6)
		High	1.20 (0.57 - 2.53)	0.74 (0.10 - 5.30)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.98 (0.74 - 1.29)	0.83 (0.44 - 1.57)
		High	1.11 (0.78 - 1.6)	1.02 (0.48 - 2.18)
	Within 50 m from secondary highways and major roads (III)	Low	1.10 (0.9 - 1.34)	1.54 (1.06 - 2.23)
		High	1.04 (0.81 - 1.33)	1.19 (0.76 - 1.88)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.95 (0.79 - 1.13)	0.66 (0.43 - 1.01)
		High	1.01 (0.84 - 1.21)	0.95 (0.65 - 1.38)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.07 (0.91 - 1.27)	1.39 (1.01 - 1.93)
		High	1.10 (0.89 - 1.35)	1.16 (0.78 - 1.73)
Management	Within 50 m from expressways and primary highways (I)	Low	1.20 (0.83 - 1.76)	1.35 (0.63 - 2.87)
		High	1.06 (0.59 - 1.93)	0.94 (0.23 - 3.8)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.00 (0.76 - 1.32)	0.98 (0.56 - 1.72)
		High	0.96 (0.69 - 1.34)	1.38 (0.75 - 2.56)
	Within 50 m from secondary highways and major roads (III)	Low	1.06 (0.85 - 1.31)	1.55 (1.05 - 2.28)
		High	1.08 (0.85 - 1.38)	1.29 (0.81 - 2.08)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.94 (0.80 - 1.12)	0.75 (0.51 - 1.10)
		High	0.87 (0.73 - 1.05)	0.97 (0.66 - 1.43)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.05 (0.89 - 1.25)	1.40 (1.01 - 1.95)
		High	1.07 (0.88 - 1.30)	1.26 (0.85 - 1.88)

Table 36. Comparison between HR of different road proximity categories for low and high levels of Neighborhood-SES variables, when considering ACS and CHF health outcomes

Neighborhood-level SES	Pollutant	Level	Health Outcomes	
			ACS	CHF
Other language	Within 50 m from expressways and primary highways (I)	Low	1.15 (0.77 - 1.72)	0.69 (0.22 - 2.15)
		High	1.23 (0.75 - 2.02)	1.65 (0.67 - 4.02)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.36 (1.01 - 1.81)	0.69 (0.30 - 1.55)
		High	0.79 (0.55 - 1.12)	1.24 (0.69 - 2.24)
	Within 50 m from secondary highways and major roads (III)	Low	0.98 (0.79 - 1.2)	1.42 (0.95 - 2.10)
		High	1.09 (0.86 - 1.37)	1.45 (0.94 - 2.23)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.06 (0.89 - 1.26)	0.60 (0.38 - 0.94)
		High	0.94 (0.79 - 1.13)	0.91 (0.63 - 1.33)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.12 (0.95 - 1.32)	1.24 (0.87 - 1.77)
		High	0.97 (0.80 - 1.19)	1.47 (1.03 - 2.11)
Linguistic isolation	Within 50 m from expressways and primary highways (I)	Low	1.22 (0.81 - 1.85)	1.02 (0.38 - 2.75)
		High	1.15 (0.66 - 1.98)	1.93 (0.79 - 4.69)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.27 (0.93 - 1.74)	0.49 (0.18 - 1.33)
		High	0.81 (0.57 - 1.15)	1.24 (0.69 - 2.23)
	Within 50 m from secondary highways and major roads (III)	Low	1.02 (0.82 - 1.26)	1.67 (1.13 - 2.48)
		High	1.07 (0.85 - 1.35)	1.42 (0.93 - 2.17)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.06 (0.89 - 1.25)	0.58 (0.37 - 0.92)
		High	0.94 (0.79 - 1.12)	0.86 (0.60 - 1.25)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.13 (0.95 - 1.34)	1.37 (0.95 - 1.96)
		High	0.96 (0.79 - 1.17)	1.48 (1.04 - 2.11)
University	Within 50 m from expressways and primary highways (I)	Low	1.12 (0.78 - 1.59)	0.60 (0.22 - 1.62)
		High	1.19 (0.67 - 2.11)	0.73 (0.18 - 2.95)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.10 (0.81 - 1.50)	0.97 (0.48 - 1.96)
		High	1.03 (0.74 - 1.42)	0.88 (0.45 - 1.72)
	Within 50 m from secondary highways and major roads (III)	Low	1.00 (0.82 - 1.22)	1.09 (0.73 - 1.62)
		High	1.07 (0.85 - 1.36)	1.42 (0.96 - 2.11)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.14 (0.95 - 1.35)	0.84 (0.54 - 1.28)
		High	1.02 (0.85 - 1.21)	1.06 (0.77 - 1.47)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.05 (0.89 - 1.24)	1.03 (0.73 - 1.45)
		High	1.10 (0.91 - 1.34)	1.17 (0.82 - 1.67)
Unemployment	Within 50 m from expressways and primary highways (I)	Low	1.26 (0.79 - 2.02)	1.00 (0.32 - 3.15)
		High	1.29 (0.90 - 1.86)	1.81 (0.92 - 3.55)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.39 (1.03 - 1.87)	0.75 (0.33 - 1.71)
		High	0.91 (0.68 - 1.22)	0.98 (0.53 - 1.82)
	Within 50 m from secondary highways and major roads (III)	Low	1.02 (0.82 - 1.26)	1.23 (0.80 - 1.90)
		High	1.13 (0.91 - 1.40)	1.47 (0.97 - 2.23)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.01 (0.84 - 1.20)	1.18 (0.81 - 1.72)
		High	0.93 (0.78 - 1.10)	0.80 (0.55 - 1.17)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.17 (0.98 - 1.39)	1.15 (0.79 - 1.69)
		High	1.05 (0.88 - 1.25)	1.50 (1.06 - 2.12)
Family income	Within 50 m from expressways and primary highways (I)	Low	1.21 (0.80 - 1.84)	0.98 (0.36 - 2.64)
		High	1.36 (0.78 - 2.35)	0.50 (0.07 - 3.59)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.85 (0.63 - 1.14)	1.05 (0.59 - 1.84)
		High	1.24 (0.89 - 1.73)	1.34 (0.68 - 2.63)
	Within 50 m from secondary highways and major roads (III)	Low	1.09 (0.87 - 1.36)	1.51 (1.01 - 2.26)
		High	1.05 (0.83 - 1.32)	1.13 (0.70 - 1.80)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.95 (0.80 - 1.13)	0.70 (0.47 - 1.03)
		High	1.09 (0.92 - 1.30)	0.80 (0.54 - 1.19)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	0.97 (0.81 - 1.16)	1.43 (1.02 - 2.01)
		High	1.16 (0.96 - 1.41)	1.06 (0.70 - 1.60)

Table 36. Comparison between HR of different road proximity categories for low and high levels of Neighborhood -SES variables, when considering ACS and CHF health outcomes (cont.)

Neighborhood-level SES	Pollutant	Level	Health Outcomes	
			ACS	CHF
Personal income	Within 50 m from expressways and primary highways (I)	Low	1.38 (0.96 - 1.99)	1.12 (0.49 - 2.52)
		High	1.20 (0.66 - 2.18)	0.98 (0.24 - 3.97)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.83 (0.61 - 1.13)	1.02 (0.58 - 1.81)
		High	1.05 (0.75 - 1.45)	1.19 (0.62 - 2.25)
	Within 50 m from secondary highways and major roads (III)	Low	1.13 (0.91 - 1.42)	1.50 (1.00 - 2.24)
		High	1.06 (0.83 - 1.34)	1.28 (0.83 - 1.99)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	0.92 (0.77 - 1.09)	0.67 (0.45 - 1.00)
		High	1.07 (0.90 - 1.27)	1.04 (0.73 - 1.47)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.02 (0.86 - 1.23)	1.37 (0.98 - 1.92)
		High	1.10 (0.91 - 1.34)	1.21 (0.82 - 1.77)
Governmental transfers	Within 50 m from expressways and primary highways (I)	Low	0.65 (0.21 - 2.01)	0 (0 - 0)
		High	1.28 (0.90 - 1.83)	1.31 (0.65 - 2.67)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.92 (0.59 - 1.46)	0.47 (0.12 - 1.90)
		High	0.85 (0.65 - 1.12)	1.08 (0.66 - 1.78)
	Within 50 m from secondary highways and major roads (III)	Low	0.96 (0.73 - 1.25)	1.17 (0.68 - 2.02)
		High	1.02 (0.83 - 1.25)	1.46 (1.01 - 2.11)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.07 (0.89 - 1.29)	0.84 (0.54 - 1.31)
		High	0.93 (0.79 - 1.10)	0.68 (0.47 - 0.99)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	0.99 (0.79 - 1.25)	0.93 (0.56 - 1.56)
		High	1.00 (0.85 - 1.18)	1.44 (1.06 - 1.96)
Low income	Within 50 m from expressways and primary highways (I)	Low	1.48 (1.00 - 2.19)	1.10 (0.41 - 2.97)
		High	1.38 (0.90 - 2.11)	2.12 (0.99 - 4.54)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.38 (1.01 - 1.90)	0.56 (0.21 - 1.53)
		High	1.05 (0.79 - 1.40)	0.95 (0.50 - 1.80)
	Within 50 m from secondary highways and major roads (III)	Low	0.92 (0.73 - 1.15)	1.08 (0.67 - 1.73)
		High	0.99 (0.79 - 1.26)	1.66 (1.10 - 2.51)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.05 (0.87 - 1.27)	0.91 (0.59 - 1.43)
		High	0.98 (0.82 - 1.17)	1.02 (0.71 - 1.47)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.11 (0.93 - 1.33)	0.96 (0.64 - 1.45)
		High	1.04 (0.86 - 1.25)	1.69 (1.19 - 2.41)
Home ownership	Within 50 m from expressways and primary highways (I)	Low	1.41 (0.97 - 2.04)	1.26 (0.56 - 2.86)
		High	1.21 (0.75 - 1.95)	0.77 (0.19 - 3.11)
	Between 50 and 150 m from expressways and primary highways (II)	Low	0.92 (0.70 - 1.22)	1.23 (0.75 - 2.04)
		High	1.53 (1.06 - 2.19)	0.78 (0.25 - 2.47)
	Within 50 m from secondary highways and major roads (III)	Low	1.18 (0.96 - 1.46)	1.52 (1.03 - 2.24)
		High	0.88 (0.68 - 1.13)	1.09 (0.63 - 1.86)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.07 (0.91 - 1.27)	1.10 (0.79 - 1.53)
		High	1.09 (0.90 - 1.32)	1.02 (0.64 - 1.63)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.10 (0.93 - 1.31)	1.57 (1.14 - 2.18)
		High	1.06 (0.87 - 1.30)	0.99 (0.61 - 1.59)
Neighborhood stress	Within 50 m from expressways and primary highways (I)	Low	1.56 (0.86 - 2.84)	1.32 (0.33 - 5.34)
		High	1.40 (0.98 - 2.01)	1.50 (0.70 - 3.20)
	Between 50 and 150 m from expressways and primary highways (II)	Low	1.22 (0.87 - 1.72)	0.68 (0.25 - 1.84)
		High	1.08 (0.82 - 1.41)	0.92 (0.50 - 1.71)
	Within 50 m from secondary highways and major roads (III)	Low	0.91 (0.71 - 1.17)	1.13 (0.67 - 1.92)
		High	0.99 (0.80 - 1.24)	1.42 (0.95 - 2.12)
	Between 50 and 150 m from secondary highways and major roads (IV)	Low	1.01 (0.84 - 1.22)	0.88 (0.55 - 1.39)
		High	0.98 (0.82 - 1.16)	1.01 (0.71 - 1.43)
	Within 150 m from expressways and primary highways or within 50 m from secondary highways and major roads (V)	Low	1.08 (0.88 - 1.31)	1.04 (0.65 - 1.64)
		High	1.05 (0.89 - 1.25)	1.44 (1.03 - 2.02)

Appendix I

Table 37. Distribution of health outcomes by different covariate categories (DA-SES) for black carbon traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,125	2,443	158,125	2,443	158,125	2,443
	Female	183,324	1,125	183,324	1,125	183,324	1,125
Age	Born before 1925	28,511	862	28,511	862	28,511	862
	Born btw 1925 - 1934	54,737	1,002	54,737	1,002	54,737	1,002
	Born btw 1935 - 1944	94,475	940	94,475	940	94,475	940
	Born after 1944	163,726	764	163,726	764	163,726	764
Chinese minority	1ST QUARTILE- LOW	68,122	888	68,089	921	68,821	189
	2ND QUARTILE	68,648	823	68,578	893	69,286	185
	3RD QUARTILE	67,854	703	67,776	781	68,402	155
	4TH QUARTILE	68,387	613	68,321	679	68,861	139
	5TH QUARTILE - HIGH	68,438	541	68,398	581	68,855	124
Income	1ST QUARTILE- LOW	68,315	723	68,276	762	68,866	172
	2ND QUARTILE	68,203	757	68,171	789	68,784	176
	3RD QUARTILE	68,368	761	68,301	828	68,950	179
	4TH QUARTILE	68,178	688	68,095	771	68,733	133
	5TH QUARTILE - HIGH	68,385	639	68,319	705	68,892	132
University	1ST QUARTILE- LOW	68,577	880	68,531	926	69,267	190
	2ND QUARTILE	68,095	719	68,015	799	68,658	156
	3RD QUARTILE	67,794	757	67,769	782	68,392	159
	4TH QUARTILE	68,374	656	68,351	679	68,880	150
	5TH QUARTILE - HIGH	68,609	556	68,496	669	69,028	137
Transportation	1ST QUARTILE- LOW	69,292	767	69,222	837	69,907	152
	2ND QUARTILE	68,737	742	68,640	839	69,327	152
	3RD QUARTILE	65,494	716	65,437	773	66,073	137
	4TH QUARTILE	69,490	709	69,485	714	70,013	186
	5TH QUARTILE - HIGH	68,436	634	68,378	692	68,905	165
Coefficient of variation	1ST QUARTILE- LOW	68,204	813	68,129	888	68,840	177
	2ND QUARTILE	67,815	733	67,771	777	68,382	166
	3RD QUARTILE	70,916	732	70,855	793	71,482	166
	4TH QUARTILE	66,015	676	65,989	702	66,555	136
	5TH QUARTILE - HIGH	68,499	614	68,418	695	68,966	147
Percent of owned dwellings	1ST QUARTILE- LOW	68,268	764	68,248	784	68,838	194
	2ND QUARTILE	67,800	698	67,756	742	68,340	158
	3RD QUARTILE	69,308	688	69,263	733	69,827	169
	4TH QUARTILE	67,191	671	67,102	760	67,719	143
	5TH QUARTILE - HIGH	68,882	747	68,793	836	69,501	128
Average 2000 family income ($)	1ST QUARTILE- LOW	68,191	822	68,175	838	68,823	190
	2ND QUARTILE	68,236	753	68,192	797	68,822	167
	3RD QUARTILE	68,290	696	68,242	744	68,826	160
	4TH QUARTILE	68,384	651	68,258	777	68,899	136
	5TH QUARTILE - HIGH	68,348	646	68,295	699	68,855	139
Employment rate (%)	1ST QUARTILE- LOW	68,239	834	68,219	854	68,853	220
	2ND QUARTILE	68,109	752	68,071	790	68,705	156
	3RD QUARTILE	68,043	680	68,000	723	68,578	145
	4TH QUARTILE	68,707	698	68,654	751	69,273	132
	5TH QUARTILE - HIGH	68,351	604	68,218	737	68,816	139
% people in labor working in management	1ST QUARTILE- LOW	68,247	768	68,222	793	68,842	173
	2ND QUARTILE	67,409	715	67,343	781	67,964	160
	3RD QUARTILE	68,000	693	67,935	758	68,518	175
	4TH QUARTILE	69,583	714	69,533	764	70,154	143
	5TH QUARTILE - HIGH	68,210	678	68,129	759	68,747	141
Incidence of low income in 2000 %	1ST QUARTILE- LOW	68,074	764	68,048	790	68,693	145
	2ND QUARTILE	68,109	698	68,008	799	68,654	153
	3RD QUARTILE	68,792	677	68,723	746	69,303	166
	4TH QUARTILE	67,990	653	67,891	752	68,482	161
	5TH QUARTILE - HIGH	68,484	776	68,492	768	69,093	167

Table 38. Distribution of health outcomes by different covariate categories (DA-SES) for NO traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,677	2,455	158,677	2,455	158,677	2,455
	Female	183,974	1,126	183,974	1,126	183,974	1,126
Age	Born before 1925	28,593	863	28,593	863	28,593	863
	Born btw 1925 - 1934	54,911	1,008	54,911	1,008	54,911	1,008
	Born btw 1935 - 1944	94,843	942	94,843	942	94,843	942
	Born after 1944	164,304	768	164,304	768	164,304	768
Chinese minority	1ST QUARTILE- LOW	68,548	891	68,508	931	69,248	191
	2ND QUARTILE	67,908	819	67,837	890	68,546	181
	3RD QUARTILE	68,745	709	68,668	786	69,297	157
	4TH QUARTILE	68,837	621	68,773	685	69,317	141
	5TH QUARTILE - HIGH	68,613	541	68,572	582	69,030	124
Income	1ST QUARTILE- LOW	68,527	726	68,483	770	69,079	174
	2ND QUARTILE	68,444	758	68,411	791	69,026	176
	3RD QUARTILE	68,548	765	68,482	831	69,134	179
	4TH QUARTILE	68,545	690	68,461	774	69,102	133
	5TH QUARTILE - HIGH	68,587	642	68,521	708	69,097	132
University	1ST QUARTILE- LOW	68,028	871	67,971	928	68,709	190
	2ND QUARTILE	69,391	737	69,317	811	69,970	158
	3RD QUARTILE	67,963	757	67,936	784	68,561	159
	4TH QUARTILE	68,450	657	68,427	680	68,957	150
	5TH QUARTILE - HIGH	68,819	559	68,707	671	69,241	137
Transportation	1ST QUARTILE- LOW	69,866	773	69,789	850	70,485	154
	2ND QUARTILE	68,852	742	68,755	839	69,442	152
	3RD QUARTILE	65,725	721	65,672	774	66,309	137
	4TH QUARTILE	69,703	709	69,694	718	70,226	186
	5TH QUARTILE - HIGH	68,505	636	68,448	693	68,976	165
Coefficient of variation	1ST QUARTILE- LOW	68,429	813	68,353	889	69,065	177
	2ND QUARTILE	68,310	739	68,259	790	68,881	168
	3RD QUARTILE	71,066	737	71,008	795	71,637	166
	4TH QUARTILE	66,123	677	66,098	702	66,664	136
	5TH QUARTILE - HIGH	68,723	615	68,640	698	69,191	147
Percent of owned dwellings	1ST QUARTILE- LOW	68,457	766	68,438	785	69,029	194
	2ND QUARTILE	68,314	705	68,261	758	68,859	160
	3RD QUARTILE	68,265	670	68,216	719	68,769	166
	4TH QUARTILE	68,499	693	68,417	775	69,046	146
	5TH QUARTILE - HIGH	69,116	747	69,026	837	69,735	128
Average 2000 family income ($)	1ST QUARTILE- LOW	68,412	824	68,390	846	69,044	192
	2ND QUARTILE	68,452	755	68,408	799	69,040	167
	3RD QUARTILE	68,649	698	68,598	749	69,187	160
	4TH QUARTILE	68,573	657	68,450	780	69,094	136
	5TH QUARTILE - HIGH	68,565	647	68,512	700	69,073	139
Employment rate (%)	1ST QUARTILE- LOW	68,500	834	68,478	856	69,114	220
	2ND QUARTILE	68,108	753	68,072	789	68,705	156
	3RD QUARTILE	68,869	687	68,827	729	69,409	147
	4TH QUARTILE	68,470	696	68,408	758	69,034	132
	5TH QUARTILE - HIGH	68,704	611	68,573	742	69,176	139
% people in labor working in management	1ST QUARTILE- LOW	68,643	773	68,611	805	69,241	175
	2ND QUARTILE	67,683	717	67,617	783	68,240	160
	3RD QUARTILE	68,095	694	68,028	761	68,614	175
	4TH QUARTILE	69,887	718	69,840	765	70,462	143
	5TH QUARTILE - HIGH	68,343	679	68,262	760	68,881	141
Incidence of low income in 2000 %	1ST QUARTILE- LOW	68,400	768	68,376	792	69,023	145
	2ND QUARTILE	68,662	704	68,553	813	69,211	155
	3RD QUARTILE	68,637	676	68,567	746	69,148	165
	4TH QUARTILE	68,390	656	68,291	755	68,884	162
	5TH QUARTILE - HIGH	68,562	777	68,571	768	69,172	167

Table 39. Distribution of health outcomes by different covariate categories (DA-SES) for NO_2 traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,664	2,454	158,664	2,454	158,664	2,454
	Female	183,966	1,126	183,966	1,126	183,966	1,126
Age	Born before 1925	28,592	862	28,592	862	28,592	862
	Born btw 1925 - 1934	54,909	1,008	54,909	1,008	54,909	1,008
	Born btw 1935 - 1944	94,836	942	94,836	942	94,836	942
	Born after 1944	164,293	768	164,293	768	164,293	768
Chinese minority	1ST QUARTILE- LOW	68,545	890	68,504	931	69,244	191
	2ND QUARTILE	67,904	819	67,833	890	68,542	181
	3RD QUARTILE	68,731	709	68,654	786	69,283	157
	4TH QUARTILE	68,837	621	68,773	685	69,317	141
	5TH QUARTILE - HIGH	68,613	541	68,572	582	69,030	124
Income	1ST QUARTILE- LOW	68,526	726	68,482	770	69,078	174
	2ND QUARTILE	68,443	758	68,410	791	69,025	176
	3RD QUARTILE	68,482	762	68,414	830	69,065	179
	4TH QUARTILE	68,604	692	68,521	775	69,163	133
	5TH QUARTILE - HIGH	68,575	642	68,509	708	69,085	132
University	1ST QUARTILE- LOW	68,026	871	67,969	928	68,707	190
	2ND QUARTILE	69,388	737	69,314	811	69,967	158
	3RD QUARTILE	67,962	757	67,935	784	68,560	159
	4TH QUARTILE	68,445	656	68,421	680	68,951	150
	5TH QUARTILE - HIGH	68,809	559	68,697	671	69,231	137
Transportation	1ST QUARTILE- LOW	69,853	773	69,776	850	70,472	154
	2ND QUARTILE	68,849	742	68,752	839	69,439	152
	3RD QUARTILE	65,721	721	65,668	774	66,305	137
	4TH QUARTILE	69,703	709	69,694	718	70,226	186
	5TH QUARTILE - HIGH	68,504	635	68,446	693	68,974	165
Coefficient of variation	1ST QUARTILE- LOW	68,428	813	68,352	889	69,064	177
	2ND QUARTILE	68,309	738	68,257	790	68,879	168
	3RD QUARTILE	71,053	737	70,995	795	71,624	166
	4TH QUARTILE	66,121	677	66,096	702	66,662	136
	5TH QUARTILE - HIGH	68,719	615	68,636	698	69,187	147
Percent of owned dwellings	1ST QUARTILE- LOW	68,455	765	68,435	785	69,026	194
	2ND QUARTILE	68,312	705	68,259	758	68,857	160
	3RD QUARTILE	68,262	670	68,213	719	68,766	166
	4TH QUARTILE	68,490	693	68,408	775	69,037	146
	5TH QUARTILE - HIGH	69,111	747	69,021	837	69,730	128
Average 2000 family income ($)	1ST QUARTILE- LOW	68,410	824	68,388	846	69,042	192
	2ND QUARTILE	68,452	754	68,407	799	69,039	167
	3RD QUARTILE	68,545	698	68,494	749	69,083	160
	4TH QUARTILE	68,670	657	68,547	780	69,191	136
	5TH QUARTILE - HIGH	68,553	647	68,500	700	69,061	139
Employment rate (%)	1ST QUARTILE- LOW	68,500	833	68,477	856	69,113	220
	2ND QUARTILE	68,106	753	68,070	789	68,703	156
	3RD QUARTILE	68,867	687	68,825	729	69,407	147
	4TH QUARTILE	68,453	696	68,391	758	69,017	132
	5TH QUARTILE - HIGH	68,704	611	68,573	742	69,176	139
% people in labor working in management	1ST QUARTILE- LOW	68,642	773	68,610	805	69,240	175
	2ND QUARTILE	67,681	717	67,615	783	68,238	160
	3RD QUARTILE	68,094	694	68,027	761	68,613	175
	4TH QUARTILE	69,876	717	69,828	765	70,450	143
	5TH QUARTILE - HIGH	68,337	679	68,256	760	68,875	141
Incidence of low income in 2000 %	1ST QUARTILE- LOW	68,386	768	68,362	792	69,009	145
	2ND QUARTILE	68,660	704	68,551	813	69,209	155
	3RD QUARTILE	68,636	676	68,566	746	69,147	165
	4TH QUARTILE	68,387	656	68,288	755	68,881	162
	5TH QUARTILE - HIGH	68,561	776	68,569	768	69,170	167

Table 40. Distribution of health outcomes by different covariate categories (DA-SES) for $PM_{2.5}$ traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	149,974	2,320	149,974	2,320	149,974	2,320
	Female	174,916	1,080	174,916	1,080	174,916	1,080
Age	Born before 1925	27,467	824	27,467	824	27,467	824
	Born btw 1925 - 1934	52,185	958	52,185	958	52,185	958
	Born btw 1935 - 1944	89,562	899	89,562	899	89,562	899
	Born after 1944	155,676	719	155,676	719	155,676	719
Chinese minority	1ST QUARTILE- LOW	64,612	863	64,613	862	65,294	181
	2ND QUARTILE	65,111	771	65,034	848	65,703	179
	3RD QUARTILE	64,808	673	64,753	728	65,334	147
	4TH QUARTILE	65,209	574	65,140	643	65,650	133
	5TH QUARTILE - HIGH	65,150	519	65,110	559	65,553	116
Income	1ST QUARTILE- LOW	64,937	674	64,906	705	65,447	164
	2ND QUARTILE	64,941	722	64,919	744	65,493	170
	3RD QUARTILE	64,947	733	64,896	784	65,509	171
	4TH QUARTILE	65,022	657	64,949	730	65,548	131
	5TH QUARTILE - HIGH	65,043	614	64,980	677	65,537	120
University	1ST QUARTILE- LOW	64,781	829	64,752	858	65,429	181
	2ND QUARTILE	65,105	697	65,051	751	65,648	154
	3RD QUARTILE	64,739	718	64,710	747	65,307	150
	4TH QUARTILE	65,016	628	64,997	647	65,500	144
	5TH QUARTILE - HIGH	65,249	528	65,140	637	65,650	127
Transportation	1ST QUARTILE- LOW	64,367	722	64,327	762	64,951	138
	2ND QUARTILE	66,213	700	66,116	797	66,768	145
	3RD QUARTILE	63,831	715	63,793	753	64,408	138
	4TH QUARTILE	65,583	661	65,565	679	66,062	182
	5TH QUARTILE - HIGH	64,896	602	64,849	649	65,345	153
Coefficient of variation	1ST QUARTILE- LOW	63,263	756	63,211	808	63,854	165
	2ND QUARTILE	64,424	691	64,389	726	64,954	161
	3RD QUARTILE	67,983	707	67,930	760	68,532	158
	4TH QUARTILE	63,298	652	63,273	677	63,820	130
	5TH QUARTILE - HIGH	65,922	594	65,847	669	66,374	142
Percent of owned dwellings	1ST QUARTILE- LOW	64,885	737	64,875	747	65,444	178
	2ND QUARTILE	64,956	658	64,922	692	65,449	165
	3RD QUARTILE	64,729	637	64,682	684	65,208	158
	4TH QUARTILE	65,466	659	65,397	728	65,989	136
	5TH QUARTILE - HIGH	64,854	709	64,774	789	65,444	119
Average 2000 family income ($)	1ST QUARTILE- LOW	64,889	769	64,889	769	65,474	184
	2ND QUARTILE	64,927	724	64,889	762	65,492	159
	3RD QUARTILE	64,963	661	64,918	706	65,474	150
	4TH QUARTILE	65,075	625	64,970	730	65,568	132
	5TH QUARTILE - HIGH	65,036	621	64,984	673	65,526	131
Employment rate (%)	1ST QUARTILE- LOW	64,748	792	64,740	800	65,327	213
	2ND QUARTILE	65,078	716	65,053	741	65,643	151
	3RD QUARTILE	65,121	653	65,085	689	65,633	141
	4TH QUARTILE	65,022	659	64,969	712	65,559	122
	5TH QUARTILE - HIGH	64,921	580	64,803	698	65,372	129
% people in labor working in management	1ST QUARTILE- LOW	65,254	729	65,245	738	65,817	166
	2ND QUARTILE	63,916	679	63,865	730	64,441	154
	3RD QUARTILE	65,136	675	65,075	736	65,643	168
	4TH QUARTILE	65,131	669	65,097	703	65,668	132
	5TH QUARTILE - HIGH	65,453	648	65,368	733	65,965	136
Incidence of low income in 2000 %	1ST QUARTILE- LOW	65,434	743	65,421	756	66,044	133
	2ND QUARTILE	64,291	649	64,206	734	64,786	154
	3RD QUARTILE	65,568	658	65,509	717	66,074	152
	4TH QUARTILE	64,541	615	64,443	713	65,003	153
	5TH QUARTILE - HIGH	65,056	735	65,071	720	65,627	164

Table 41. Distribution of health outcomes by different covariate categories (DA-SES) for road proximity

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,808	2,460	158,808	2,460	158,808	2,460
	Female	184,140	1,128	184,140	1,128	184,140	1,128
Age	Born before 1925	28,614	863	28,614	863	28,614	863
	Born btw 1925 - 1934	54,939	1,010	54,939	1,010	54,939	1,010
	Born btw 1935 - 1944	94,937	946	94,937	946	94,937	946
	Born after 1944	164,458	769	164,458	769	164,458	769
Chinese minority	1ST QUARTILE- LOW	68,625	893	68,586	932	69,327	191
	2ND QUARTILE	67,978	822	67,908	892	68,619	181
	3RD QUARTILE	68,812	709	68,735	786	69,364	157
	4TH QUARTILE	68,886	623	68,823	686	69,368	141
	5TH QUARTILE - HIGH	68,647	541	68,606	582	69,064	124
Income	1ST QUARTILE- LOW	68,591	727	68,547	771	69,144	174
	2ND QUARTILE	68,505	760	68,473	792	69,089	176
	3RD QUARTILE	68,599	767	68,534	832	69,187	179
	4TH QUARTILE	68,611	691	68,527	775	69,169	133
	5TH QUARTILE - HIGH	68,642	643	68,577	708	69,153	132
University	1ST QUARTILE- LOW	68,097	873	68,041	929	68,780	190
	2ND QUARTILE	69,456	739	69,383	812	70,037	158
	3RD QUARTILE	68,007	759	67,980	786	68,607	159
	4TH QUARTILE	68,506	658	68,484	680	69,014	150
	5TH QUARTILE - HIGH	68,882	559	68,770	671	69,304	137
Transportation	1ST QUARTILE- LOW	69,916	774	69,839	851	70,536	154
	2ND QUARTILE	68,906	742	68,809	839	69,496	152
	3RD QUARTILE	65,781	724	65,730	775	66,368	137
	4TH QUARTILE	69,757	710	69,749	718	70,281	186
	5TH QUARTILE - HIGH	68,588	638	68,531	695	69,061	165
Coefficient of variation	1ST QUARTILE- LOW	68,505	814	68,429	890	69,142	177
	2ND QUARTILE	68,368	740	68,317	791	68,940	168
	3RD QUARTILE	71,121	740	71,064	797	71,695	166
	4TH QUARTILE	66,172	678	66,148	702	66,714	136
	5TH QUARTILE - HIGH	68,782	616	68,700	698	69,251	147
Percent of owned dwellings	1ST QUARTILE- LOW	68,541	767	68,522	786	69,114	194
	2ND QUARTILE	68,377	707	68,325	759	68,924	160
	3RD QUARTILE	68,312	670	68,263	719	68,816	166
	4TH QUARTILE	68,552	696	68,472	776	69,102	146
	5TH QUARTILE - HIGH	69,166	748	69,076	838	69,786	128
Average 2000 family income ($)	1ST QUARTILE- LOW	68,494	824	68,472	846	69,126	192
	2ND QUARTILE	68,506	757	68,462	801	69,096	167
	3RD QUARTILE	68,596	702	68,547	751	69,138	160
	4TH QUARTILE	68,732	657	68,609	780	69,253	136
	5TH QUARTILE - HIGH	68,620	648	68,568	700	69,129	139
Employment rate (%)	1ST QUARTILE- LOW	68,382	835	68,361	856	68,997	220
	2ND QUARTILE	68,350	754	68,313	791	68,948	156
	3RD QUARTILE	68,922	688	68,881	729	69,463	147
	4TH QUARTILE	68,522	700	68,462	760	69,090	132
	5TH QUARTILE - HIGH	68,772	611	68,641	742	69,244	139
% people in labor working in management	1ST QUARTILE- LOW	68,709	775	68,678	806	69,309	175
	2ND QUARTILE	67,744	719	67,679	784	68,303	160
	3RD QUARTILE	68,161	694	68,094	761	68,680	175
	4TH QUARTILE	69,933	721	69,887	767	70,511	143
	5TH QUARTILE - HIGH	68,401	679	68,320	760	68,939	141
Incidence of low income in 2000 %	1ST QUARTILE- LOW	68,448	770	68,426	792	69,073	145
	2ND QUARTILE	68,721	707	68,613	815	69,273	155
	3RD QUARTILE	68,698	677	68,628	747	69,210	165
	4TH QUARTILE	68,442	656	68,343	755	68,936	162
	5TH QUARTILE - HIGH	68,639	778	68,648	769	69,250	167

