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FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

RAMAGE-MORIN, Pamela Louise

AUTEUR DE LA THÈSE - AUTHOR OF THESIS

M.Sc.(Epidemiology)

GRADE - DEGREE

Department of Epidemiology and Community Medicine

FACULTÉ, ÉCOLE, DÉPARTEMENT - FACULTY, SCHOOL, DEPARTMENT

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Income Inequality and Health in Canada, 1981-1996

Yue Chen

DIRECTEUR DE LA THÈSE - THESIS SUPERVISOR

EXAMINATEURS DE LA THÈSE - THESIS EXAMINERS

Rama C. Nair

Ian W. McDowell

Robert A. Spasoff

J.-M. De Koninck, Ph.D.

LE DOYEN DE LA FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

SIGNATURE

DEAN OF THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

Income Inequality and Health in Canada, 1981-1996

by

Pamela Louise Ramage-Morin

Thesis submitted to
the School of Graduate Studies and Research
in partial fulfilment of the requirements for the
MSc degree in Epidemiology

University of Ottawa
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ABSTRACT

Background:

U.S. and other studies have established an inverse association between a variety of measures of income inequality and population health.

Objectives:

To describe income inequality (market income and income after tax) and population health (eight measures) in Canada and the provinces between 1981 and 1996; to establish associations between these variables; and to explore whether the associations are measure dependent.

Method:

Ecologic, analytic, mixed-design study, based on analysis of existing data.

Results:

The association between the Gini coefficient (market income) and total mortality was very weak in 1981 and 1986, but very strong in 1991 and 1996. Otherwise, associations between income inequality and different health outcomes were non-existent, weak, or sporadic.

Conclusions:

Income inequality depends on the income concept used. Associations between income inequality and health are measure dependent. Structural changes in Canadian society may account for the emerging association between income inequality and total mortality from 1991 onwards.

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LIST OF ABBREVIATIONS

ACPH	Federal, Provincial and Territorial Advisory Committee on Population Health
ASMR	Age-standardized mortality rate
CIHI	Canadian Institute of Health Information
CMA	Census metropolitan area
CPI	Consumer price index
DALE	Disability-adjusted life expectancy
DALY	Disability-adjusted life years
DFLE	Disability-free life expectancy
DLI	Data Liberation Initiative
EF	Economic family
ECM	External cause mortality
GDP	Gross domestic product
GNP	Gross national product
GSS	General Social Survey
HALE	Health-adjusted life expectancy
HPS	Health Promotion Survey
ICD	International Classification of Diseases
IAT	Income after tax
IMR	Infant mortality rate
LBW	Low birth weight
LICOs	Low income cut-offs
MI	Market income
NPHS	National Population Health Survey
PPP	Purchasing power parity
QALY	Quality-adjusted life years
RHI	Robin Hood index
RR	Rate ratio
SBCS	Smoking Behaviour of Canadians Survey
SES	Socioeconomic status
SMR	Standardized mortality ratio
UI	Unattached individual
WHO	World Health Organization
WLS	Weighted least-squares

CHAPTER 1 INTRODUCTION

It is well documented in the literature that populations with high levels of income inequality[1] or wider income distributions have poorer levels of overall health than populations with narrower income distributions, after controlling for other differences (Kennedy et al., 1996; Kawachi et al., 1997; Wilkinson, 1996, 1999; Kennedy et al., 1998). A great deal of this research has been based in the United States (Kaplan et al., 1996; Kennedy et al., 1996; Kawachi et al., 1997; Kennedy et al., 1998; Deaton et al., 1999a; Deaton, 1999b, 2001). To a lesser extent this issue has been explored in the Canadian context (Wolfson, 1985; Rashid, 1998; Yalnizyan, 1998; Wolfson et al., 1999a; Ross et al., 2000).

It is essential from the outset to distinguish the work on income inequality and health from some European, Australian and Middle Eastern studies (Mackenbach et al, 1997; Turrell et al., 2000, Manor et al., 1997, Wagstaff et al., 1991) that examine socioeconomic inequalities in health, where the health gradient is summarized using inequality measures. The latter approach explores inequality of the outcome variable (health) while this thesis examines inequality of the risk variable (income) and its association with overall levels of health found in Canada and the provinces. These differences are summarized in Table 1.1.

---

[1] Income inequality refers to the relative width of the income distribution. Some attention in the literature has also been paid to "income polarization" which refers to a bimodal income distribution.

Table 1.1 Comparison of risk factor and outcome variables in studies of income inequality and health versus socioeconomic inequalities in health

	Risk factor	Outcome
Income inequality studies		
Variable	income inequality	average health
Level	ecological	ecological
Socioeconomic inequalities in health studies		
Variable	SES	health inequality
Level	individual	ecological

The development of a social safety net has been a distinguishing feature of Canada compared to the United States. It includes programmes, such as employment insurance, that have helped lessen income inequality by supporting economically vulnerable sectors of the population (e.g. the unemployed). In addition, a public health insurance plan was established after the passage of legislation in the late 1950s and 1960s. The system, known as Medicare, resulted from the Hospital Insurance and Diagnostic Services Act (HIDS) in 1957 and the Medical Care Act in 1966-67. Medicare buffered the population from the adverse effects of income inequality by mandating accessible health care, independent of consumers' ability to pay. However, concern has been mounting in response to changes which threaten the very existence of the social safety net, including reduced employment insurance benefits and stricter eligibility criteria, the delisting of medical services and so on. Political forces, including the federal Alliance Party and provincial Conservatives in Alberta and Ontario, appear to be initiating these changes as they drive social and economic policy towards that which is found in the U.S. (Raphael, 2000:57). With respect to Medicare, Mhatre and Deber (1992) clearly outline the emerging issues that challenge the survival of this support system, within the context of

growing resource constraints. This threat to the social safety net comes at a time when economic concerns (recession; high unemployment, inflation and interest rates; and large government deficits) as well as demographic and epidemiologic changes (increasing numbers of multiple-earner families and an aging population, accompanied by a shift from infectious to chronic, degenerative diseases) have increased demand on the "system" (Love et al., 1991; Mhatre et al., 1992). With the erosion of this safety net, one would expect an increase in income inequality and a corresponding negative impact on population health.

The focus of income inequality studies is on relative, as distinct from absolute, income (Kennedy et al., 1996:1007). Wilkinson argues that developed countries, which have passed through the epidemiological transition[2], are characterized by populations that have generally attained the minimum level of per capita income required to meet basic needs for health and well-being[3] (1996:45). That is, most people can afford sufficient food, access to clean water and adequate housing. Once a population has reached this point, the absolute level of material affluence is no longer as important for health as individuals' level of affluence compared to other members of society. Relative income is a reflection

---

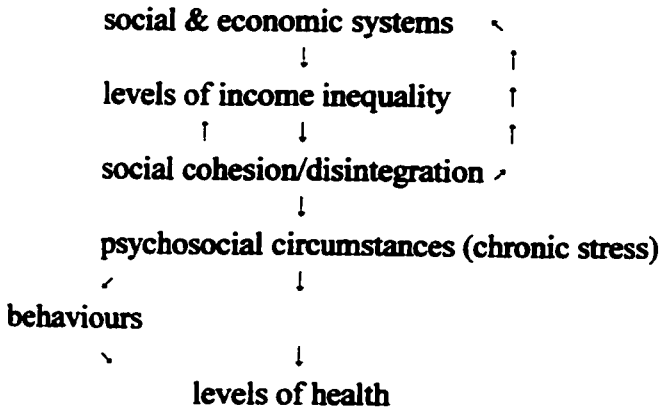
2 The 'epidemiological transition' denotes a major change from predominantly infectious disease mortality, which is paramount in poorer countries, to deaths from chronic, degenerative diseases found more commonly in wealthier countries (Wilkinson, 1996:43).

3 Wilkinson suggests this minimum income is $5,000 (international dollars) per capita in 1990 (1996:34). For a definition of international dollars please see Appendix A.

of one's social position in relation to the rest of society (Wilkinson, 1996:176) and therefore embraces concepts such as hierarchy, social class and stratification, perceived value to society, and feelings of relative deprivation. Wilkinson refers to the environment created by these feelings as "psychosocial circumstances", a combination of the psychological and social aspects of relative deprivation that are coupled with, although distinct from, the material circumstances associated with social position (1996:175, 176).

Wilkinson argues that levels of income inequality are intrinsically linked to social cohesion. That is, societies that are cohesive will not tolerate high levels of income inequality, and conversely, societies in which there are narrow income distributions promote cohesiveness to prevent social disintegration (1996:134). Societies with lower levels of cohesion are characteristically less supportive and more hostile, as evidenced by higher homicide rates and smaller proportions of the populations who feel trusting of others (Wilkinson, 1999:261; Marmot et al., 2001:1235). As well, societies with wider income distributions are associated with illness inducing factors such as racism and gender discrimination (Marmot et al., 2001:1235). The level of social cohesion, or conversely social disintegration, within a society creates an array of psychosocial circumstances. While Wilkinson suggests that there are a vast number of possible pathways linking the psychosocial environment to health, he presents evidence emphasizing the importance of chronic stress (1996: 154). Chronic stress is a psychosocial condition that impacts on health directly, for example by weakening the immune system, as well as indirectly through the predisposition to health risk behaviours

such as smoking (Wilkinson, 1996:179, 185). This pathway between income inequality and health is illustrated below:



The issue of inequality and its impact on health has been approached from a number of perspectives. Brunner and Marmot (1999) document the link between social organization, stress, and health. They discuss primate studies, which have been particularly useful for identifying biological responses that are related to hierarchical position and chronic stress. One advantage of these studies is that the material circumstances of the subjects can be controlled so that the impact of subordinate and superior positions is strictly psychosocial.

Deaton (2001) presents an interesting anthropological perspective based on the understanding that hunting and gathering societies exhibited relatively flat hierarchical structures, and were socially and physically healthy. He suggests that humans developed social tools during this period, including the value of fairness, that allowed them to live in cooperative groups. As a rule, these communities had social norms, customs and taboos

that discouraged excessive accumulation by a few individuals (Deaton, 2001:5). Weiner's work on the Trobrianders of Papua New Guinea provides an interesting, present day, case study. She describes how a chief's wealth was measured by his ability to give away that same wealth: "With good harvests, chiefs can be generous, distributing large amounts of yams to many villagers as payment for their work" (1988:105) and "giving yams is a sign of fecundity, nurturance, and power" (1988:106). This is not unexpected in hunting and gathering societies where successful interdependence means survival for the whole community, and wealth in the form of food cannot be accumulated indefinitely without rotting. This changed with the evolution of agricultural, then industrial, and now information based societies. Nikiforuk, in *The Fourth Horseman* (1991), provides an interesting assessment of diseases associated with these structural changes, reinforcing Deaton's claims regarding the health of hunting and gathering peoples. Nikiforuk states that "they stood tall, had good teeth" and were generally so healthy that infanticide was required to prevent overcrowding (Nikiforuk, 1991:7). Living in small groups limited the perpetuation of infectious diseases that relied on human hosts, while they avoided diseases such as measles, that appeared once animals were domesticated during the agricultural period (Nikiforuk, 1991:8; Deaton, 2001:5). Deaton relates this level of health to social structure, emphasizing that the original hunting and gathering societies modeled the most beneficial form of social relations, that is, ones characterized by very narrow "income" distributions. The social structure was based on an evolved need for fairness and equity. The presumption is that the implementation of "fairness", through the reduction of income inequality, in any society, regardless of whether it is agricultural,

industrial, or information based, would have a positive impact on population health. However, a cautionary note about this argument lies in the emphasis placed on fairness and equity versus the other beneficial traits outlined by Deaton including the presence of regular exercise; high fibre, low fat, and low meat diets; and pollution free environments. The question is, if these factors had remained constant, and social stratification increased, would the levels of physical health and social relations have remained unchanged?

The work of Miller (in Amick et al., 1995:343) provides a framework suitable for viewing the relationship between income inequality and health. Miller locates individuals in terms of their resources, relationships, and relative position. The first, resource position, focuses on peoples' material attributes, including individual salary and wealth as well as public and private resources available to members. There are direct effects on health that result from these material resources, as well as indirect (social-psychological) effects, including feelings of empowerment or fatalism, and confidence to modify one's situation or not. The second factor, relational position, has to do with one's social roles and positions, the connections between individuals and groups. Miller cites the example of unemployment. While the loss of income may strain material resources, the loss of social position (both within the family and the wider community) may also have a detrimental impact on health. The final factor, relative position, is comparative and pertains to inequalities. It has less to do with the absolute quantity of resources or quality of relationships, and more to do with the comparison of one's position against others. Presumably, in developed countries at least, good relative position implies good relational

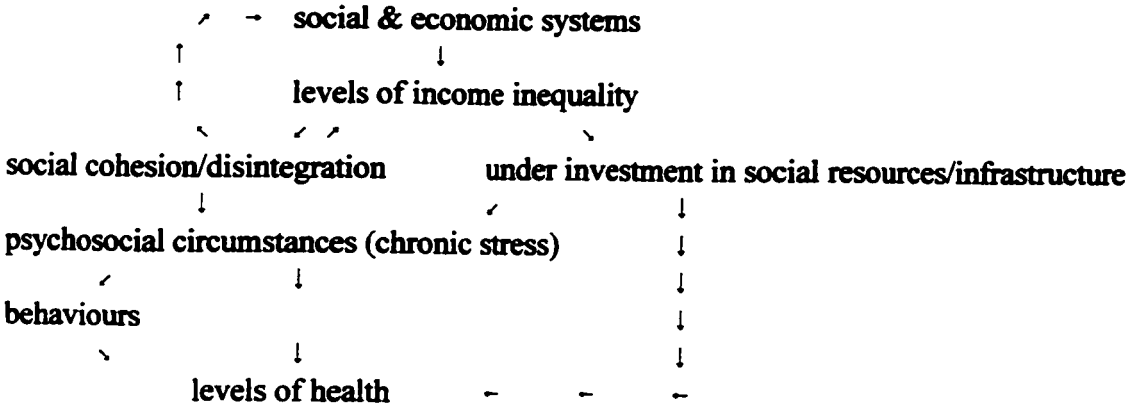
and resource position. Thus, one would expect higher levels of population health in communities where more people had good relative positions, that is, there was more income equality.

The two most cited hypotheses offering explanations for the link between income inequality and health are the *psychosocial* and *neo-material* hypotheses. Wilkinson's proposed pathway, presented earlier, is compatible with the psychosocial hypothesis. Ross (2001) characterizes this approach as "our appraisal of place in the social order", stating that life's difficulties are more likely to manifest themselves pathologically when people are surrounded by others with more enviable circumstances. As the Whitehall studies have shown, there is not a dichotomy of the envied and the envious. Even though those with higher social position appear to benefit from a "host defense", the health gradient still exists between groups at the higher end of the occupational scale. Thus, Wilkinson states that in areas with high levels of income inequality the health of the whole population suffers, not just those at the more deprived end of the scale (ACPH, 1999a:185; Wilkinson, 1996). He states, for example, that the lack of social cohesion resulting from income inequality makes driving on the roads more dangerous for everyone, as accident rates increase with a rise in aggressive behaviour (Wilkinson, 1996:155). Wealthier people feel compelled to protect themselves from violence and crime, as well as the declining educational and health care systems (Raphael, 1998:380). The well-off and the more deprived members of society all experience a loss of personal control over their lives (Raphael, 1998:381). In other words, all people are subjected to

chronic stress resulting from a less cohesive society where individuals are driven to focus on their own interests above those of the community.

The second major approach used to explain the link between income inequality and health lies in the *neo-material hypothesis*. From this perspective, societies that tolerate wider income distributions also tend to under-invest in social resources and infrastructure including education and health care, which in turn has an impact on health (Statistics Canada, 1999b:79). Kaplan et al. (1996) found that income inequality was significantly associated with under-investment in human and social capital including expenditures on medical care, police protection, and education. Although Lynch et al. (2000) include individual resources as part of the neo-material factors, Ross (2001) places more emphasis on public goods and infrastructure when she describes the neo-material hypothesis as being "about exposure to the material conditions within jurisdictions". It is not enough for hospitals, schools, and recreation centres to exist, they need to be accessible, financially, geographically and socially. Hence the concern in Canada over the existence and accessibility of public resources. The reduced federal role in public institutions, and the subsequent pressure on provincial budgets (Mhatre et al., 1992:654), has given rise to contentious solutions such as tax credits for private school tuition and user fees for health care services. Proponents of the neo-material approach would view this decreasing government investment as the link between income inequality and health in Canada.

What distinguishes the neo-material approach from a strictly material explanation is the inclusion of psychosocial factors. In other words, the psychosocial and neo-material approaches are not mutually exclusive. Indeed, Marmot et al. state that "the inclusion of psychosocial pathways in neo-material factors might arguably be considered a major difference between neo-material and material factors" (2001:1234). Thus, while inadequate housing poses a direct health hazard, so too does the knowledge of one's sub-standard circumstances through stress, poor self-esteem, feelings of powerlessness, and so on (Miller, 1995:343). The following pathway integrates both hypotheses:



The mechanisms relating income inequality to health, while including material insufficiencies, seem particularly closely related to chronic stress. Whether that stress is generated from a lack of material resources, inadequate social prestige, or the knowledge that others have more in comparison to one's own situation, is however, important in terms of policy initiatives for addressing the situation. The difficulty with those that focus on material explanations is that there is the temptation to disregard inequality per

se, and focus on providing resources for those who are less well off in the community, leaving those who are more privileged to advance their positions and thereby increase inequality. A stark reminder of this approach was evident in a recent article in *The Economist*, Does inequality matter? The first point of note was that in merit based systems, such as those found in Canada and the U.S., unequal outcomes "ought not to be a cause for concern" (2001:9). In other words, income inequality is not only normal, it is desirable as it demonstrates the opportunity for merit based advancement. Moderating this view was the statement that governments should intervene in situations "where opportunities are not genuinely equal". And finally, the article concluded that the real problem lies, not in the gap between the rich and poor, but in poverty. While there is no doubt that the poorest families in society could benefit from material improvements, this approach disregards the psychosocial consequences of inequality at all levels of the hierarchy.

It is possible that some confusion arises from two related processes acting concurrently. The first, well documented process is the positive relationship between socioeconomic status (SES) and health. This relationship is robust regardless of the measures selected for SES (income, occupational class, education) and health (self-reported health, morbidity, mortality). Disease does not appear randomly, poorer people are more likely to suffer from ill health and, as Miller suggested, some privileged people gain an enhanced sense of well-being from the disadvantages of others (1995:345). At the same time, this process is situated within a broader relationship of income inequality and

population health. This relationship exists at an ecological level and has been found to be robust across different measures of income inequality (Kawachi et al., 1997) and health including life expectancy (Marmot et al., 1999:108), total mortality (Wilkinson, 1996:78), infant mortality (Wilkinson, 1996:83), low birth weight (Kaplan et al., 1996:1001), accident mortality (Wilkinson, 1996:154), homicide (Kaplan et al., 1996:1001), suicide (Wilkinson, 1996:162) and self-reported health (Kennedy et al., 1998:921; Wilkinson, 1996:88). Thus, while people of lower SES will likely experience poorer levels of health in their community, their health would be optimized if they lived in a community with a narrower income distribution. This is supported by the work of Kahn et al. (2000) who found that low income women living in U.S. states with high income inequality had a higher risk of depressive symptoms than low income women living in states with low income inequality. The overlapping processes can be represented in a two-by-two table where the lightest cell represents the optimum conditions for health and, conversely, the darkest cell indicates the most disadvantaged position (Table 1.2).

Table 1.2 The overlapping impact of income inequality and socioeconomic status

		Socioeconomic status (level effect)	
		Low	High
Income inequality (spread effect)	High		
	Low		

It is assumed that the impact of income inequality on health represents the major direction of influence in this relationship. However, it is conceivable that levels of population

health could influence levels of income inequality. Given that demographic changes can drive levels of income inequality (e.g. an increase in the proportion of single parents living at lower income levels) (Rashid, 1998:14), it is possible that health status changes in a proportion of the population could result in a shift of the income distribution, and could subsequently have an impact on levels of income inequality. The population health consequences resulting from the Chernobyl nuclear accident, for example, may be sufficient to have an impact on levels of income inequality. This amounts to selective social mobility whereby health status influences social position and therefore ultimately the width of the income distribution. Wilkinson cites a number of studies that acknowledge this process but suggests the effects of health status on social mobility are negligible (1996:59). In this thesis the direction of influence is assumed to be from income inequality to health in accordance with the majority of studies exploring this topic.

The work on income inequality and health raises two major questions with respect to Canada. The first concerns the levels of income inequality that have existed in Canada as a whole and within each province, and how have these levels have changed over time. Is there stability, has income inequality steadily increased or decreased, or does it fluctuate with recessionary periods? In other words, what level of exposure have Canadians had to this proposed societal determinant of health? This question has been addressed to some extent in the literature, although with conflicting results. A major report from the Centre for Social Justice documents a growing disparity between the wealthiest and poorest

families in Canada (Yalnizyan, 1998). The work of Rashid, in his exploration of income inequality in Canada between 1970 and 1995, appears to support this finding (1998:16). He concludes that income inequality among families has increased, particularly as a result of recessions in the early 1980s and 1990s. However, Rashid does not suggest that this is a uniform trend across Canada. He states that income inequality has increased significantly "among dual-earner families, young families and families in Ontario and British Columbia". In contrast, Wolfson and Murphy conclude that income inequality has remained stable over the last decade (ACPH, 1999a:49). Comparison of these reports is complicated by the use of different measures of income inequality, income figures that may either include or exclude government transfers and taxes (income concept), and the use of different income groups.

The second major question regarding the work on income inequality and health is whether an association between these variables exists in Canada as it does in the U.S. It is possible that the social safety net in Canada has reduced income inequality as well as buffered the population from its effects. Ross et al. support this argument in a study that compared the relationship between income inequality and mortality in Canada and the United States (2000:898-902). They conclude that there is no relationship in Canada while there is in the U.S., suggesting that this relationship is not automatic but instead one that is mediated by the distribution of social and economic resources. Thus differences between the two countries in material and social circumstances (e.g. the social safety net in Canada) account for the absence of this relationship in Canada. However,

associations, or lack thereof, may depend upon the measures used to operationalize health. These questions will be addressed in this thesis in order to establish if, and under what conditions, income inequality may be considered an important social determinant of population health in Canada.

CHAPTER 2 AIMS & OBJECTIVES

2.1 Purpose

To investigate the relationship between income inequality and population health in Canada and the provinces from 1981 to 1996.

2.2 Objectives

(1) To establish the levels of income inequality during the 1981-1996 period in Canada and the provinces, using three income inequality measures (the decile ratio, Robin Hood index and Gini coefficient) and two income concepts (market income and income after tax).

(2) To explore health trends from 1981 to 1996 in Canada and the provinces using various outcome measures (self-reported health, total mortality, infant mortality, low birth weight, accident mortality, homicide, suicide, life expectancy).

(3) To examine the relationship between income inequality and population health in Canada and in the provinces over time, and between the provinces at four time points (1981, 1986, 1991 and 1996).

2.3 Expectations

(1) Income inequality is inversely related to population health.

(2) This relationship exists using a variety of health outcomes and measures of wellness for the population including self-reported health, total mortality, infant mortality, low birth weight, accident mortality, homicide, suicide, and life expectancy.

(3) Between 1981 and 1996 family income inequality has increased (particularly during the recessions of the early 1980s and early 1990s) resulting in progressively slower rates of improvement in population health.

(4) Provinces with the greatest increases in family income inequality between 1981 and 1996 had the smallest improvements in population health during the same time period.

CHAPTER 3 MATERIALS & METHODS

3.1 Study Design

This thesis is an ecologic study. Morgenstern states that this type of study is an effective tool for assessing the impact of social processes (1998:462), such as the consequences of income inequality for population health that are being evaluated in this thesis. Susser (1994) presents the ecologic approach as a means for studying health within an environmental (social or physical) context. In addition to being ecologic, this thesis is an analytic, mixed-design study, based on a secondary analysis of existing data (Table 3.1.1).

Table 3.1.1 Ecologic study designs [4]

Method of exposure measurement	Method of grouping
Exploratory: no exposure or exposure not measured	Multiple group design: Grouped by place
	Time-trend design: Grouped by time
Analytic: **Primary exposure variable measured and included**	**Mixed design:** **Grouped by place and time**

There is some debate over the use of the word "analytic" in the classification of ecologic studies. Morgenstern, in his chapter on ecologic studies in Rothman and Greenland's *Modern Epidemiology* (1998:459-80), states that prior to 1980 ecologic studies were simply classified as descriptive (1998:459). By definition, an ecologic study could not be analytic. Hennekens et al. support this approach when they groups correlational (ecologic) studies with case reports, case series, and cross-sectional surveys under the

[4] Table adapted from Morgenstern, H. in Rothman, K.J. and Greenland, S. (1998).

banner of descriptive studies (1987:16-18). Morgenstern, in contrast, divides ecologic studies into those that are exploratory and those that are analytic. In exploratory studies, there is no exposure of interest or the exposure is not measured. They are designed to generate hypotheses, and include studies that map the spatial distribution of disease where an environmental etiology is suspected, as well as migrant studies that compare disease rates among migrants and residents in their countries of emigration and immigration to generate genetic or lifestyle disease causation hypotheses (Morgenstern, 1998:463). Analytic studies, in contrast, have an exposure variable that is measured and included in the analysis (Morgenstern, 1998:463). The decision was made to follow Morgenstern's classification and include "analytic" in the description of the study design for the thesis.

Two levels of measurement are evident in the variables. The exposure variable (income inequality) is global while the health outcome variables and covariates are aggregate. Global measures are attributes of groups or places that have no corresponding measure at the individual level, while aggregate measures are summaries of individual attributes, often expressed as means or proportions (Morgenstern, 1998:460).

This thesis is a completely ecologic study (versus partially ecologic or multilevel) where the units of analysis are Canada and the individual provinces. The level of inference is ecologic (versus biologic) with the aim of estimating the effect of exposure on group rates.

3.2 Study Population

Canada and the ten provinces from 1981 to 1996 comprise the study population for this thesis. The territories are excluded due to data limitations.

In Canada, provincial population size varies widely with Prince Edward Island being the smallest. Since small populations can result in unstable exposure and outcome measures, some studies have attempted to overcome this instability by combining populations and reporting on the "Atlantic Region". This approach was not taken here as it would reduce the already meagre number of units from 10 to 7, if one can avoid the temptation of grouping the prairie provinces. Alternatively, Prince Edward Island could have been dropped from the analyses, although this approach also reduces the number of cases. Consequently results for Prince Edward Island are presented and the reader is asked to review them with caution. This is the approach taken by Statistics Canada in a number of their publications.

3.3 Definition of Income Concepts

Measures of income inequality yield quite different results depending upon the income concepts on which they are based. The following classification (Table 3.3.1) defines the major income concepts (Lasnier, 2000:24)[5].

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[5] Please see Appendix B for the full *Classification of Income Sources*.

Table 3.3.1 Classification of income concepts

Total income
Market income
Earnings
Investment income
Pension income
Government transfers
(Old Age Security, Canada Pension Plan, Employment Insurance Benefits, GST Credit, Social assistance, Child Tax Benefit, etc.)
Other income
(Income tax payable)
Income after tax

Discussion surrounding the rationale for selecting one type of income (income concept) over another in order to measure income inequality is notably absent from the literature. This thesis uses two concepts: *market income* and *income after tax*[6]. Amick et al. (1995:347) refer to market income as the "original distribution of income...", the distribution that exists prior to governmental redistribution, and stress its importance for monitoring the prevention of income inequality. Income inequality measures based on market income reveal the "essential" level of inequality, that which exists prior to the equalizing effects of government transfers and the taxation system. *Income after tax* illustrates the "manufactured" level of inequality, which is based on disposable income (total money income less income tax payable) and illuminates the impact of income related policies (e.g. Employment insurance benefits, taxation levels).

It is important to examine the relationship between income inequality and health based on both income concepts. The core question is which income concept generates a person's

[6] The term *market income* is synonymous with *income before transfers*, a term which is frequently used in Statistics Canada publications.

sense of their social position in relation to the larger community, and thereby promotes levels of social cohesion or disintegration from which the psychosocial circumstances evolve that ultimately have an impact on health. One approach to this question is to establish whether people's sense of social position is based simply on the quantity of income, or if the source of income is also important. I would argue that hierarchy develops based on the original (market) income and that taxation and government transfers, while equalizing to income, are not necessarily equalizing to the social hierarchy. This suggests that government transfer and taxation policy have a greater impact on material circumstances than on the psychosocial circumstances generated by the original income inequality. One would therefore expect a stronger relationship between income inequality and health when the former is based on market income. This issue will be explored by duplicating analyses using both income concepts.

3.4 Definition of Income Groups

Various income groups have been used in the measurement of inequality, including families, unattached individuals, and "all units" (the combination of the former two groups) (Statistics Canada, 1997:26). Rashid (1998) analyzes family income inequality in detail with income groups that reflect family structure (husband-wife families, male lone-parent families, etc.) and family age (defined by the age of the husband/lone-parent). Family size also features in some analyses, although the greatest differences are found between family sizes of 1 (unattached individuals) and all other families (Love, 1979). At Statistics Canada a distinction is made between census and economic families.

Census Family
Census families are also referred to as "immediate" or "nuclear" families. They consist of either a husband and wife (with or without children who have never married) or a parent with one or more children who have never married, living together in the same dwelling. (*Family incomes, Census families, 1992.* Statistics Canada, Household Surveys Division, Catalogue Number 13-208, page 16).

Economic Family
Economic families are defined as "a group of individuals related by blood, marriage or adoption, who shared a common dwelling unit at the time of the survey". (*Income after tax, distributions by size in Canada, 1981.* Statistics Canada, Consumer Income and Expenditure Division, Catalogue Number 13-210, page 23). The concept of economic families is broader than that of census families. For example, a household with parents, children and grandparents would comprise two census families but only one economic family.

This thesis focuses on families (as opposed to unattached individuals or all units) for two reasons. First, families and unattached individuals form two distinct groups with regards to levels of income inequality. To blend these groups results in neither being well represented. Selecting families, which consistently have lower levels of income inequality, is the more conservative approach. Second, most Canadians live in family units. For example, in 1996, there were 3.9 million unattached individuals in Canada compared to 8.3 million economic families composed of two or more members (Statistics Canada, 1999c).

In addition, this thesis focuses specifically on economic (as opposed to census) families. Economic families were chosen because it is the income group used in the Survey of Consumer Finances, the data source from which the income inequality measures were calculated. As well, this income group reflects the actual living arrangements found in the population.

3.5 Definition of Income Inequality Indicators

Income inequality measures reflect the scale of economic difference within the population. Societies with wider income distributions are considered less egalitarian. Thus, income inequality is an indicator for the amount of social hierarchy that exists within a society. A number of measures have been used in studies to illustrate levels of income inequality including the:

i) Lorenz curve and associated Gini coefficient (Rashid, 1998:14; Kennedy et al., 1998:917; Kawachi et al., 1997:1121; Wolfson, 1997:12)

ii) Robin Hood index (Kennedy et al., 1996:1004; Kawachi et al., 1997:1121)
Index of concentration
Index of dissimilarity

iii) decile ratio (Yalnizyan, 1998:47; Kawachi et al., 1997:1121)

iv) proportion of total income earned by the bottom 50% ("median share" (Ross et al., 2000:899)), 60% and 70% of households (Kawachi et al., 1997:1121)

v) Atkinson Index (Kawachi et al., 1997:1121)

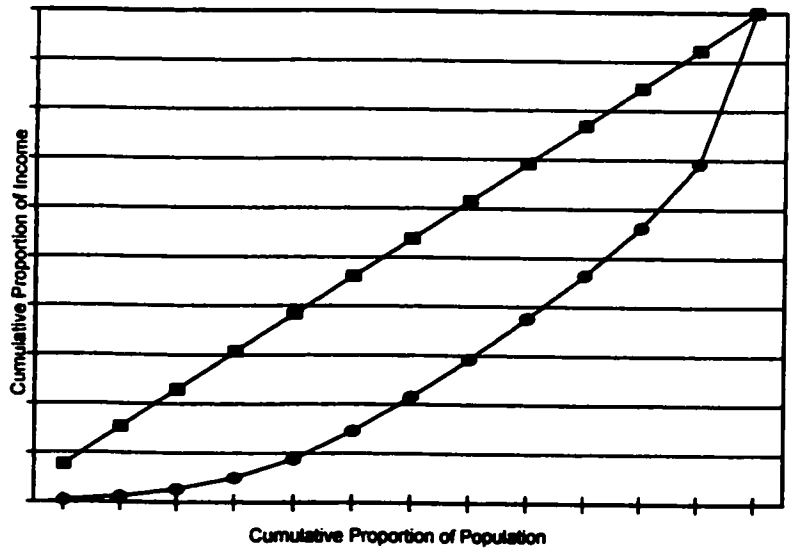
vi) Theil's entropy measure (Kawachi et al., 1997:1121)

The Gini coefficient and Robin Hood index were selected for this thesis to enhance comparability with the work from the U.S. As well, the Gini coefficient is closely related to the "gold standard" Lorenz curve. The decile ratio was selected because it is used in Canada by the Centre for Social Justice as a base on which to promote policy alternatives for moderating income inequality (Yalnizyan, 1998). An assessment of this measure will establish if it is a viable alternative to the former two measures. These measures are discussed in more detail below.

3.5.1 Lorenz Curve

The Lorenz curve is a graphical device used to illustrate the inequality of income distributions (Figure 3.5.1.1). The cumulative share of income accrued is plotted on the ordinate against the cumulative proportion of population on the abscissa. A 45 degree line is used for reference, marking the condition of equal distribution. The line for complete inequality, where one person holds the entire income, follows the horizontal axis to 100% and then the vertical axis. The Lorenz curve always has its concave surface facing upwards and it can dip below the horizontal axis when negative incomes are involved. Wolfson refers to the comparison of Lorenz curves as the "'gold standard' for judging changes in inequality" (1997:19). He suggests that summary measures of income inequality are used simply for convenience as they allow more concise reporting than a series of Lorenz curves.