Table 42. Distribution of health outcomes by different covariate categories (Neighborhood-SES) for black carbon traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,128	2,440	157,683	2,885	160,183	385
	Female	183,326	1,123	183,479	970	184,042	407
Age	Born before 1925	28,513	860	28,740	633	28,977	396
	Born btw 1925 - 1934	54,740	999	54,635	1,104	55,500	239
	Born btw 1935 - 1944	94,475	940	94,199	1,216	95,313	102
	Born after 1944	163,726	764	163,588	902	164,435	55
% of total population whose home language is neither English nor French (OTHLANG)	1ST QUARTILE- LOW	65,030	847	64,974	903	65,712	165
	2ND QUARTILE	70,988	752	70,930	810	71,554	186
	3RD QUARTILE	67,971	682	67,904	749	68,492	161
	4TH QUARTILE	69,249	654	69,144	759	69,769	134
	5TH QUARTILE - HIGH	68,216	628	68,210	634	68,698	146
% of total population without knowledge of English or French (LINGISOL)	1ST QUARTILE- LOW	64,698	790	64,641	847	65,335	153
	2ND QUARTILE	70,147	802	70,087	862	70,758	191
	3RD QUARTILE	68,304	687	68,229	762	68,821	170
	4TH QUARTILE	74,924	712	74,809	827	75,489	147
	5TH QUARTILE - HIGH	63,381	572	63,396	557	63,822	131
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	1ST QUARTILE- LOW	68,075	894	67,981	988	68,780	189
	2ND QUARTILE	69,090	713	69,051	752	69,650	153
	3RD QUARTILE	68,164	702	68,125	741	68,723	143
	4TH QUARTILE	66,934	654	66,919	669	67,448	140
	5TH QUARTILE - HIGH	69,191	600	69,086	705	69,624	167
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	1ST QUARTILE- LOW	67,041	779	66,973	847	67,666	154
	2ND QUARTILE	67,954	687	67,873	768	68,489	152
	3RD QUARTILE	71,847	717	71,797	767	72,400	164
	4TH QUARTILE	66,343	671	66,243	771	66,844	170
	5TH QUARTILE - HIGH	68,269	709	68,276	702	68,826	152
Median annual family income ($) (FAM_INCOME)	1ST QUARTILE- LOW	68,325	687	68,348	664	68,854	158
	2ND QUARTILE	68,542	717	68,457	802	69,099	160
	3RD QUARTILE	67,798	785	67,677	906	68,394	189
	4TH QUARTILE	68,871	680	68,803	748	69,416	135
	5TH QUARTILE - HIGH	67,918	694	67,877	735	68,462	150
Average annual employment income ($) (INCOME)	1ST QUARTILE- LOW	68,023	695	68,021	697	68,553	165
	2ND QUARTILE	68,665	703	68,598	770	69,226	142
	3RD QUARTILE	68,089	810	68,015	884	68,718	181
	4TH QUARTILE	68,816	709	68,726	799	69,373	152
	5TH QUARTILE - HIGH	67,861	646	67,802	705	68,355	152
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	1ST QUARTILE- LOW	69,119	635	69,053	701	69,633	121
	2ND QUARTILE	68,691	684	68,622	753	69,226	149
	3RD QUARTILE	68,302	736	68,218	820	68,860	178
	4TH QUARTILE	67,326	736	67,256	806	67,900	162
	5TH QUARTILE - HIGH	68,016	772	68,013	775	68,606	182
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	1ST QUARTILE- LOW	67,214	785	67,118	881	67,852	147
	2ND QUARTILE	69,975	768	69,937	806	70,562	181
	3RD QUARTILE	68,533	710	68,472	771	69,079	164
	4TH QUARTILE	67,105	676	67,031	750	67,622	159
	5TH QUARTILE - HIGH	68,627	624	68,604	647	69,110	141
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	1ST QUARTILE- LOW	68,879	661	68,813	727	69,378	162
	2ND QUARTILE	67,354	627	67,333	648	67,823	158
	3RD QUARTILE	67,983	739	67,906	816	68,573	149
	4TH QUARTILE	69,355	808	69,314	849	69,966	197
	5TH QUARTILE - HIGH	67,883	728	67,796	815	68,485	126
% of families spending 30% or more of income on shelter costs (STRESS)	1ST QUARTILE- LOW	68,559	735	68,508	786	69,166	128
	2ND QUARTILE	69,954	788	69,856	886	70,568	174
	3RD QUARTILE	65,880	664	65,819	725	66,376	168
	4TH QUARTILE	69,007	673	68,976	704	69,518	162
	5TH QUARTILE - HIGH	68,054	703	68,003	754	68,597	160

Table 43. Distribution of health outcomes by different covariate categories (Neighbourhood-SES) for NO traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,680	2,452	158,232	2,900	160,746	386
	Female	183,976	1,124	184,126	974	184,692	408
Age	Born before 1925	28,595	861	28,820	636	29,058	398
	Born btw 1925 - 1934	54,914	1,005	54,807	1,112	55,680	239
	Born btw 1935 - 1944	94,843	942	94,565	1,220	95,683	102
	Born after 1944	164,304	768	164,166	906	165,017	55
% of total population whose home language is neither English nor French (OTHLANG)	1ST QUARTILE- LOW	65,576	852	65,512	916	66,261	167
	2ND QUARTILE	71,054	752	70,996	810	71,620	186
	3RD QUARTILE	68,295	686	68,229	752	68,820	161
	4TH QUARTILE	68,798	645	68,690	753	69,311	132
	5TH QUARTILE - HIGH	68,933	641	68,931	643	69,426	148
% of total population without knowledge of English or French (LINGISOL)	1ST QUARTILE- LOW	65,230	795	65,166	859	65,870	155
	2ND QUARTILE	70,225	802	70,164	863	70,836	191
	3RD QUARTILE	68,757	691	68,682	766	69,278	170
	4TH QUARTILE	64,644	628	64,542	730	65,147	125
	5TH QUARTILE - HIGH	73,800	660	73,804	656	74,307	153
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	1ST QUARTILE- LOW	68,622	899	68,521	1,000	69,330	191
	2ND QUARTILE	69,133	713	69,093	753	69,693	153
	3RD QUARTILE	68,232	702	68,193	741	68,791	143
	4TH QUARTILE	67,280	659	67,266	673	67,799	140
	5TH QUARTILE - HIGH	69,389	603	69,285	707	69,825	167
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	1ST QUARTILE- LOW	67,174	782	67,106	850	67,802	154
	2ND QUARTILE	68,366	691	68,286	771	68,905	152
	3RD QUARTILE	71,929	718	71,878	769	72,483	164
	4TH QUARTILE	66,742	675	66,636	781	67,245	172
	5TH QUARTILE - HIGH	68,445	710	68,452	703	69,003	152
Median annual family income ($) (FAM_INCOME)	1ST QUARTILE- LOW	68,723	690	68,740	673	69,253	160
	2ND QUARTILE	68,594	718	68,509	803	69,152	160
	3RD QUARTILE	68,161	788	68,039	910	68,760	189
	4TH QUARTILE	68,159	670	68,085	744	68,695	134
	5TH QUARTILE - HIGH	69,019	710	68,985	744	69,578	151
Average annual employment income ($) (INCOME)	1ST QUARTILE- LOW	68,409	698	68,401	706	68,940	167
	2ND QUARTILE	68,751	704	68,684	771	69,313	142
	3RD QUARTILE	68,280	812	68,204	888	68,911	181
	4TH QUARTILE	69,291	713	69,201	803	69,852	152
	5TH QUARTILE - HIGH	67,925	649	67,868	706	68,422	152
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	1ST QUARTILE- LOW	69,324	637	69,258	703	69,840	121
	2ND QUARTILE	69,032	689	68,965	756	69,572	149
	3RD QUARTILE	68,391	736	68,306	821	68,949	178
	4TH QUARTILE	67,478	739	67,407	810	68,055	162
	5TH QUARTILE - HIGH	68,431	775	68,422	784	69,022	184
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	1ST QUARTILE- LOW	67,306	785	67,210	881	67,944	147
	2ND QUARTILE	70,755	778	70,711	822	71,350	183
	3RD QUARTILE	68,621	711	68,560	772	69,168	164
	4TH QUARTILE	67,144	677	67,070	751	67,662	159
	5TH QUARTILE - HIGH	68,830	625	68,807	648	69,314	141
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	1ST QUARTILE- LOW	69,067	662	69,001	728	69,567	162
	2ND QUARTILE	67,392	628	67,371	649	67,862	158
	3RD QUARTILE	69,915	761	69,829	847	70,524	152
	4TH QUARTILE	68,324	797	68,286	835	68,925	196
	5TH QUARTILE - HIGH	67,958	728	67,871	815	68,560	126
% of families spending 30% or more of income on shelter costs (STRESS)	1ST QUARTILE- LOW	68,993	741	68,942	792	69,606	128
	2ND QUARTILE	70,418	792	70,315	895	71,034	176
	3RD QUARTILE	65,930	665	65,868	727	66,427	168
	4TH QUARTILE	69,048	674	69,017	705	69,560	162
	5TH QUARTILE - HIGH	68,267	704	68,216	755	68,811	160

Table 44. Distribution of health outcomes by different covariate categories (Neighborhood-SES) for NO_2 traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,667	2,451	158,218	2,900	160,732	386
	Female	183,968	1,124	184,118	974	184,684	408
Age	Born before 1925	28,594	860	28,818	636	29,056	398
	Born btw 1925 - 1934	54,912	1,005	54,805	1,112	55,678	239
	Born btw 1935 - 1944	94,836	942	94,558	1,220	95,676	102
	Born after 1944	164,293	768	164,155	906	165,006	55
% of total population whose home language is neither English nor French (OTHLANG)	1ST QUARTILE- LOW	65,563	852	65,499	916	66,248	167
	2ND QUARTILE	71,047	751	70,988	810	71,612	186
	3RD QUARTILE	68,295	686	68,229	752	68,820	161
	4TH QUARTILE	69,446	657	69,342	761	69,969	134
	5TH QUARTILE - HIGH	68,284	629	68,278	635	68,767	146
% of total population without knowledge of English or French (LINGISOL)	1ST QUARTILE- LOW	65,217	795	65,153	859	65,857	155
	2ND QUARTILE	70,218	801	70,156	863	70,828	191
	3RD QUARTILE	68,757	691	68,682	766	69,278	170
	4TH QUARTILE	64,644	628	64,542	730	65,147	125
	5TH QUARTILE - HIGH	73,799	660	73,803	656	74,306	153
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	1ST QUARTILE- LOW	68,619	899	68,518	1,000	69,327	191
	2ND QUARTILE	69,128	713	69,088	753	69,688	153
	3RD QUARTILE	68,232	702	68,193	741	68,791	143
	4TH QUARTILE	67,279	659	67,265	673	67,798	140
	5TH QUARTILE - HIGH	69,377	602	69,272	707	69,812	167
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	1ST QUARTILE- LOW	67,167	782	67,099	850	67,795	154
	2ND QUARTILE	68,355	690	68,274	771	68,893	152
	3RD QUARTILE	71,927	718	71,876	769	72,481	164
	4TH QUARTILE	66,742	675	66,636	781	67,245	172
	5TH QUARTILE - HIGH	68,444	710	68,451	703	69,002	152
Median annual family income ($) (FAM_INCOME)	1ST QUARTILE- LOW	68,723	690	68,740	673	69,253	160
	2ND QUARTILE	68,593	718	68,508	803	69,151	160
	3RD QUARTILE	68,159	788	68,037	910	68,758	189
	4TH QUARTILE	68,153	670	68,079	744	68,689	134
	5TH QUARTILE - HIGH	69,007	709	68,972	744	69,565	151
Average annual employment income ($) (INCOME)	1ST QUARTILE- LOW	68,409	698	68,401	706	68,940	167
	2ND QUARTILE	68,750	704	68,683	771	69,312	142
	3RD QUARTILE	68,277	812	68,201	888	68,908	181
	4TH QUARTILE	69,286	713	69,196	803	69,847	152
	5TH QUARTILE - HIGH	67,913	648	67,855	706	68,409	152
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	1ST QUARTILE- LOW	69,307	637	69,241	703	69,823	121
	2ND QUARTILE	69,031	688	68,963	756	69,570	149
	3RD QUARTILE	68,391	736	68,306	821	68,949	178
	4TH QUARTILE	67,475	739	67,404	810	68,052	162
	5TH QUARTILE - HIGH	68,431	775	68,422	784	69,022	184
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	1ST QUARTILE- LOW	67,289	785	67,193	881	67,927	147
	2ND QUARTILE	70,754	778	70,710	822	71,349	183
	3RD QUARTILE	68,619	710	68,557	772	69,165	164
	4TH QUARTILE	67,143	677	67,069	751	67,661	159
	5TH QUARTILE - HIGH	68,830	625	68,807	648	69,314	141
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	1ST QUARTILE- LOW	69,067	662	69,001	728	69,567	162
	2ND QUARTILE	67,391	627	67,369	649	67,860	158
	3RD QUARTILE	69,915	761	69,829	847	70,524	152
	4TH QUARTILE	68,310	797	68,272	835	68,911	196
	5TH QUARTILE - HIGH	67,952	728	67,865	815	68,554	126
% of families spending 30% or more of income on shelter costs (STRESS)	1ST QUARTILE- LOW	68,981	741	68,930	792	69,594	128
	2ND QUARTILE	70,409	792	70,306	895	71,025	176
	3RD QUARTILE	65,930	665	65,868	727	66,427	168
	4TH QUARTILE	69,048	673	69,016	705	69,559	162
	5TH QUARTILE - HIGH	68,267	704	68,216	755	68,811	160

Table 45. Distribution of health outcomes by different covariate categories (Neighborhood-SES) for $PM_{2.5}$ traffic pollution

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	149,977	2,317	149,575	2,719	151,924	370
	Female	174,918	1,078	175,075	921	175,610	386
Age	Born before 1925	27,469	822	27,687	604	27,912	379
	Born btw 1925 - 1934	52,188	955	52,103	1,040	52,916	227
	Born btw 1935 - 1944	89,562	899	89,305	1,156	90,362	99
	Born after 1944	155,676	719	155,555	840	156,344	51
% of total population whose home language is neither English nor French (OTHLANG)	1ST QUARTILE- LOW	68,524	844	68,476	892	69,197	171
	2ND QUARTILE	58,702	669	58,678	693	59,203	168
	3RD QUARTILE	68,025	666	67,926	765	68,543	148
	4TH QUARTILE	63,882	619	63,811	690	64,372	129
	5TH QUARTILE - HIGH	65,762	597	65,759	600	66,219	140
% of total population without knowledge of English or French (LINGISOL)	1ST QUARTILE- LOW	63,624	789	63,578	835	64,257	156
	2ND QUARTILE	66,862	748	66,791	819	67,425	185
	3RD QUARTILE	64,984	641	64,916	709	65,472	153
	4TH QUARTILE	66,719	651	66,641	729	67,239	131
	5TH QUARTILE - HIGH	62,706	566	62,724	548	63,141	131
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	1ST QUARTILE- LOW	64,974	837	64,905	906	65,632	179
	2ND QUARTILE	67,917	697	67,883	731	68,459	155
	3RD QUARTILE	61,167	647	61,139	675	61,687	127
	4TH QUARTILE	65,510	647	65,497	660	66,019	138
	5TH QUARTILE - HIGH	65,327	567	65,226	668	65,737	157
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	1ST QUARTILE- LOW	65,525	776	65,452	849	66,150	151
	2ND QUARTILE	69,088	684	69,030	742	69,626	146
	3RD QUARTILE	59,574	603	59,538	639	60,032	145
	4TH QUARTILE	65,305	661	65,207	759	65,797	169
	5TH QUARTILE - HIGH	65,403	671	65,423	651	65,929	145
Median annual family income ($) (FAM_INCOME)	1ST QUARTILE- LOW	65,369	651	65,407	613	65,869	151
	2ND QUARTILE	64,604	667	64,522	749	65,115	156
	3RD QUARTILE	65,005	753	64,898	860	65,578	180
	4TH QUARTILE	65,769	652	65,704	717	66,292	129
	5TH QUARTILE - HIGH	64,148	672	64,119	701	64,680	140
Average annual employment income ($) (INCOME)	1ST QUARTILE- LOW	64,356	647	64,368	635	64,844	159
	2ND QUARTILE	66,252	678	66,196	734	66,797	133
	3RD QUARTILE	64,531	769	64,468	832	65,127	173
	4TH QUARTILE	65,961	687	65,876	772	66,498	150
	5TH QUARTILE - HIGH	63,795	614	63,742	667	64,268	141
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	1ST QUARTILE- LOW	64,883	604	64,820	667	65,376	111
	2ND QUARTILE	65,644	661	65,585	720	66,162	143
	3RD QUARTILE	65,374	706	65,300	780	65,908	172
	4TH QUARTILE	63,876	696	63,819	753	64,416	156
	5TH QUARTILE - HIGH	65,118	728	65,126	720	65,672	174
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	1ST QUARTILE- LOW	65,056	797	64,996	857	65,712	141
	2ND QUARTILE	68,018	716	67,965	769	68,549	185
	3RD QUARTILE	63,329	670	63,267	732	63,852	147
	4TH QUARTILE	64,160	629	64,110	679	64,640	149
	5TH QUARTILE - HIGH	64,332	583	64,312	603	64,781	134
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	1ST QUARTILE- LOW	64,918	618	64,869	667	65,384	152
	2ND QUARTILE	64,902	608	64,885	625	65,354	156
	3RD QUARTILE	65,153	713	65,088	778	65,728	138
	4TH QUARTILE	64,843	720	64,802	761	65,379	184
	5TH QUARTILE - HIGH	65,079	736	65,006	809	65,689	126
% of families spending 30% or more of income on shelter costs (STRESS)	1ST QUARTILE- LOW	65,453	709	65,403	759	66,044	118
	2ND QUARTILE	63,936	728	63,860	804	64,502	162
	3RD QUARTILE	64,775	652	64,718	709	65,258	169
	4TH QUARTILE	65,721	639	65,698	662	66,205	155
	5TH QUARTILE - HIGH	65,010	667	64,971	706	65,525	152

Table 46. Distribution of health outcomes by different covariate categories (Neighborhood-SES) for different road proximity categories

Variables	Category	ACS		CCS		CHF	
		Censored	Event	Censored	Event	Censored	Event
Sex	Male	158,811	2,457	158,365	2,903	160,882	386
	Female	184,142	1,126	184,293	975	184,860	408
Age	Born before 1925	28,616	861	28,841	636	29,079	398
	Born btw 1925 - 1934	54,942	1,007	54,835	1,114	55,710	239
	Born btw 1935 - 1944	94,937	946	94,661	1,222	95,781	102
	Born after 1944	164,458	769	164,321	906	165,172	55
% of total population whose home language is neither English nor French (OTHLANG)	1ST QUARTILE- LOW	65,642	853	65,578	917	66,328	167
	2ND QUARTILE	71,122	755	71,065	812	71,691	186
	3RD QUARTILE	68,364	687	68,299	752	68,890	161
	4TH QUARTILE	68,850	646	68,743	753	69,364	132
	5TH QUARTILE - HIGH	68,975	642	68,973	644	69,469	148
% of total population without knowledge of English or French (LINGISOL)	1ST QUARTILE- LOW	65,296	796	65,232	860	65,937	155
	2ND QUARTILE	70,302	804	70,242	864	70,915	191
	3RD QUARTILE	68,818	692	68,743	767	69,340	170
	4TH QUARTILE	64,689	630	64,589	730	65,194	125
	5TH QUARTILE - HIGH	73,848	661	73,852	657	74,356	153
% of total population (>=20 years of age) with any university degree (UNIVERSITY)	1ST QUARTILE- LOW	68,704	902	68,603	1,003	69,415	191
	2ND QUARTILE	69,192	715	69,153	754	69,754	153
	3RD QUARTILE	68,280	703	68,242	741	68,840	143
	4TH QUARTILE	67,321	660	67,308	673	67,841	140
	5TH QUARTILE - HIGH	69,456	603	69,352	707	69,892	167
Seasonally adjusted unemployment rate among persons aged 25 years and over (UNEMPLOYMENT)	1ST QUARTILE- LOW	67,234	783	67,166	851	67,863	154
	2ND QUARTILE	68,419	691	68,339	771	68,958	152
	3RD QUARTILE	71,976	721	71,927	770	72,533	164
	4TH QUARTILE	66,803	676	66,698	781	67,307	172
	5TH QUARTILE - HIGH	68,521	712	68,528	705	69,081	152
Median annual family income ($) (FAM_INCOME)	1ST QUARTILE- LOW	68,796	691	68,813	674	69,327	160
	2ND QUARTILE	68,644	720	68,560	804	69,204	160
	3RD QUARTILE	68,220	791	68,100	911	68,822	189
	4TH QUARTILE	68,220	670	68,146	744	68,756	134
	5TH QUARTILE - HIGH	69,073	711	69,039	745	69,633	151
Average annual employment income ($) (INCOME)	1ST QUARTILE- LOW	68,480	700	68,472	708	69,013	167
	2ND QUARTILE	68,803	706	68,738	771	69,367	142
	3RD QUARTILE	68,339	814	68,264	889	68,972	181
	4TH QUARTILE	69,343	714	69,253	804	69,905	152
	5TH QUARTILE - HIGH	67,988	649	67,931	706	68,485	152
% of aggregate neighbourhood income from any government transfer (TRANSFERS)	1ST QUARTILE- LOW	69,390	637	69,324	703	69,906	121
	2ND QUARTILE	69,079	690	69,012	757	69,620	149
	3RD QUARTILE	68,443	739	68,360	822	69,004	178
	4TH QUARTILE	67,536	740	67,466	810	68,114	162
	5TH QUARTILE - HIGH	68,505	777	68,496	786	69,098	184
% of persons in households below the low-income cut-off (LICO) (LOW_INCOME)	1ST QUARTILE- LOW	67,362	786	67,266	882	68,001	147
	2ND QUARTILE	70,818	778	70,774	822	71,413	183
	3RD QUARTILE	68,675	714	68,616	773	69,225	164
	4TH QUARTILE	67,199	679	67,126	752	67,719	159
	5TH QUARTILE - HIGH	68,899	626	68,876	649	69,384	141
% of occupied dwellings that are owner-occupied (OWNED_HOMES)	1ST QUARTILE- LOW	69,151	663	69,085	729	69,652	162
	2ND QUARTILE	67,425	630	67,405	650	67,897	158
	3RD QUARTILE	69,986	763	69,901	848	70,597	152
	4TH QUARTILE	68,375	798	68,338	835	68,977	196
	5TH QUARTILE - HIGH	68,016	729	67,929	816	68,619	126
% of families spending 30% or more of income on shelter costs (STRESS)	1ST QUARTILE- LOW	69,041	742	68,990	793	69,655	128
	2ND QUARTILE	70,480	793	70,378	895	71,097	176
	3RD QUARTILE	65,984	666	65,923	727	66,482	168
	4TH QUARTILE	69,091	676	69,061	706	69,605	162
	5TH QUARTILE - HIGH	68,357	706	68,306	757	68,903	160

Table 47. Distribution of subjects by the two levels of socioeconomic indicators at DA-level of aggregation and the four quartiles of traffic pollutants

DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Chinese population	NO	Low	24,800	20,312	14,507	9,820
		High	7,076	14,302	20,995	26,781
	NO_2	Low	30,512	19,613	9,553	9,757
		High	4,892	12,349	29,569	22,344
	Black Carbon	Low	18,705	19,827	13,979	16,499
		High	16,990	16,934	16,916	18,139
	$PM_{2.5}$	Low	19,060	18,026	16,309	12,049
		High	8,185	14,341	20,311	22,831
University	NO	Low	22,929	20,852	14,713	10,405
		High	14,376	15,429	18,889	20,684
	NO_2	Low	26,491	18,997	10,676	12,733
		High	11,941	16,196	21,696	19,535
	Black Carbon	Low	15,016	19,890	16,677	17,874
		High	19,198	14,683	17,975	17,308
	$PM_{2.5}$	Low	13,315	17,557	19,698	15,017
		High	18,137	11,973	16,270	19,379
Employment	NO	Low	12,313	17,350	18,680	20,991
		High	22,399	16,259	15,620	15,037
	NO_2	Low	11,657	14,403	20,722	22,551
		High	23,483	17,538	13,179	15,115
	Black Carbon	Low	14,096	16,605	18,001	20,371
		High	19,088	18,980	15,683	15,203
	$PM_{2.5}$	Low	12,119	16,590	17,804	19,017
		High	19,588	16,174	15,068	14,652
Family income	NO	Low	11,894	15,052	19,128	23,162
		High	20,487	18,140	17,551	13,034
	NO_2	Low	10,932	12,717	19,363	26,222
		High	20,909	21,722	16,661	9,908
	Black Carbon	Low	10,360	14,568	20,397	23,688
		High	22,419	18,995	13,703	13,877
	$PM_{2.5}$	Low	8,638	15,859	20,142	21,003
		High	26,168	14,126	14,399	10,940
Personal income	NO	Low	11,003	15,470	19,396	23,384
		High	20,244	16,891	17,454	14,640
	NO_2	Low	10,039	13,127	21,436	24,650
		High	19,869	20,497	16,876	11,975
	Black Carbon	Low	11,941	16,415	19,023	21,659
		High	21,452	18,122	14,443	15,007
	$PM_{2.5}$	Low	7,750	15,720	20,782	21,344
		High	25,307	14,207	13,952	12,168

Table 47. Distribution of subjects by the two levels of socioeconomic indicators at DA-level of aggregation and the four quartiles of traffic pollutants (cont.)

DA-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Transportation	NO	Low	26,667	18,258	13,595	12,119
		High	5,181	13,264	20,570	30,126
	NO_2	Low	33,665	18,996	10,167	7,798
		High	2,995	8,829	21,926	35,389
	Black Carbon	Low	23,305	21,009	11,602	14,142
		High	7,945	14,945	23,137	23,043
	$PM_{2.5}$	Low	23,341	15,508	14,169	12,037
		High	8,160	15,239	18,413	23,683
Low income	NO	Low	25,434	18,210	14,694	10,830
		High	9,932	15,040	18,836	25,531
	NO_2	Low	29,769	21,173	10,356	7,856
		High	7,244	12,080	21,733	28,280
	Black Carbon	Low	23,528	20,135	11,579	13,596
		High	10,905	14,927	21,435	21,993
	$PM_{2.5}$	Low	25,575	17,572	13,741	9,265
		High	8,767	15,348	17,617	24,055
Home ownership	NO	Low	7,776	12,830	19,075	29,542
		High	24,139	18,834	14,690	12,200
	NO_2	Low	6,027	9,886	19,751	33,556
		High	27,787	21,778	12,505	7,788
	Black Carbon	Low	8,358	13,236	22,913	24,525
		High	23,992	20,654	12,563	12,420
	$PM_{2.5}$	Low	8,969	14,563	17,549	24,535
		High	24,481	16,556	13,489	11,009
Income variation	NO	Low	17,514	16,734	15,276	19,718
		High	16,777	18,227	17,674	16,660
	NO_2	Low	17,874	15,279	14,098	21,990
		High	15,447	19,423	20,989	13,475
	Black Carbon	Low	15,629	15,965	17,466	19,957
		High	19,295	18,963	15,043	15,811
	$PM_{2.5}$	Low	14,038	15,852	14,895	19,219
		High	18,950	16,427	16,215	14,906
Management	NO	Low	15,335	19,099	17,613	17,369
		High	19,508	16,314	16,830	16,370
	NO_2	Low	15,288	16,706	17,666	19,755
		High	19,271	19,824	16,782	13,139
	Black Carbon	Low	13,873	18,152	18,642	18,346
		High	21,383	18,244	13,932	15,329
	$PM_{2.5}$	Low	12,086	17,821	18,818	17,239
		High	23,036	14,411	14,027	14,608

Table 48. Distribution of subjects by the two levels of socioeconomic indicators at neighborhood level of aggregation and the four quartiles of traffic pollutants

Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Other language	NO	Low	23,159	15,579	16,466	11,224
		High	5,792	14,553	21,247	27,982
	NO_2	Low	29,388	18,894	8,826	9,307
		High	4,945	9,697	27,986	26,285
	Black Carbon	Low	21,033	17,972	11,106	15,766
		High	16,856	14,723	16,581	20,684
	$PM_{2.5}$	Low	20,050	17,921	14,360	17,010
		High	7,733	14,227	20,811	23,579
Linguistic isolation	NO	Low	22,496	14,807	16,287	12,435
		High	5,031	14,287	24,499	30,643
	NO_2	Low	27,538	16,933	10,562	10,979
		High	4,571	9,947	30,852	29,089
	Black Carbon	Low	20,965	15,807	12,709	16,007
		High	13,187	16,229	15,840	18,697
	$PM_{2.5}$	Low	20,905	16,441	12,517	14,518
		High	7,842	14,209	20,093	21,118
University	NO	Low	26,931	23,150	12,104	7,336
		High	14,117	14,553	19,563	21,759
	NO_2	Low	34,032	20,006	6,222	9,258
		High	10,576	15,229	21,982	22,192
	Black Carbon	Low	17,255	21,473	13,926	16,315
		High	15,892	14,263	19,522	20,114
	$PM_{2.5}$	Low	14,398	18,701	18,642	14,034
		High	17,634	11,513	17,700	19,026
Unemployment	NO	Low	23,153	17,056	16,592	11,155
		High	12,706	18,298	18,852	19,299
	NO_2	Low	28,027	20,770	10,483	8,669
		High	11,665	13,282	19,229	24,978
	Black Carbon	Low	21,234	17,754	13,809	15,023
		High	11,182	18,302	20,018	19,476
	$PM_{2.5}$	Low	26,784	16,412	13,945	9,134
		High	9,853	18,085	21,123	17,002
Family income	NO	Low	9,326	14,131	22,078	23,878
		High	22,764	18,468	17,432	11,065
	NO_2	Low	9,315	11,100	22,848	26,150
		High	22,078	23,428	15,441	8,769
	Black Carbon	Low	9,056	17,412	20,834	21,710
		High	24,397	17,779	12,238	14,198
	$PM_{2.5}$	Low	6,607	15,588	22,584	21,228
		High	28,234	13,570	13,792	9,200

Table 48. Distribution of subjects by the two levels of socioeconomic indicators at neighborhood level of aggregation and the four quartiles of traffic pollutants (cont.)