Figure 3.5.1.1 Lorenz Curve



3.5.2 Gini Coefficient

The Gini coefficient is a ratio of the area between the Lorenz curve and the 45 degree line to the total area below the 45 degree line. Theoretically a Gini coefficient may lie anywhere between zero and one[7], where 0 indicates no inequality. However, Rashid (1998:14) states that the Gini coefficient usually ranges between 0.2 (low inequality) and 0.5 (high inequality). A change of one percentage point (e.g.. 0.31 to 0.32) is considered significant (Rashid, 1998:14). There are conflicting reports as to whether the Gini coefficient is more sensitive to the middle or the ends of the income distribution. Deaton states that it is "(too) sensitive to the top of the distribution" (1999b:22), while Kennedy et al. report that the Gini coefficient is sensitive to the extreme ends of the income distribution, in that it is highly correlated with the proportion of income earned by the bottom and top 10% of households (Kennedy et al., 1996:1005-1007). Kawachi et al. (1997:1126) state that this measure lacks sensitivity when income transfers take place between households that are both close to the middle of the income distribution. However, Wolfson (1997:9) presents the Gini coefficient as a "middle-sensitive..income inequality measure". A modeling exercise using fictitious data supports the notion that the Gini coefficient is more sensitive to income transfers at either end of the distribution than redistributions around the middle (Appendix C). For a detailed description on the plotting of Lorenz curves and calculations of the Gini coefficient, please see Shryock, 1976:98.

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[7] Although the Gini coefficient may be greater than one when negative incomes are included in the calculations, for practical purposes 0 and 1 can be considered the outer limits of this measure.

3.5.3 Robin Hood Index (RHI)

The Robin Hood index indicates the share of total income that must be redistributed from households above the mean to those below the mean in order to achieve an equal income distribution between the two halves. It is equivalent to the maximum vertical distance between the Lorenz curve and the 45 degree reference line. The RHI is more highly correlated with the proportions of income earned by the bottom 50%, 60% and 70% of households than with the bottom or top 10% (Kennedy et al., 1996:1006). A weakness of this measure is that redistributions of income among households that are on the same side of the mean will not alter the index (Kawachi et al., 1997:1126). Details on the calculation of the RHI are provided by Kennedy et al. (1996:1007). While their example groups the population by decile, Kennedy states that the RHI "can be calculated off of any distribution of shares" (Personal communication, 07 April, 2000).

The change in RHI was calculated using the modeling exercise described in Appendix C. Overall, the RHI appears to be a less sensitive measure than the Gini coefficient, especially when the redistribution takes place around the middle of the income distribution. Further discussion on the RHI can be found in Shryock where it is referred to as the "Index of Concentration" (1976:99)[8].

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[8] Shryock's focus is on the concentration of populations rather than income, although he acknowledges these measures have historically been used to measure the concentration of wealth and income. To avoid confusion, it is worth noting that the Robin Hood index (used in this thesis) and the "Index of Concentration" (Shryock), refer to the same measure. In addition, the Robin Hood index has been described as similar to the Index of Dissimilarity, another term seen in the literature (Kennedy, personal communication, 07 April 2000; Shryock, 1976:99,

3.5.4 Decile Ratio

The decile ratio is calculated by dividing the total income earned by the richest 10% of the population by the total income earned by the poorest 10%, or equivalently, by taking the ratio of the average income in the top decile to the average income in the bottom decile. This measure was used extensively in a 1998 report by the Centre for Social Justice titled *The Growing Gap: A report on growing inequality between the rich and poor in Canada* (Yalnizyan). By definition, the decile ratio ignores the middle 80% of the income distribution. Wolfson states that the decile ratio has "no redeeming features for the measurement of formal concepts of inequality or polarization" (1997:10). He goes on to suggest that it continues to be used because it is simple to understand and widely available. Kawachi and Kennedy (1997) explored the association between a number of income inequality measures and mortality and found a high correlation between the decile ratio and other measures, including the Gini coefficient and Robin Hood index. However, they go on to state that this high correlation does make the measures interchangeable, that "a theoretical justification for the choice of indicator is critical in assessing the impact of social and economic policies on income distribution and mortality" (Kawachi et al., 1997:1127). This measure is included to explore its performance in the Canadian context.

Spasoff, personal communication, 24 June 2001). Mackenbach and Kunst used the Index of Dissimilarity to describe health inequalities (1997). Their definition also suggests it is equivalent to the Robin Hood index.

3.6 Definition of Health Outcome Variables

The WHO ambitiously defined health in 1948 as " *a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"* (cited in Beaglehole et al. 1993:13). While conceptually useful, this definition is difficult to operationalize. In practice, a number of "health indicators" are used as proxy measures of population health, many of which measure mortality. Inferences are made from mortality trends about population health and risk factors for morbidity such as access to care, nutritional intake and even levels of socioeconomic development. Examples of different measures from the literature that explores the income inequality-health relationship include total mortality (Wilkinson, 1996:78), accident mortality[9] (Wilkinson, 1996:154), homicide (Kaplan et al., 1996:1001), suicide (Wilkinson, 1996:162), infant mortality (Wilkinson, 1996:83), low birth weight (Kaplan et al., 1996:1001), and the percentage of the population with poor levels of self-reported health (Kennedy et al., 1998:921; Wilkinson, 1996:88).

Péron and Strohmenger classify these indicators into three groups (1985:101-236). The first, "Indicators of the Level of Health" include mortality rates and life expectancy at birth. The second group "Indicators of Health Problems", are used to illuminate patterns

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[9] The term "external cause mortality" is used in this thesis in place of "accident mortality". This is based on the understanding that the events we commonly refer to as accidents are, in fact, non-random events predictably occurring in certain populations. For example, one only has to reflect on car insurance rates to realize that the probability of experiencing a car "accident" is highest in the young male population. Other vulnerable sub-groups may include homeless people, alcoholics, and children who reside on farms.

of morbidity in the population and thus help identify the "obstacles to moving to higher health levels" (Péron & Strohmenger, 1985:135). These indicators include cause-specific mortality (homicide, suicide and external cause mortality) and self-rated health status. The infant mortality rate and prevalence of low birth weight are included in the final category, "Indicators Specific to Certain Stages of the Life Cycle". A more detailed review of these health indicators follows.

3.6.1 Indicators of the Level of Health

3.6.1.1 Total Mortality

Total mortality is the most reliable measure of "health", due to reporting and recording regulations. For this thesis, total mortality was standardized both directly and indirectly. Direct standardization produces *age-standardized mortality rates* (ASMRs), which are expressed as deaths per 100,000 population, and allows for comparisons between provinces and/or across time. The 1991 Canadian population was selected as the standard. For indirect standardization, *standardized mortality ratios* (SMRs) were calculated using the 1991 Canadian rates as standard. These are expressed as percentages and theoretically may only be compared to the 1991 Canadian standard (100%), although in practice SMRs tend to be compared with each other. While more difficult to interpret than the ASMRs, SMRs are a useful measure when data by age group are unavailable (e.g. provincial level cause-specific mortality), which precludes the calculation of ASMRs.

3.6.1.2 Life Expectancy at Birth

Life expectancy at birth is another common indicator used to measure the level of a population's health. It is defined as the "average number of years an individual is expected to live if current mortality rates continue" (Beaglehole et al., 1993:24). This measure is influenced more by mortality at younger ages than by deaths later on in life.

3.6.2 Indicators of Health Problems

3.6.2.1 External Cause Mortality[10]

Injuries and deaths due to external causes are positively correlated with income differences (Wilkinson, 1996:155). Wilkinson suggests that these incidents reflect the way people perceive themselves in relation to unknown others and, as such, indicate the level of social cohesion that exists within society. In driving, for example, people may see others as obstacles, or alternatively, recognize that everyone's safety is interrelated and subsequently drive in an appropriate manner. External cause mortality includes homicide, suicide and all other causes coded E800-E999 in the International Classification of Diseases, Ninth Revision (WHO, 1975). External cause mortality at the provincial level is presented as SMRs, and as such, the results may only be compared to the 1991 Canadian standard (100%).

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[10] For convenience, mortality from external causes of injury and poisoning will simply be referred to as "external cause mortality".

3.6.2.2 Homicide

Homicide is a measure of the social health of a population. It has a positive association with income inequality and a stronger association with the income distribution than has total mortality (Wilkinson, 1996:156). Homicide is defined by codes E960-E969 in the ICD-9 and is a subset of external cause mortality. Provincial homicide mortality is presented using SMRs.

3.6.2.3 Suicide

An inverse association between suicide and homicide has been identified (Wilkinson, 1996:163). However, suicide has also been shown to relate to income inequality and unemployment and is a major part of total mortality for young people living in deprived areas (Wilkinson, 1996:162). Suicide is defined by ICD-9 codes E950-E959 and, like homicide, is presented for provinces using SMRs.

3.6.2.4 Self-Rated Health

Self-rated health status is a strong predictor of mortality and the onset of disability (Kennedy et al. 1998:917). It appears to be effective in capturing morbidity levels in a population. Some studies use the percentage of the population who rate their health as fair or poor (Kennedy et al., 1998:917). Due to the relatively small numbers for the respondent category "poor" at the provincial level, this thesis uses the percent of the population who responded "excellent" when asked to compare their health to others their own age. The top two categories (excellent and very good) were not combined as this

eliminated most of the variation between provinces.

3.6.3 Indicators Specific to Certain Stages of the Life Cycle

3.6.3.1 Infant Mortality

The infant mortality rate is defined as the number of infant deaths (less than one year of age) for a given year divided by the number of live births in the same year. It is expressed per 1,000 live births. This measure is considered to reflect the general hygiene and health conditions which exist in a population (Péron et al., 1985:194). In addition, it is considered sensitive to changes in socioeconomic conditions and health-care interventions (Beaglehole et al., 1993:22).

3.6.3.2 Low Birth Weight (LBW)

Birth weight is a principal determinant of an infant's future health (ACPH, 1999b:255). Low birth weight is closely linked to infant mortality in that babies weighing less than 2,500 grams at birth are more likely to die in their first year of life than are bigger babies. Because birth weight is influenced by resources such as the mother's access to care and nutritional intake, it is a useful indicator of health and social development in the whole population. However, since selecting LBW as a health outcome measure, three issues emerged compromising its usefulness. They relate to the definition, categorization and interpretation of LBW and are addressed below.

a) The definition of low birth weight

Since 1948, the international definition of low birth weight has included live births weighing 2,500 grams or less (Péron et al., 1985:219). This definition later changed to include only those live births weighing less than 2,500 grams. Due to digit preference (the tendency to record rounded measurements), the decision to exclude live births weighing 2,500 grams could substantially lower the percent of newborns categorized as LBW. Péron and Strohmenger state that in 1976 the recommendation was made to adopt the new definition, while acknowledging that most published studies continued to use the old definition. Furthermore, they go on to caution that "the indicator obtained may vary significantly depending on the definition chosen" (1985:219). This thesis contains LBW data of 2,500 grams or less (1981) as well as LBW data of less than 2,500 grams (1986, 1991, 1996).

b) The categorization of low birth weight

Péron and Strohmenger (1985:215) recommend distinguishing between:

i) Small-for-gestational-age babies (includes those born at term)
These LBW births are most common in Third World countries where poverty (absolute and relative) is widespread (Levitt et al., 1993:767). They result from conditions such as insufficient nourishment in utero, preeclampsia, maternal smoking and age of mother, particularly those in the older and younger age groups (ACPH, 1999b:255).

ii) Pre-term babies (born before 37 weeks gestation)
This category of LBW is a more common problem in Canada, and presumably other developed countries. While the exact causes of preterm births are difficult to pinpoint, "women who are economically, socially and educationally, deprived are at greater risk" (Levitt et al., 1993:767).

The LBW data in this thesis are not categorized as recommended. The available data grouped all low birth weight babies together irrespective of gestational age.

c) The interpretation of low birth weight as a health outcome measure

At first glance, the interpretation of low birth weight prevalence as a health indicator is straight forward. That is, a high prevalence of low birth weight babies indicates poor levels of population health. However, an increase in the prevalence of LBW births may reflect advances in medical care that allow pre-term labour to progress to live (albeit low weight) births versus stillbirths and therefore indicate improved health status in the community.

In light of the difficulties associated with the definition, categorization and interpretation of low birth weight, the decision was made to abandon it as a health outcome measure for this thesis.

3.7 Definition of Covariates

It is desirable to control in the analysis for other variables known to affect population health. The following covariates were selected from the literature.

3.7.1 Median Income

Median income is defined as that income above and below which half the total population lies. The median incomes reported in this thesis are specifically for economic families.

That is, unattached individuals have been excluded from the calculation of median incomes. In addition, median incomes are presented in constant 1997 dollars (i.e. adjusted for inflation) as opposed to current dollars.

3.7.2 Low Income Cut-Offs (LICOs)

LICOs identify economic families (and unattached individuals) who usually spend more than 54.7% of their incomes on basic necessities including food, shelter and clothing, placing them in "straitened circumstances" (ACPH, 1999b:39). LICOs are limits calculated by Statistics Canada from the Family Expenditure Survey, which are updated annually (using the CPI) to reflect the changing cost of living, and periodically rebased (most recently in 1992). In addition, these cut-offs are differentiated by community size of residence and family size.

The percentage of economic families living below the LICO will be used as a proxy measure for poverty in this thesis. It must be noted that Statistics Canada, which produces the LICOs, does not endorse this approach. Ivan Fellegi, Chief Statistician of Canada, emphasizes that although LICOs identify those in the population who are significantly worse off than the average, it does not necessarily mean that they are poor (Lasnier, 2000:35). However, Fellegi also recognizes that, as yet, there is no acceptable definition of poverty and so the LICOs allow analysis of the relatively worst off families in Canada. Kennedy et al. (1996) and Kawachi and Kennedy (1997) adjusted for poverty in their U.S. studies relating income inequality and health. Their poverty variable is

based on a federal poverty index available with U.S. census data.

3.7.3 Smoking

Most Canadian health surveys categorize smokers in the following way:

Current smokers
    Daily or regular smokers
    Occasional smokers
Not at all (Includes former smokers and those who never smoked)

The majority of current smokers smoke on a daily basis, in contrast to occasional smokers who comprise a relatively small proportion of the smoking population. "Smoking" in this thesis is defined as the percent of the Canadian population, aged 15-years and older, who currently smoke cigarettes on a daily basis. Excluded are people who currently smoke on an occasional basis. This selection differs slightly from studies by Kaplan et al. (1996:1001) and Kennedy et al. (1996:1004-7) in which all current smokers were used. Kaplan et al. used the proportion of current smokers as a health outcome measure, whereas Kennedy et al. viewed smoking as a covariate when they examined the income inequality/mortality association after controlling for the proportion of current smokers in the population.

3.8 Data Sources

3.8.1 Income Inequality

Income inequality data used in this thesis are custom tabulations produced by Statistics

Canada from the Survey of Consumer Finances[11] (Appendix D). This survey, which has been conducted annually since 1971, provides information on the income distributions for individuals and families. All persons residing in Canada, aged 15 years and over, are targeted except those living in the territories, on Reserves or in institutions and full-time members of the Canadian Armed Forces living in Barracks. The survey consists of approximately 35,000 households or about 65,000 individuals, and has a response rate of around 80%. Results for 1981, 1986, 1991 and 1996 are based on the 1982, 1987, 1992 and 1997 surveys respectively.

3.8.2 Population Counts

Population counts from 1981 to 1996 were obtained from Statistics Canada's *Nation Series*. Please see Appendix E for detailed references on the population count data, as well as the following health outcome and covariate data.

3.8.3 Health Outcomes

Health outcome data were obtained from published reports and from calculations based on data made available through the Data Liberation Initiative. A summary of sources is presented in Table 3.8.3.1.

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[11] These custom tabulations replaced my own calculations. The tabulations were offered by Statistics Canada after a problem with one of the public use microdata files was identified. In the interests of time, they were gratefully accepted.

Table 3.8.3.1 Sources of health outcome data

Health outcome	Year	Source
Total mortality	1981-1986	Statistics Canada, *Vital statistics*
	1991	Statistics Canada, *Deaths*
	1996	Statistics Canada, *Nation Series*
Life expectancy at birth	1981	Statistics Canada, *Life tables*
	1986-1996	Statistics Canada, *Vital Statistics Compendium, 1996*
Mortality from external causes, injury & poisoning	1981-1991	Statistics Canada, *Causes of Death*
	1996	Statistics Canada, *Health Statistics at a Glance*
Homicide	1981-1996	As for Mortality from external causes, injury & poisoning
Suicide	1981-1996	As for Mortality from external causes, injury & poisoning
Self-rated health	1981	Not available
	1986-1991	Health & Welfare Canada, *Health Promotion Survey, 1996*
	1996	ACPH, *Statistical Report on the Health of Canadians* *National Population Health Survey*
Infant mortality	1981	Statistics Canada, *Vital Statistics*
	1986-1996	Statistics Canada, *Vital Statistics Compendium, 1996*
Low birth weight	1981-1996	As for Infant mortality

Selecting data for self-rated health was problematic. The lack of consistency between national surveys reporting this health variable for the same time points was the major issue. Not only did the absolute results vary between what are presumably comparable surveys, but also the relative ranking of the provinces at given times. Appendix F, *Data problems arising from national surveys*, describes the problem in detail including factors

examined to explain the discrepancies between surveys and the process used to select data for analyses. This appendix includes a section on the covariate "smoking" for which the same problems exist.