Neighborhood-level SES	Pollutant	SES Level	Pollutant Quartile			
			1st Q	2nd Q	3rd Q	4th Q
Personal income	NO	Low	23,159	15,579	16,466	11,224
		High	5,792	14,553	21,247	27,982
	NO_2	Low	29,388	18,894	8,826	9,307
		High	4,945	9,697	27,986	26,285
	Black Carbon	Low	21,033	17,972	11,106	15,766
		High	16,856	14,723	16,581	20,684
	$PM_{2.5}$	Low	20,050	17,921	14,360	17,010
		High	7,733	14,227	20,811	23,579
Governmental transfers	NO	Low	22,496	14,807	16,287	12,435
		High	5,031	14,287	24,499	30,643
	NO_2	Low	27,538	16,933	10,562	10,979
		High	4,571	9,947	30,852	29,089
	Black Carbon	Low	20,965	15,807	12,709	16,007
		High	13,187	16,229	15,840	18,697
	$PM_{2.5}$	Low	20,905	16,441	12,517	14,518
		High	7,842	14,209	20,093	21,118
Low income	NO	Low	26,931	23,150	12,104	7,336
		High	14,117	14,553	19,563	21,759
	NO_2	Low	34,032	20,006	6,222	9,258
		High	10,576	15,229	21,982	22,192
	Black Carbon	Low	17,255	21,473	13,926	16,315
		High	15,892	14,263	19,522	20,114
	$PM_{2.5}$	Low	14,398	18,701	18,642	14,034
		High	17,634	11,513	17,700	19,026
Home ownership	NO	Low	23,153	17,056	16,592	11,155
		High	12,706	18,298	18,852	19,299
	NO_2	Low	28,027	20,770	10,483	8,669
		High	11,665	13,282	19,229	24,978
	Black Carbon	Low	21,234	17,754	13,809	15,023
		High	11,182	18,302	20,018	19,476
	$PM_{2.5}$	Low	26,784	16,412	13,945	9,134
		High	9,853	18,085	21,123	17,002
Neighborhood stress	NO	Low	9,326	14,131	22,078	23,878
		High	22,764	18,468	17,432	11,065
	NO_2	Low	9,315	11,100	22,848	26,150
		High	22,078	23,428	15,441	8,769
	Black Carbon	Low	9,056	17,412	20,834	21,710
		High	24,397	17,779	12,238	14,198
	$PM_{2.5}$	Low	6,607	15,588	22,584	21,228
		High	28,234	13,570	13,792	9,200

Table 49. Distribution of subjects by the two levels of socioeconomic indicators at DA-level of aggregation and the five road proximity categories

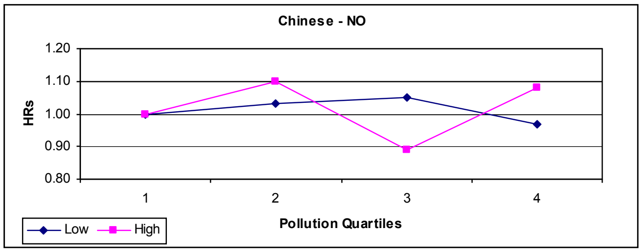
DA-level SES	Pollutant	SES Level	Road proximity		DA-level SES	Pollutant	SES Level	Road proximity	
			0	1				0	1
Chinese population	Road I	Low	67,845	1,673	Transportation	Road I	Low	69,592	1,098
		High	68,416	772			High	67,193	2,033
	Road II	Low	66,787	2,731		Road II	Low	68,158	2,532
		High	64,990	4,198			High	63,537	5,689
	Road III	Low	61,764	7,754		Road III	Low	63,568	7,122
		High	62,126	7,062			High	60,157	9,069
	Road IV	Low	56,558	12,960		Road IV	Low	58,937	11,753
		High	52,072	17,116			High	47,673	21,553
	Road V	Low	57,717	11,801		Road V	Low	60,203	10,487
		High	57,360	11,828			High	52,771	16,455
University	Road I	Low	66,941	2,029	Low income	Road I	Low	68,259	959
		High	68,715	726			High	67,377	2,040
	Road II	Low	64,779	4,191		Road II	Low	66,791	2,427
		High	66,034	3,407			High	64,272	5,145
	Road III	Low	61,397	7,573		Road III	Low	62,615	6,603
		High	62,576	6,865			High	61,097	8,320
	Road IV	Low	56,095	12,875		Road IV	Low	56,569	12,649
		High	50,563	18,878			High	51,256	18,161
	Road V	Low	55,560	13,410		Road V	Low	59,523	9,695
		High	58,654	10,787			High	54,228	15,189
Employment	Road I	Low	67,524	1,693	Home ownership	Road I	Low	67,172	2,136
		High	68,518	865			High	68,939	975
	Road II	Low	64,921	4,296		Road II	Low	63,715	5,593
		High	66,476	2,907			High	67,425	2,489
	Road III	Low	60,513	8,704		Road III	Low	59,824	9,484
		High	62,792	6,591			High	63,717	6,197
	Road IV	Low	52,238	16,979		Road IV	Low	48,301	21,007
		High	55,210	14,173			High	58,395	11,519
	Road V	Low	54,714	14,503		Road V	Low	52,474	16,834
		High	59,271	10,112			High	60,346	9,568
Family income	Road I	Low	67,000	2,318	Income variation	Road I	Low	67,635	1,684
		High	68,639	629			High	68,741	657
	Road II	Low	63,670	5,648		Road II	Low	65,132	4,187
		High	66,653	2,615			High	66,457	2,941
	Road III	Low	60,833	8,485		Road III	Low	61,189	8,130
		High	63,009	6,259			High	61,907	7,491
	Road IV	Low	52,228	17,090		Road IV	Low	55,814	13,505
		High	54,210	15,058			High	53,287	16,111
	Road V	Low	53,146	16,172		Road V	Low	55,603	13,716
		High	59,932	9,336			High	58,564	10,834
Personal income	Road I	Low	67,260	2,058	Management	Road I	Low	67,634	1,850
		High	68,502	783			High	68,118	962
	Road II	Low	64,126	5,192		Road II	Low	64,993	4,491
		High	66,387	2,898			High	65,493	3,587
	Road III	Low	61,321	7,997		Road III	Low	61,823	7,661
		High	63,032	6,253			High	62,586	6,494
	Road IV	Low	52,434	16,884		Road IV	Low	53,330	16,154
		High	53,259	16,026			High	54,067	15,013
	Road V	Low	54,333	14,985		Road V	Low	55,757	13,727
		High	59,537	9,748			High	58,294	10,786

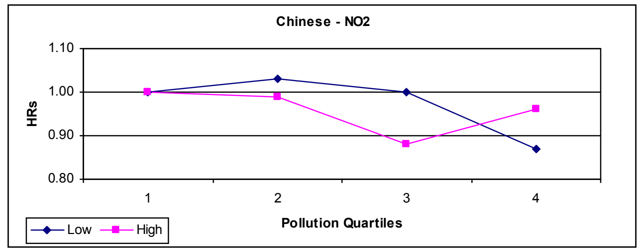
Table 50. Distribution of subjects by the two levels of socioeconomic indicators at neighborhood-level of aggregation and the five road proximity categories

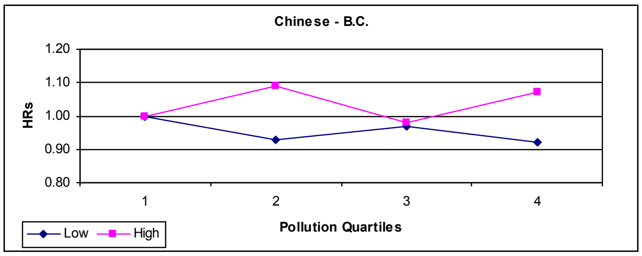
DA-level SES	Pollutant	SES Level	Road proximity		DA-level SES	Pollutant	SES Level	Road proximity	
			0	1				0	1
Other language	Road I	Low	64,958	1,537	Personal income	Road I	Low	67,290	1,890
		High	68,412	1,205			High	67,732	905
	Road II	Low	63,816	2,679		Road II	Low	64,438	4,742
		High	65,521	4,096			High	65,189	3,448
	Road III	Low	59,011	7,484		Road III	Low	61,949	7,231
		High	62,199	7,418			High	61,533	7,104
	Road IV	Low	53,753	12,742		Road IV	Low	52,777	16,403
		High	52,139	17,478			High	50,636	18,001
	Road V	Low	55,089	11,406		Road V	Low	55,512	13,668
		High	57,065	12,552			High	57,491	11,146
Linguistic isolation	Road I	Low	64,652	1,440	Governmental transfers	Road I	Low	69,455	572
		High	73,369	1,140			High	67,337	1,945
	Road II	Low	63,586	2,506		Road II	Low	67,791	2,236
		High	70,196	4,313			High	64,100	5,182
	Road III	Low	58,876	7,216		Road III	Low	63,963	6,064
		High	66,278	8,231			High	60,626	8,656
	Road IV	Low	52,164	13,928		Road IV	Low	54,741	15,286
		High	54,920	19,589			High	52,274	17,008
	Road V	Low	55,223	10,869		Road V	Low	61,284	8,743
		High	61,016	13,493			High	53,906	15,376
University	Road I	Low	67,778	1,828	Low income	Road I	Low	66,804	1,344
		High	69,055	1,004			High	67,962	1,563
	Road II	Low	66,705	2,901		Road II	Low	65,830	2,318
		High	65,927	4,132			High	64,534	4,991
	Road III	Low	61,644	7,962		Road III	Low	60,949	7,199
		High	62,323	7,736			High	60,951	8,574
	Road IV	Low	58,222	11,384		Road IV	Low	56,402	11,746
		High	49,437	20,622			High	50,479	19,046
	Road V	Low	57,220	12,386		Road V	Low	57,555	10,593
		High	57,508	12,551			High	54,777	14,748
Unemployment	Road I	Low	66,946	1,071	Home ownership	Road I	Low	67,920	1,894
		High	67,238	1,995			High	67,520	1,225
	Road II	Low	65,426	2,591		Road II	Low	64,251	5,563
		High	64,617	4,616			High	66,824	1,921
	Road III	Low	60,610	7,407		Road III	Low	61,169	8,645
		High	61,352	7,881			High	62,286	6,459
	Road IV	Low	55,273	12,744		Road IV	Low	50,309	19,505
		High	51,863	17,370			High	57,595	11,150
	Road V	Low	57,114	10,903		Road V	Low	54,038	15,776
		High	55,012	14,221			High	59,217	9,528
Family income	Road I	Low	67,726	1,761	Neighborhood stress	Road I	Low	69,185	598
		High	68,930	854			High	67,157	1,906
	Road II	Low	64,253	5,234		Road II	Low	67,466	2,317
		High	67,033	2,751			High	64,102	4,961
	Road III	Low	61,477	8,010		Road III	Low	63,156	6,627
		High	63,241	6,543			High	60,476	8,587
	Road IV	Low	52,189	17,298		Road IV	Low	57,089	12,694
		High	54,948	14,836			High	51,853	17,210
	Road V	Low	54,746	14,741		Road V	Low	60,337	9,446
		High	59,760	10,024			High	53,918	15,145

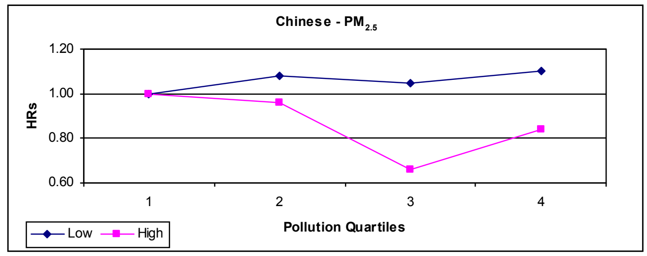
Appendix II: Dissemination area level covariates in conjunction with traffic related pollutants

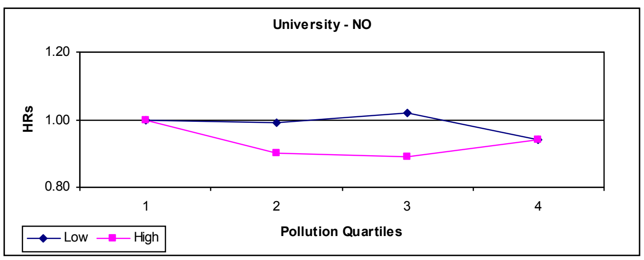
ACS health outcomes

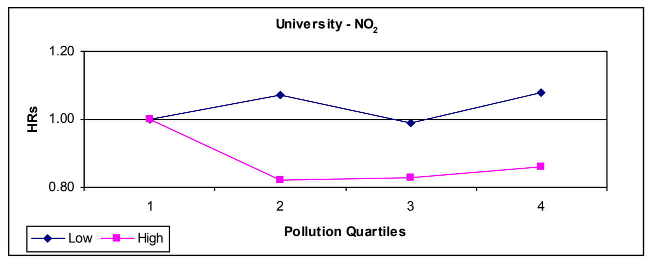


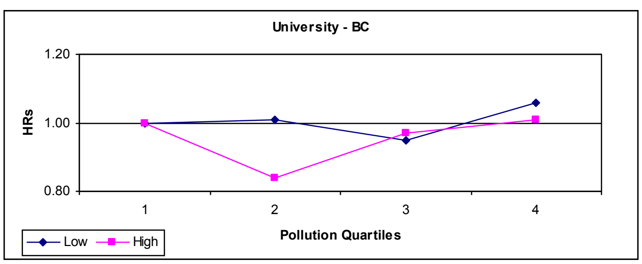


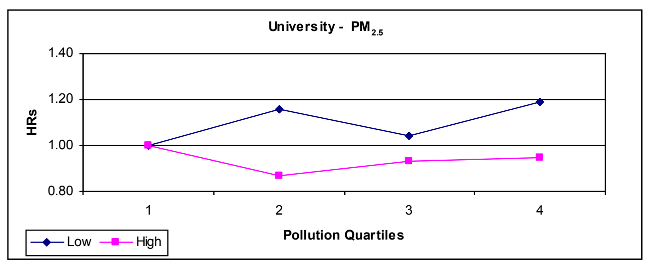


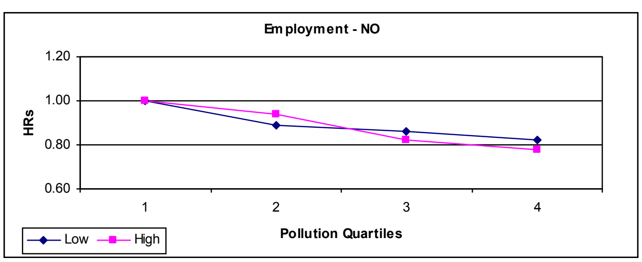


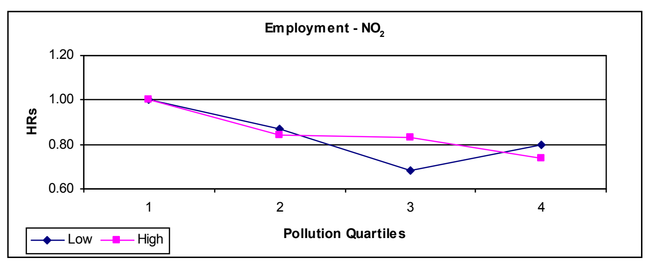


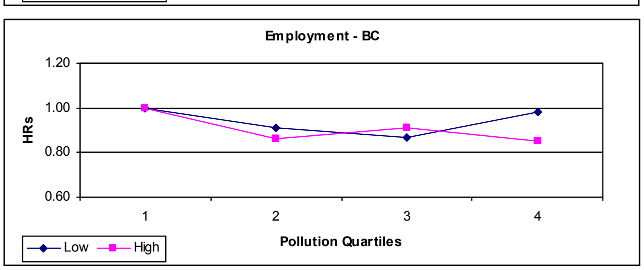


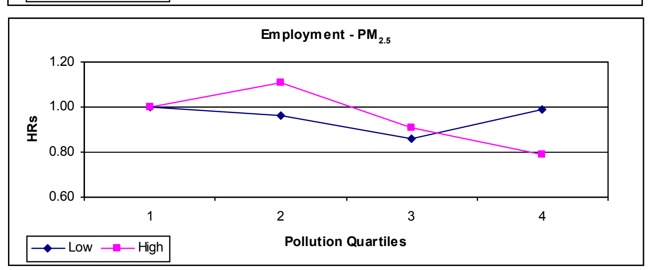


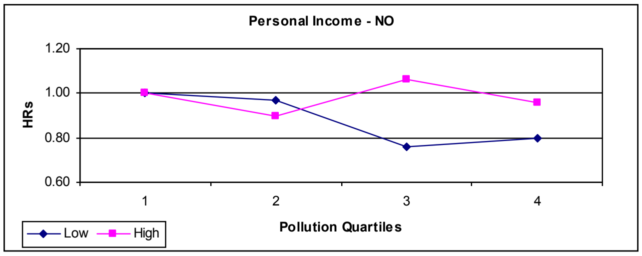








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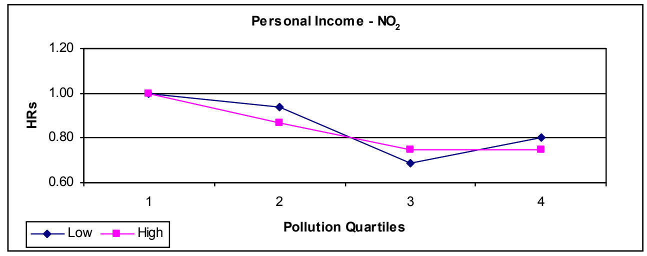
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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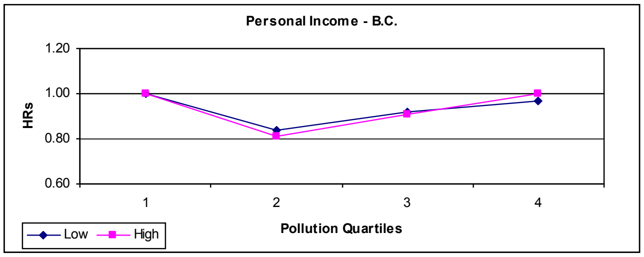
HRs
1
2
3
4
Pollution Quartiles
Low
High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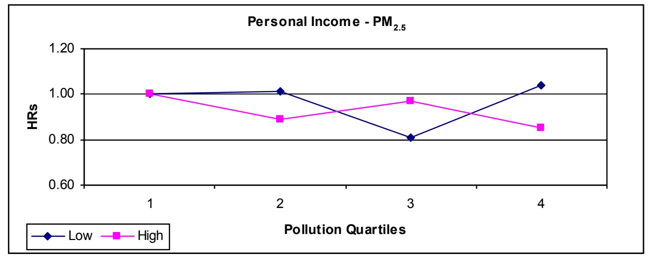
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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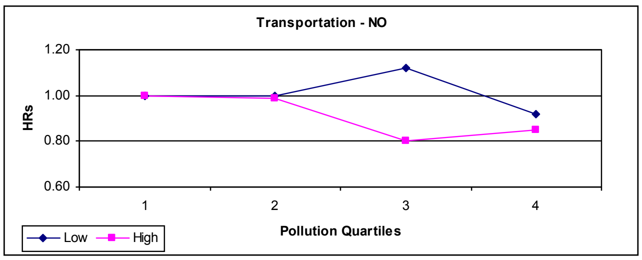
HRs
1
2
3
4
Pollution Quartiles
Low
High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HRs
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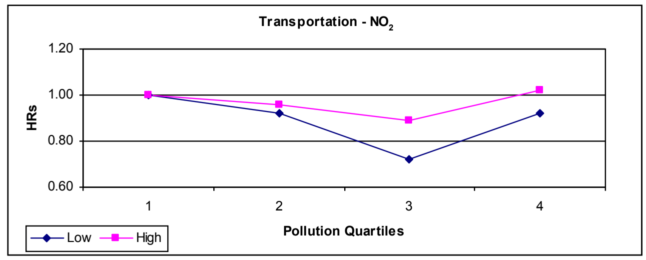
3
4
Pollution Quartiles
Low
High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HRs
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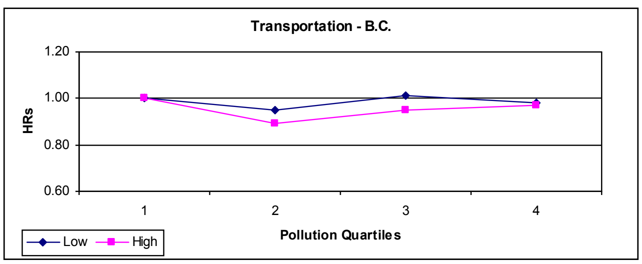
2
3
4
Pollution Quartiles
Low
High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0.60
HRs
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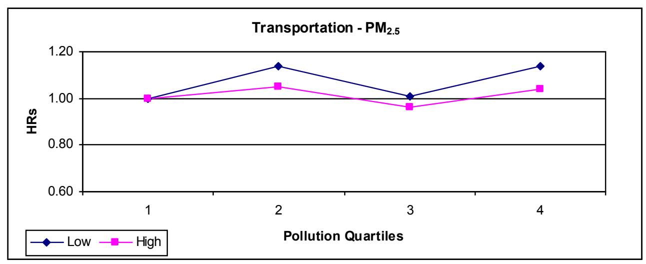
2
3
4
Pollution Quartiles
Low
High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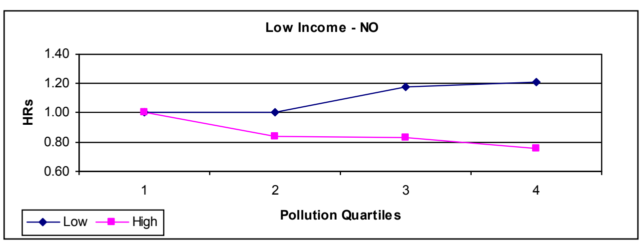
HRs
1
2
3
4
Pollution Quartiles
Low
High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0.60
HRs
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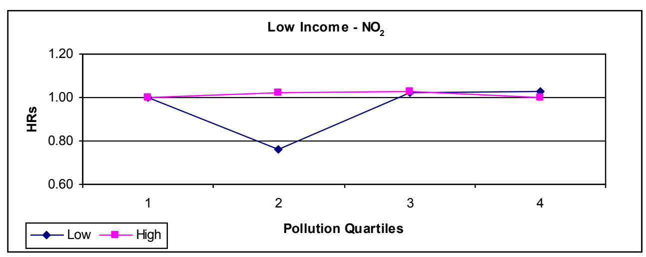
2
3
4
Pollution Quartiles
Low
High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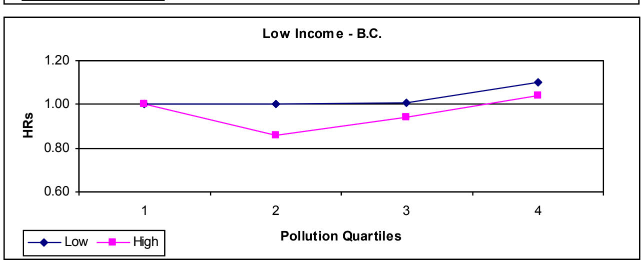
HRs
1
2
3
4
Pollution Quartiles
Low
High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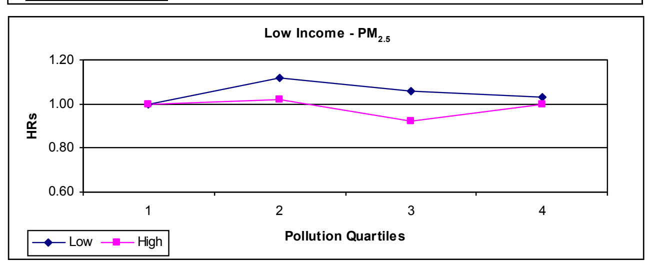
HRs
1
2
3
4
Pollution Quartiles
Low
High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1.00
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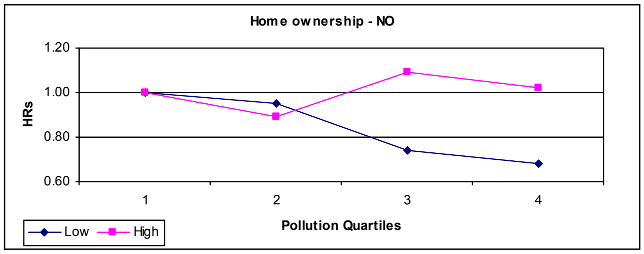
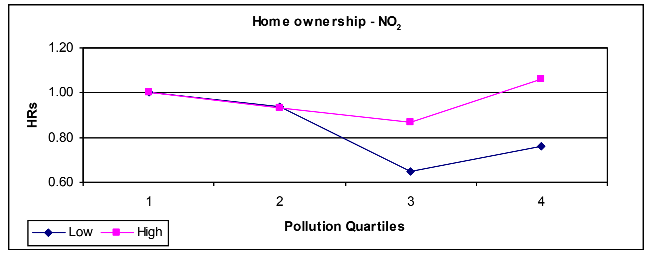
HRs
1
2
3
4
Pollution Quartiles
Low
High


Home ownership - NO
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High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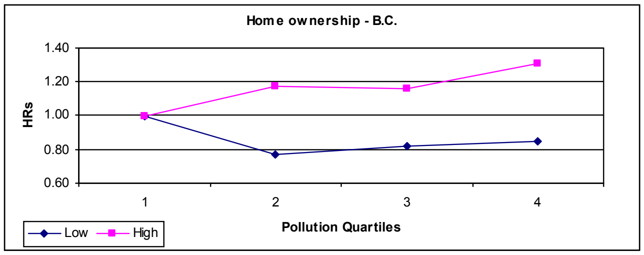
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Home ownership - B.C.
HRs
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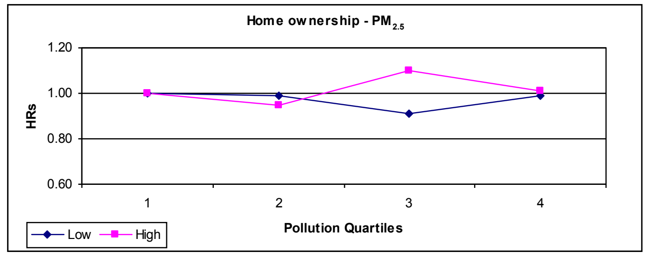
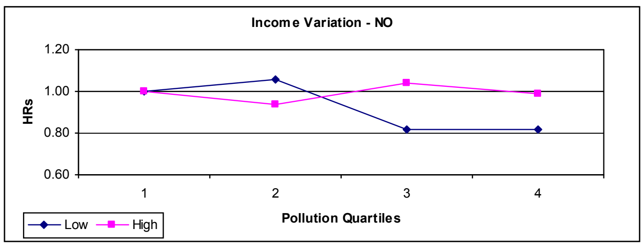
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Home ownership - $PM_{2.5}$
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Income Variation - NO
HRs
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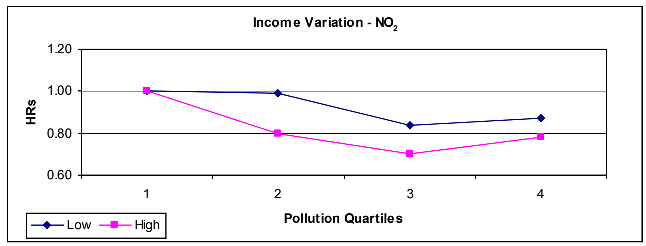
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Income Variation - NO_2
HRs
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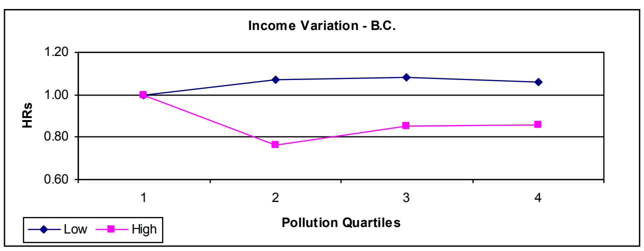
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Income Variation - B.C.
HRs
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1.00
0.80
0.60
1
2
3
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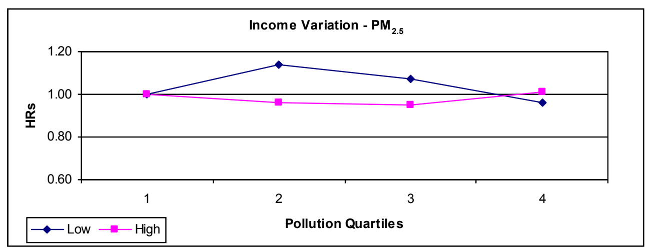
Pollution Quartiles
Low
High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HRs
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0.80
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1
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3
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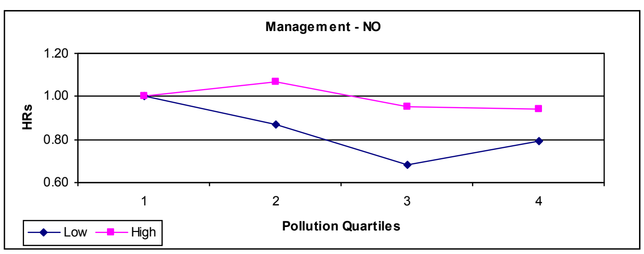
Pollution Quartiles
Low
High


Management - NO
HRs
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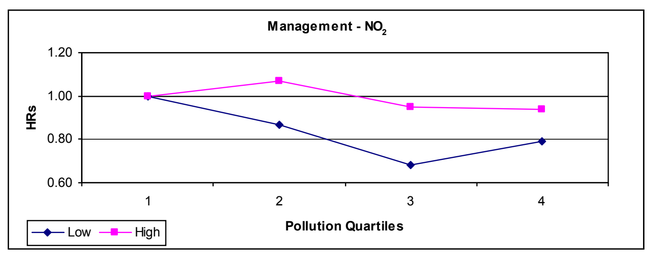
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High


Management - NO_2
HRs
1.20
1.00
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1
2
3
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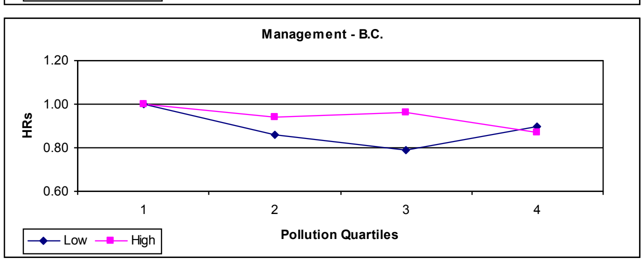
Pollution Quartiles
Low
High


Management - B.C.
HRs
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1.00
0.80
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1
2
3
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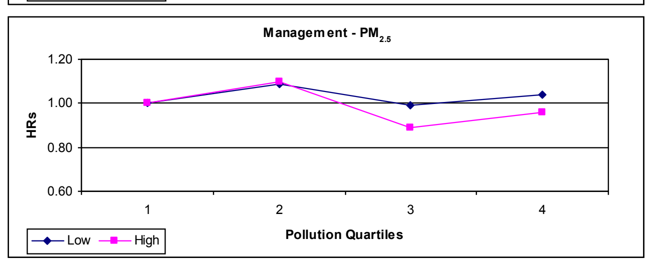
Pollution Quartiles
Low
High


Management - $PM_{2.5}$
HRs
1.20
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0.80
0.60
1
2
3
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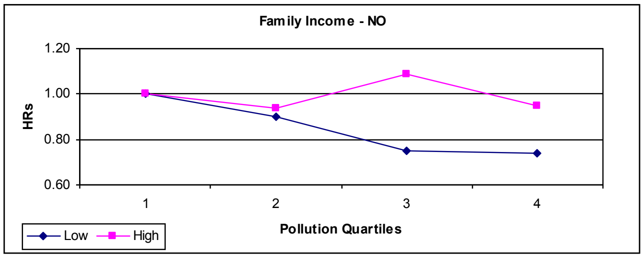
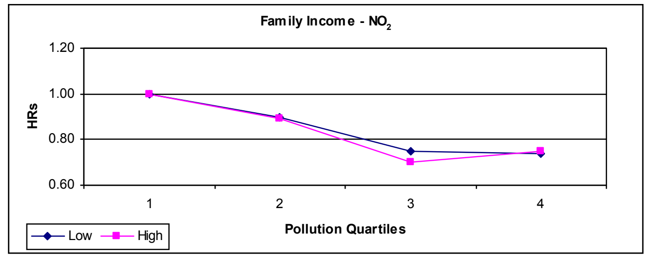
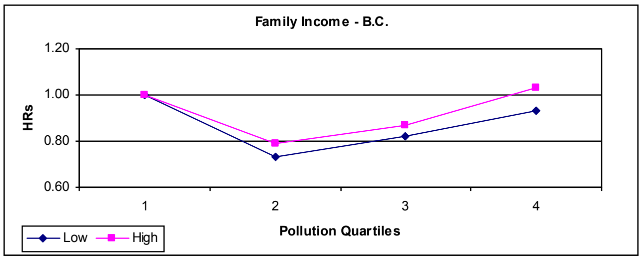
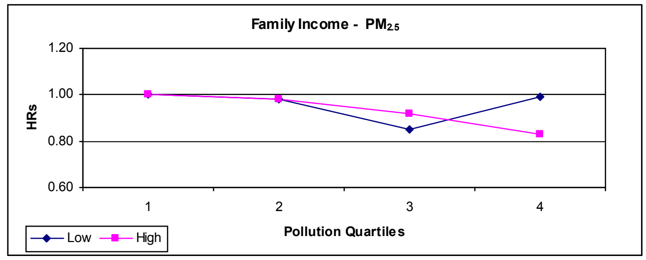
Pollution Quartiles
Low
High