3.8.4 Covariates

As mentioned earlier, Appendix E has detailed references for the covariate data. A summary of the data sources is presented in Table 3.8.4.1.

Table 3.8.4.1 Sources of covariate data

Covariate	Year	Source
Median income	1981-1996	Statistics Canada, *Income Trends in Canada: 1980-1997*
Low income cut-offs (LICOs)	1981-1996	As for Median income
Smoking	1981	Millar, W.J. *Smoking Behaviours of Canadians, 1981*
	1986-1991	Health & Welfare Canada, *Health Promotion Survey*
	1996	Statistics Canada, *National Population Health Survey, 1996-1997*

3.9 Statistical Analyses

The statistical analyses aimed to identify for income inequality and health:

a) major trends in Canada over time (1981-1996)
b) major trends in each province over time (1981-1996)
c) major differences between the provinces at each time point (1981, 1986, 1991, 1996)

The analyses, which are summarized in Table 3.9.1, were conducted in four steps that are described below (Sections 3.9.1 to 3.9.4). In the first two sections, income inequality and

health are examined separately. The latter sections involve the exploration of income inequality and health together.

Table 3.9.1 Summary of analyses

Focus of analysis	Analysis	Objective	Methods section	Results section
Income inequality	Descriptive	(1)	3.9.1	4.1
Health outcomes	Descriptive	(2)	3.9.2	4.2
Longitudinal: Relationship between income inequality and health	Comparison of relative changes in each 5-year period: $(T_2 - T_1)/T_1 * 100$	(3)	3.9.3	4.3
Cross-sectional: Relationship between income inequality and health	Regression Restricted model: $Y'_{Health} = a + b_1(\text{income inequality})$ Full model: $Y'_{Health} = a + b_1(\text{income inequality}) + b_2(\text{covariate})$ Rate ratio (RR): $Y'_{Health}(\text{max. Gini})/Y'_{Health}(\text{min. Gini})$	(3)	3.9.4	4.4

3.9.1 Analysis of income inequality

Income inequality was analyzed using descriptive statistics and graphs. Pearson correlation coefficients were used to assess the strength and direction of associations between the three income inequality measures. The examination of income inequality was repeated using market income and income after tax.

3.9.2 Analysis of health outcomes

The seven health outcomes were analyzed using descriptive statistics and graphs.

3.9.3 Longitudinal analysis: relative changes in income inequality and in health

This longitudinal analysis compared the relative changes in income inequality, for each 5-year period, with the relative changes in each health outcome. These comparisons were used to identify possible relationships (i.e. coincidental trends) between income inequality and health over time in Canada and the provinces. The expectation was that relative increases and decreases in income inequality would coincide with relative decreases and increases in population health respectively. The measurement of income inequality in this and all future analyses was restricted to the Gini coefficient.

A "time-lag" analysis was attempted that compared changes in income inequality for one 5-year period with changes in health for the following 5-year period. As the analysis proved difficult to follow, and the results were void of identifiable trends, this analysis was abandoned and is not presented in the results

3.9.4 Cross-sectional analysis: regression of health on income inequality for the provinces, 1981, 1986, 1991 and 1996

The cross-sectional analysis began with a review of scatterplots for each health outcome by income inequality (Gini coefficient) for market income and income after tax, in order to identify linear relationships between the independent and dependent variables. Subsequently, the regression analysis was limited to the Gini coefficient (market income) and total mortality for 1991 and 1996. The expectation was that provinces with higher levels of income inequality would have lower levels of population health. Both restricted

and full models are presented, the full models having controlled for the covariates. Each covariate was introduced separately into the multiple regression equation because of the small number of cases, and to avoid multicollinearity between median income and LICOs, which are highly correlated.

Weighted least-squares (WLS) regression was performed using provincial populations as weights. Kleinbaum et al. state that this method of analysis is appropriate "when a regression model is to be fit to a set of data for which the assumptions of variance homogeneity and/or independence do not hold" (1998:250). The variances of the dependent variable (in this case total mortality) would naturally be smaller for the more populous provinces. The WLS regression accounts for the influence of the different sized populations of the ten provinces.

Rate ratios (RR) were calculated to compare the health (total mortality) of those more exposed to that of those less exposed to income inequality[12]. Morgenstern (1982, 1995) presented a method for calculating RRs using ecological level data that was based on extreme values for the exposure. In this case, the population would be exposed when X (Gini coefficient) = 1, indicating absolute income inequality, and not exposed when X = 0, where the income is evenly distributed.

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[12] Morgenstern used the terms *risk ratio* and *relative risk* interchangeably in his 1982 paper, and substitutes the term *rate ratio* in his updated 1995 paper. The most recent terminology is used here.

From: $Y' = a + b_1(X)$, Exposed: $Y' = a + b_1(1)$
Not exposed: $Y' = a + b_1(0)$
Therefore: $RR = (a + b_1)/a$
$= 1 + b_1/a$

Morgenstern acknowledged that these extreme exposure values usually lie well outside the range of data (1995:69). Not surprisingly, results based on this method produced RRs that were either unrealistic or impossible to interpret: unrealistic because populations do not have Gini coefficients of 0 and 1, and impossible to interpret as some negative RRs resulted. To address these shortcomings, RRs were calculated on more realistic estimations of exposure. The highest and lowest Gini coefficients obtained at a provincial level throughout the study were selected for this purpose (Table 3.9.4.1).

Table 3.9.4.1 Maximum and minimum provincial Gini coefficients, by income concept, 1981 to 1996

	Maximum (exposed)	Minimum (not exposed)
Market income	0.492 (Nfld. 1991)	0.346 (Ont. 1981)
Income after tax	0.323 (Sask. 1981)	0.269 (PEI 1986)

The RR then becomes the risk of mortality when exposed to the "maximum" level of income inequality compared to the risk with exposure to the "minimum" level of income inequality, where "maximum" and "minimum" are based on actual data and are therefore relative to time and place.

Restricted model: $$RR = \frac{Y'_{Exposed} = a + b_1(0.492)}{Y'_{Not\ exposed} = a + b_1(0.346)}$$

To calculate the rate ratios for the full models, the mean provincial values for each covariate were used in the equations. For example, each province had a percentage of the population who were daily smokers for each time point in the study. The weighted means of these percentages for each year were used to calculate the relevant RRs.

Full model:

$$RR = \frac{Y'_{Exposed} = a + b_1(0.492) + b_2(mean:cov)}{Y'_{Not\ exposed} = a + b_1(0.346) + b_2(mean:cov)}$$

Finally, adjusted R^2 values are presented. They express the percentage of variation in total mortality that can be explained by the independent variables. The difference between adjusted R^2 for the restricted and full models indicates the additional amount of variation in total mortality that could be accounted for by models containing the covariates. Adjusted R^2, rather than R^2, values are used as R^2 over estimates the fit of the model to the population (Norušis, 1990:251). That is, the model fits the data on which it is based better than the population. The adjustment to R^2 is:

$$R_a^2 = R^2 - \frac{p(1 - R^2)}{N - p - 1}$$

where p is the number of independent variables in the equation and N is the number of observations (Norušis, 1990:252).

CHAPTER 4 RESULTS

This chapter follows the sequence set out in Table 3.9.1.

4.1 Income Inequality

4.1.1 Market Income

The presentation of market income inequality is restricted to the Gini coefficient and the Robin Hood index. Decile ratios are excluded from this section as they proved to be uninterpretable when calculated using the negative incomes that exist in some lower income groups. These incomes commonly result from negative investment or self-employment incomes. Normally the value of the decile ratio increases as income inequality increases. However, negative incomes in the lowest decile result in large negative decile ratios that become smaller as income inequality increases, from infinity to gradually approaching zero. For further discussion on this issue, please see Appendix G.

a) Income inequality trend in Canada, 1981-1996

Market income inequality rose substantially in Canada between 1981 and 1996 when measured using the Gini coefficient and the Robin Hood index (Table 4.1.1.1; Figures 4.1.1.1 and 4.1.1.2). The greatest increase took place between 1981 and 1986, when the Gini coefficient rose from 0.371 to 0.402 and the RHI increased from 25.8% to 28.1%.

Table 4.1.1.1 Change in income inequality (market income), Canada, 1981-1996

	Year			
Measure	1981	1996	Absolute change	Relative change (%)
Gini coefficient	0.371	0.431	0.060	16.2
Robin Hood index (%)	25.8	30.4	4.6	17.8

b) Income inequality trends in the provinces, 1981-1996

Market income inequality was higher in 1996 than in 1981 for every province, when measured using either the Gini coefficient or the Robin Hood index (also in Figures 4.1.1.1 and 4.1.1.2). Provinces with the lowest levels of income inequality in 1981 showed the greatest relative increases over the study period. Ontario, Quebec and Alberta had relative increases in income inequality that were greater than those found in Canada as a whole. The magnitude of the increases was slightly higher when using the Robin Hood index than when using the Gini coefficient (Table 4.1.1.2).

Table 4.1.1.2 Provinces with the greatest overall increases in income inequality (market income), 1981-1996; Gini coefficient and Robin Hood index

	Year			
Province	1981	1996	Absolute change	Relative change (%)
Gini coefficient				
Ontario	0.346	0.419	0.073	21.1
Quebec	0.381	0.447	0.066	17.3
Alberta	0.347	0.407	0.060	17.3
Robin Hood index (%)				
Ontario	23.9	29.2	5.3	22.2
Quebec	26.5	31.7	5.2	19.6
Alberta	24.0	28.4	4.4	18.3

The remaining provinces had relative increases in income inequality, between 1981 and 1996, that were smaller than Canada as a whole. The smallest increases were found in provinces that had some of the highest levels of income inequality in 1981 (Table 4.1.1.3). Again, the RHI consistently showed larger relative increases than the Gini coefficient.

Table 4.1.1.3 Provinces with the smallest overall increases in income inequality (market income), 1981-1996; Gini coefficient and Robin Hood index

	Year			
Province	1981	1996	Absolute change	Relative change (%)
Gini coefficient				
PEI	0.416	0.423	0.007	1.7
NB	0.438	0.459	0.021	4.8
Sask	0.409	0.429	0.020	4.9
Robin Hood index (%)				
PEI	29.4	30.3	0.9	3.1
NB	31.0	32.8	1.8	5.8
Sask	28.6	30.7	2.1	7.3

While there were overall increases in income inequality in all provinces, the nature of the increases varied. For example, in Quebec, Ontario, Manitoba and Alberta the increases were monotonic while those in Nova Scotia, Saskatchewan and British Columbia coincided with the recessionary periods of the early 1980s and early 1990s, with decreases in between. These trends were evident for both the Gini coefficient and the RHI.

c) Income Inequality differences between the provinces, 1981, 1986, 1991 and 1996

A regional gradient appeared whereby Ontario, Alberta and British Columbia tended to have the lowest levels of market income inequality while the eastern provinces experienced the highest levels, particularly Newfoundland for the latter decade of the study period (Table 4.1.1.4). The range between provinces initially increased, peaking in 1986 (RHI) or 1991 (Gini coefficient), before narrowing again.

Table 4.1.1.4 Range in income inequality (market income), by year and province, Gini coefficient and Robin Hood index

	Lowest		Highest		
Year	Province	Inequality Measure	Province	Inequality Measure	|Difference|
Gini coefficient					
1981	Ontario	0.346	NB	0.438	0.092
1986	Ontario	0.375	Nfld	0.479	0.104
1991	BC	0.383	Nfld	0.492	0.109
1996	BC	0.406	Nfld	0.482	0.076
Robin Hood index (%)					
1981	Ontario	23.9	NB	31.0	7.1
1986	Ontario	25.8	Nfld	35.4	9.6
1991	BC	26.9	Nfld	35.7	8.8
1996	Alberta	28.4	Nfld	35.3	6.9

4.1.2 Income After Tax

a) Income inequality trend in Canada, 1981-1996

There was a slight overall increase in after-tax income inequality in Canada between 1981 and 1996 according to all three measures of income inequality (Table 4.1.2.1, Figures 4.1.2.1, 4.1.2.2 and 4.1.2.3).

Table 4.1.2.1 Change in income inequality (income after tax), Canada, 1981-1996

	Year			
Measure	1981	1996	Absolute change	Relative change (%)
Gini coefficient	0.290	0.305	0.015	5.2
Robin Hood index (%)	20.3	21.5	1.2	5.9
Decile ratio	8.1	8.4	0.3	3.7

The Gini coefficient and Robin Hood index rose during the recessions of the early 1980s and early 1990s, and decreased in the interim period. The decile ratio remained stable during the early 1980s, decreased between recessions and increased from 1991 to 1996.

b) Income inequality trends in the provinces, 1981-1996

The slight overall increase in after-tax income inequality seen in Canada over the study period belied the variability that was evident in the provinces (also in Figures 4.1.2.1, 4.1.2.2 and 4.1.2.3, Tables 4.1.2.2 and 4.1.2.3). Between four and six of the provinces had higher levels of income inequality in 1996 than in 1981, depending on the income inequality measure used, while 1996 levels were equal to or lower than in 1981 for the remaining provinces.

Table 4.1.2.2 Provinces with the greatest overall increases in income inequality (income after tax), 1981-1996; Gini coefficient, Robin Hood index and decile ratio

	Province	Year 1981	1996	Absolute change	Relative change (%)
Gini coefficient					
	Ontario	0.278	0.302	0.024	8.6
	Alberta	0.287	0.305	0.018	6.3
	NS	0.284	0.296	0.012	4.2
Robin Hood index (%)					
	Ontario	19.4	21.2	1.8	9.3
	Alberta	19.9	21.3	1.4	7.0
	NS	19.9	21.2	1.3	6.5
Decile Ratio					
	BC	8.2	9.4	1.2	14.6
	NS	7.5	8.1	0.6	8.0
	Ontario	7.5	8.1	0.6	8.0

The Gini coefficient and RHI were consistent with each other in the trends they produced for after-tax income inequality. The magnitude of the greatest overall increases was slightly higher when using the RHI than when using the Gini coefficient (Table 4.1.2.2). In contrast, the size of the greatest overall decreases was lower with the RHI than with

Gini coefficient (Table 4.1.2.3). The decile ratio differed substantially from the other two measures in both the ranking of provinces and the magnitude of relative change.

Table 4.1.2.3 Provinces with the greatest overall decreases in income inequality (income after tax), 1981-1996; Gini coefficient, Robin Hood index and decile ratio

	Province	Year 1981	1996	Absolute change	Relative change (%)
Gini coefficient					
	Sask	0.323	0.294	-0.029	-9.0
	PEI	0.286	0.273	-0.013	-4.5
	NB	0.307	0.297	-0.010	-3.3
Robin Hood index (%)					
	Sask	22.7	20.7	-2.0	-8.8
	PEI	20.0	19.4	-0.6	-3.0
	NB	21.5	21.0	-0.5	-2.3
Decile ratio					
	Manitoba	10.4	7.7	-2.7	-26.0
	Sask	10.7	8.4	-2.3	-21.5
	NB	8.6	7.7	-0.9	-10.5

c) Income Inequality differences between the provinces, 1981, 1986, 1991 and 1996

The lowest levels of after-tax income inequality were found most often in PEI, while some of the highest levels were found in Saskatchewan in the 1980s and Alberta in the 1990s (Table 4.1.2.4). The interprovincial range increased from 1981 to 1986 for each measure of income inequality, and decreased thereafter.

Table 4.1.2.4 Range in income inequality (income after tax), by year and province, Gini coefficient, Robin Hood index and decile ratio

	Lowest		Highest		
Year	Province	Inequality Measure	Province	Inequality Measure	|Difference|
Gini coefficient					
1981	Ontario	0.278	Sask	0.323	0.045
1986	PEI	0.269	Sask	0.322	0.053
1991	PEI	0.275	Alberta	0.306	0.031
1996	PEI	0.273	Alberta	0.305	0.032
Robin Hood index (%)					
1981	Ontario	19.4	Sask	22.7	3.3
1986	PEI	18.9	Sask	23.0	4.1
1991	PEI	19.2	Alberta	21.5	2.3
1996	PEI	19.4	Alberta	21.3	1.9
Decile ratio					
1981	PEI	6.7	Sask	10.7	4.0
1986	PEI	5.7	Sask	11.6	5.9
1991	PEI	6.3	Alberta	8.3	2.0
1996	PEI	6.2	BC	9.4	3.2

4.1.3 Conclusion

The Gini coefficient and RHI generated nearly identical trends and patterns of income inequality, but the decile ratio was not consistent with the other two measures. The differences in strength of association between measures are illustrated using the Pearson correlation coefficient (Table 4.1.3.1)

Table 4.1.3.1 Strength of association (Pearson r) between measures of income inequality for the provinces, by year and income concept

	Market income	Income after tax		
Year	Gini x RHI	Gini x RHI	Gini x DR	RHI x DR
1981	1.00	1.00	0.81	0.79
1986	0.99	0.99	0.93	0.92
1991	1.00	0.96	0.86	0.76
1996	0.99	0.96	0.71	0.62

All future analyses involving income inequality will be limited to the Gini coefficient. The decile ratio does not perform as adequately as the two measures that incorporate the whole income distribution. To conduct analyses using both the Gini coefficient and RHI would be redundant. The Gini coefficient has been selected because it is more highly regarded in the literature, being directly based on the gold standard Lorenz curve.

Figure 4.1.1.1 Income inequality (Gini coefficient) based on market income, Canada and provinces, 1981-1996

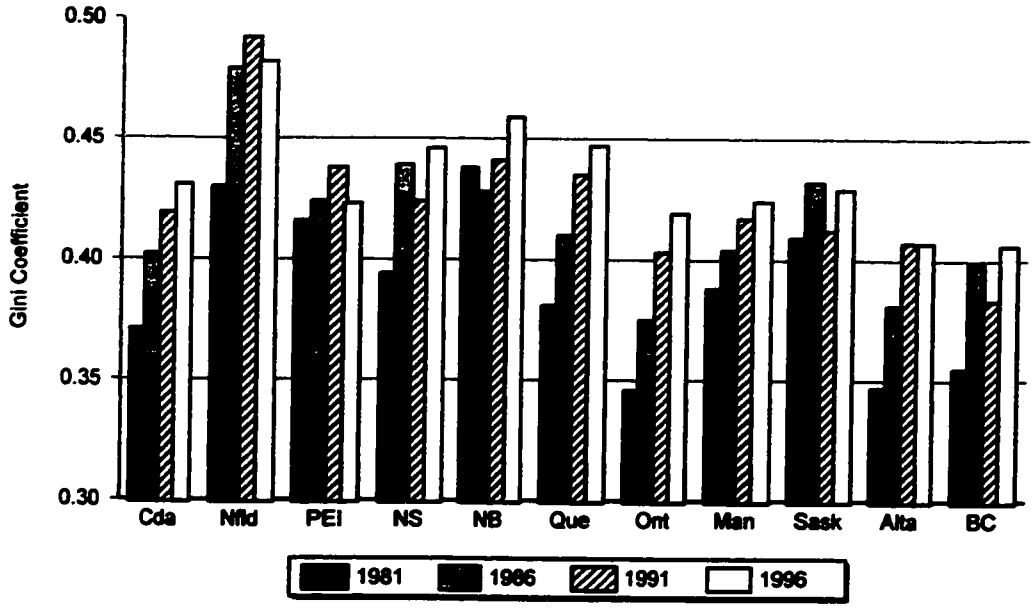


Figure 4.1.1.2 Income inequality (Robin Hood index) based on market income, Canada and provinces, 1981-1996

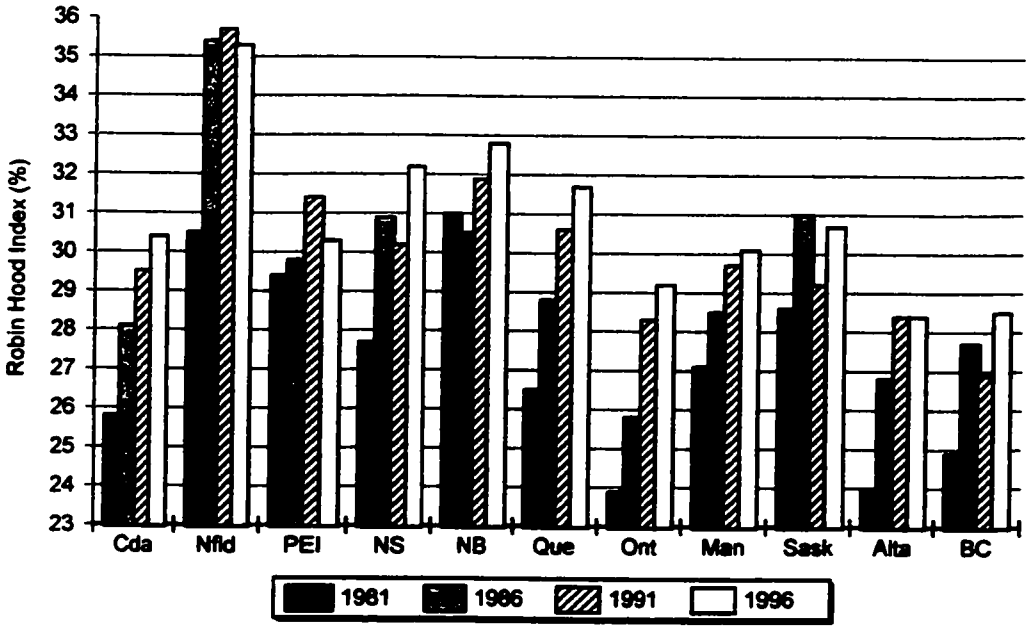


Figure 4.1.2.1 Income inequality (Gini coefficient) based on income after tax, Canada and provinces, 1981-1996

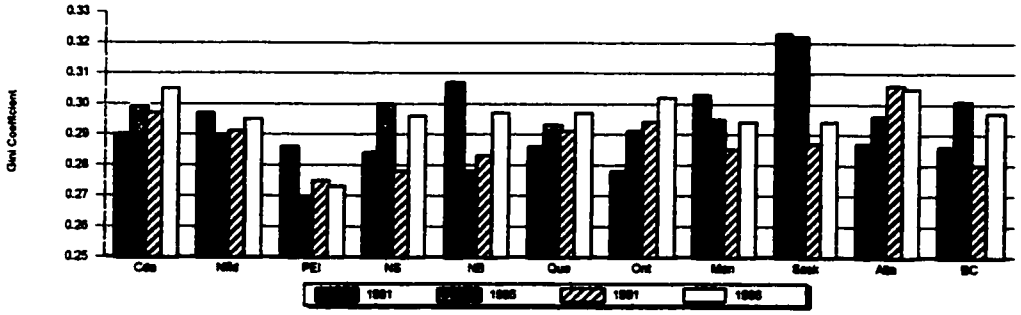


Figure 4.1.2.2 Income inequality (Robin Hood index) based on income after tax, Canada and provinces, 1981-1996

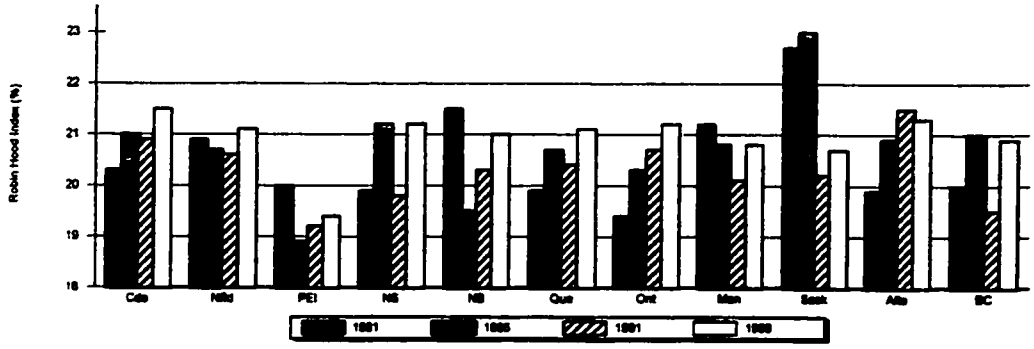
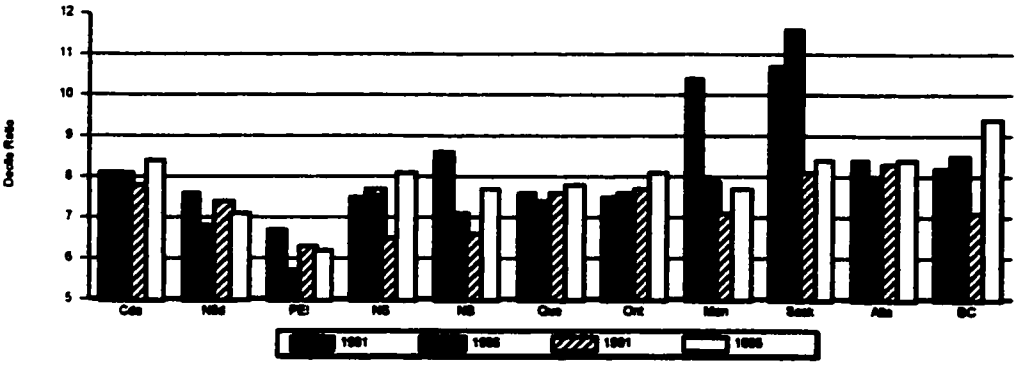


Figure 4.1.2.3 Income inequality (decile ratio) based on income after tax, Canada and provinces, 1981-1996



4.2 Health Outcomes

4.2.1 Total Mortality

a) Total mortality trend in Canada, 1981-1996

The age-standardized total mortality rate in Canada declined steadily between 1981 and 1996 from 8.2 to 6.9 deaths per 1,000 population, a decrease of 16% (Figure 4.2.1.1).

b) Total mortality trends in the provinces, 1981-1996

With the exception of Prince Edward Island, every province had lower levels of total mortality in 1996 than in 1981 (see also Figure 4.2.1.1). Provinces with the greatest relative decreases in total mortality rates were those with the highest rates in 1981 (Table 4.2.1.1).

Table 4.2.1.1 Provinces with the greatest and smallest overall decreases in total mortality rates (deaths/100,000 population) 1981-1996

	Province	Year 1981	Year 1996	Absolute change	Relative change (%)
Greatest decreases					
	Quebec	852	709	-143	-16.8
	NS	876	730	-146	-16.7
	Ontario	823	686	-137	-16.6
	Alberta	805	671	-134	-16.6
Smallest decreases					
	PEI	752	777	25	3.3
	Nfld	811	738	-73	-9.0
	Sask	739	668	-71	-9.6

c) Total mortality differences between the provinces, 1981, 1986, 1991 and 1996

An east-west gradient existed throughout the study period, with higher total mortality rates in the eastern provinces than the west. The range in total mortality between

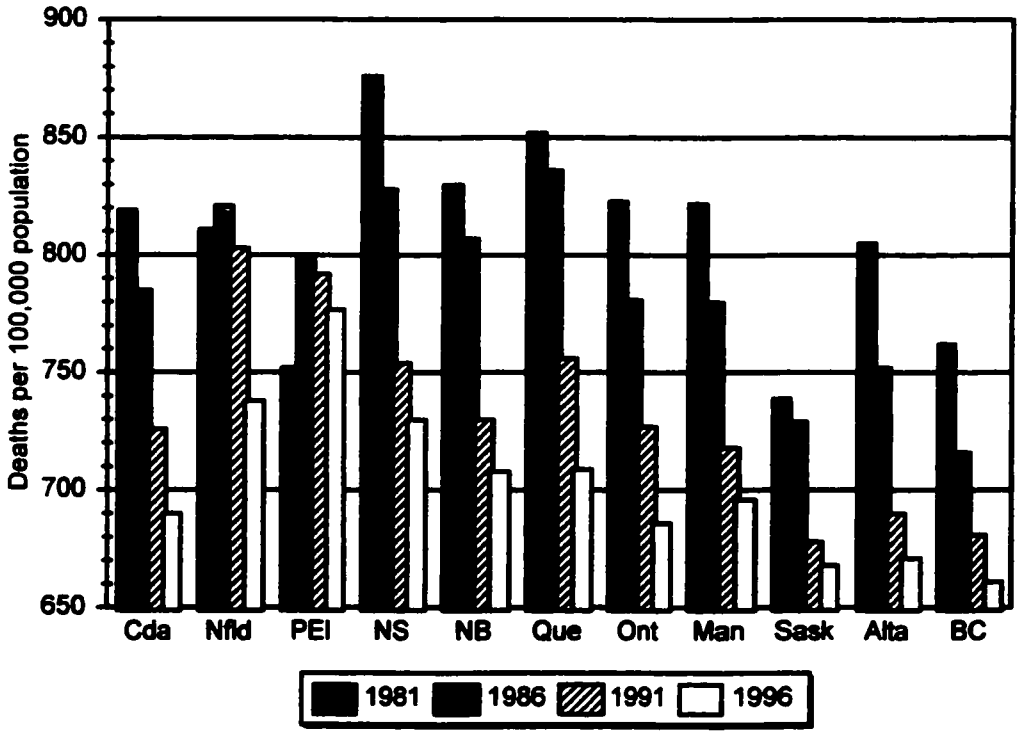
provinces decreased in the early 1980s and early 1990s and increased in between (Table 4.2.1.2).

Table 4.2.1.2 Range in total mortality (deaths/100,000 population), by year and province

	Lowest		Highest		
Year	Province	Deaths	Province	Deaths	Difference
1981	Sask	739	NS	876	137
1986	BC	716	Quebec	836	120
1991	Sask	678	Nfld	803	125
1996	BC	661	PEI	777	116

Figure 4.2.1.1 Total mortality rates, Canada and provinces, 1981-1996

Age standardized to the 1991 Canadian population



4.2.2 Life Expectancy at Birth

a) Life Expectancy trend in Canada, 1981-1996

Life expectancy at birth rose steadily in Canada between 1981 and 1996 (Figure 4.2.2.1). For children born in 1981, average life expectancy was approximately 75 years compared to almost 79 years for children born in 1996, an increase of over 4%.

b) Life Expectancy trends in the provinces, 1981-1996

Every province had a higher average life expectancy at birth in 1996 than in 1981 (also in Figure 4.2.2.1). Provinces with the smallest increases began with some of the highest life expectancies (Table 4.2.2.1).

Table 4.2.2.1 Provinces with the greatest and smallest overall increases in average life expectancy at birth, 1981-1996

		Year			
	Province	1981	1996	Absolute change	Relative change (%)
Greatest increases					
	Quebec	74.9	78.4	3.5	4.6
	NS	74.7	77.8	3.1	4.2
	Alberta	75.5	78.7	3.1	4.2
Smallest increases					
	PEI	76.7	77.3	0.6	0.8
	Sask	76.0	78.5	2.5	3.2
	Nfld	75.3	77.8	2.4	3.3

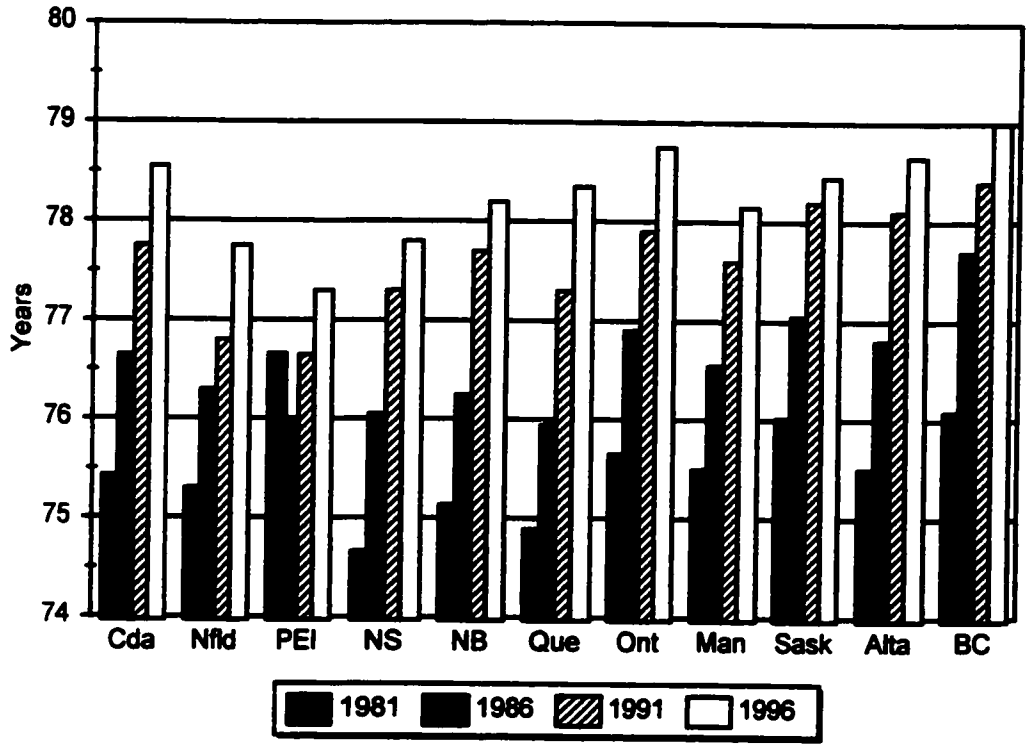
c) Life expectancy differences between the provinces, 1981, 1986, 1991 and 1996

An east-west gradient existed throughout the study period, with higher average life expectancy at birth in the western provinces. The range between provinces decreased in the early 1980s and then remained constant (Table 4.2.2.2).

Table 4.2.2.2 Range in average life expectancy at birth, by year and province

	Shortest		Longest		
Year	Province	Years	Province	Years	|Difference|
1981	NS	74.7	PEI	76.7	2.0
1986	Que & PEI	76.0	BC	77.7	1.7
1991	PEI	76.7	BC	78.4	1.7
1996	PEI	77.3	BC	79.0	1.7

Figure 4.2.2.1 Average life expectancy at birth, Canada and provinces, 1981-1996 [13]



[13] Life expectancy data were readily available for males and females separately, but not always for both sexes together. Consequently, average life expectancy was used as an estimate for males and females together. The inaccuracy of this approach is acknowledged, given the male and female populations are not quite equal. However, it is considered to be an acceptable estimation.