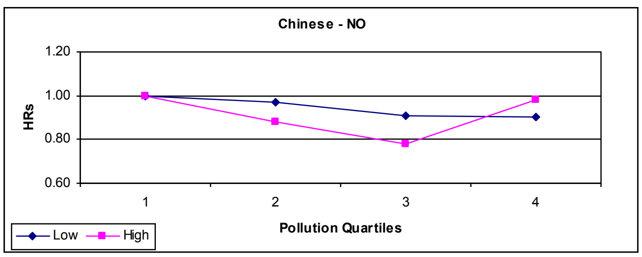


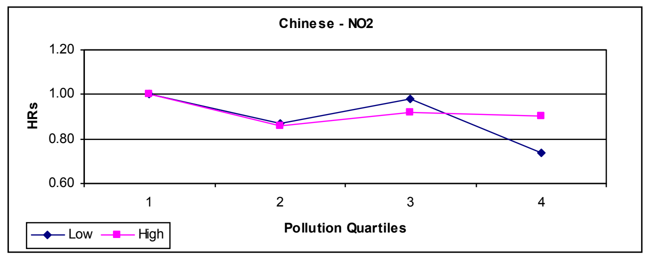


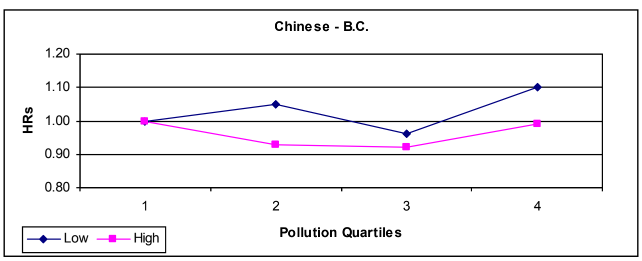


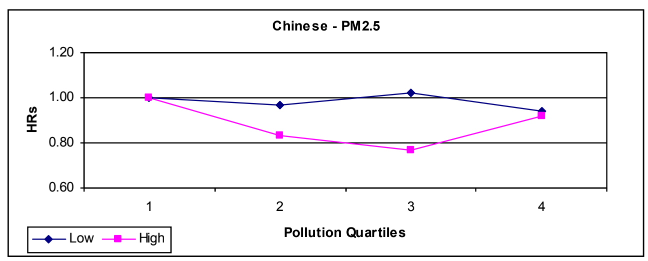


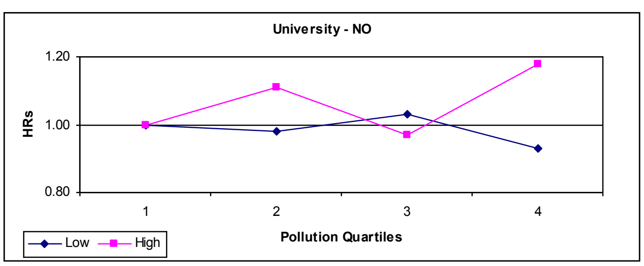
CCS health outcomes

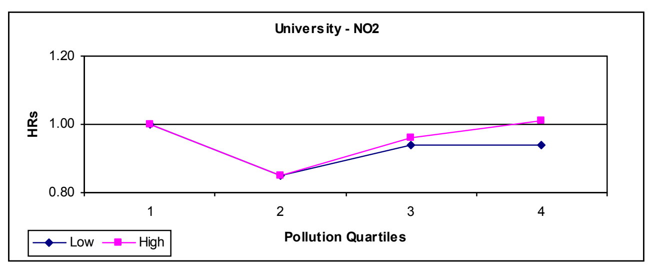


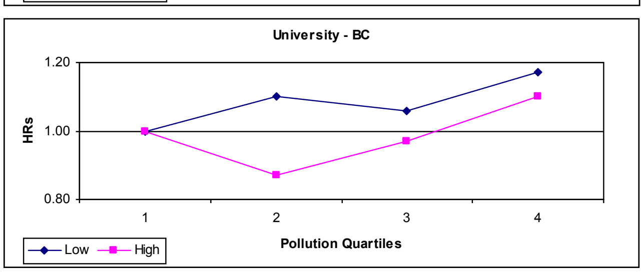


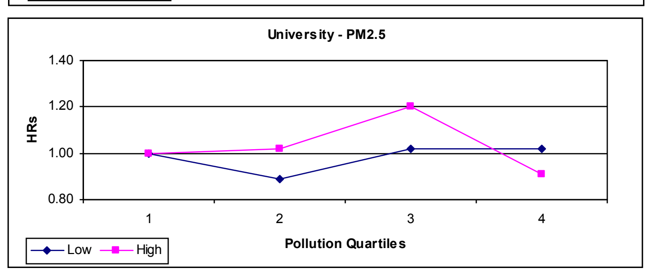


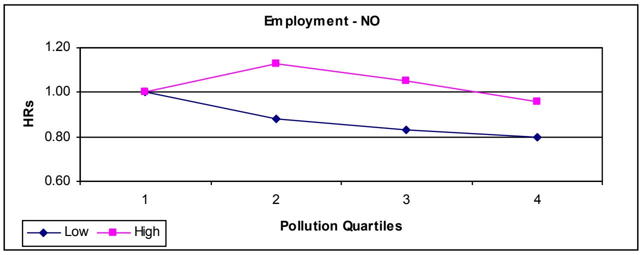


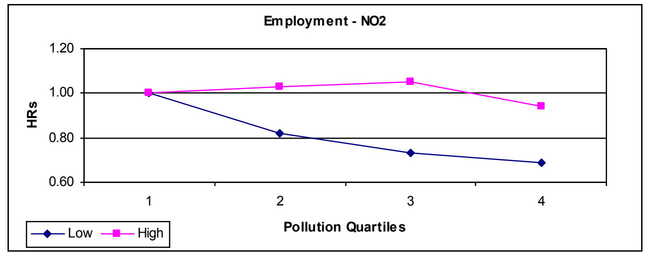


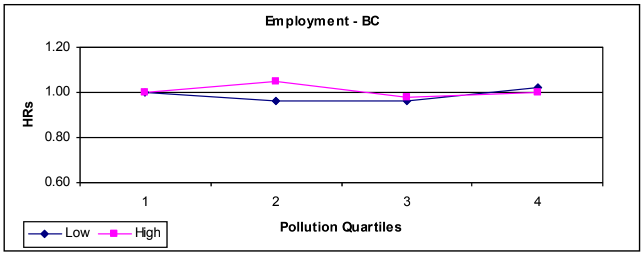







Employment - NO
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Employment - NO2
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Employment - BC
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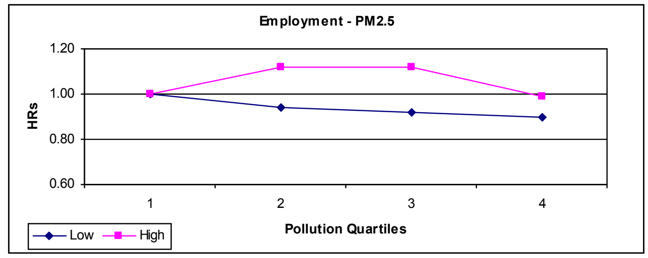
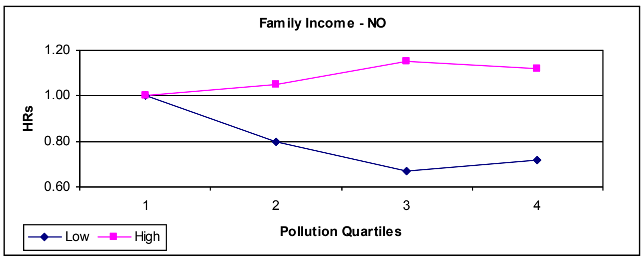
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Employment - PM2.5
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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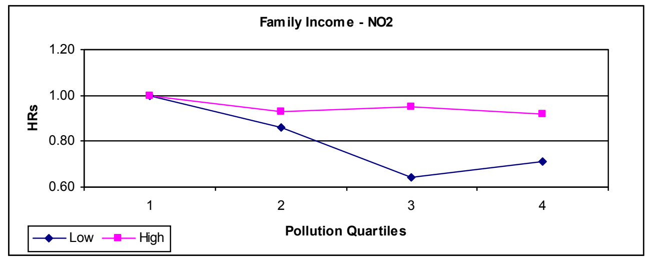
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - NO2
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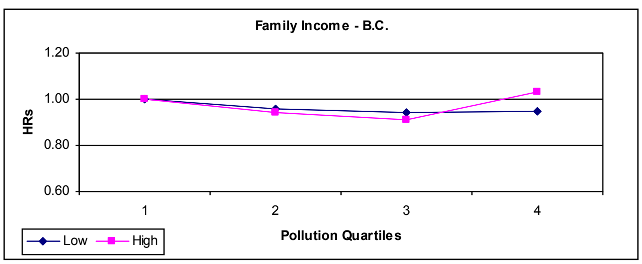
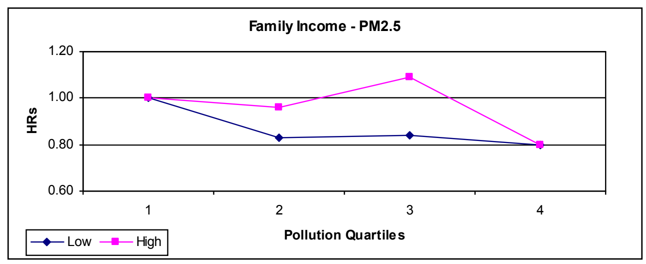
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - B.C.
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - PM2.5
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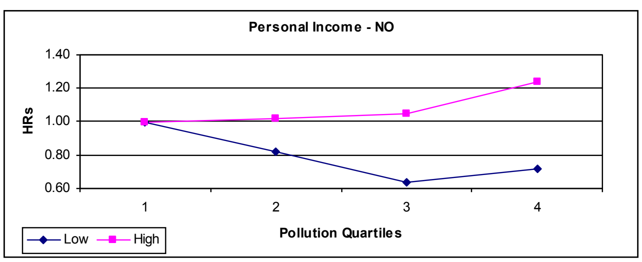
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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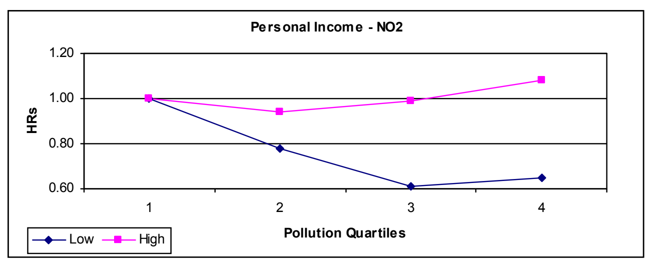
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Personal Income - NO2
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1.00
0.80
0.60
HRs
1
2
3
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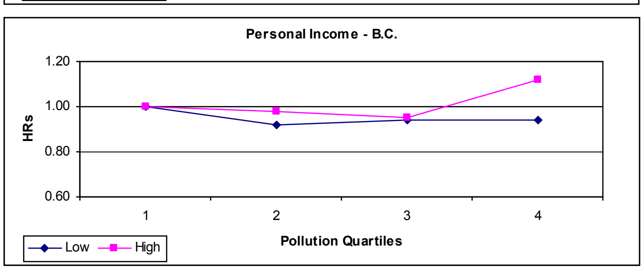
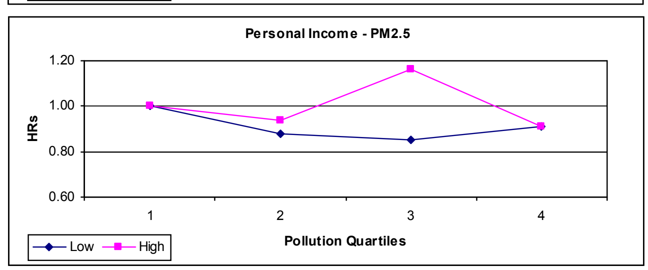
Pollution Quartiles
Low
High


Personal Income - B.C.
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Personal Income - PM2.5
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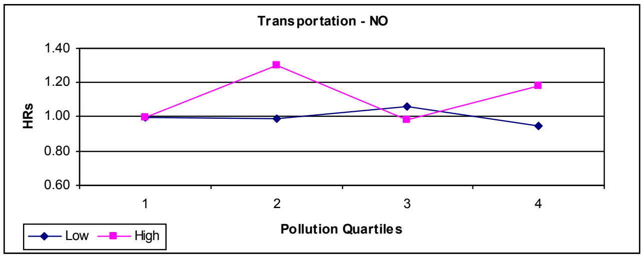
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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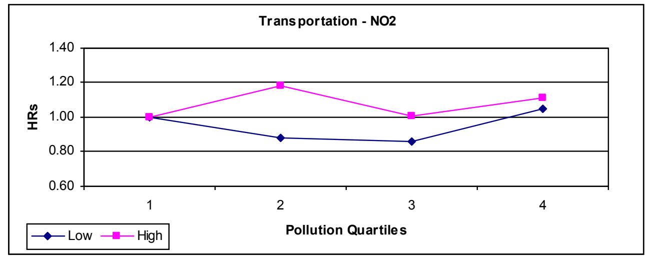
1
2
3
4
Pollution Quartiles
Low
High


Transportation - NO2
HRs
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1.00
0.80
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1
2
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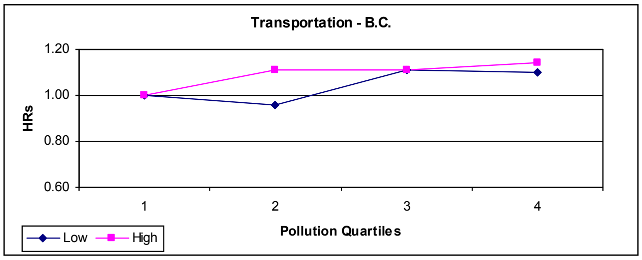
Pollution Quartiles
Low
High


Transportation - B.C.
HRs
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Pollution Quartiles
Low
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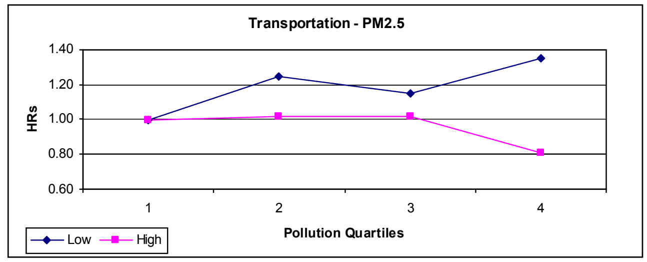
Transportation - PM2.5
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Pollution Quartiles
Low
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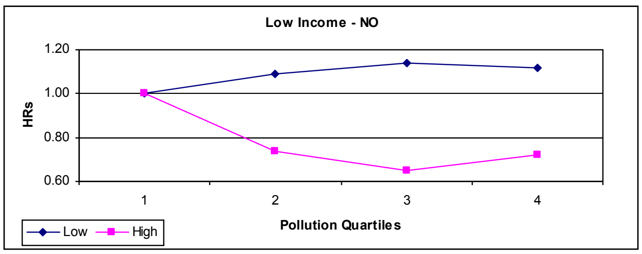
Low Income - NO
HRs
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Pollution Quartiles
Low
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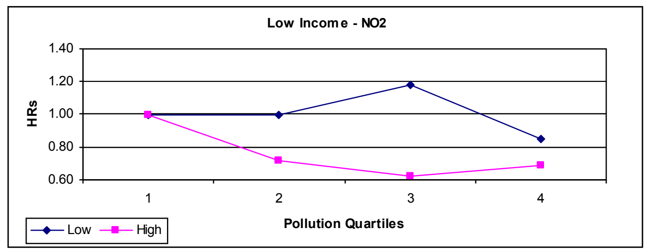
Low Income - NO2
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Pollution Quartiles
Low
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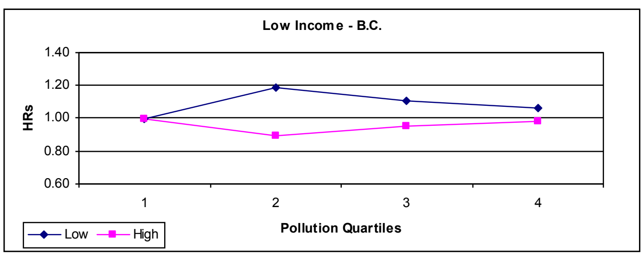
Low Income - B.C.
HRs
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Pollution Quartiles
Low
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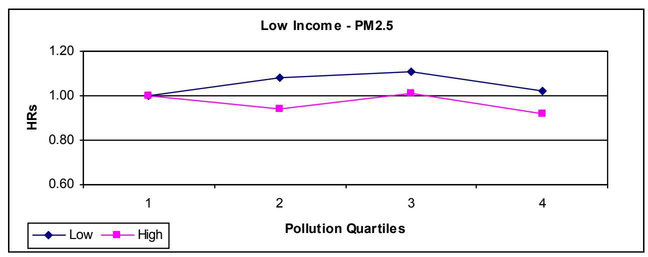
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HRs
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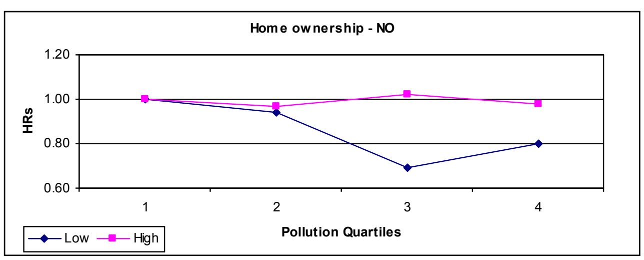
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HRs
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1.00
0.80
0.60
1
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3
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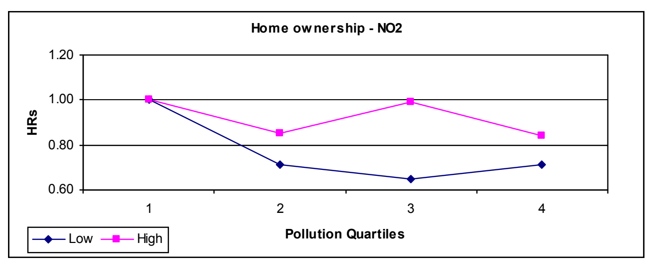
Pollution Quartiles
Low
High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Pollution Quartiles
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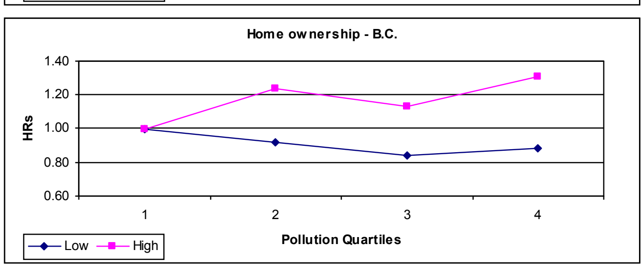
Home ownership - B.C.
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Pollution Quartiles
Low
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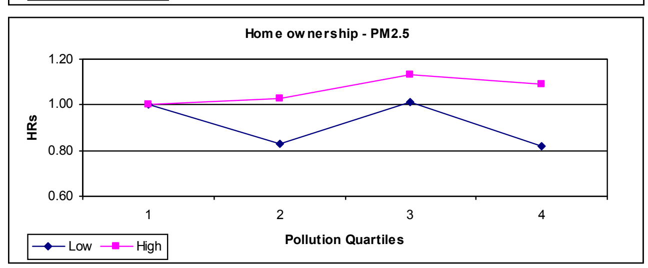
Home ownership - PM2.5
HRs
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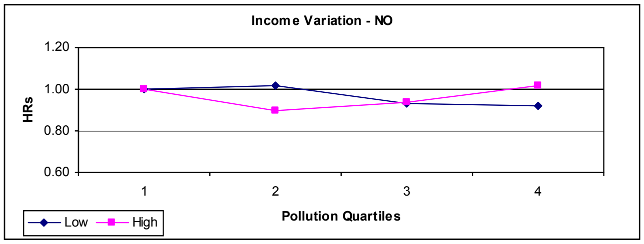
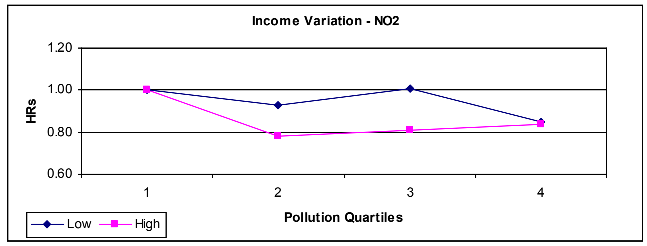
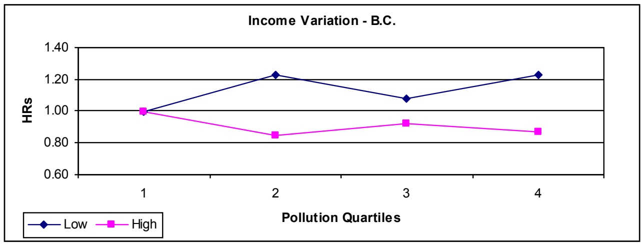
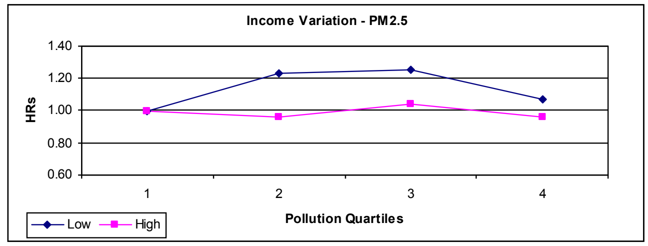
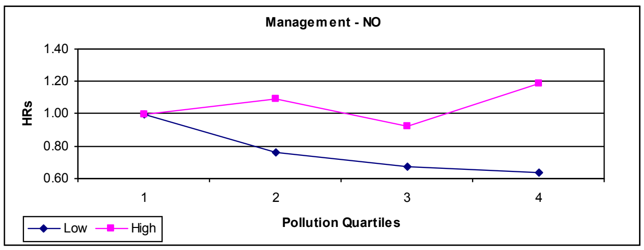
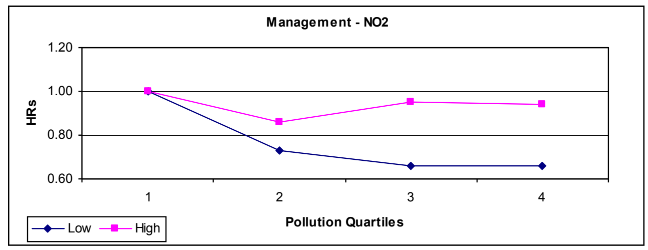


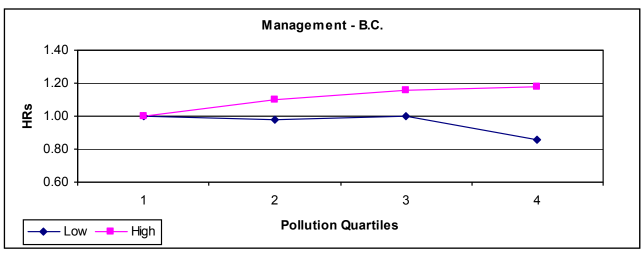


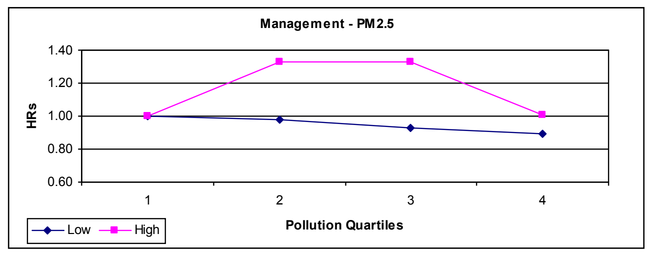




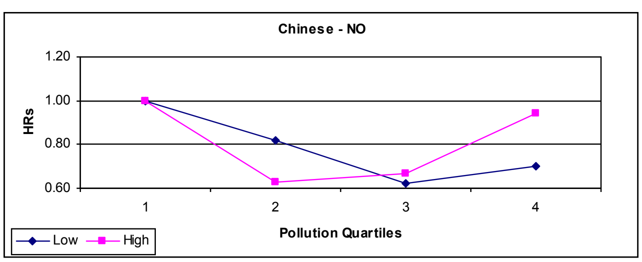


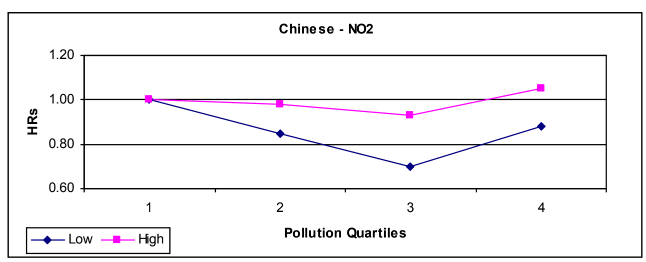


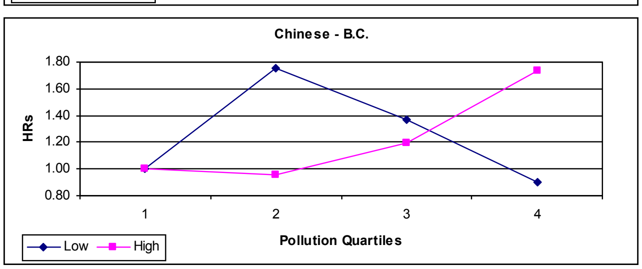


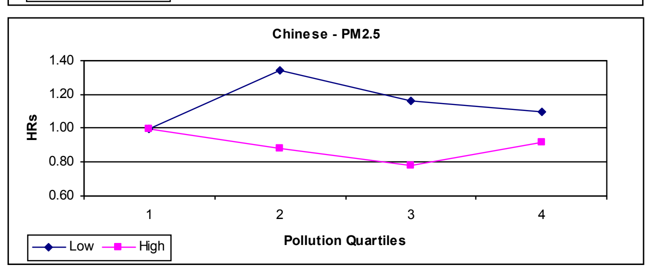


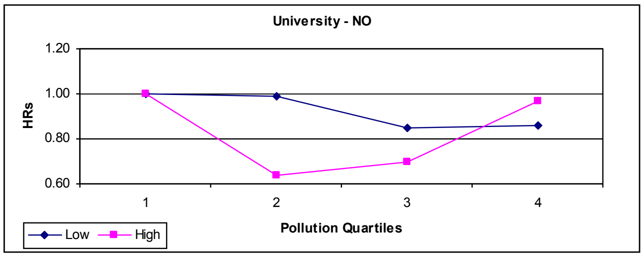
CHF health outcomes

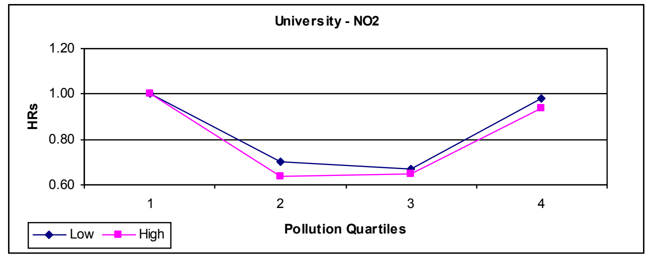


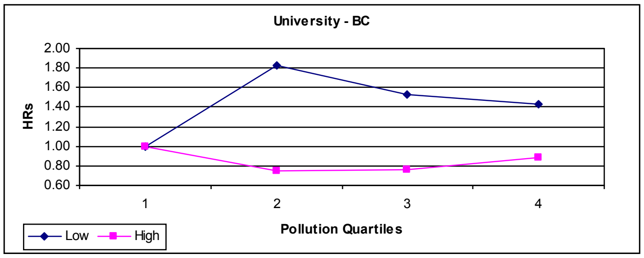


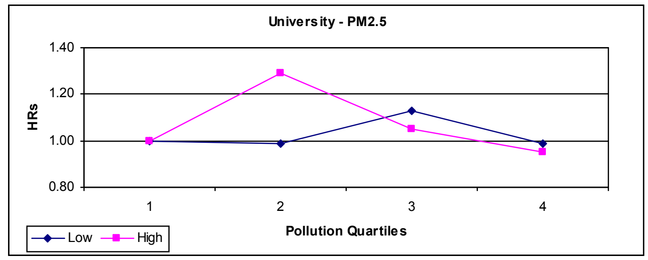


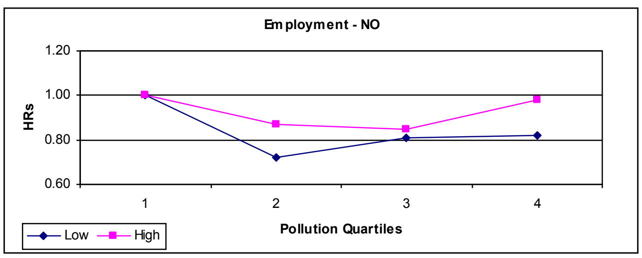


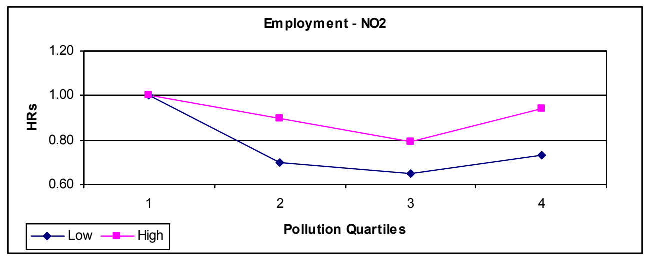

University - NO
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

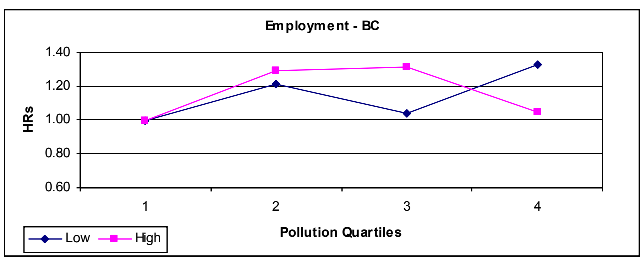

University - NO2
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

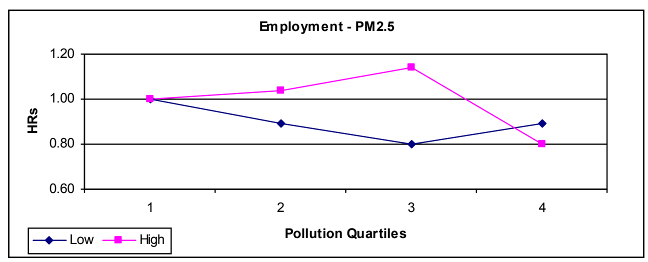

University - BC
HRs
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

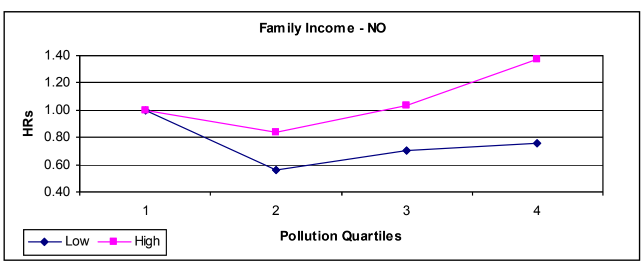

University - PM2.5
HRs
1.40
1.20
1.00
0.80
1
2
3
4
Pollution Quartiles
Low
High

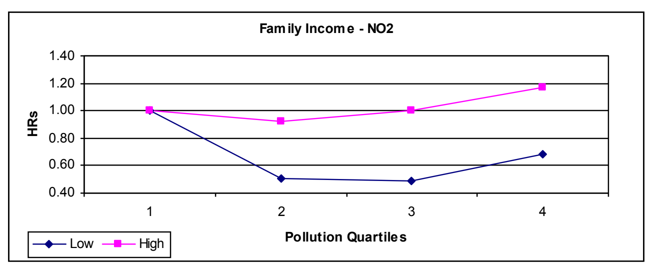

Employment - NO
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

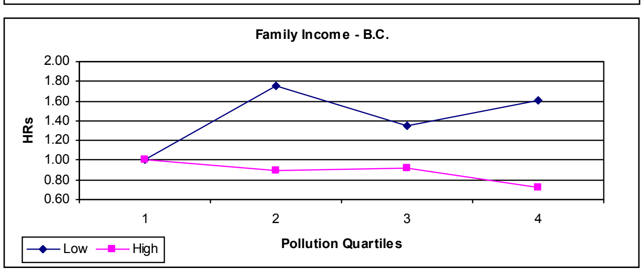

Employment - NO2
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

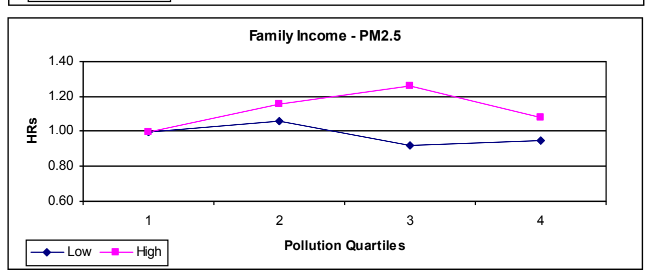

Employment - BC
HRs
1.40
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

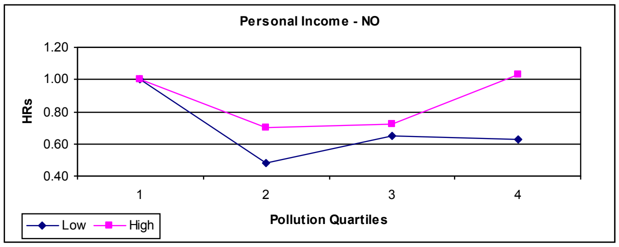

Employment - PM2.5
HRs
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

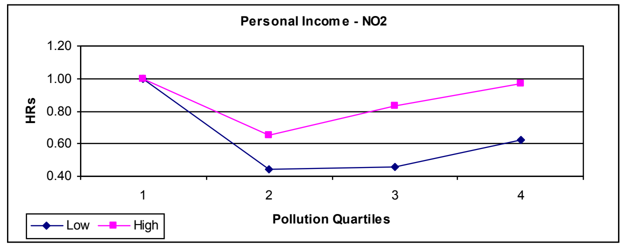

Family Income - NO
HRs
1.40
1.20
1.00
0.80
0.60
0.40
1
2
3
4
Pollution Quartiles
Low
High

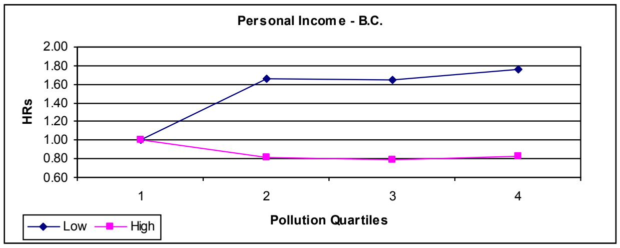

Family Income - NO2
HRs
1.40
1.20
1.00
0.80
0.60
0.40
1
2
3
4
Pollution Quartiles
Low
High