4.2.3 External Cause Mortality

a) External cause mortality trend in Canada, 1981-1996

External cause mortality (ASMRs) decreased in Canada over the study period from 65 deaths per 100,000 in 1981 to 46 deaths per 100,000 in 1996, a relative decline of 29%. The corresponding SMRs were 137% in 1981 compared to 95% in 1996 (Figure 4.2.3.1).

b) External cause mortality trends in the provinces, 1981-1996

With the exception of PEI, every province had a lower SMR in 1996 than in 1981, indicating a consistent trend to lower external cause mortality across Canada (also in Figure 4.2.3.1, Table 4.2.3.1)[14]. Two of the provinces with the greatest decreases (British Columbia and Saskatchewan) had the highest SMRs in 1981.

Table 4.2.3.1 Provinces with the greatest and smallest overall decreases in external cause mortality (SMR) 1981-1996

		SMR (%)			
	Province	1981	1996	Absolute change	Relative change (%)
Greatest decreases					
	BC	174	89	-85.0	-48.9
	Nfld	128	78	-50.0	-39.1
	Sask	160	103	-57.0	-35.6
Smallest decreases					
	PEI	78	96	18.0	23.1
	NS	123	100	-23.0	-18.7
	Quebec	138	106	-32.0	-23.2

[14] Provincial level external cause mortality is presented using SMRs and comparable only to the 1991 Canadian Standard (100%).

c) External cause mortality differences between the provinces, 1981, 1986, 1991 and 1996

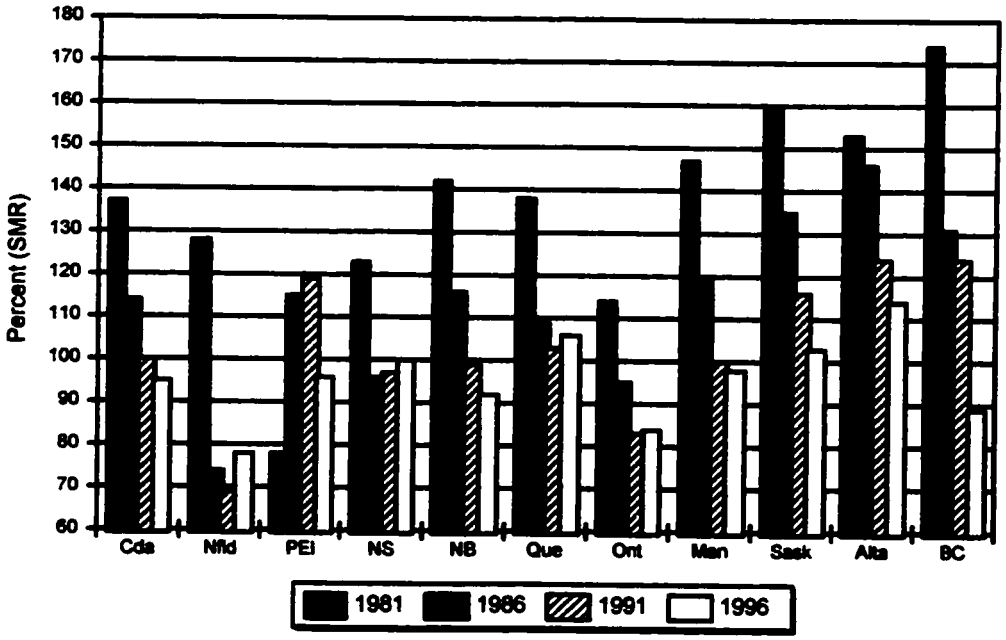
There was an east-west gradient of SMRs throughout most of the study period, interrupted only by the consistently lower SMRs in Ontario. The range in SMRs decreased monotonically from 1981 to 1996 (Table 4.2.3.2).

Table 4.2.3.2 Range in external cause mortality SMRs, by year and province

	Lowest		Highest		
Year	Province	SMR (%)	Province	SMR (%)	Difference
1981	PEI	78	BC	174	96
1986	Nfld	74	Alta	146	72
1991	Nfld	69	Alta & BC	124	55
1996	Nfld	78	Alta	114	36

Figure 4.2.3.1 External cause mortality SMRs, Canada and provinces, 1981-1996

1991 Canadian rates as standard



4.2.4 Homicide

a) Homicide trend in Canada, 1981-1996

There was an overall decline in homicide rates (ASMRs) in Canada from 1981 to 1996 as it fluctuated between 2.3 and 1.8 deaths per 100,000 population. The corresponding SMRs ranged between a high of 101% (1981) and a low of 79% (1991) (Figure 4.2.4.1). The SMRs decreased during the recessions in the early 1980s and early 1990s, and increased in the interim period.

b) Homicide trends in the provinces, 1981-1996

Homicide SMRs fluctuated a great deal within the provinces across time (also in Figure 4.2.4.1), but many are based on small numbers of expected events (e.g. 17 deaths in New Brunswick, 12 deaths in Newfoundland, and 3 in PEI in 1996). Three provinces showed net increases in SMRs while the others exhibited decreases (Table 4.2.4.1)

Table 4.2.4.1 Provinces with overall increases and the greatest overall decreases in homicide (SMR) 1981-1996

		SMR (%)			
	Province	1981	1996	Absolute change	Relative change (%)
Increases					
	Nfld	8	48	40.0	500.0
	NS	32	74	42.0	131.3
	Manitoba	154	176	22.0	14.3
Greatest decreases					
	NB	117	42	-75.0	-64.1
	BC	171	71	-100.0	-58.5
	Alberta	130	89	-41.0	-31.5

c) Homicide differences between the provinces, 1981, 1986, 1991 and 1996

A strong regional dichotomy was present in homicide mortality between 1981 and 1996.

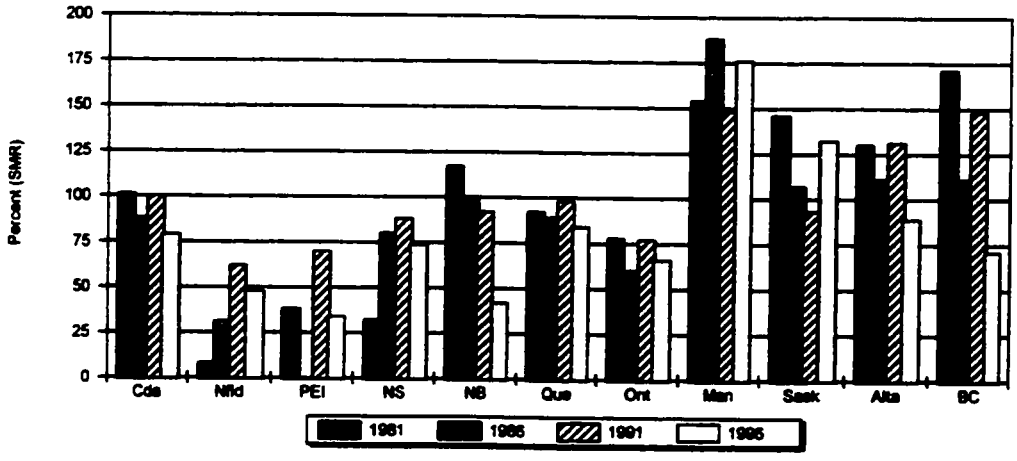
Provinces west of Ontario had much higher SMRs than those found in central and Atlantic Canada (Table 4.2.4.2). With the exception of New Brunswick in 1981, the SMRs for every province east of Manitoba were less than 100% for every time point in the study period, indicating that these provinces had fewer homicides than expected compared to the 1991 Canadian standard. In contrast, provinces west of Ontario generally had greater than expected homicide mortality. Manitoba, in particular, stood out with excesses in homicide mortality of up to 88% in 1986, based on 45 observed deaths compared to the 24 expected.

Table 4.2.4.2 Range in homicide SMRs, by year and province

	Lowest		Highest		
Year	Province	SMR (%)	Province	SMR (%)	|Difference|
1981	Nfld	8	BC	171	163
1986	PEI	0	Manitoba	188	188
1991	Nfld	62	Man & BC	148	86
1996	PEI	34	Manitoba	176	142

Figure 4.2.4.1 Homicide SMRs, Canada and provinces, 1981-1996

1991 Canadian rates as standard



4.2.5 Suicide

a) Suicide trend in Canada, 1981-1996

There was an overall decrease in suicide rates (ASMRs) in Canada over the study period. The decline was not monotonic as rates fluctuated between 13 and 15 deaths per 100,000 population. The corresponding SMRs ranged between 108% (1981) and 100% (1991) (Figure 4.2.5.1). The SMRs increased during the recessions and decreased between 1986 and 1991, a trend that was opposite to that found with homicide.

b) Suicide trends in the provinces, 1981-1996

There were overall increases in SMRs for provinces east of Ontario and overall decreases in Ontario and most western provinces (Table 4.2.5.1).

Table 4.2.5.1 Provinces with the greatest overall increases and decreases in suicide (SMR) 1981-1996

		SMR (%)			
	Province	1981	1996	Absolute change	Relative change (%)
Greatest increases					
	Nfld	36	52	16.0	44.4
	Quebec	126	155	29.0	23.0
	PEI	59	69	10.0	16.9
Greatest decreases					
	BC	111	78	-33.0	-29.7
	Manitoba	111	82	-29.0	-26.1
	Sask	140	110	-30.0	-21.4

c) Suicide differences between the provinces, 1981, 1986, 1991 and 1996

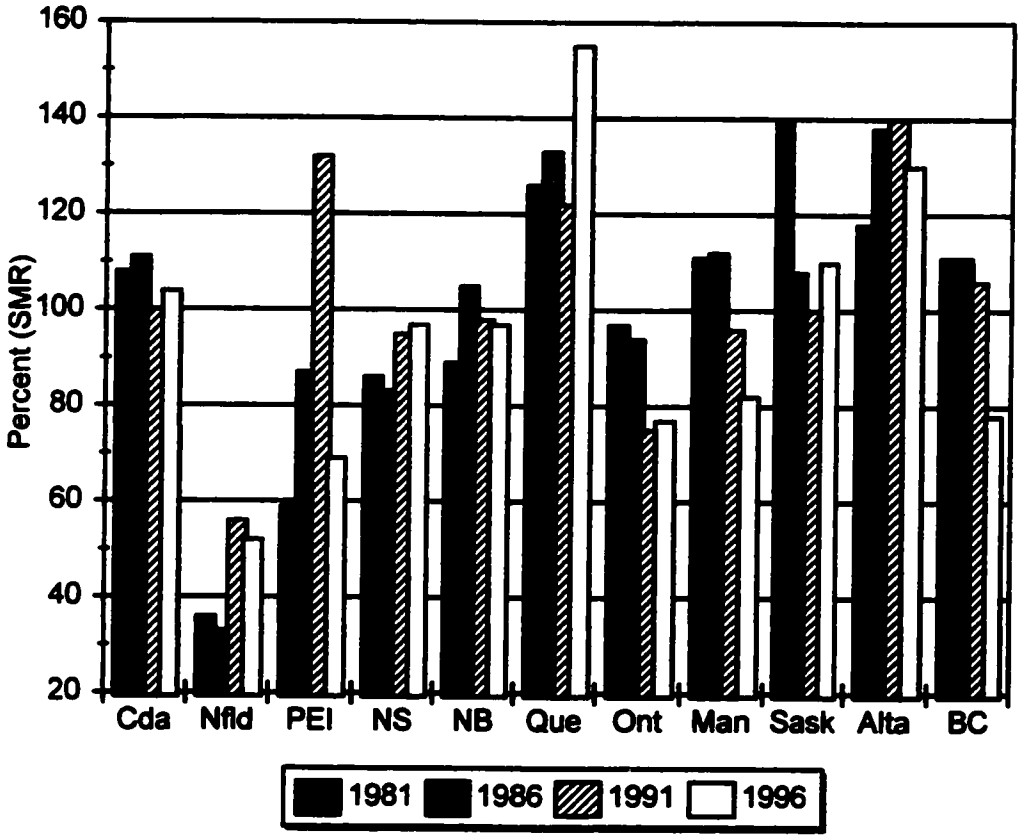
Throughout the study period, Newfoundland consistently had the lowest SMRs while Quebec and Alberta had the highest (Table 4.2.5.2).

Table 4.2.5.2 Range in suicide SMRs, by year and province

	Lowest		Highest		
Year	Province	SMR (%)	Province	SMR (%)	|Difference|
1981	Nfld	36	Sask	140	104
1986	Nfld	33	Alberta	138	105
1991	Nfld	56	Alberta	140	84
1996	Nfld	52	Quebec	155	103

Figure 4.2.5.1 Suicide SMRs, Canada and provinces, 1981-1996

1991 Canadian rates as standard



4.2.6 Self-Rated Health

Trends in self-rated health were based on the Health Promotion Surveys (1985, 1990) and the National Population Health Survey (1996-97). Appendix F addresses data concerns relating to these and other surveys that include self-rated health status data.

a) Self-rated health trend in Canada, 1985-1996

Self-rated health remained stable in Canada from 1985 to 1996 with between 24.7% and 25.6% of the Canadian population rating their health as excellent (Figure 4.2.6.1).

b) Self-rated health trends in the provinces, 1985-1996

The stability in self-rated health, evident in Canada, did not exist in all provinces (also in Figure 4.2.6.1). Only six of the ten provinces had higher levels of self-rated health in 1996 than in 1985 (Table 4.2.6.1). For seven provinces, the percentage of the population rating their health as excellent increased between the recessions and decreased during the recession in the early 1990s.

Table 4.2.6.1 Provinces with the greatest overall increases and decreases in self-rated health (percent of population rating their health as "excellent") 1985-1996

	Province	Year 1985	1996	Absolute change	Relative change (%)
Greatest increases					
	Nfld	20.6	25.8	5.2	25.2
	NS	16.4	18.8	2.4	14.6
	Alberta	22.3	25.5	3.2	14.3
Greatest decreases					
	Quebec	30.1	26.8	-3.3	-11.0
	Sask	18.1	16.9	-1.2	-6.6
	BC	25.1	24.4	-0.7	-2.8

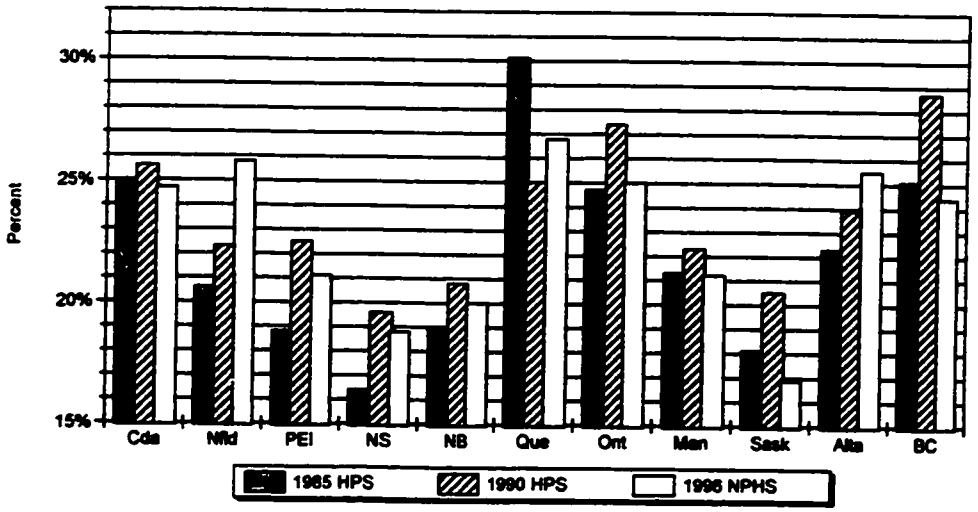
c) Self-rated health differences between the provinces, 1981, 1986, 1991 and 1996

The percentage of the population rating their health as "excellent" was highest in Quebec, Ontario and western Canada from 1985 to 1996 (also in Figure 4.2.6.1). However, the range between provinces narrowed after 1985 (Table 4.2.6.2)

Table 4.2.6.2 Range in self-rated health (percentage of the population who rate their health as "excellent") by year and province

	Lowest		Highest		
Year	Province	Percent	Province	Percent	|Difference|
1985	NS	16.4	Quebec	30.1	13.7
1990	NS	19.6	BC	28.7	9.1
1996	Sask	16.9	Quebec	26.8	9.9

Figure 4.2.6.1 Self-rated health (percentage of the population who rated their health as "excellent"), Canada and provinces, 1986-1996



4.2.7 Infant Mortality

a) Infant mortality trend in Canada, 1981-1996

The infant mortality rate in Canada declined substantially over the fifteen year study period from 9.6 to 5.6 deaths per 1,000 live births, a decrease of 42% (Figure 4.2.7.1).

b) Infant mortality trends in the provinces, 1981-1996

Every province had lower IMRs in 1996 than in 1981 (also in Figure 4.2.7.1). For the majority of provinces the decrease was monotonic with the greatest decreases evident before 1991. PEI, Nova Scotia and New Brunswick showed the greatest overall relative decreases in IMRs (Table 4.2.7.1).

Table 4.2.7.1 Provinces with the greatest and smallest overall decreases in infant mortality rates (deaths/1,000 live births) 1981-1996

	Year			
Province	1981	1996	Absolute change	Relative change (%)
Greatest decreases				
PEI	13.2	4.7	-8.5	-64.4
NB	10.9	4.9	-6.0	-55.0
NS	11.5	5.6	-5.9	-51.3
Smallest decreases				
Sask	11.8	8.4	-3.4	-28.8
Nfld	9.7	6.6	-3.1	-32.0
Ontario	8.8	5.7	-3.1	-35.2

c) Infant mortality differences between the provinces, 1981, 1986, 1991 and 1996

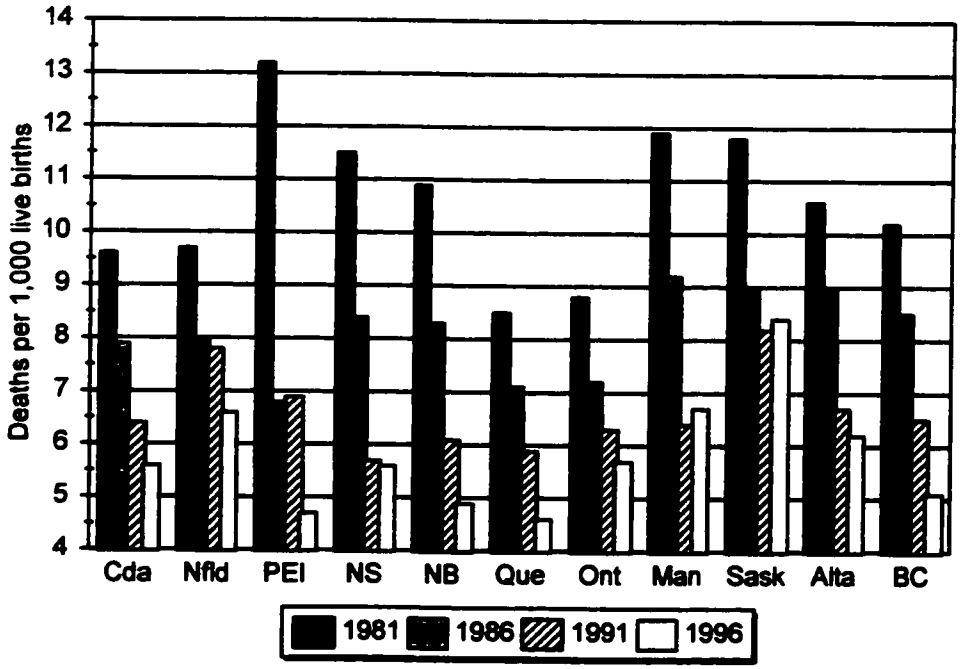
Infant mortality was comparatively lower in central Canada and higher in the eastern and western provinces from 1981 to 1996 (Table 4.2.7.2). Quebec in particular had

consistently low IMRs over the fifteen year period. The range in IMRs was highest at the beginning and end of the study period.

Table 4.2.7.2 Range in infant mortality rates (deaths/1,000 live births), by year and province

	Lowest		Highest		
Year	Province	Deaths	Province	Deaths	Difference
1981	Quebec	8.5	PEI	13.2	4.7
1986	PEI	6.8	Manitoba	9.2	2.4
1991	NS	5.7	Sask	8.2	2.5
1996	Quebec	4.6	Sask	8.4	3.8

Figure 4.2.7.1 Infant mortality rate (deaths per 1,000 live births), Canada and provinces, 1981-1996



4.3 Longitudinal Analyses

In the following section, the relationships reported are those between income inequality and **health** regardless of the direction of scale of individual health outcomes. For example, increases in income inequality that are associated with decreases in infant mortality or increases in life expectancy are both referred to as *positive* associations because both cases represent increases in levels of population health. Decreases in income inequality associated with the same health outcomes represent *inverse* or *negative* associations.

4.3.1 Relative changes in income inequality and in health for Canada, 1981-1996

A number of corresponding trends were identified between income inequality and health in Canada. The results in Table 4.3.1.1 are followed by a brief description.

Table 4.3.1.1 Relative changes (percent) in income inequality and health outcomes for each 5-year time period, Canada

	1981-1986	1986-1991	1991-1996
Income inequality			
Market income (Gini coefficient)	8.4	4.2	2.9
Income after tax (Gini coefficient)	3.1	-0.7	2.7
Health outcomes			
Total mortality	-4.2	-7.5	-5.0
Life expectancy	1.6	1.4	1.0
External cause mortality	-16.8	-12.3	-5.0
Homicide	-12.9	13.6	-21.0
Suicide	2.8	-9.9	4.0
Self-rated health	-	2.4	-3.5
Infant mortality	-17.7	-19.0	-12.5

a) Market income

Market income inequality showed successively diminishing relative increases at each time period (Table 4.3.1.1). Only two health outcomes bore a resemblance to this pattern, life expectancy and external cause mortality (also in Table 4.3.1.1). In a mirror image of market income inequality, life expectancy and external cause mortality improved from 1981 to 1996, albeit to a relatively lesser extent at each time period. Consequently, the greatest improvements in two health outcomes corresponded to periods with the greatest increase in market income inequality, contrary to expectations.

b) Income after tax

The overall increase in after-tax income inequality was not monotonic; it rose during the recessions and decreased during the time of relative stability from 1986 to 1991 (also in Table 4.3.1.1). Suicide rates rose and fell with after-tax income inequality, producing the expected negative relationship between income inequality and health. Homicide, in contrast, fell with the recessions and rose in between to produce a positive relationship between income inequality and health. Self-rated health also had the expected negative relationship with after-tax income inequality, rising from 1986 to 1991 and falling with the recession in the early 1990s. While total mortality and infant mortality decreased throughout the study period, their greatest relative decreases were from 1986 to 1991 when after-tax income inequality was declining.

c) Summary

At a national level both positive and negative relationships existed between the relative changes in income inequality and in health outcomes (Table 4.3.1.2).

Table 4.3.1.2 Relationships between changes in income inequality and in health, by income concept, Canada, 1981-1996

Income concept	Relationship with health status	Health outcome
Market income	positive	life expectancy external cause mortality
Income after tax	positive	homicide
	negative	suicide self-rated health
	both	total mortality infant mortality

4.3.2 Relative changes in income inequality and in health for the provinces, 1981-1996

At a provincial level, there are very few corresponding trends between relative changes in income inequality and in health (Table 4.3.2.1). The results are followed by a brief description of trends.

Table 4.3.2.1 Relative changes (percent) in income inequality and health outcomes for each 5-year time period, provinces

	1981-1986	1986-1991	1991-1996
Newfoundland			
Income inequality			
Gini coefficient (market income)	11.4	2.7	-2.0
Gini coefficient (income after tax)	-2.7	0.7	1.4
Health outcomes			
Total mortality	1.2	-2.2	-8.1
Life expectancy	1.3	0.7	1.2
External cause mortality	-42.2	-6.8	13.0
Homicide	287.5	100.0	-22.6
Suicide	-8.3	69.7	-7.1
Self-rated health	-	8.3	15.7
Infant mortality	-17.5	-2.5	-15.4
Prince Edward Island			
Income inequality			
Gini coefficient (market income)	1.9	3.3	-3.4
Gini coefficient (income after tax)	-5.9	2.2	-0.7
Health outcomes			
Total mortality	6.4	-1.0	-1.9
Life expectancy	-0.9	0.9	0.8
External cause mortality	47.4	3.5	-19.3
Homicide	-100.0	*	-51.4
Suicide	47.5	51.7	-47.7
Self-rated health	-	19.7	-6.2
Infant mortality	-48.5	1.5	-31.9
Nova Scotia			
Income inequality			
Gini coefficient (market income)	11.4	-3.4	5.2
Gini coefficient (income after tax)	5.6	-7.3	6.5
Health outcomes			
Total mortality	-5.5	-8.9	-3.2
Life expectancy	1.9	1.6	0.6
External cause mortality	-22.0	1.0	3.1
Homicide	150.0	10.0	-15.9
Suicide	-3.5	14.5	2.1
Self-rated health	-	19.5	-4.1
Infant mortality	-27.0	-32.1	-1.8

New Brunswick			
Income inequality			
Gini coefficient (market income)	-2.3	3.0	4.1
Gini coefficient (income after tax)	-9.4	1.8	4.9
Health outcomes			
Total mortality	-2.8	-9.5	-3.0
Life expectancy	1.5	1.9	0.6
External cause mortality	-18.3	-14.7	-7.1
Homicide	-15.4	-7.1	-54.3
Suicide	18.0	-6.7	-1.0
Self-rated health	-	9.5	-3.8
Infant mortality	-23.9	-26.5	-19.7
Quebec			
Income inequality			
Gini coefficient (market income)	7.6	6.1	2.8
Gini coefficient (income after tax)	2.4	-0.7	2.1
Health outcomes			
Total mortality	-1.9	-9.6	-6.2
Life expectancy	1.4	1.8	1.4
External cause mortality	-21.0	-5.5	2.9
Homicide	-3.3	10.1	-14.3
Suicide	5.6	-8.3	27.0
Self-rated health	-	-16.9	7.2
Infant mortality	-16.5	-16.9	-22.0
Ontario			
Income inequality			
Gini coefficient (market income)	8.4	7.5	4.0
Gini coefficient (income after tax)	4.7	1.0	2.7
Health outcomes			
Total mortality	-5.1	-6.9	-5.6
Life expectancy	1.6	1.3	1.1
External cause mortality	-16.7	-12.6	1.2
Homicide	-23.1	28.3	-14.3
Suicide	-3.1	-20.2	2.7
Self-rated health	-	10.9	-8.8
Infant mortality	-18.2	-12.5	-9.5

Manitoba			
Income inequality			
Gini coefficient (market income)	4.1	3.2	1.7
Gini coefficient (income after tax)	-2.6	-3.4	3.2
Health outcomes			
Total mortality	-5.1	-7.9	-3.1
Life expectancy	1.4	1.4	0.7
External cause mortality	-18.4	-16.7	-2.0
Homicide	22.1	-21.3	18.9
Suicide	0.9	-14.3	-14.6
Self-rated health	-	4.7	-4.9
Infant mortality	-22.7	-30.4	4.7
Saskatchewan			
Income inequality			
Gini coefficient (market income)	5.6	-4.6	4.1
Gini coefficient (income after tax)	-0.3	-10.9	2.4
Health outcomes			
Total mortality	-1.4	-7.0	-1.5
Life expectancy	1.4	1.5	0.3
External cause mortality	-15.6	-14.1	-11.2
Homicide	-26.7	-13.1	41.9
Suicide	-22.9	-7.4	10.0
Self-rated health	-	13.3	-17.6
Infant mortality	-23.7	-8.9	2.4
Alberta			
Income inequality			
Gini coefficient (market income)	9.8	6.8	0.0
Gini coefficient (income after tax)	3.1	3.4	-0.3
Health outcomes			
Total mortality	-6.6	-8.2	-2.8
Life expectancy	1.7	1.7	0.7
External cause mortality	-4.6	-15.1	-8.1
Homicide	-14.6	18.0	-32.1
Suicide	16.9	1.4	-7.1
Self-rated health	-	7.2	6.7
Infant mortality	-15.1	-25.6	-7.5

British Columbia			
Income inequality			
Gini coefficient (market income)	12.4	-4.0	6.0
Gini coefficient (income after tax)	5.2	-7.0	6.1
Health outcomes			
Total mortality	-6.0	-4.9	-2.9
Life expectancy	2.1	0.9	0.8
External cause mortality	-24.7	-5.3	-28.2
Homicide	-35.1	33.3	-52.0
Suicide	0.0	-4.5	-26.4
Self-rated health	-	14.3	-15.0
Infant mortality	-16.7	-23.5	-21.5

- indicates that 1981 data were not available.
* indicates that the denominator was zero

a) Market income

For most provinces, the greatest relative increases in market income inequality occurred from 1981 to 1986. This coincided with the greatest decreases in external cause mortality for six provinces (Newfoundland, Nova Scotia, Quebec, Ontario, Manitoba, and Saskatchewan) amounting to an unexpected positive relationship between income inequality and health.

Similarly, four provinces exhibited their greatest relative increase in life expectancy during this first time period (Newfoundland, Nova Scotia, Ontario and British Columbia) again signaling a positive relationship between income inequality and health.

b) Income after tax

Six provinces (Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan and British

Columbia) had their largest relative decreases in after-tax income inequality (or smallest increase in the absence of any decrease) between the recessions from 1986 to 1991. For all but British Columbia, this coincided with the greatest relative decreases in total mortality, suggesting the expected inverse relationship between income inequality and health.

Also between the recessions, most provinces showed their greatest (or only) increases in self-rated health. This suggested an inverse relationship between income inequality and health for Nova Scotia, Ontario, Manitoba, Saskatchewan and British Columbia. Quebec differed substantially from the other provinces, showing a large relative decrease (17%) in self-rated health between the recessions, followed by an increase after 1991, for an unexpected positive relationship between after-tax income inequality and health.

A clear picture failed to emerge when exploring the relationship between changes in income inequality and in health, in individual provinces over time. Like the trends found in Canada as a whole, there were some positive and some negative associations, irrespective of which income concept was used.

4.4 Cross-sectional Analyses: Regression of health on income inequality for the provinces, 1981, 1986, 1991 and 1996

This analysis began by reviewing scatterplots of the Gini coefficient (market income and income after tax) by all health outcomes (Figures 4.4.1 and 4.4.2). Very few linear

relationships between independent and dependent variables were evident. The analysis was restricted to the regression of total mortality on the Gini coefficient (market income) for 1991 and 1996 - the only two relationships that appeared to be linear (Table 4.4.1).

Table 4.4.1 Results for the regression of total mortality on income inequality (market income), 1991 and 1996

	Gini coefficient			Covariate[15]		
	b_1	p-value	RR*	b_2	p-value	Adj. R^2
1991						
Restricted model	11.5	0.004	1.26	-	-	0.63
+ Smoking	11.1	0.059	1.25	0.004	0.913	0.58
+ Med. inc. (1,000s)	17.6	0.008	1.42	0.036	0.174	0.68
+ LICO	14.3	0.015	1.33	-0.032	0.435	0.61
1996						
Restricted model	9.8	0.001	1.23	-	-	0.72
+ Smoking	9.4	0.040	1.22	0.002	0.921	0.69
+ Med. inc. (1,000s)	11.0	0.025	1.27	0.006	0.720	0.69
+ LICO	10.6	0.014	1.26	-0.012	0.745	0.69

* RR based on Gini coefficients of 0.492 (high exposure) and 0.346 (low exposure)

a) Restricted models

The scatterplots and regression results (Table 4.4.1) show that in 1991 and 1996, provinces with higher levels of income inequality, based on market income, had higher levels of total mortality. These relationships were statistically significant at a 0.05 level. In 1991 and 1996, for every 0.01 increase in Gini coefficient, there were respective increases of 0.12 and 0.10 deaths per 1,000 population. The adjusted R^2s indicate that 63% (1991) and 72% (1996) of the total variation in mortality can be explained by income inequality. The RRs suggest that people exposed to the highest observed income

[15] Detailed descriptive results for the these covariates are in Appendix H.

inequality (Gini coefficient = 0.492) would be 1.23 to 1.26 times more likely to die than people exposed to the lowest observed income inequality (Gini coefficient = 0.346).

b) Full models

Almost every relationship between income inequality and total mortality remained statistically significant after controlling for each of the covariates, at a 0.05 level of significance. The exception was in 1991 when smoking was included in the equation. The different models show that for every 0.01 increase in the Gini coefficient, there were increases of between a 0.09 and 0.18 deaths per 1,000 population, after controlling for the covariates. The adjusted R^2s were moderately high for most models with 58% or more of the variation in total mortality being explained by the variables in the equation. For the most part, the RRs remained unchanged with the introduction of covariates.

c) Summary

The cross-sectional examination of income inequality and health revealed a dearth of associations, regardless of whether income inequality was based on market income or income after tax. The only clear linear associations appeared when income inequality was measured using market income, and "health" was operationalized as total mortality. Even so, this relationship was only apparent at the latter end of the study period (1991 and 1996). However, when it did appear, it was a statistically significant relationship ($p<0.05$), even after controlling for covariates.