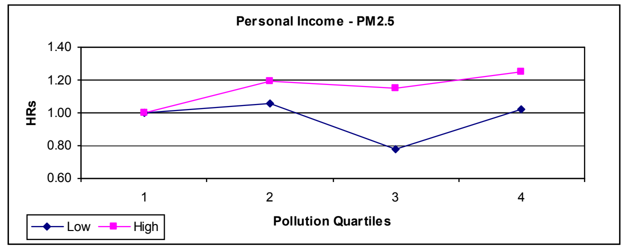

Family Income - B.C.
HRs
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

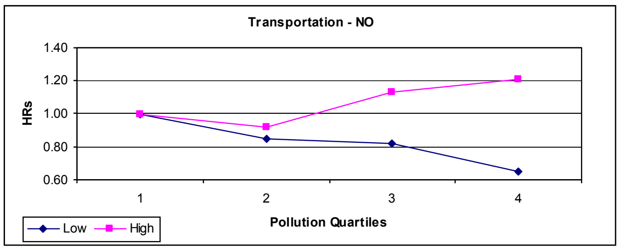

Family Income - PM2.5
HRs
1.40
1.20
1.00
0.80
0.60
1
2
3
4
Pollution Quartiles
Low
High

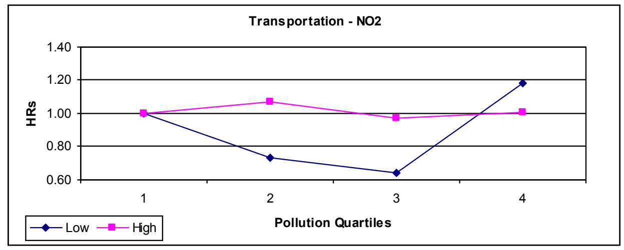

Personal Income - NO
HRs
Pollution Quartiles
Low
High

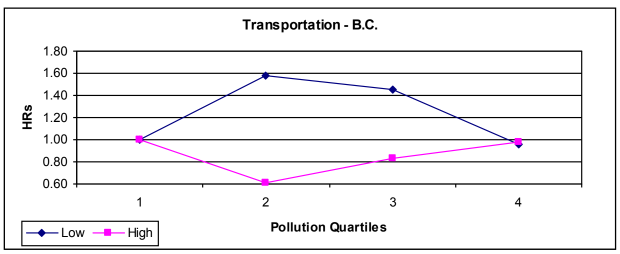

Personal Income - NO2
HRs
Pollution Quartiles
Low
High

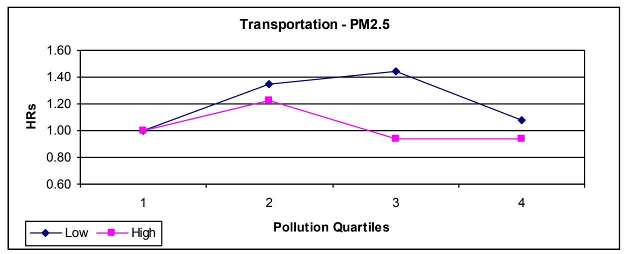

Personal Income - B.C.
HRs
Pollution Quartiles
Low
High

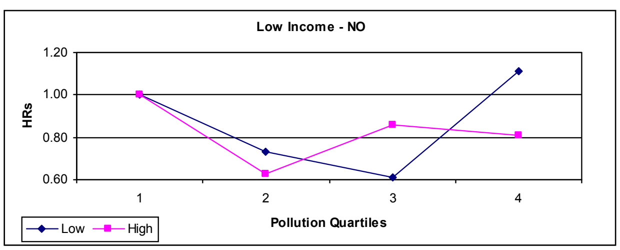

Personal Income - PM2.5
HRs
Pollution Quartiles
Low
High

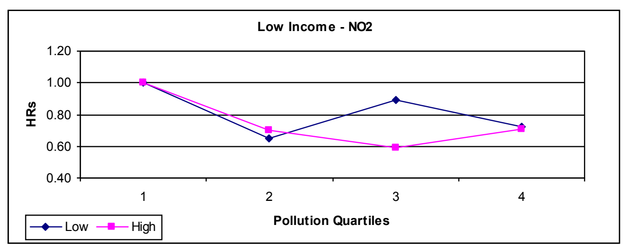

Transportation - NO
HRs
Pollution Quartiles
Low
High

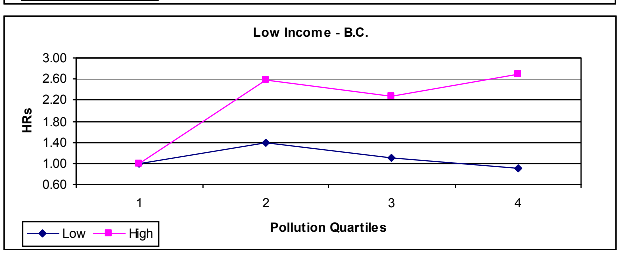

Transportation - NO2
HRs
Pollution Quartiles
Low
High

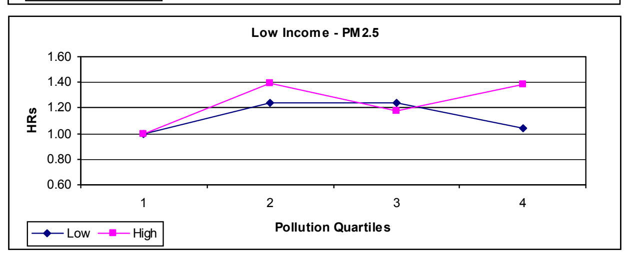

Transportation - B.C.
HRs
Pollution Quartiles
Low
High

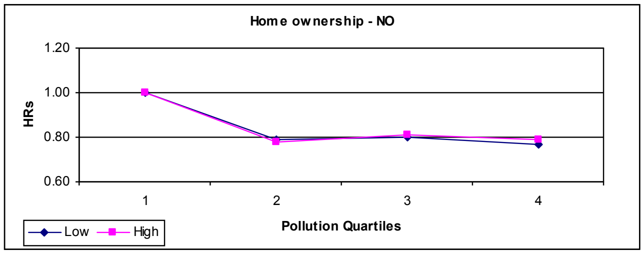

Transportation - PM2.5
HRs
Pollution Quartiles
Low
High

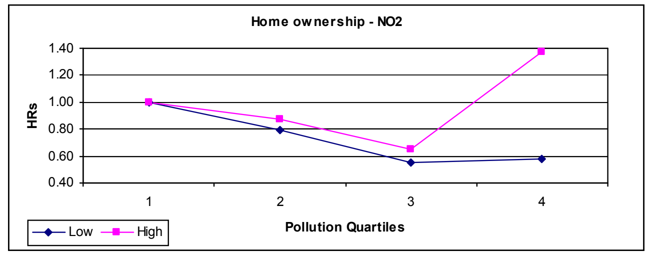

Low Income - NO
HRs
Pollution Quartiles
Low
High

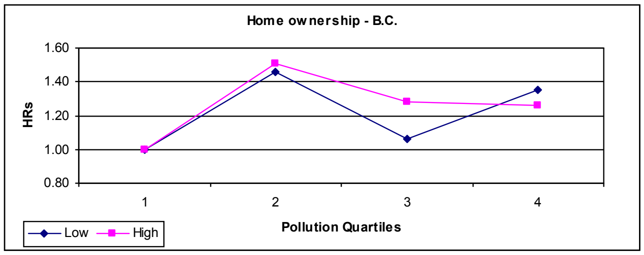

Low Income - NO2
HRs
Pollution Quartiles
Low
High

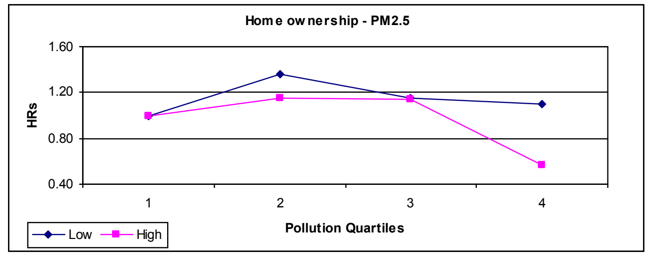

Low Income - B.C.
HRs
Pollution Quartiles
Low
High

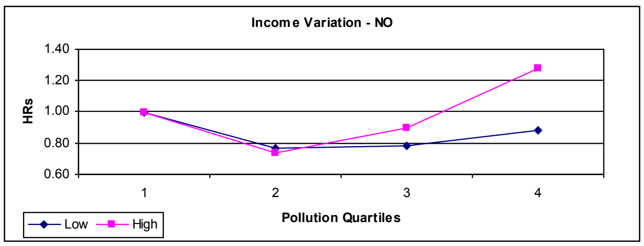

Low Income - PM2.5
HRs
Pollution Quartiles
Low
High

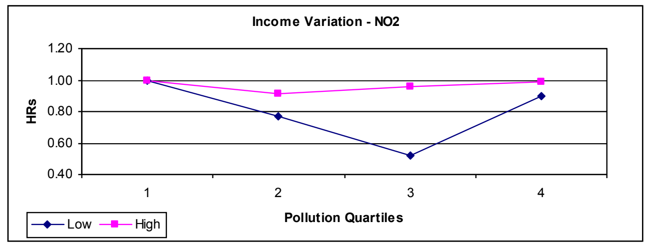

Home ownership - NO
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

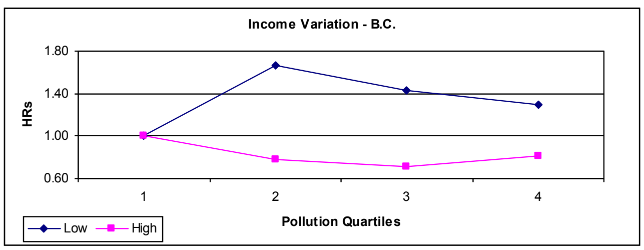

Home ownership - NO2
1.40
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

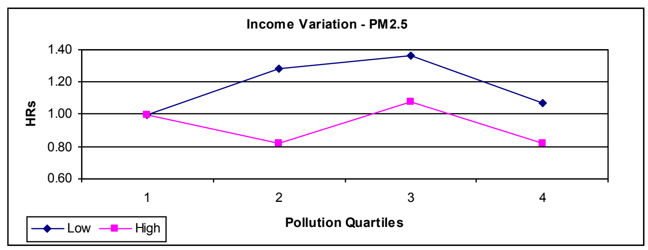

Home ownership - B.C.
1.60
1.40
1.20
1.00
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

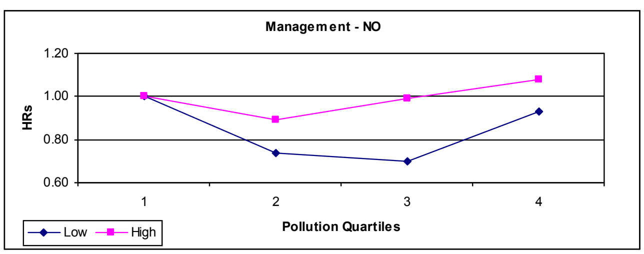

Home ownership - PM2.5
1.60
1.20
0.80
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

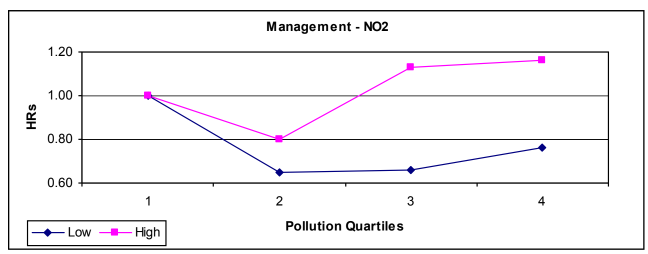

Income Variation - NO
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

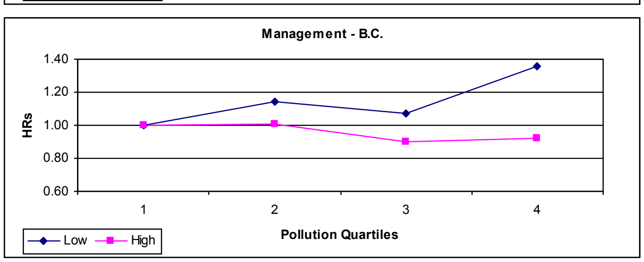

Income Variation - NO2
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

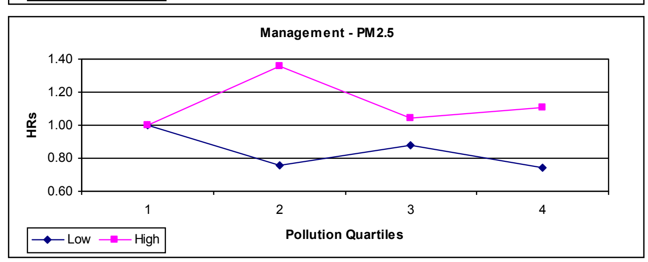

Income Variation - B.C.
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Income Variation - PM2.5
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Management - NO
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

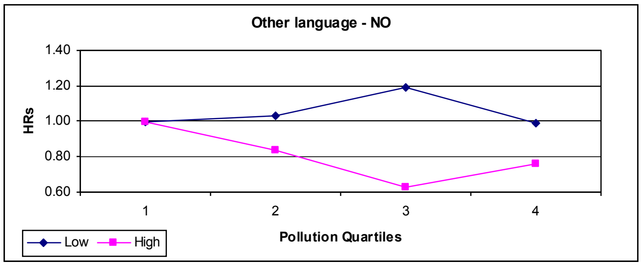

Management - NO2
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

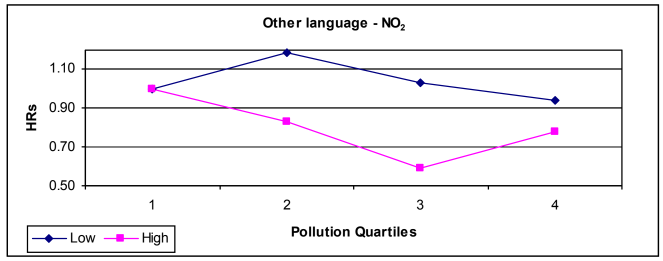

Management - B.C.
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

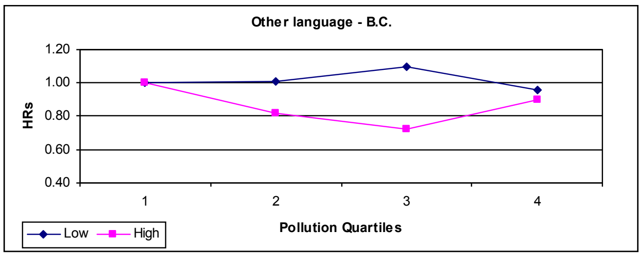

Management - PM2.5
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

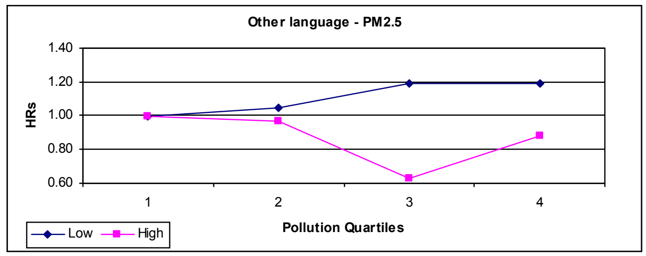
Appendix III: Neighborhood area level covariates in conjunction with traffic related pollutants

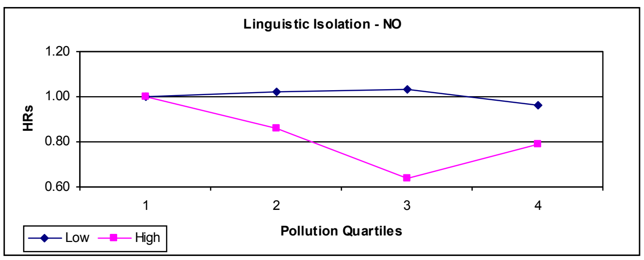
ACS health outcomes

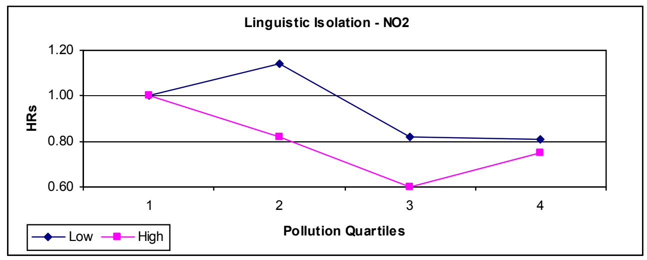


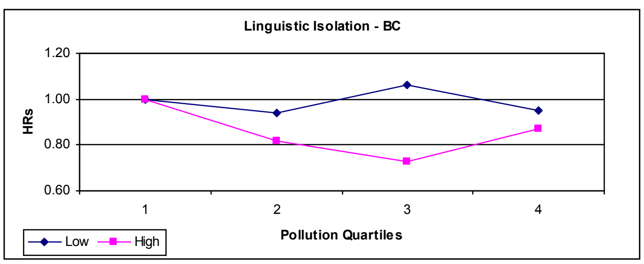


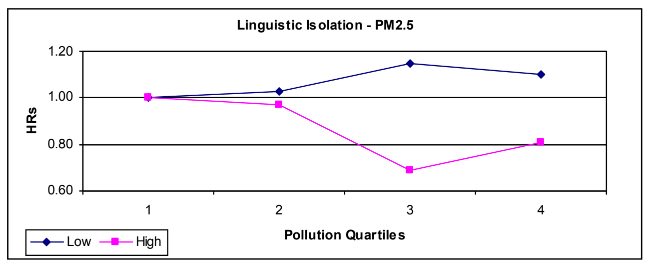


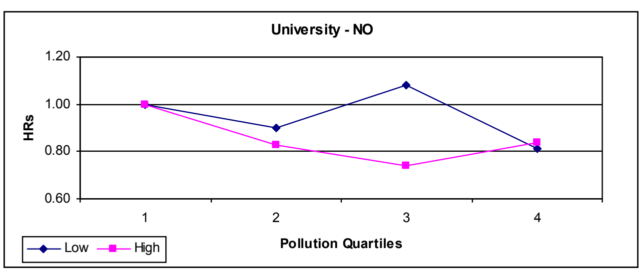


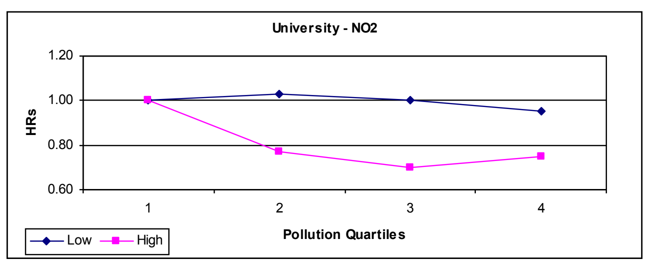


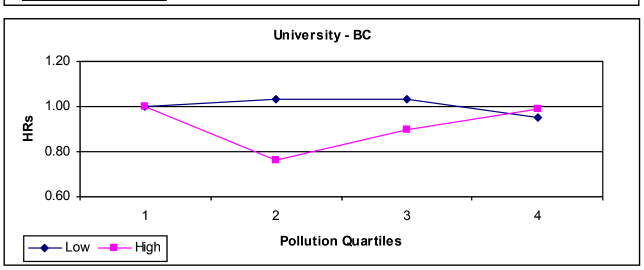


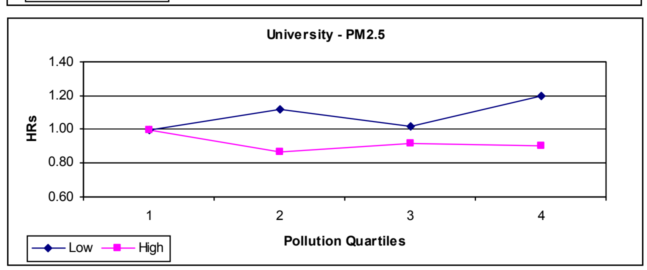


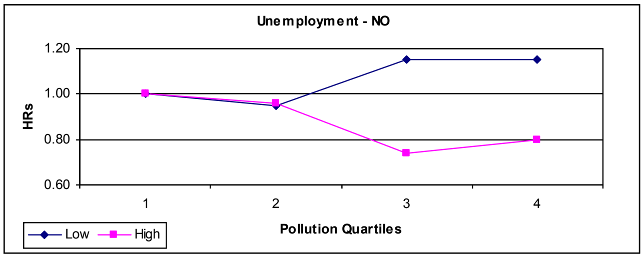


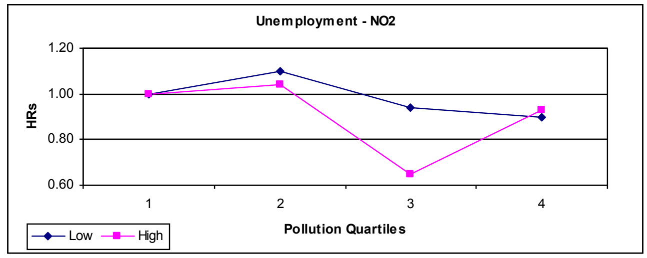


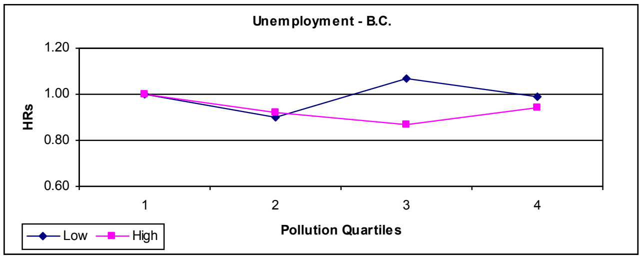


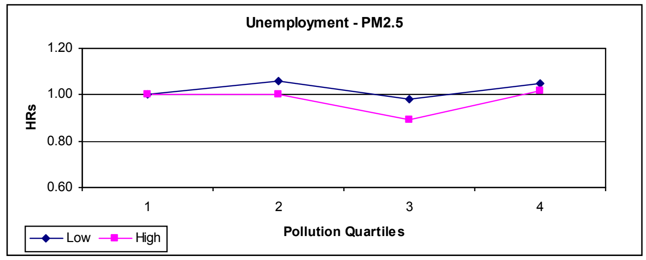


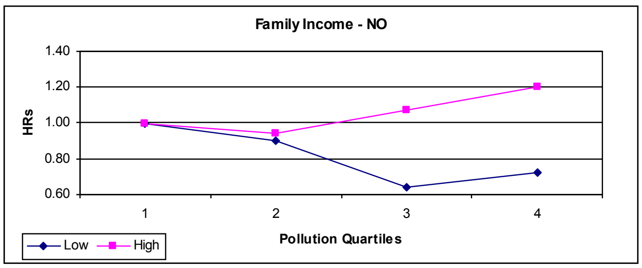


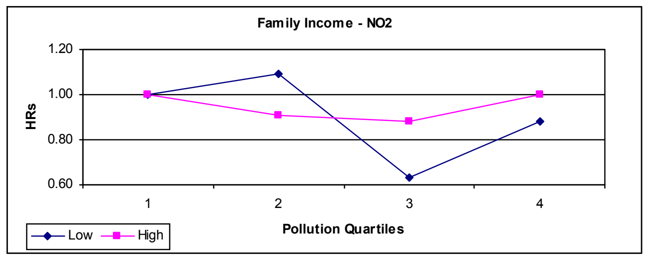

Unemployment - NO
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

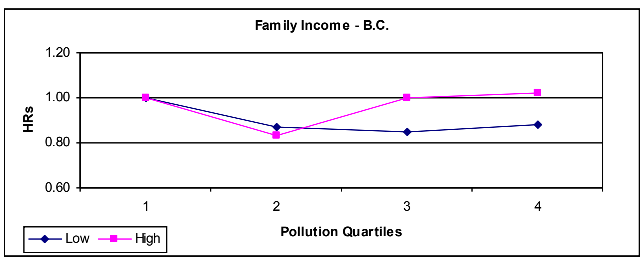

Unemployment - NO2
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Unemployment - B.C.
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Unemployment - PM2.5
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - NO
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - NO2
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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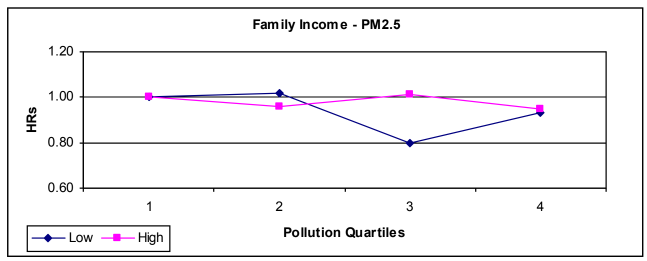
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Family Income - PM2.5
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0.80
0.60
HRs
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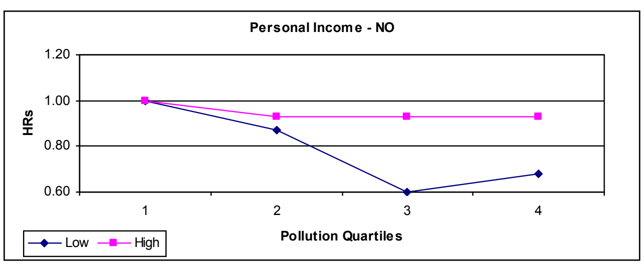
2
3
4
Pollution Quartiles
Low
High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0.80
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HRs
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3
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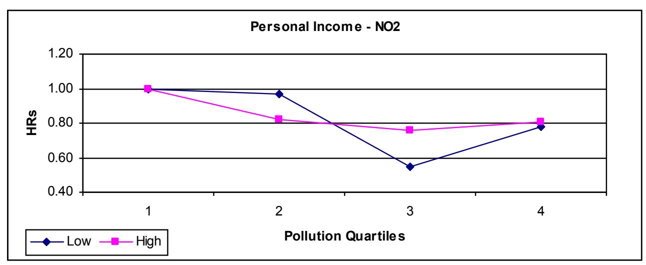
Pollution Quartiles
Low
High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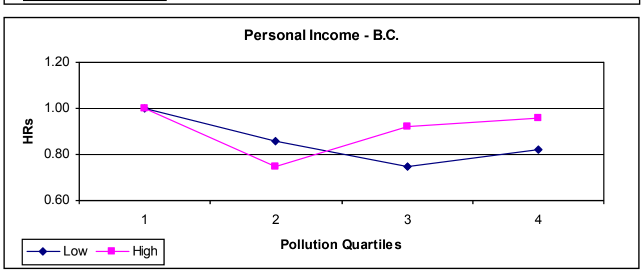
Pollution Quartiles
Low
High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0.60
HRs
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2
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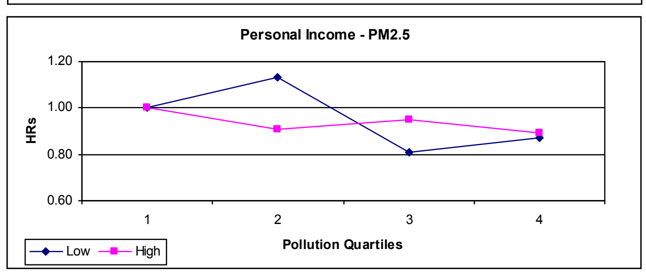
Pollution Quartiles
Low
High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HRs
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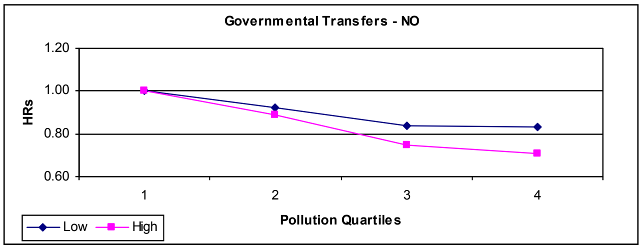
Pollution Quartiles
Low
High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HRs
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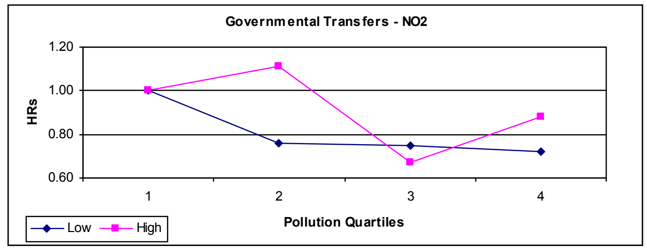
Pollution Quartiles
Low
High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HRs
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2
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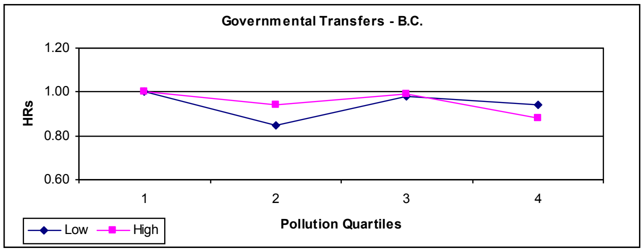
Pollution Quartiles
Low
High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0.60
HRs
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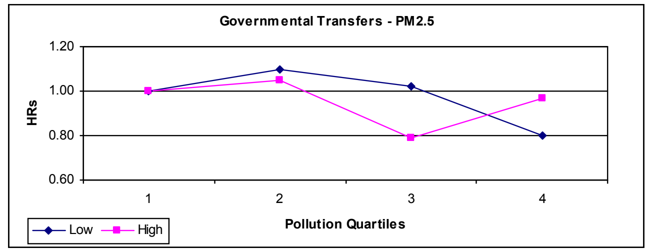
Pollution Quartiles
Low
High


Governmental Transfers - PM2.5
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0.60
HRs
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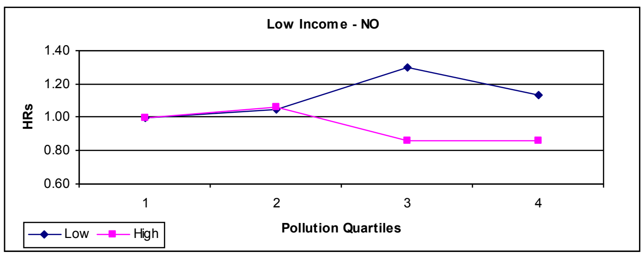
Pollution Quartiles
Low
High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HRs
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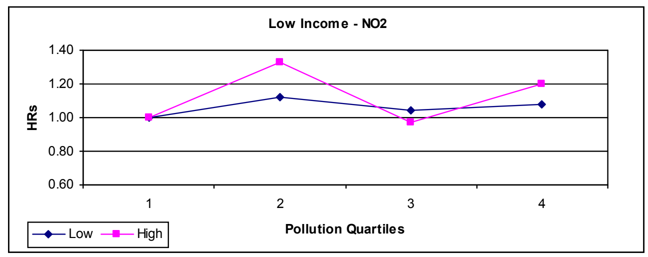
Pollution Quartiles
Low
High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HRs
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Pollution Quartiles
Low
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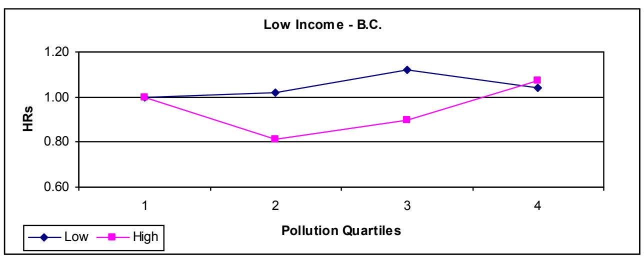
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HRs
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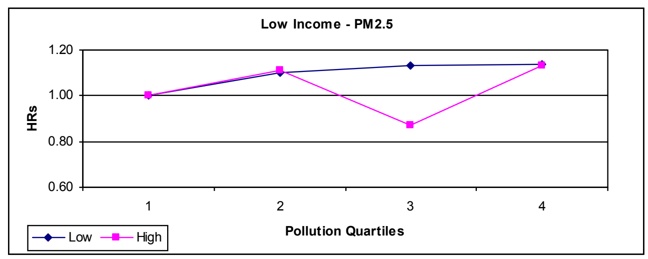
Pollution Quartiles
Low
High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HRs
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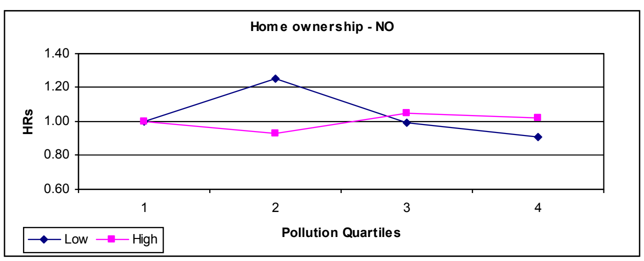
Pollution Quartiles
Low
High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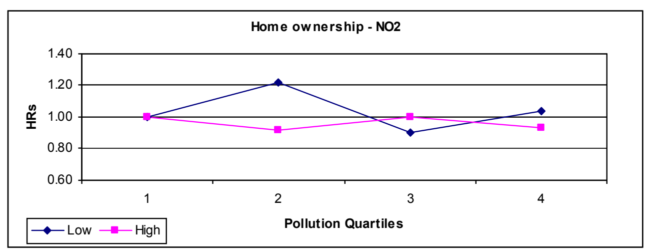
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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HRs
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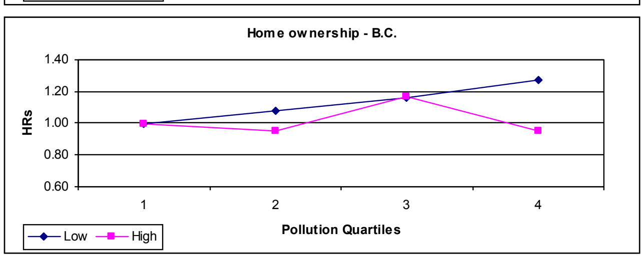
Pollution Quartiles
Low
High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1.20
1.00
0.80
0.60
HRs
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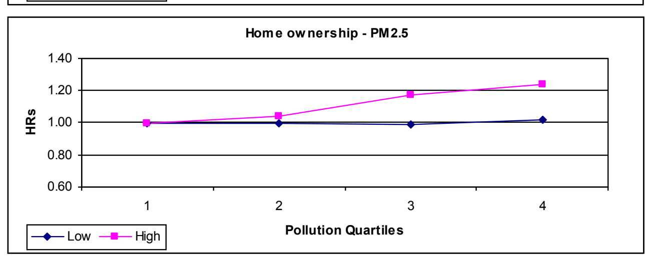
Pollution Quartiles
Low
High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1.00
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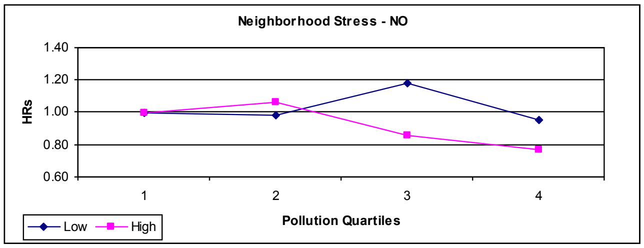
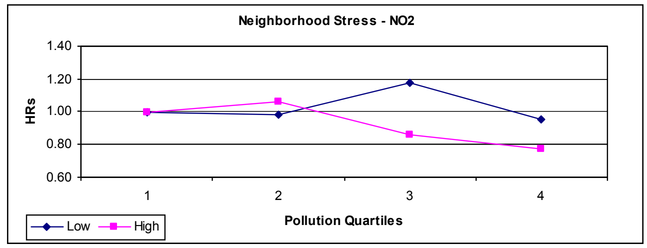
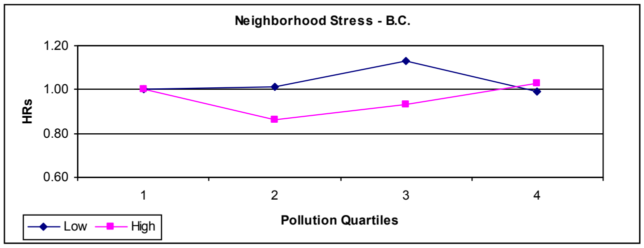
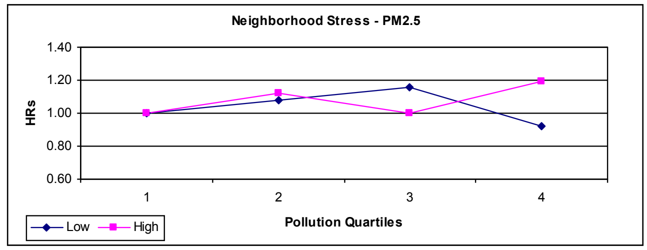
HRs
1
2
3
4
Pollution Quartiles
Low
High

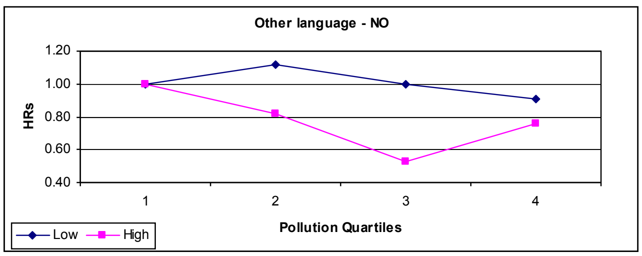


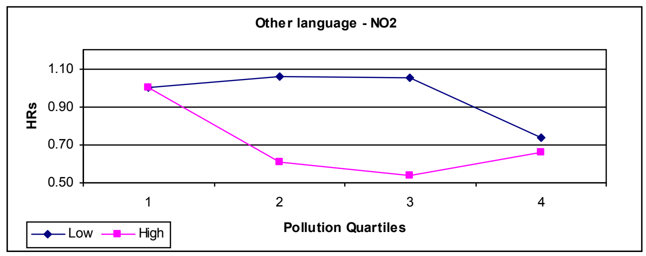


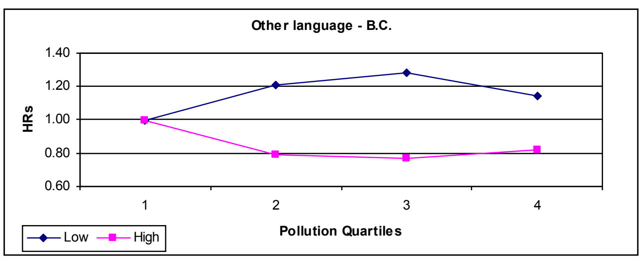


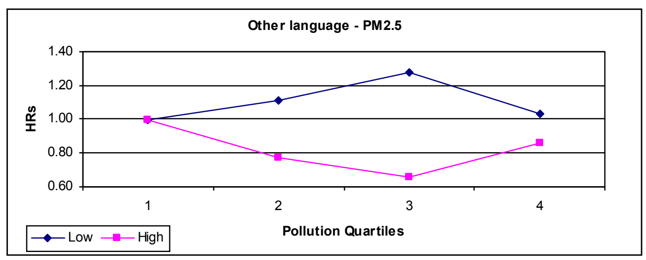


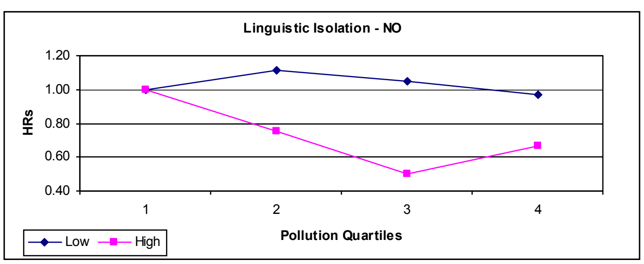
CCS health outcomes

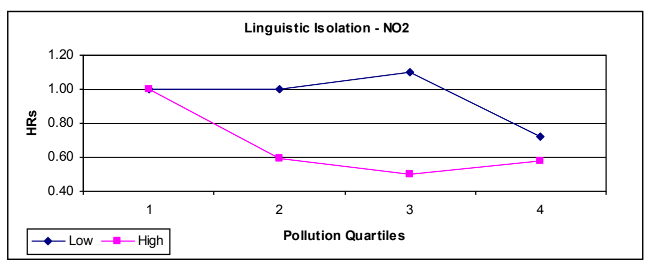


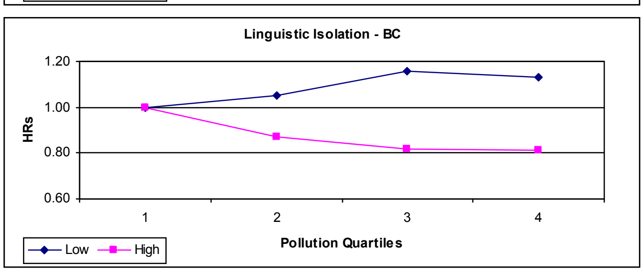


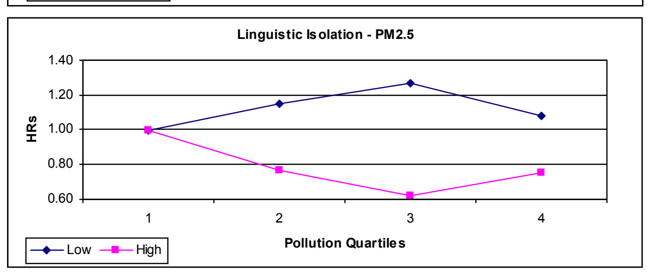


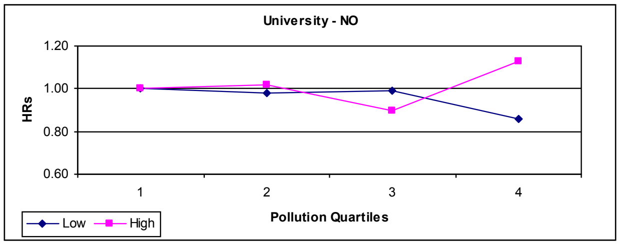








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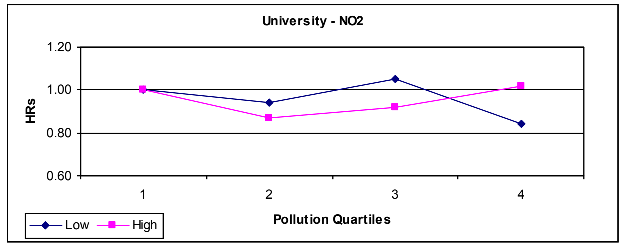
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High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1.00
0.80
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HRs
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2
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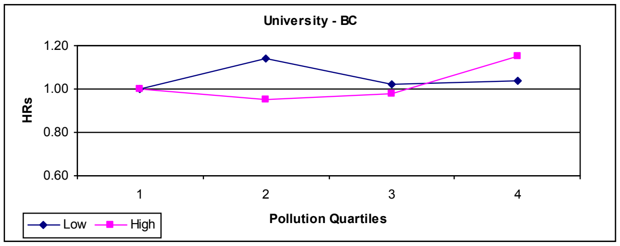
Pollution Quartiles
Low
High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HRs
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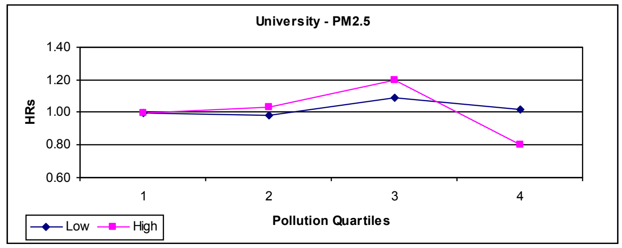
Pollution Quartiles
Low
High


University - PM2.5
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HRs
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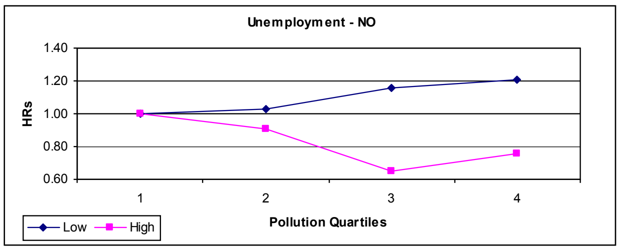
Pollution Quartiles
Low
High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HRs
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Pollution Quartiles
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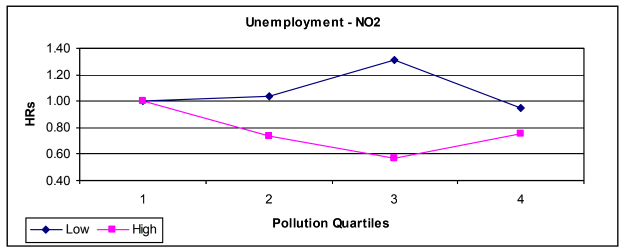
Unemployment - NO2
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HRs
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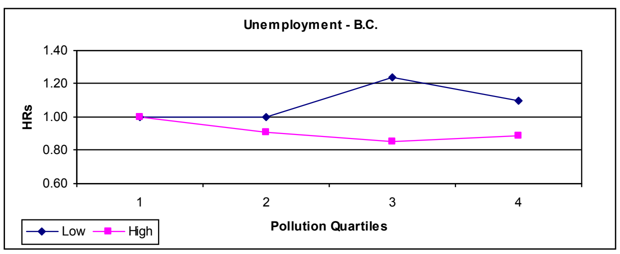
Pollution Quartiles
Low
High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HRs
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Pollution Quartiles
Low
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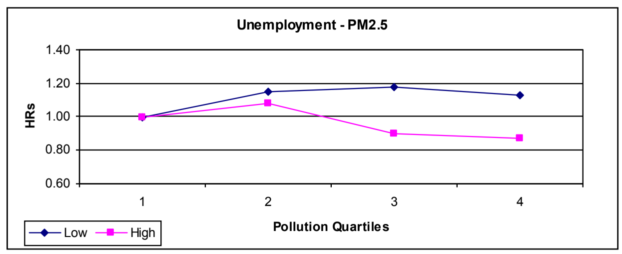
Unemployment - PM2.5
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Pollution Quartiles
Low
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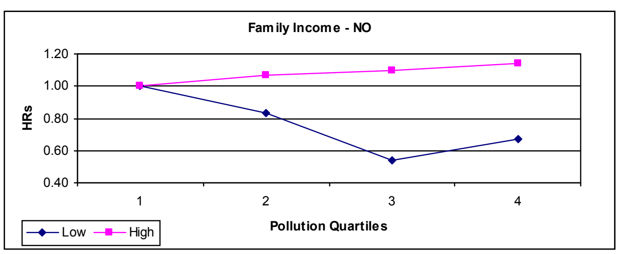
Family Income - NO
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HRs
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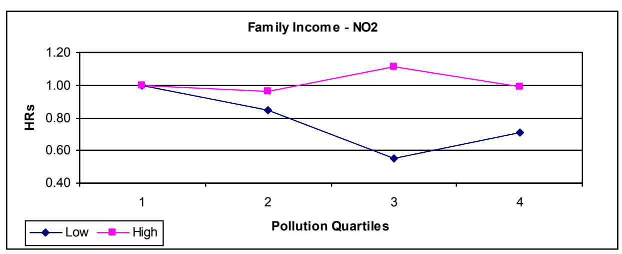
Pollution Quartiles
Low
High


Family Income - NO2
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Pollution Quartiles
Low
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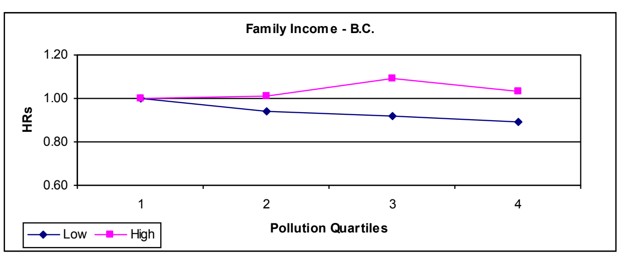
Family Income - B.C.
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HRs
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Pollution Quartiles
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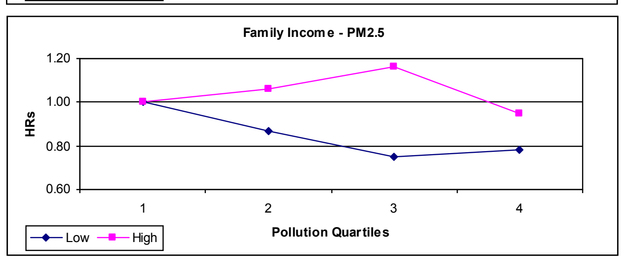
Family Income - PM2.5
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Pollution Quartiles
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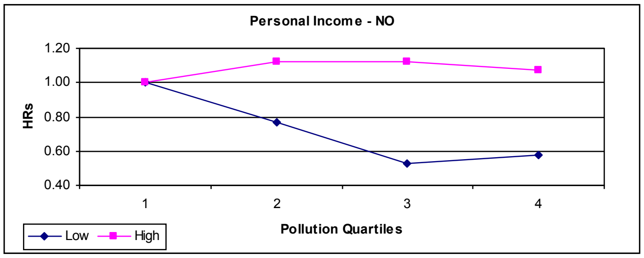
Personal Income - NO
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HRs
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Pollution Quartiles
Low
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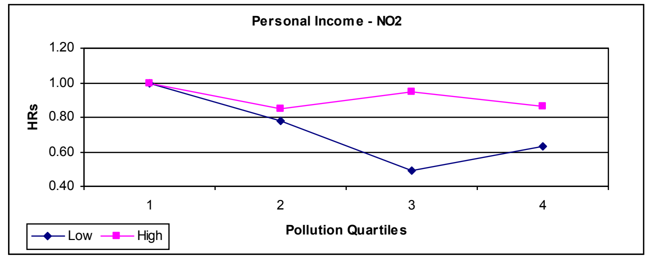
Personal Income - NO2
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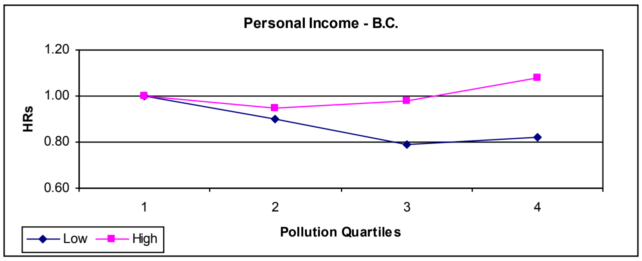
Personal Income - B.C.
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HRs
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Pollution Quartiles
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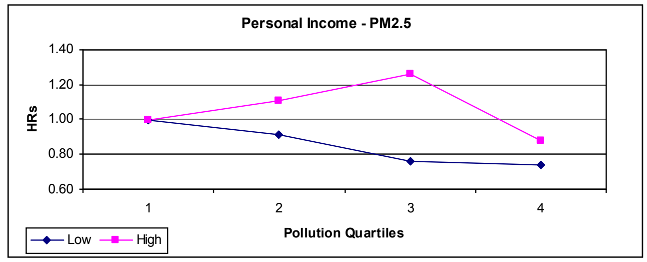
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HRs
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Pollution Quartiles
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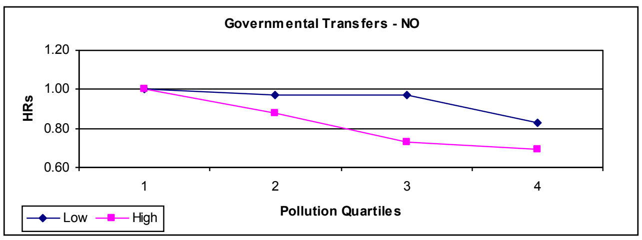
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0.80
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HRs
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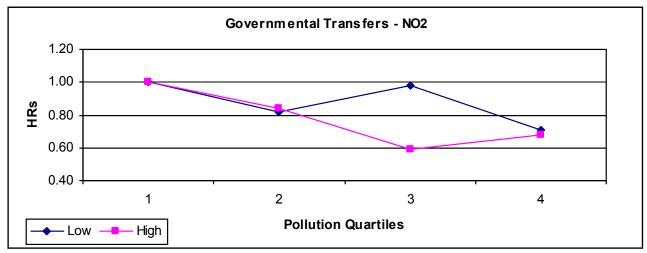
4
Pollution Quartiles
Low
High


Governmental Transfers - NO2
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HRs
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Pollution Quartiles
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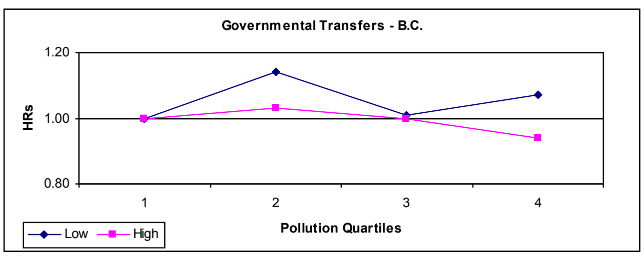
Governmental Transfers - B.C.
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1.00
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HRs
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Pollution Quartiles
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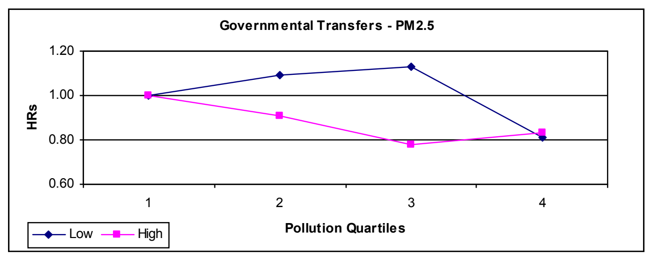
High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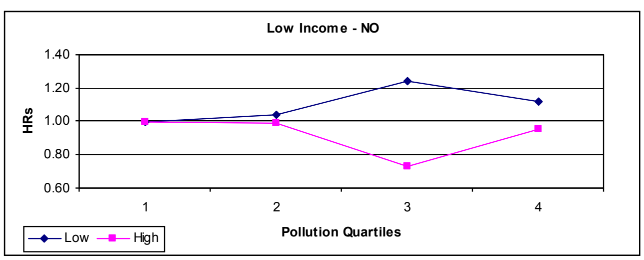
High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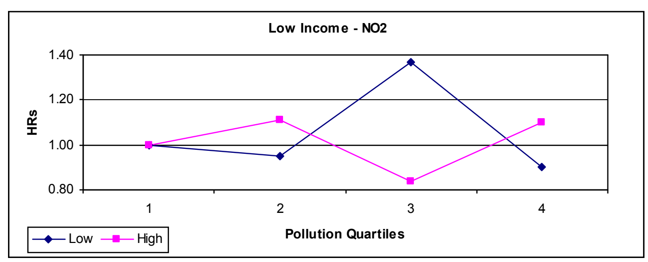
Pollution Quartiles
Low
High


Low Income - NO2
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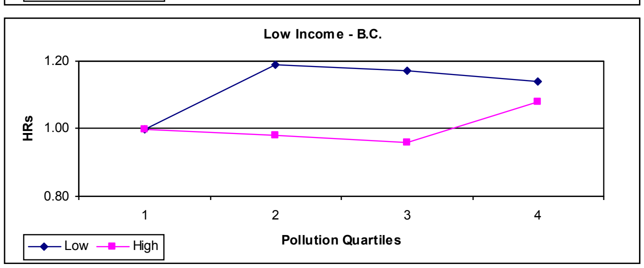
Low Income - B.C.
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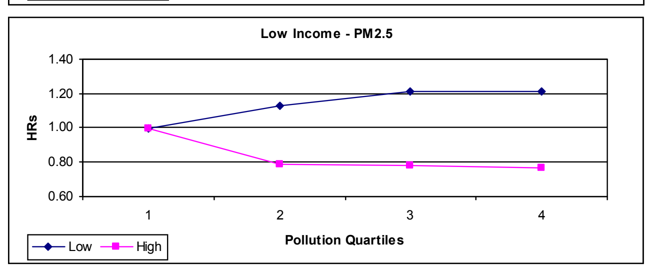
Low Income - PM2.5
1.40
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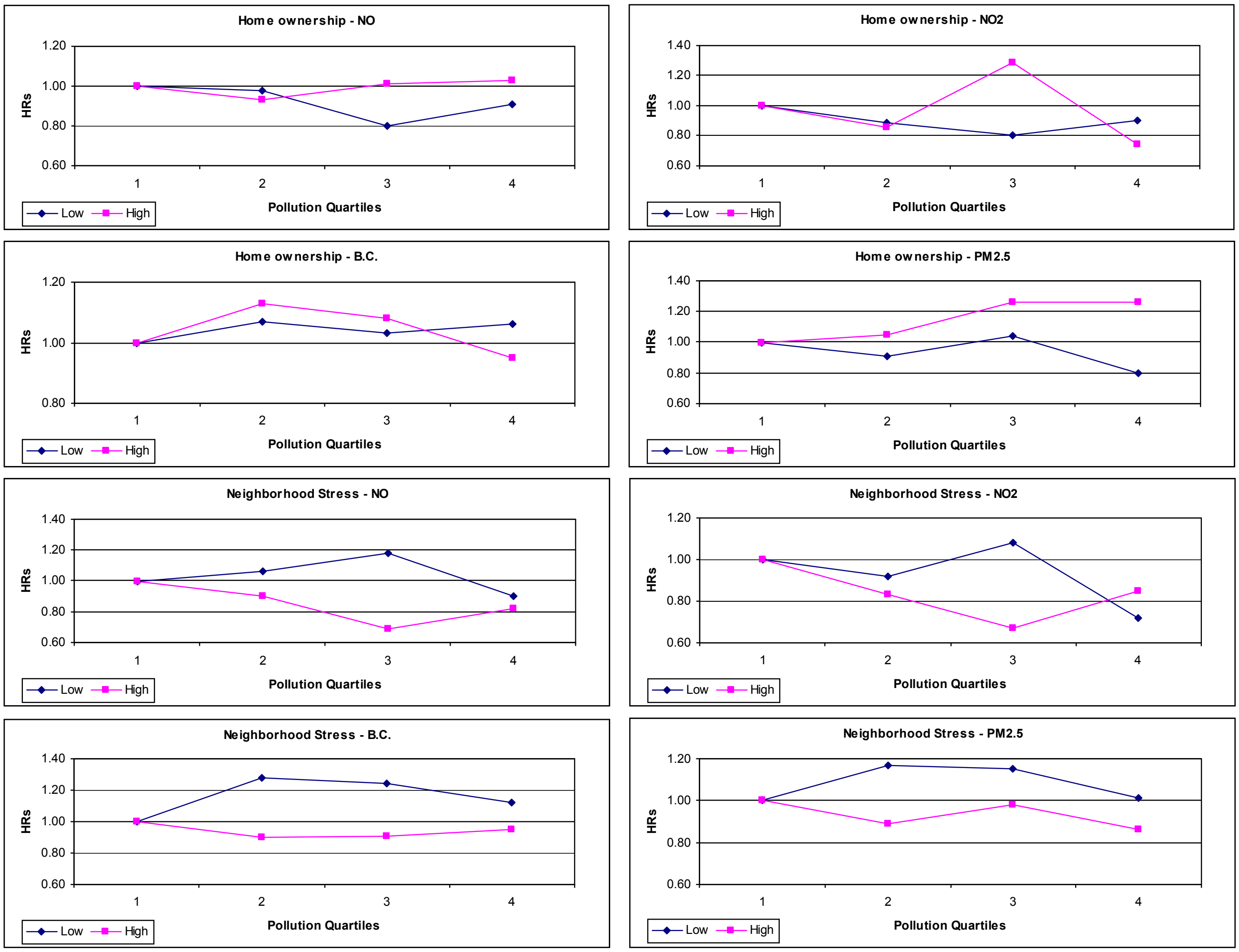
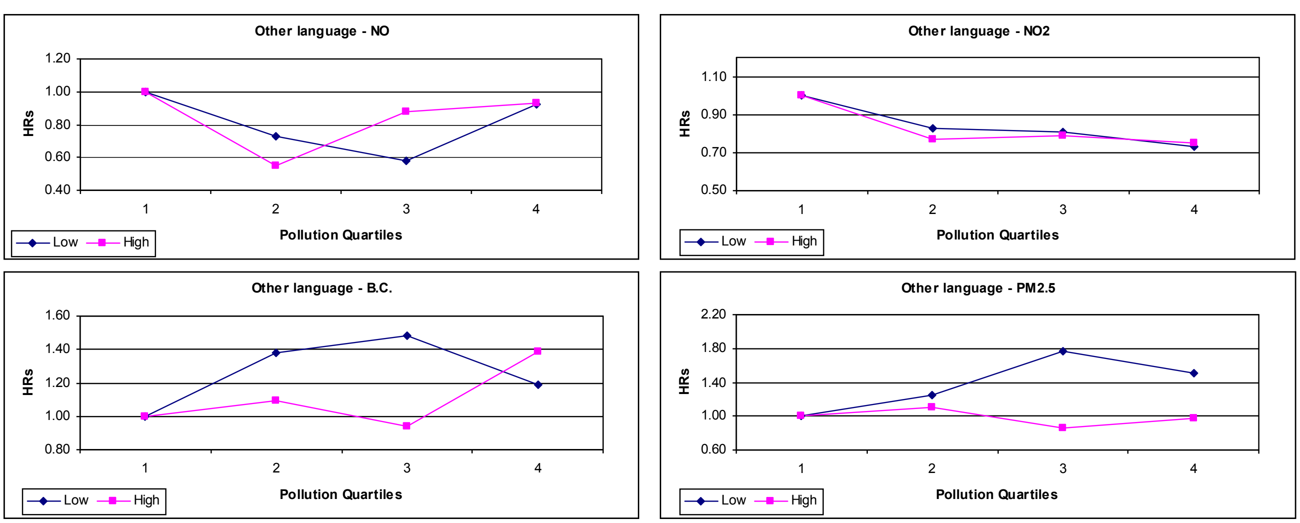
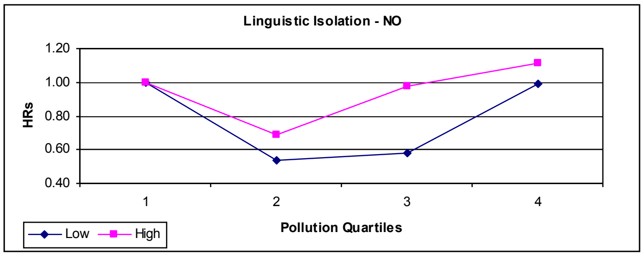
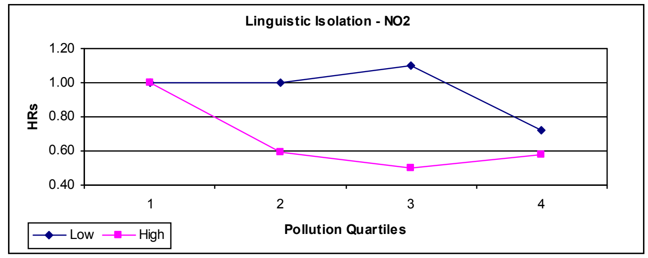
Pollution Quartiles
Low
High

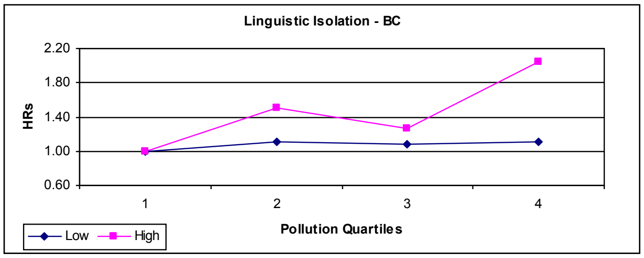


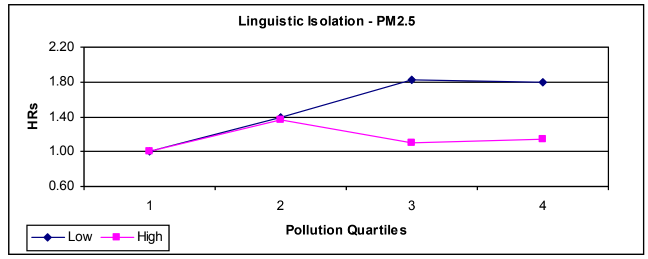
CHF health outcomes

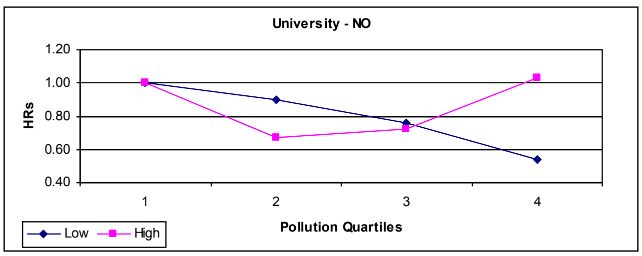


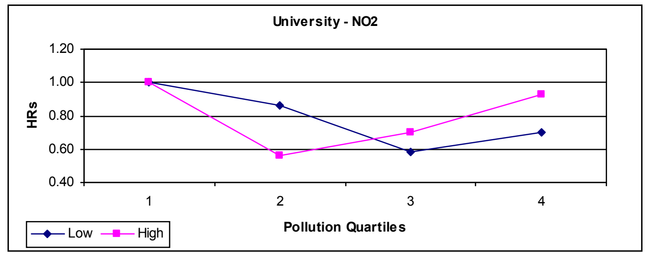

Linguistic Isolation - NO
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

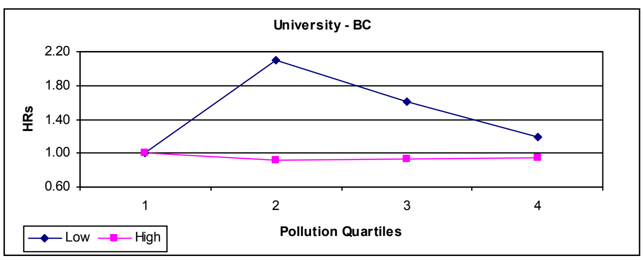

Linguistic Isolation - NO2
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

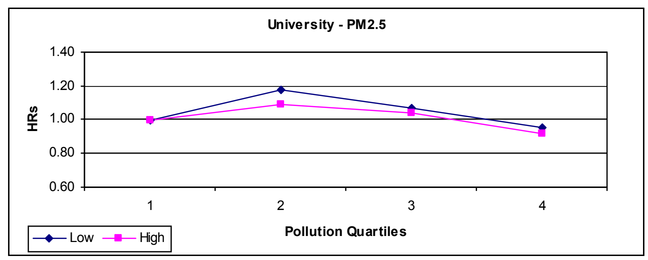

Linguistic Isolation - BC
2.20
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

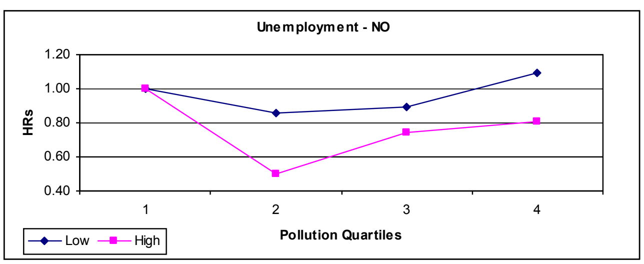

Linguistic Isolation - PM2.5
2.20
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

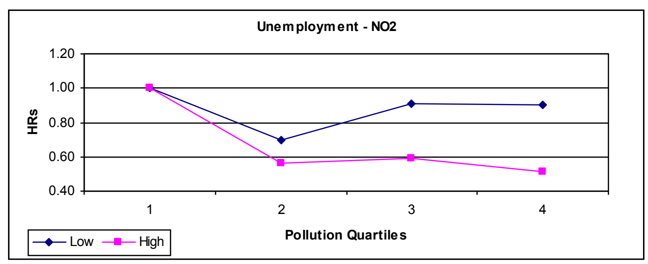

University - NO
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

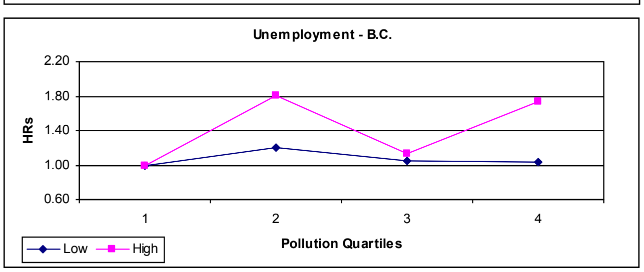

University - NO2
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

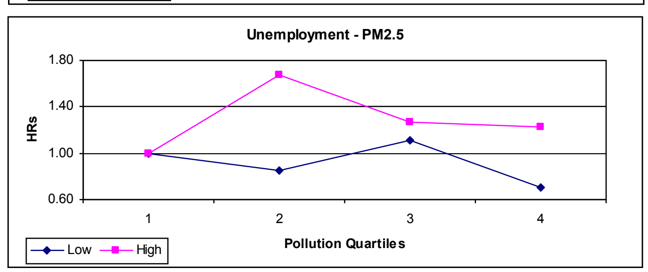

University - BC
2.20
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

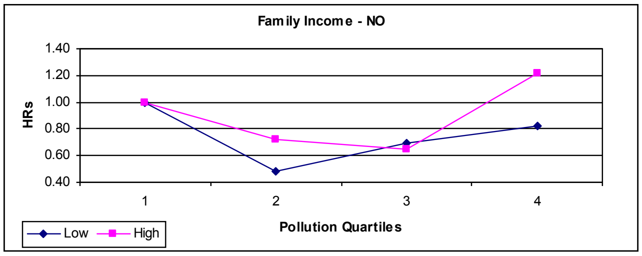

University - PM2.5
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

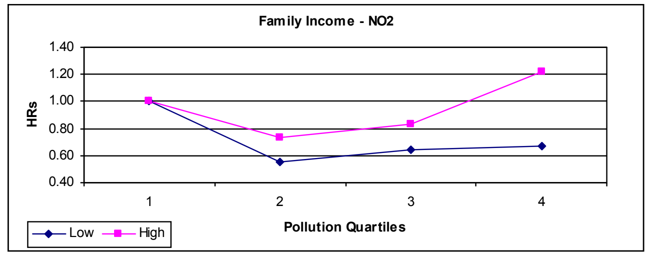

Unemployment - NO
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

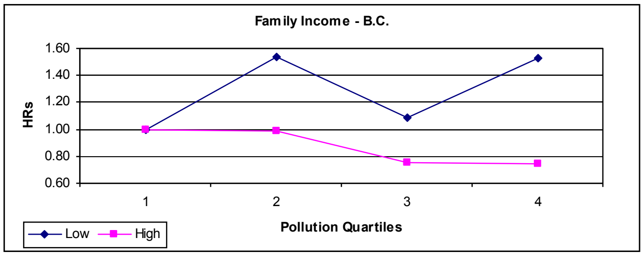

Unemployment - NO2
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

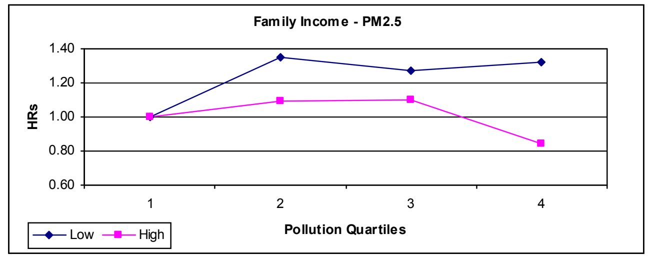

Unemployment - B.C.
2.20
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

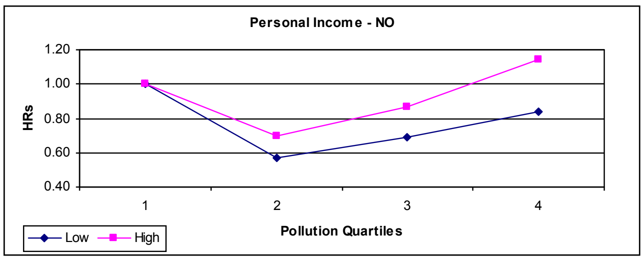

Unemployment - PM2.5
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

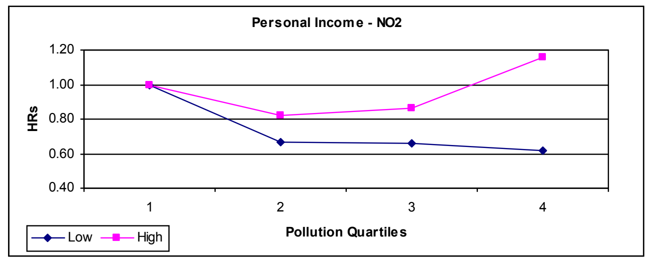

Family Income - NO
1.40
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

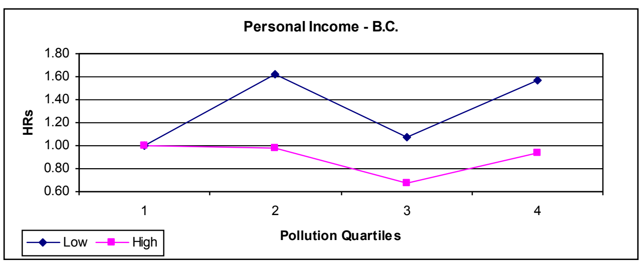

Family Income - NO2
1.40
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

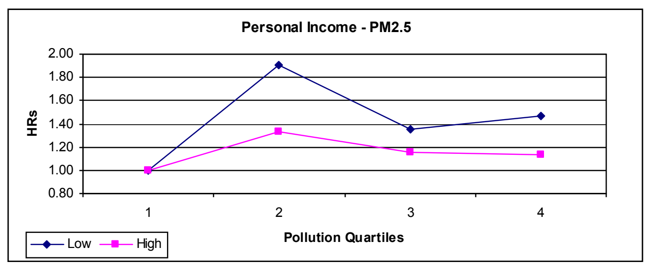

Family Income - B.C.
1.60
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

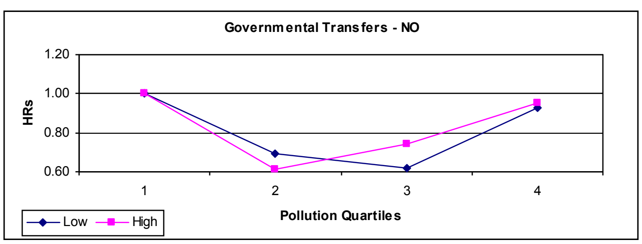

Family Income - PM2.5
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

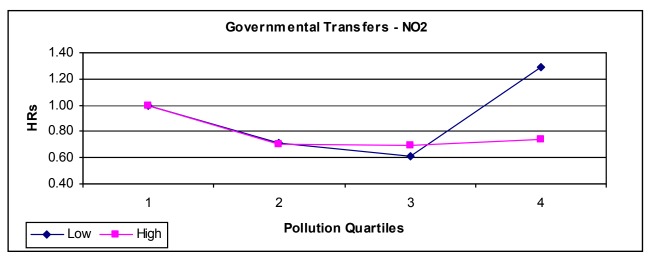

Personal Income - NO
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

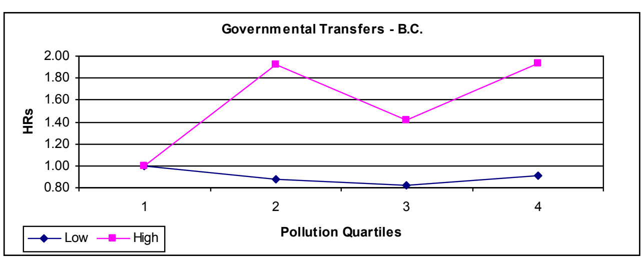

Personal Income - NO2
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

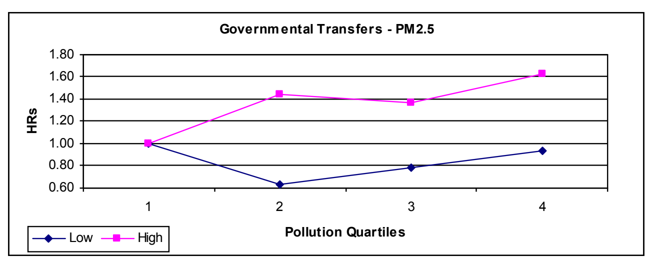

Personal Income - B.C.
1.80
1.60
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

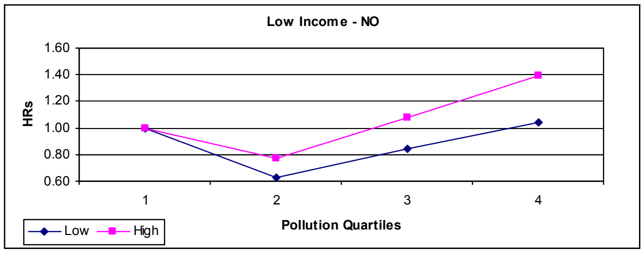

Personal Income - PM2.5
2.00
1.80
1.60
1.40
1.20
1.00
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

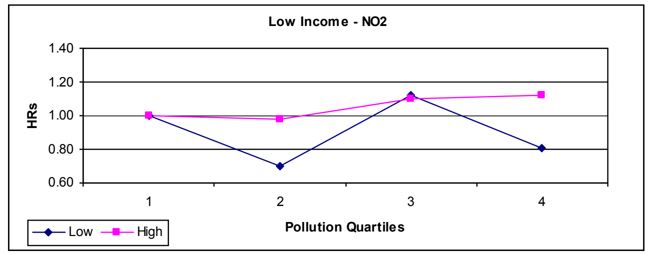

Governmental Transfers - NO
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

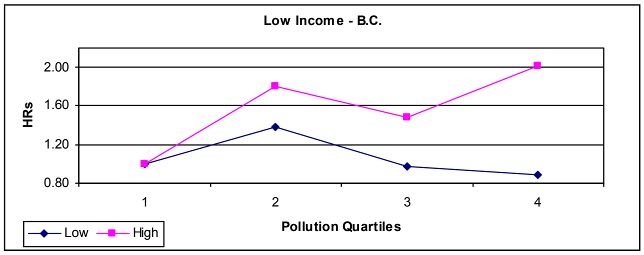

Governmental Transfers - NO2
1.40
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

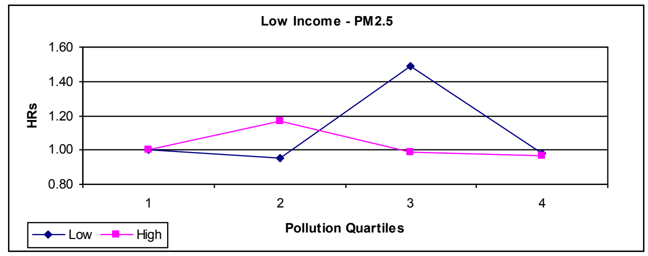

Governmental Transfers - B.C.
2.00
1.80
1.60
1.40
1.20
1.00
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

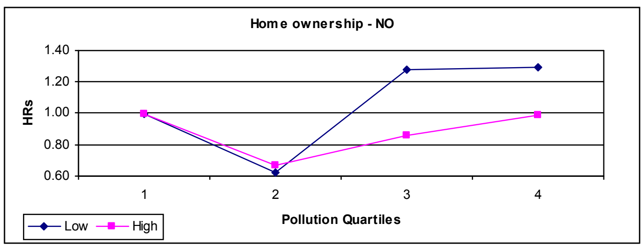

Governmental Transfers - PM2.5
1.80
1.60
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

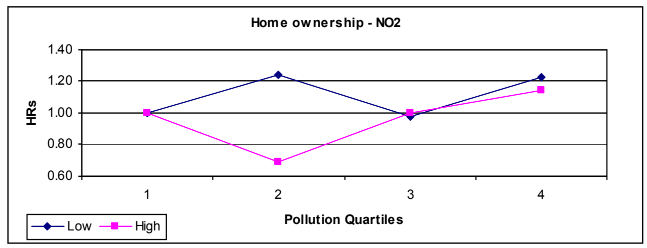

Low Income - NO
1.60
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

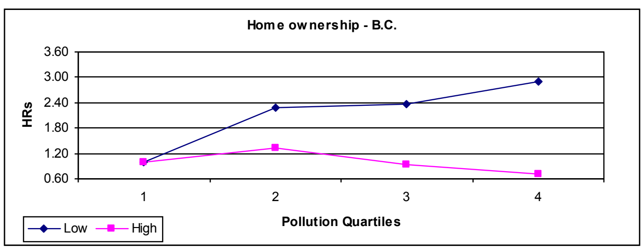

Low Income - NO2
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

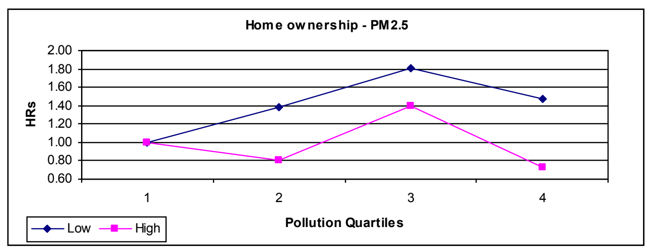

Low Income - B.C.
2.00
1.60
1.20
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

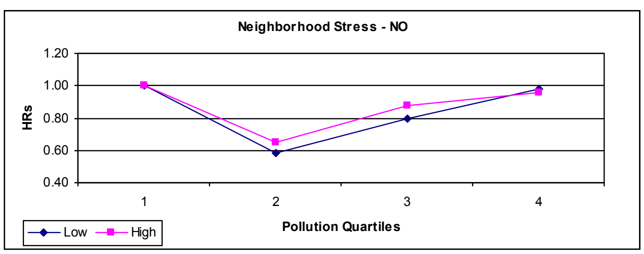

Low Income - PM2.5
1.60
1.40
1.20
1.00
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

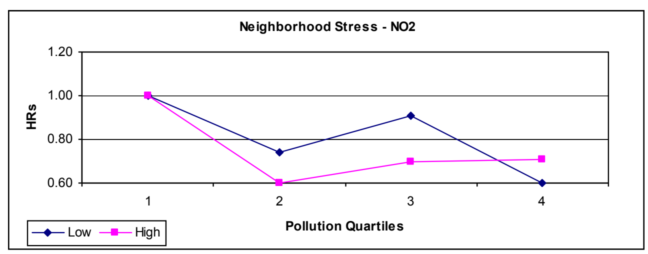

Home ownership - NO
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

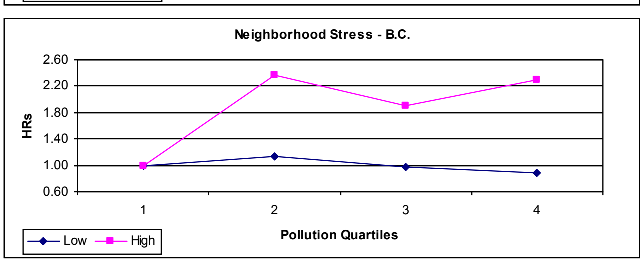

Home ownership - NO2
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

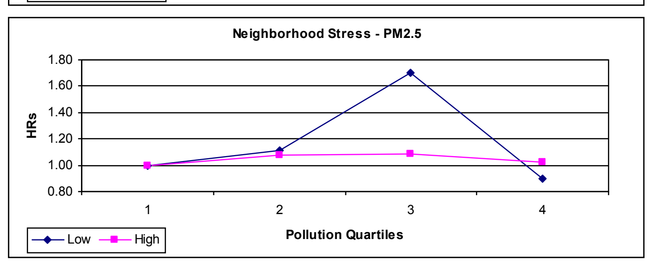

Home ownership - B.C.
3.60
3.00
2.40
1.80
1.20
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Home ownership - PM2.5
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High


Neighborhood Stress - NO
1.20
1.00
0.80
0.60
0.40
HRs
1
2
3
4
Pollution Quartiles
Low
High

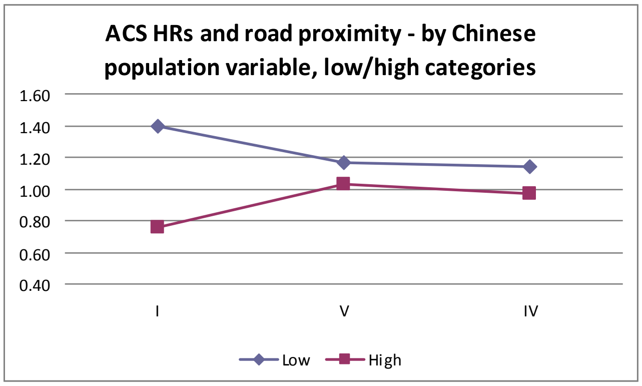

Neighborhood Stress - NO2
1.20
1.00
0.80
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

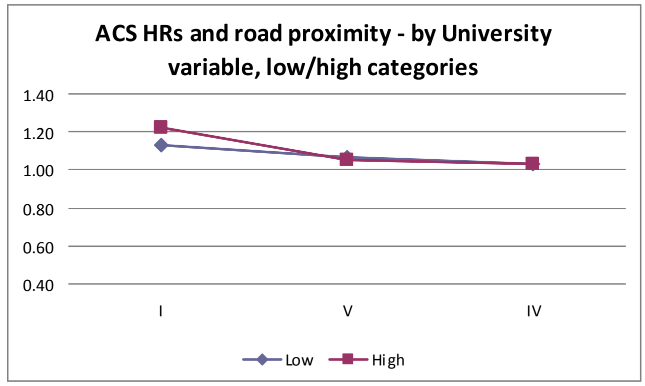

Neighborhood Stress - B.C.
2.60
2.20
1.80
1.40
1.00
0.60
HRs
1
2
3
4
Pollution Quartiles
Low
High

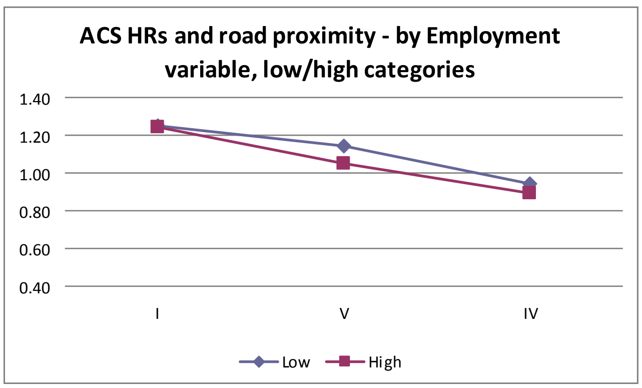

Neighborhood Stress - PM2.5
1.80
1.60
1.40
1.20
1.00
0.80
HRs
1
2
3
4
Pollution Quartiles
Low
High

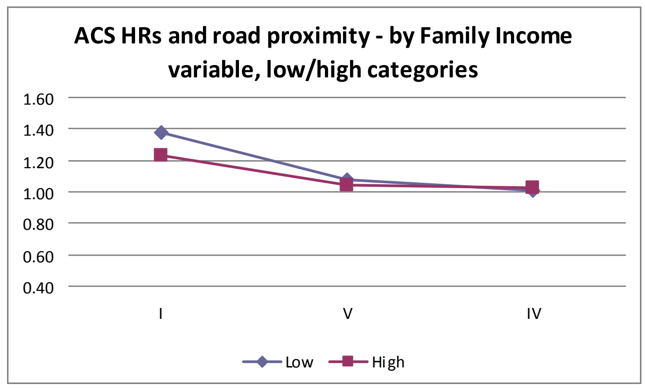
Appendix IV: Dissemination area level covariates in conjunction with road proximity

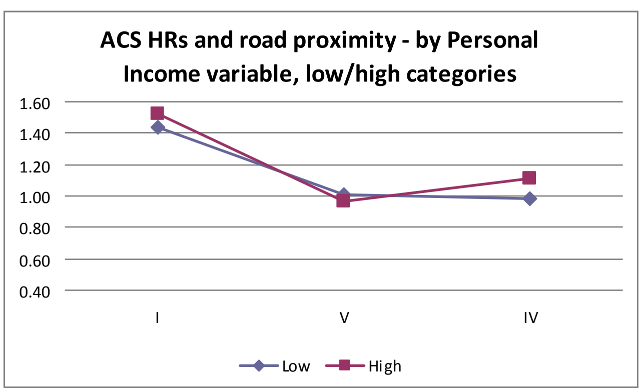
ACS health outcomes

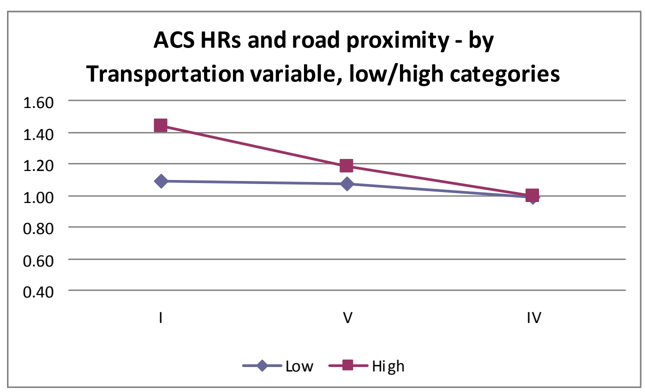


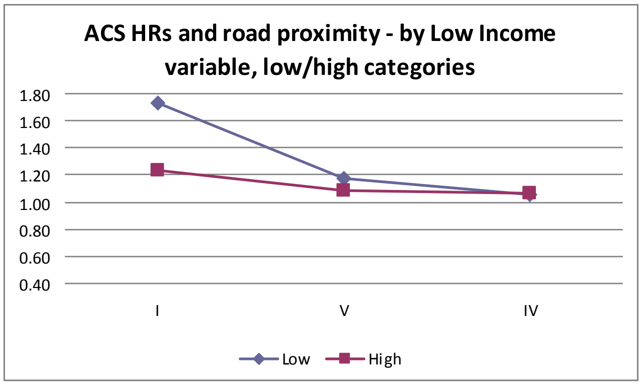


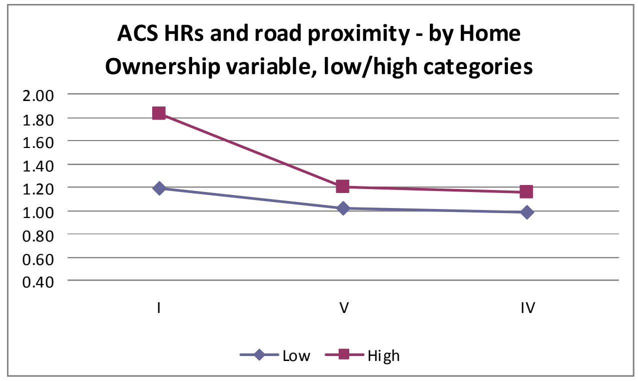


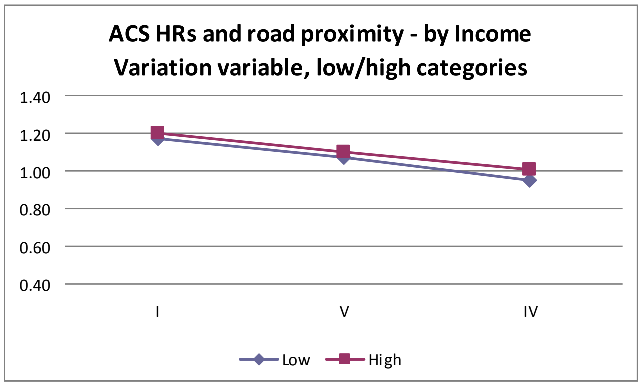


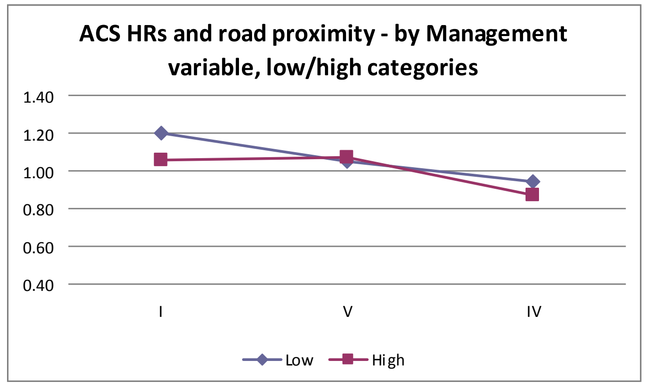




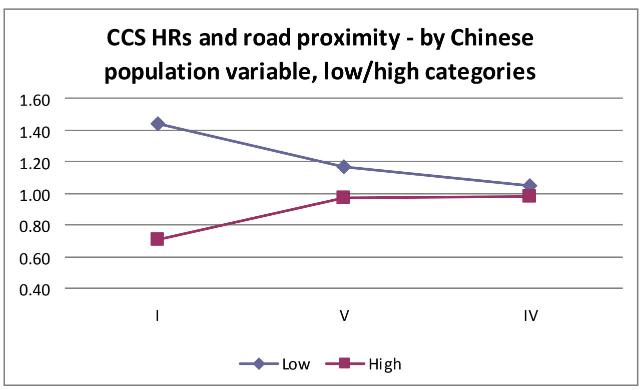


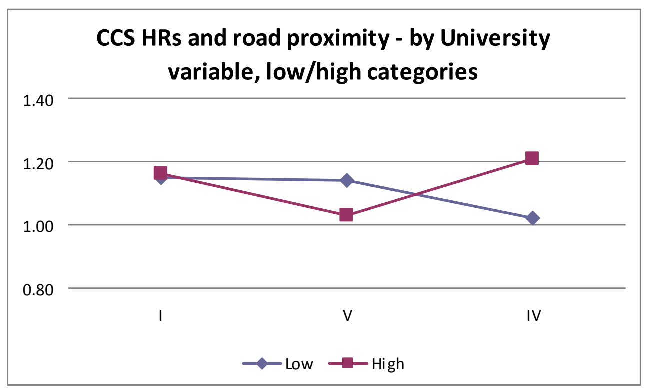


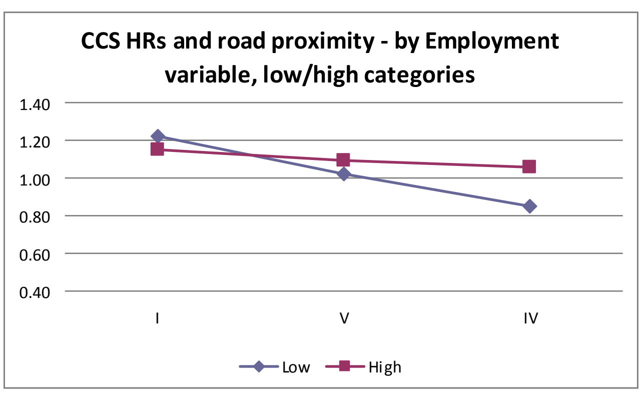


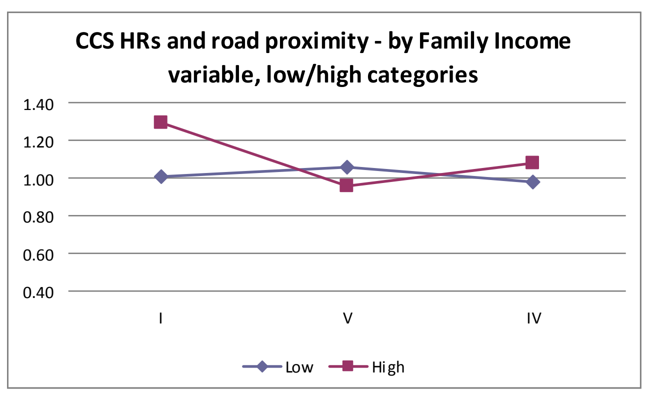


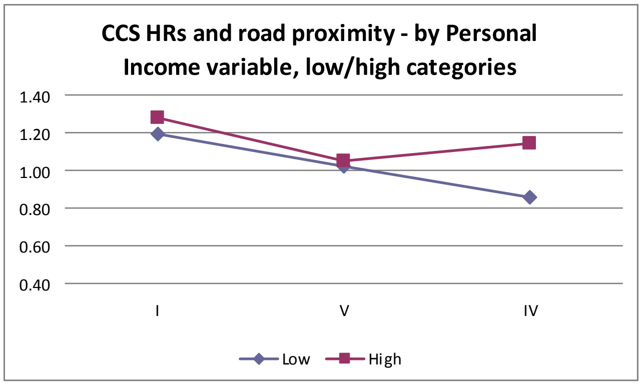
CCS health outcomes

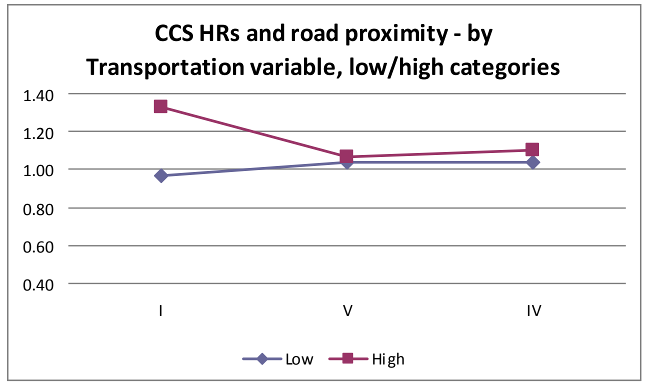


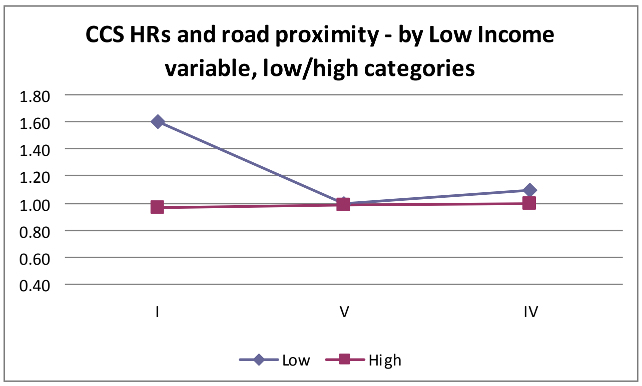


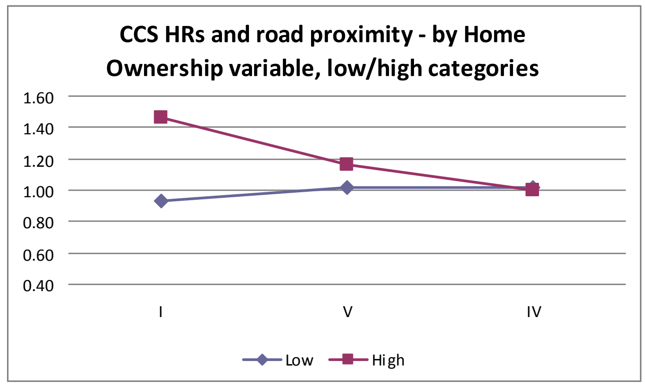


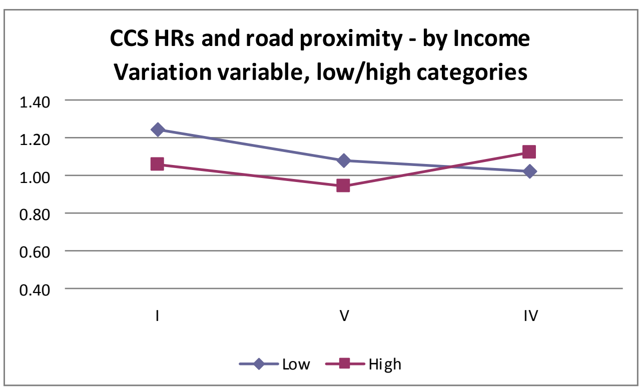


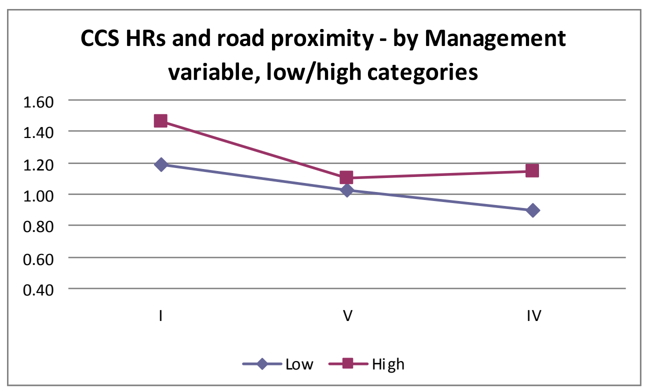




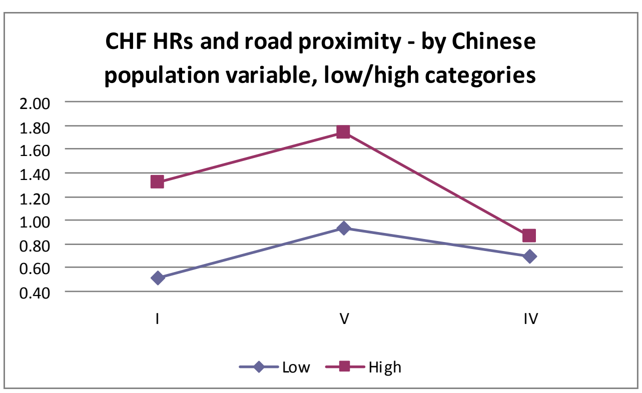


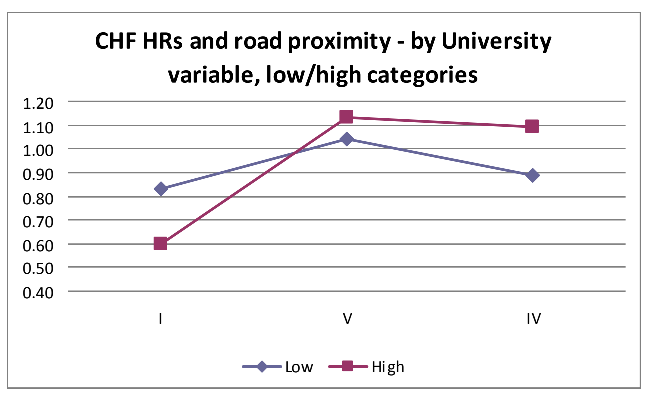


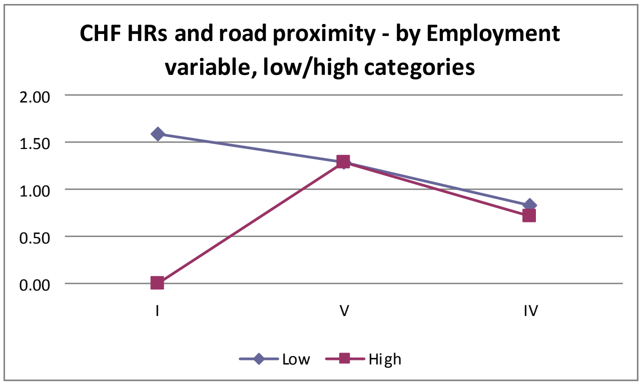




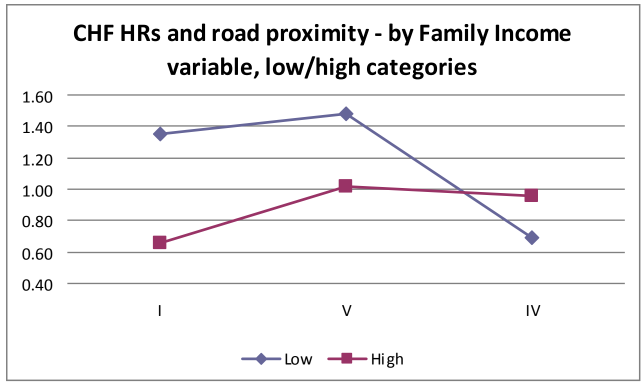
CHF health outcomes



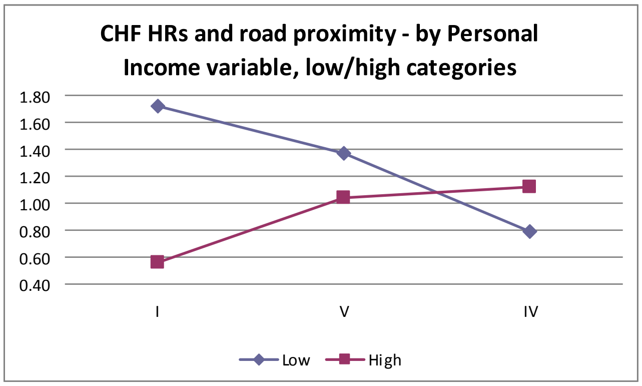




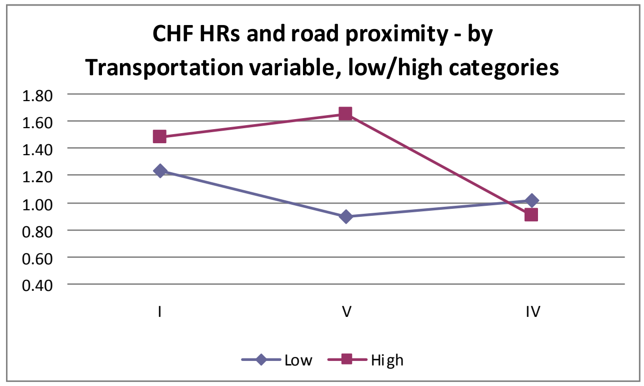
CHF HRs and road proximity - by Employment variable, low/high categories
2.00
1.50
1.00
0.50
0.00
I
V
IV
Low
High



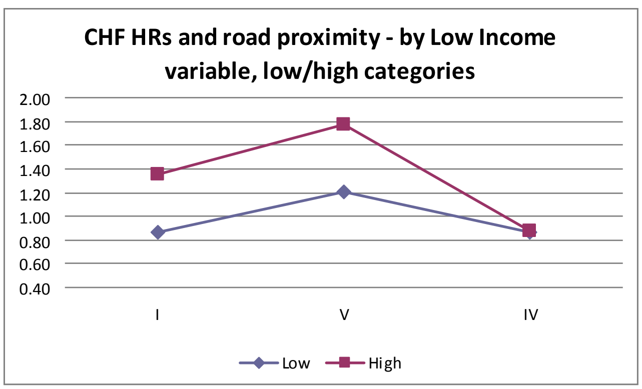
CHF HRs and road proximity - by Family Income variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High



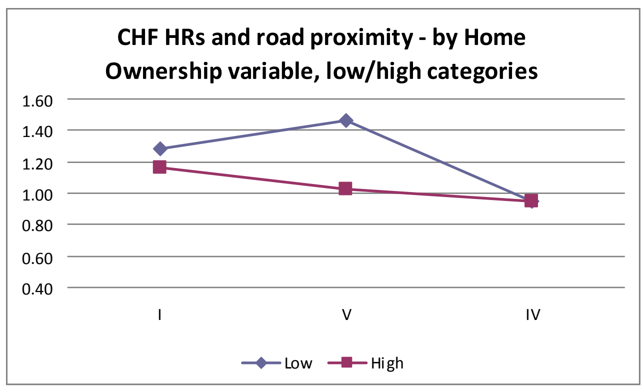
CHF HRs and road proximity - by Personal Income variable, low/high categories
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High



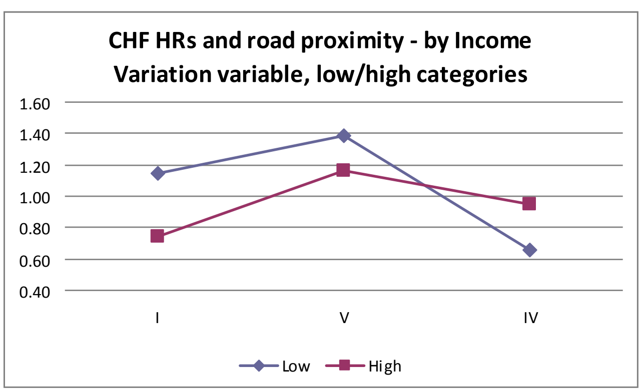
CHF HRs and road proximity - by Transportation variable, low/high categories
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High



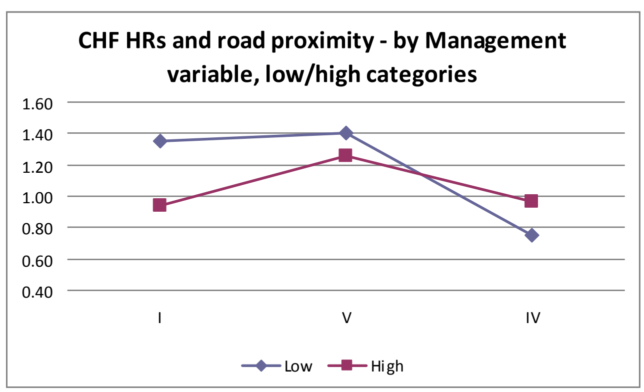
CHF HRs and road proximity - by Low Income variable, low/high categories
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High



CHF HRs and road proximity - by Home Ownership variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High



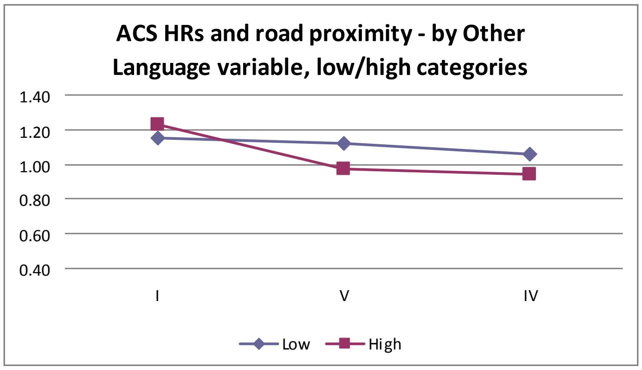
CHF HRs and road proximity - by Income Variation variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High

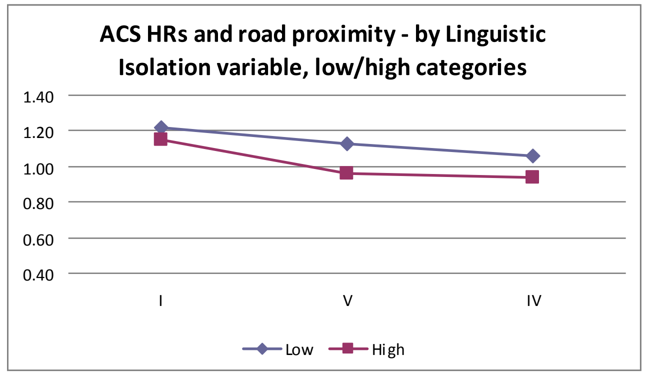


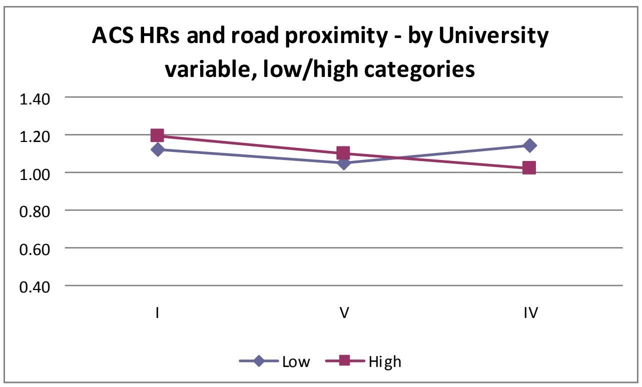
CHF HRs and road proximity - by Management variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High

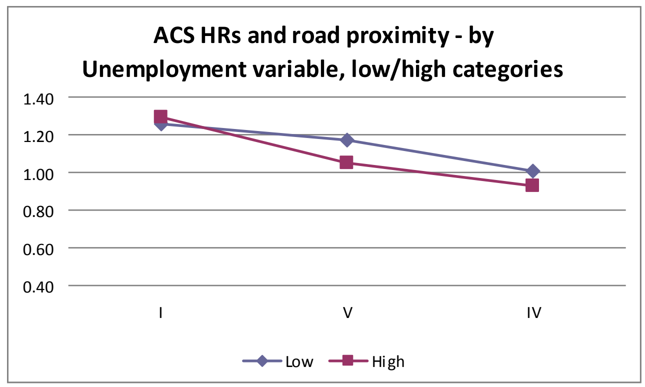
Appendix V: Neighborhood area level covariates in conjunction with road proximity

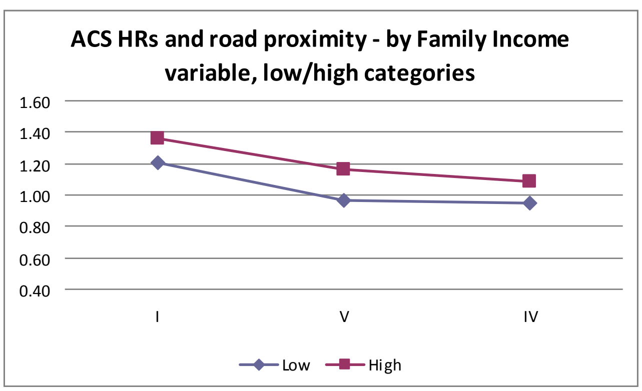
ACS health outcomes

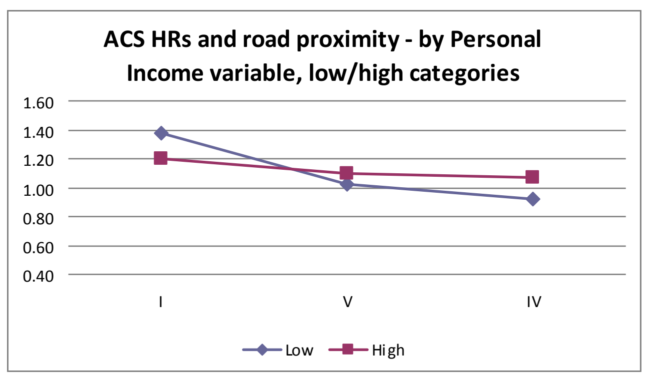


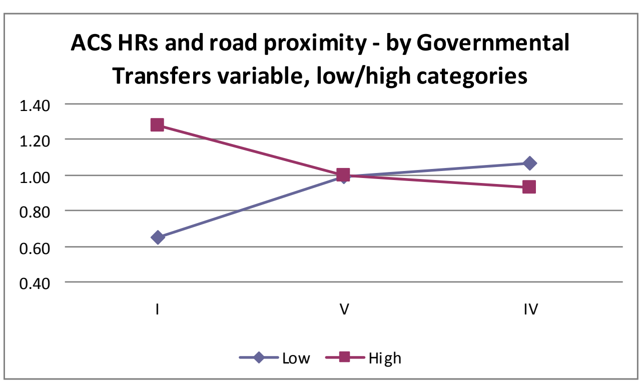


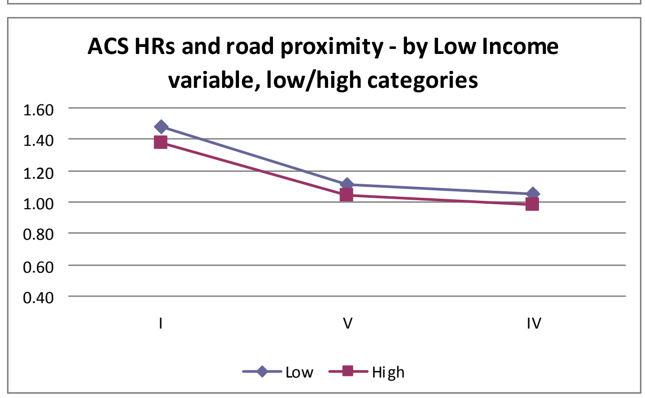


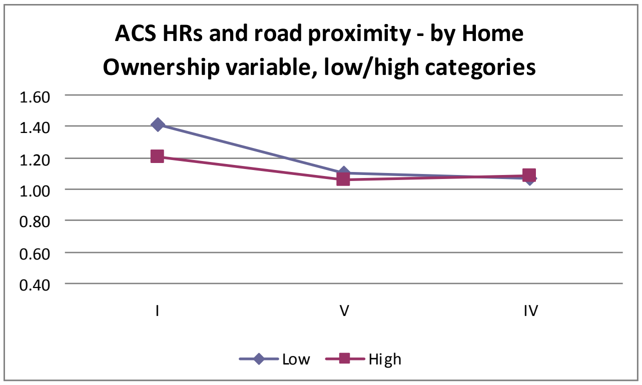


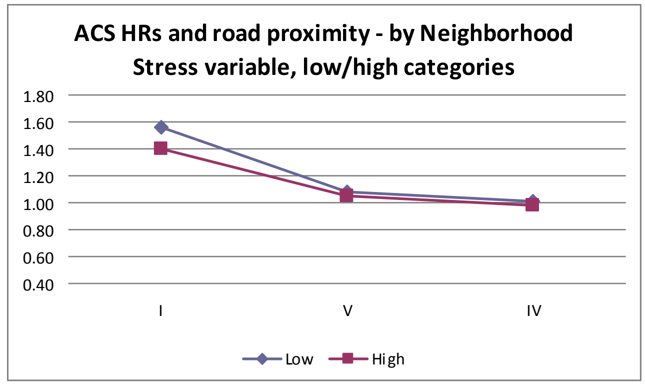




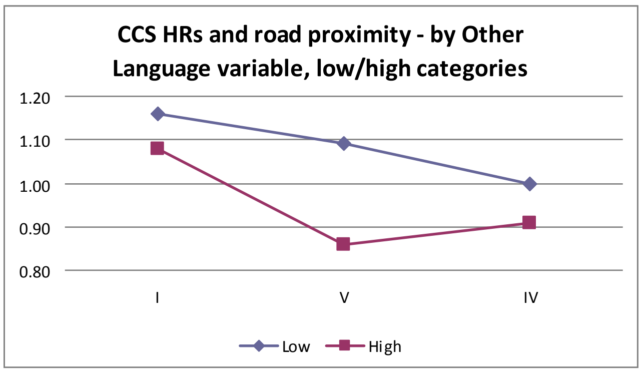


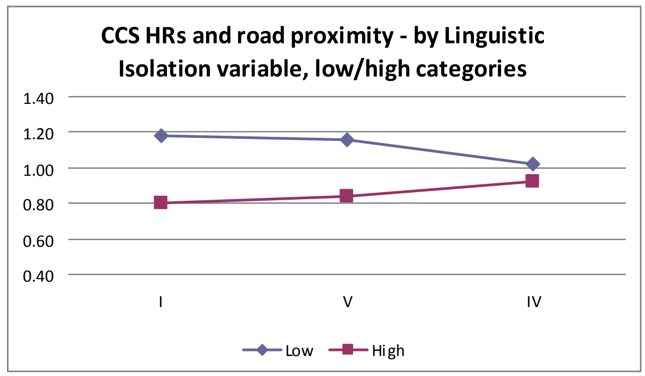


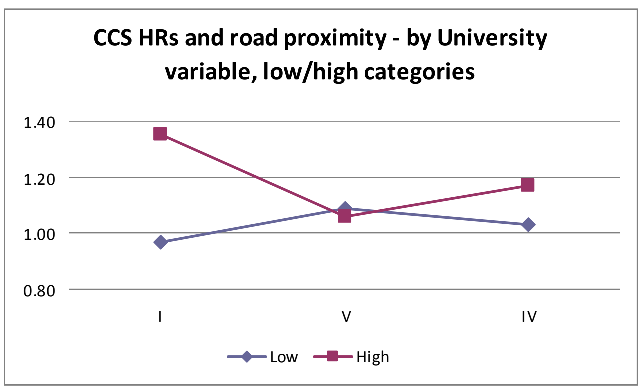


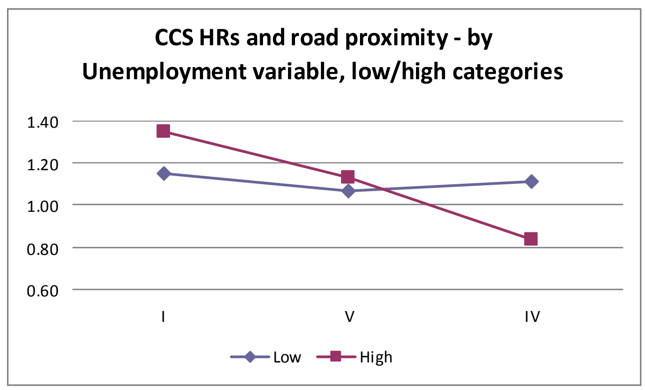


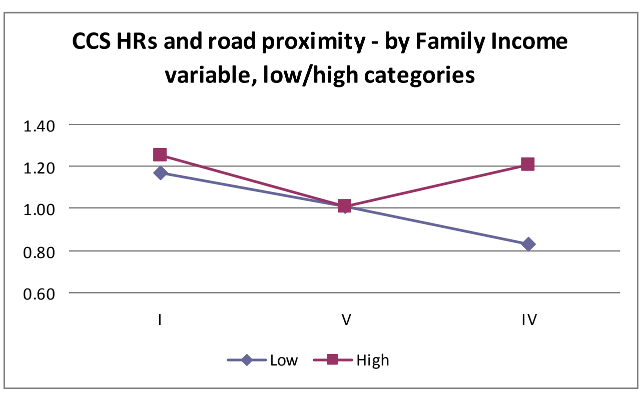
CCS health outcomes

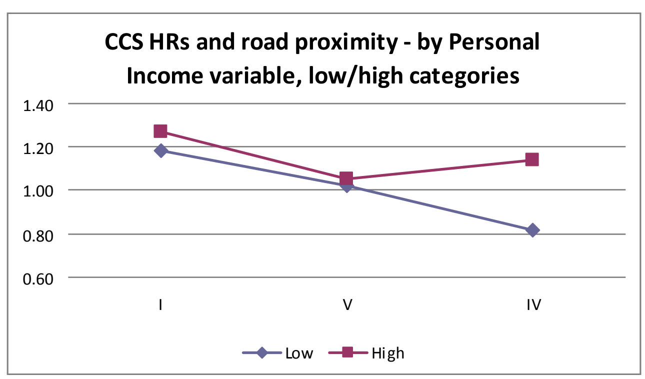


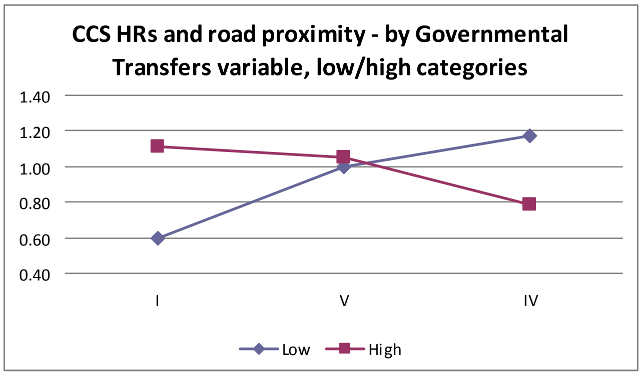


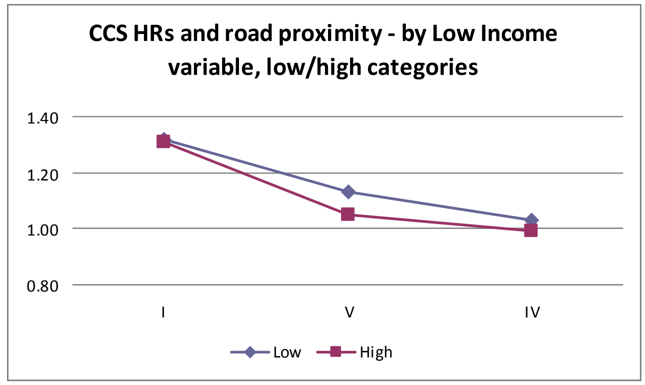


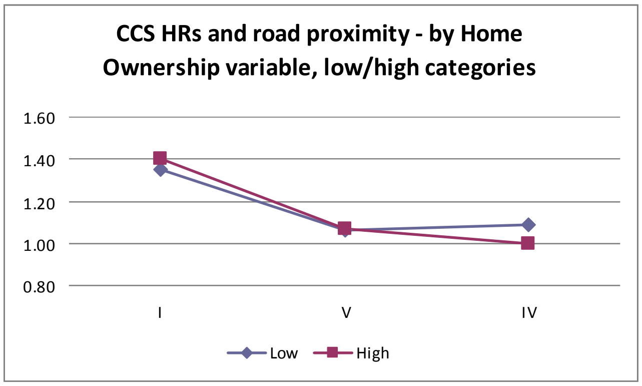


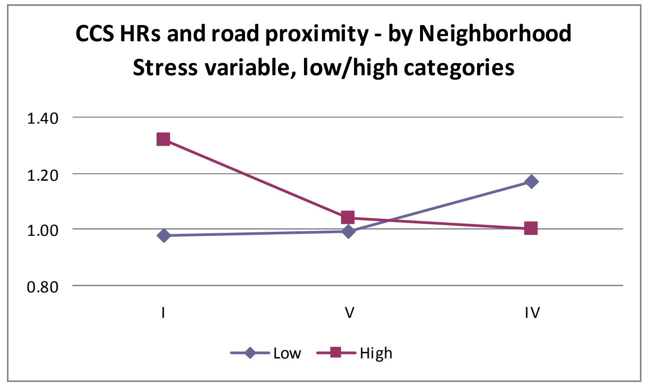




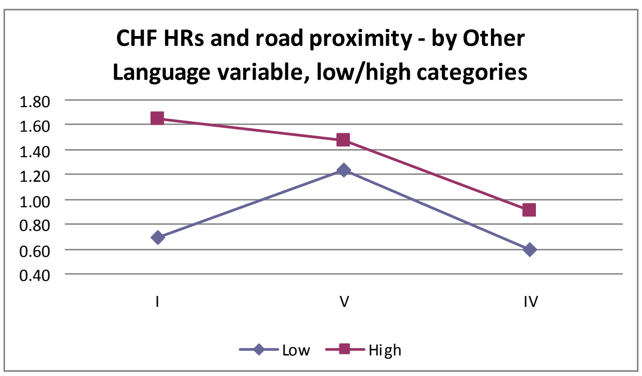


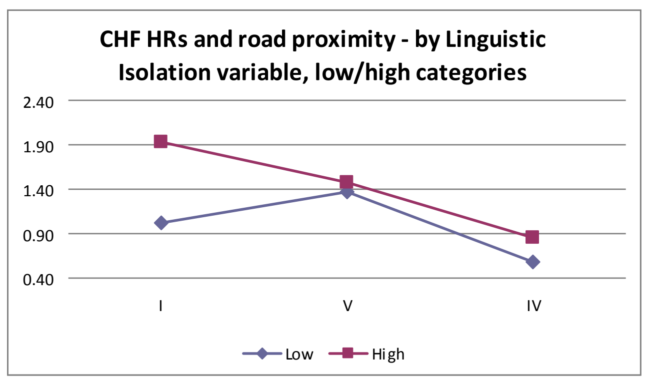


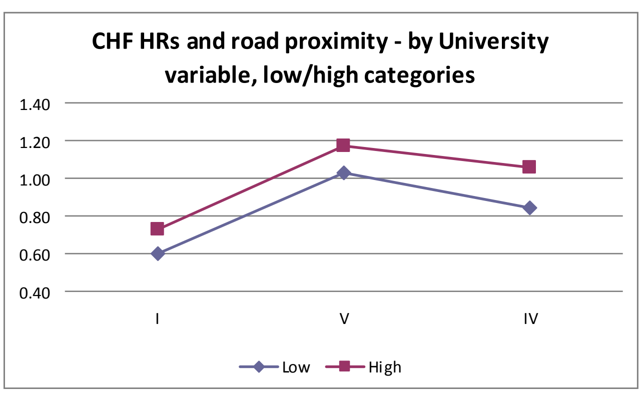


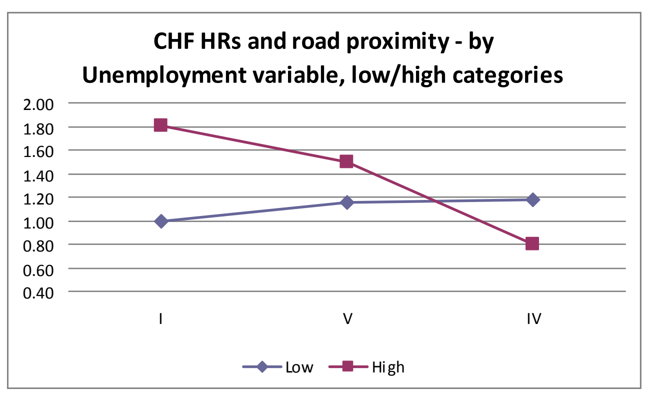


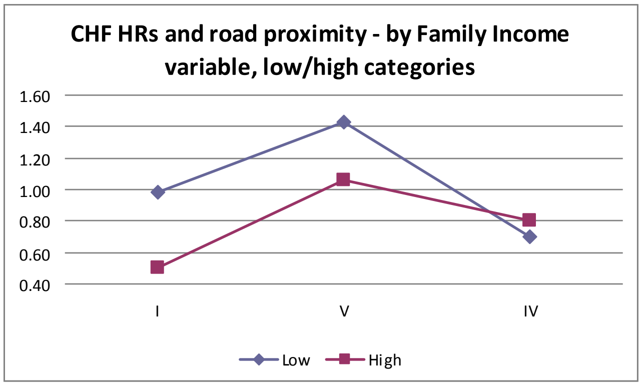
CHF health outcomes

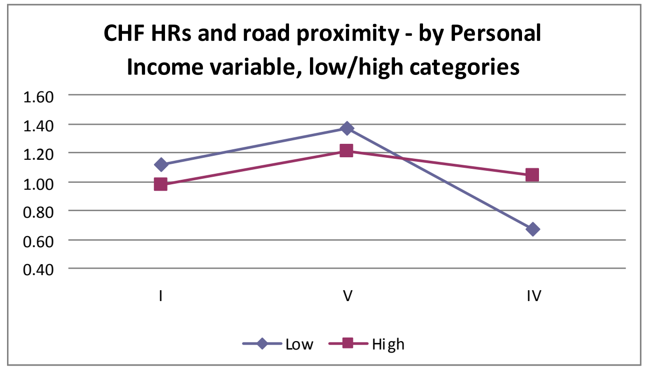


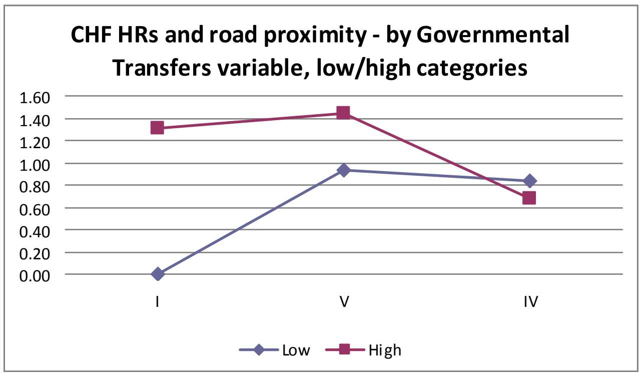


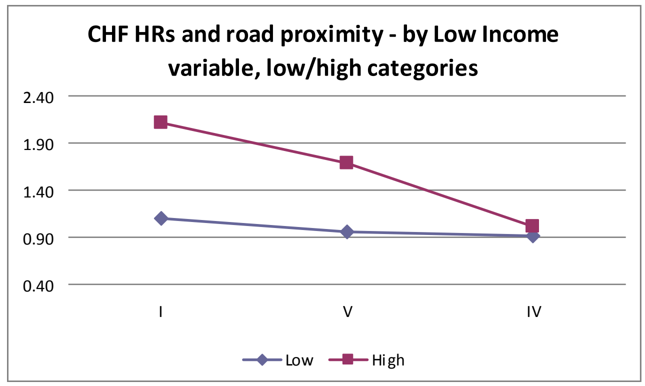


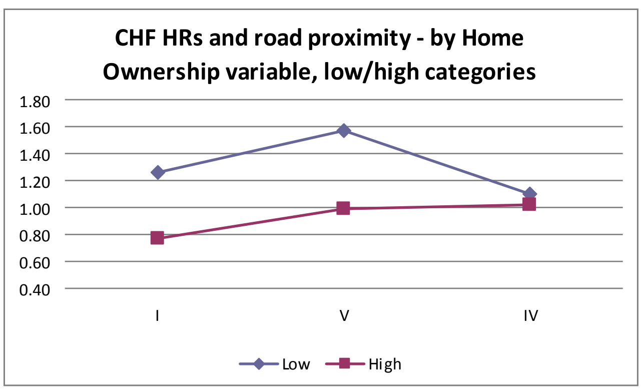


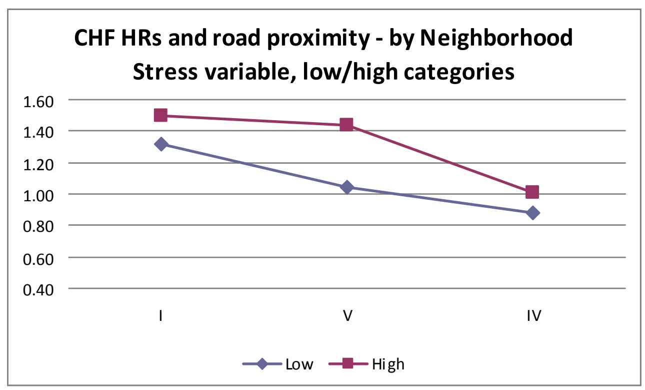

CHF HRs and road proximity - by Family Income variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High


CHF HRs and road proximity - by Personal Income variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High


CHF HRs and road proximity - by Governmental Transfers variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
I
V
IV
Low
High


CHF HRs and road proximity - by Low Income variable, low/high categories
2.40
1.90
1.40
0.90
0.40
I
V
IV
Low
High


CHF HRs and road proximity - by Home Ownership variable, low/high categories
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High


CHF HRs and road proximity - by Neighborhood Stress variable, low/high categories
1.60
1.40
1.20
1.00
0.80
0.60
0.40
I
V
IV
Low
High