Figure 4.4.1 Scatterplots: Gini coefficient (market income) by health outcomes, provinces, 1981-1996

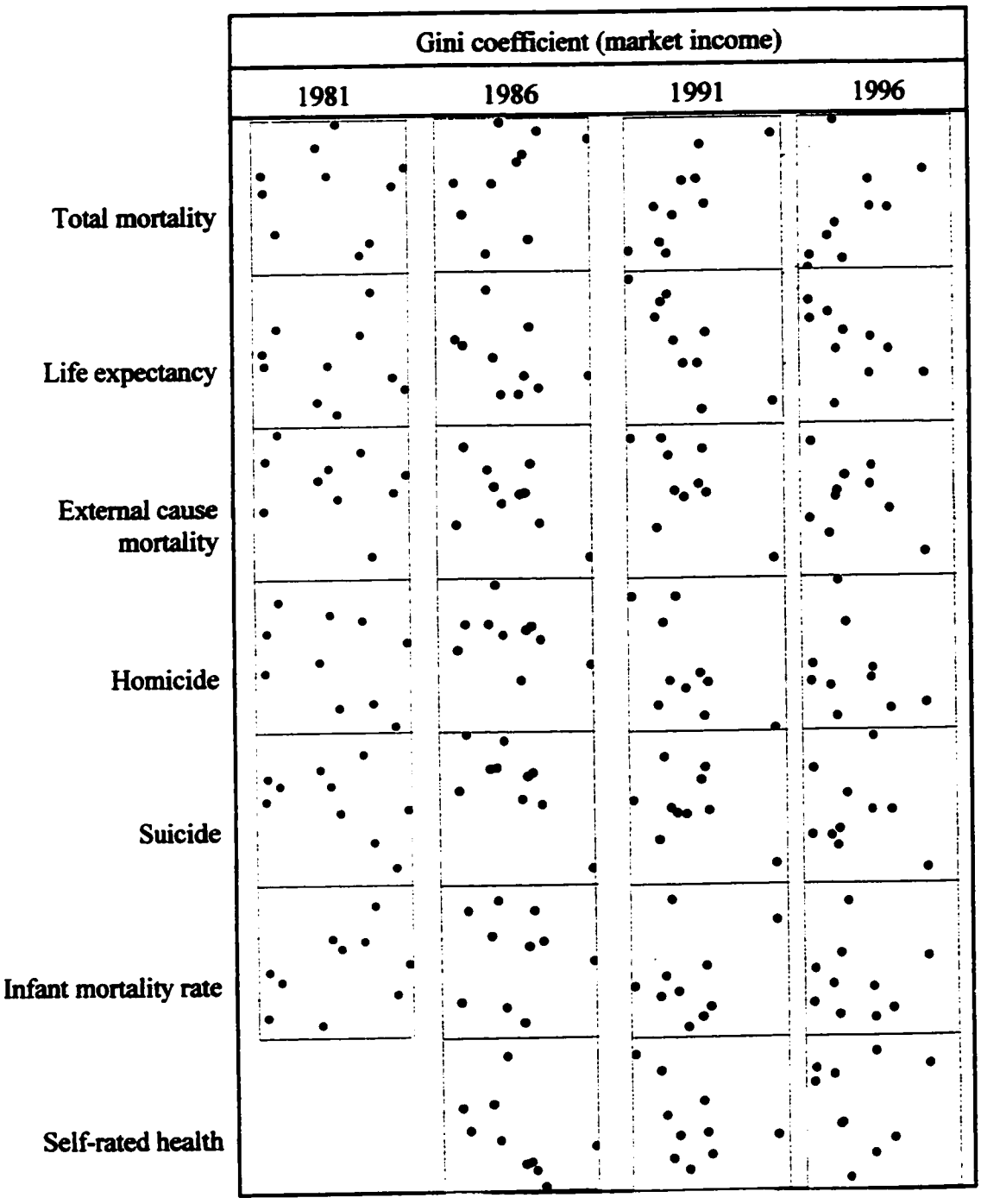
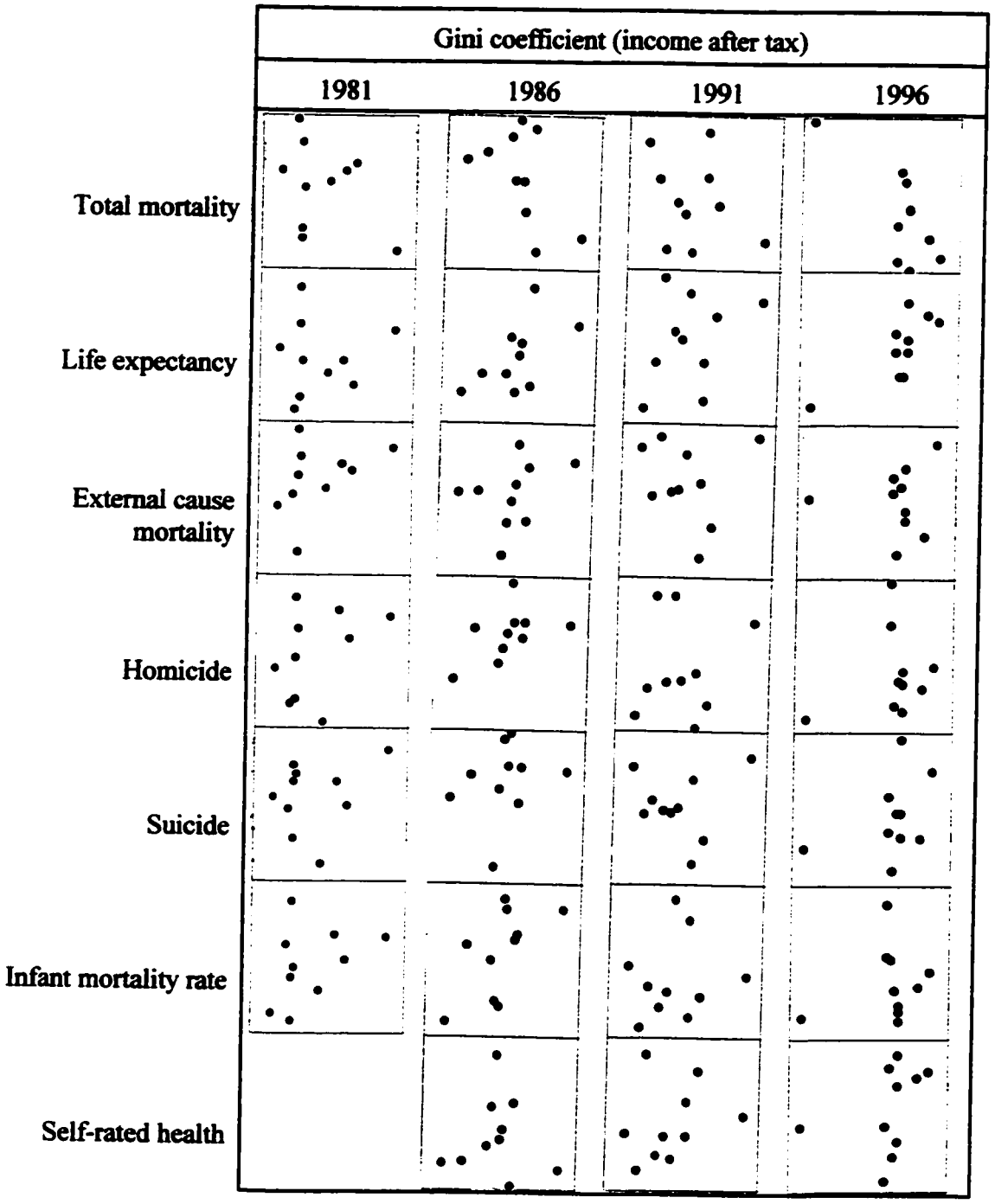


Figure 4.4.2 Scatterplots: Gini coefficient (income after tax) by health outcomes, provinces, 1981-1996



CHAPTER 5 DISCUSSION

The goals of this thesis were two-fold: first, to document the status of, and changes in, income inequality, health, and the relationship between these variables, in Canada and the provinces between 1981 and 1996; and secondly, to establish whether the results were measure dependent. Section 5.1 summarizes and discusses the key results pertaining to the levels of, and changes in, income inequality and health. Section 5.2 discusses methodological issues and limitations associated with the study, particularly those findings that relate to the performance of different measures and concepts, including measures of income inequality, income concepts, and health outcomes. Policy implications are covered in Section 5.3 while Section 5.4 concludes with recommendations.

5.1 Income Inequality and Health

The expectations presented in this thesis (Chapter 2) were not supported by the results. Levels of income inequality for economic families were not consistently related to population health in Canada or the provinces, inversely or otherwise, between 1981 and 1996. Income inequality simultaneously increased and decreased depending on the income concept used, and there were no consistent trends between either market or after-tax income inequality and the recessions in the early 1980s and 1990s. Over the same period, population health improved, according to most indicators, although there was considerable variability between provinces.

5.1.1 Income inequality in Canada and the provinces

The overall increases in income inequality in Canada that were recorded in this thesis were quite consistent with results reported by Statistics Canada:

> ...there has been an historical trend to increasing inequality on an income before transfers basis [market income] and no such trend on an after-tax basis. (Statistics Canada, 1997, 13-210:47)

Thus, Statistics Canada reported there was no increase in after-tax income inequality where I had recorded a "very slight" increase. However Rashid, when referring to the Gini coefficient, stated that changes in income inequality happen slowly and that:

> A change of one percentage point, for example, from .345 to .355 or .335 [differences of 0.01], would be considered significant. (Rashid, 1998:14)

The 5.2% increase in after-tax income inequality reported in the results (Table 4.1.2.1) was based on a change of Gini coefficient from .290 to .305, a difference of .015. It is debatable whether this was a "clinically" significant change given the 15-year time period over which it evolved.

Rashid, who tracked income inequality in Canada between 1970 and 1995, also stated that the majority of increase in income inequality took place in the early 1980s and early 1990s, following recessionary periods (1998:14). His findings were based on total income which includes market income, government transfers, investment and other income, prior to the equalizing effects of taxation. A similar trend was found in this thesis, although it was restricted to the Gini coefficient and Robin Hood index, when based on income after tax.

The increasing gap between income inequality measured with the two income concepts (income after tax and market income), indicated that taxation and government transfers played an increasingly important role between 1981 and 1996 in maintaining the lower level of after-tax income inequality in Canada. This was supported by Rashid who stated that:

> The combined effect of these two measures - government transfer payments and personal income taxes - has not only substantially reduced income inequality, it has done so to an increasing degree over the years. (Rashid, 1998:16)

In addition, while both government transfer payments and personal income taxes are income equalizers, "the impact of transfers is greater than that of income taxes" (Statistics Canada, 1997, 13-210:47).

Income inequality increased in every province between 1981 and 1996, when based on market income. When income inequality was based on income after tax, five provinces showed an overall increase while the remaining five provinces showed overall decreases.

Regional variation was evident when income inequality was compared between the provinces at each study point (1981, 1986, 1991 and 1996). Income inequality was higher in the east when based on market income and lower in the east when calculated using income after tax. This illustrated a greater degree of dependence in eastern Canada on taxation and government transfers to reduce levels of income inequality.

5.1.2 Health in Canada and the provinces

According to most measures, health improved in Canada and the provinces between 1981 and 1996. That is, life expectancy increased, while total mortality, external cause mortality and infant mortality decreased. For the remaining measures, changes in health found in Canada were not representative of the provinces. For example, the stability of self-rated health in Canada over the study period was simply the net effect of a great deal of variability found in the provinces. Additionally, the Canada level fluctuations of suicide and homicide deaths with the recessions were not generally evident in the provinces.

Comparisons of health between the provinces were somewhat more revealing. Total mortality and life expectancy, which have been described as "indicators of the level of health", demonstrated poorer levels of health in the eastern provinces. In contrast, the "indicators of health problems", homicide, suicide and external cause mortality, suggested that the health of populations in the eastern provinces was superior to that in the rest of Canada.

5.1.3 Income inequality and health in Canada and the provinces

The results reported illustrate that any attempt to describe the state of income inequality or health in Canada and the provinces, between 1981 and 1996, is measure dependent. The relationship between these risk and outcome variables differed in both strength and direction, depending on the combination of measures selected. For example, in the

longitudinal analysis, positive (unexpected) relationships existed between market income inequality and health (life expectancy and external cause mortality), as well as after-tax income inequality and health (homicide). The expected inverse relationship was evident in the longitudinal analysis when based on after-tax income inequality and suicide, as well as in the cross-sectional analysis using market income inequality and total mortality. These inconsistencies were unexpected given the results of some U.S. studies, including those of Kawachi and Kennedy (1997). Although they limited their health outcome measure to total mortality, income inequality was established using six different measures, including the Gini coefficient, Robin Hood index and decile ratio. They concluded that income inequality is associated with higher mortality, regardless of the income inequality measure used. This relationship held even after adjustment for transfers and taxes.

One relationship of note was revealed by the regression analysis that found that provinces with higher levels of market income inequality had higher levels of total mortality. The surprise, however, was that this relationship only emerged in 1991 and 1996. It is possible that the nature of the different recessions produced these changes. That is, in the earlier recession, the resource based economies of Western Canada were most affected. The recession in the early 1990s, however, had its greatest impact in the more eastern areas of Canada, particularly in and around Toronto where the effects were still being felt in 1995 (Myles et al., 2000:4). Alternatively, the increasing Americanization of Canada in terms of policy and social environment, may explain the emergence of income

inequality / health relationship. In the late 1980s and early 1990s Canadians witnessed some profound structural and policy changes such as the introduction of the Free Trade Agreement (FTA) and the North American Free Trade Agreement (NAFTA), as well as a shift in the taxation burden from corporations to individuals, and from the wealthier members of society to the middle class. These changes were implemented under Conservative leadership (Mulroney) whose agenda increased the similarities between Canada and the U.S. However, while this association between income inequality and total mortality is remarkable for its strength and sudden appearance, it is one of the very few associations between exposure and health outcomes that appeared throughout the study.

5.1.4 Explanation of results

There are a number of factors that may account for the lack of a visible and consistent relationship between income inequality and health in Canada, including the following possibilities:

a) the income inequality/health relationship does not really exist;
b) its existence is confined to the U.S.;
c) the geographic level of analysis is inappropriate.

Each of these possible explanations will be considered in detail.

a) The income inequality/health relationship does not really exist

The first possibility, that the income inequality/health relationship is spurious, was

presented by Gravelle (1998) who stated that the apparent association is a statistical artefact resulting from using population rather than individual data. His argument, which focuses on mortality, is based on two factors present at the individual level of aggregation. The first is that mortality rates improve with income, and the second is that the "return" of health improvement for each unit increase in income gradually diminishes. In other words, there is a non-linear relationship between income and mortality such that the curve is "monotone decreasing" (Deaton, 2001:9). Thus, if the income distribution widens, the reduction in mortality at the upper end will be more than offset by an increase at the lower end. This results in a higher level of mortality that can be accounted for by the increase at the lower end of the income distribution. However, Wolfson et al. refuted Gravelle's argument and demonstrated empirically that the observed relationship between income inequality and mortality "cannot be entirely or substantially explained as statistical artefacts of an underlying individual level relation between income and mortality" (1999a:953; Ross et al., 2000:899).

b) The existence of an income inequality/health relationship is confined to the U.S.

The second reason for the absence of an inverse relationship between income inequality and health in Canada lies in the possibility that this association is peculiar to the U.S. This is an unusual argument given the international level results presented by Wilkinson (1996). However, a comparison of Canada and the U.S. raises some important issues. This was done by Ross et al. (2000) in their assessment of the relation between income

inequality and mortality in Canada and the U.S., based on 10 Canadian provinces and 50 U.S. states, and between 53 Canadian and 282 U.S. metropolitan areas. While an association was found in the U.S., none was evident in Canada. The three explanations that emanated from these results (Ross et al., 2000:901) are discussed, as well as a fourth issue regarding racial composition raised by Deaton (2001:31):

i) Lower levels of exposure in Canada

If the income inequality/mortality relationship is non-linear, then in Canada, where there are lower levels of exposure (income distributions are narrower), one would expect a weaker relationship with mortality.

ii) Lower levels of privatization in Canada

Secondly, Ross et al. point to the distribution of social and economic resources; specifically the level of privatization in the U.S. compared to the more public distribution of resources in Canada (2000). Privatization means that the availability of resources is driven by the potential for profit and not necessarily by community needs. The effects of income inequality are softened in Canada, where absolute and relative income play a smaller role in determining access to education, health care, and other health promoting resources, compared to the more privatized environment in the U.S.

iii) Less economic segregation in Canada

Finally, Ross et al. suggest that there is more economic segregation in the U.S. than in Canada, resulting in "concentrations of people with high social needs in municipalities with low tax bases" (2000:901). Communities with low tax revenues are less able to support public resources such as schools, libraries, transportations systems, recreational facilities and so on. This process is not unique to the U.S. A study of the eight largest Canadian cities between 1980 and 1995 found that for half of the cities, an increase in economic segregation was the major force behind rising neighbourhood inequality. In other words, "families were increasingly sorting themselves into [economically] "like" neighbourhoods" (Myles et al. 2000). Ross's latter two explanations (privatization and economic segregation) emphasize the importance of the neo-material hypothesis.

iv) Differences in racial composition between Canada and the U.S.

Another difference between the U.S. and Canada lies in the issue of "race"[16]. Deaton addresses this when exploring income inequality in the U.S., not from the perspective of segregation, but from the view of population composition, that is, the percent of the population that is black or white (2001:31). He found that the correlation across U.S. states between income inequality and mortality weakened after controlling for race. Returning to the neo-material hypothesis, Deaton states

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16 For a Point-Counterpoint discussion on race and ethnicity in epidemiology, please see the *American Journal of Epidemiology*, August 15, 2001:291-306.

that the provision of appropriate public resources becomes more difficult in more heterogeneous populations (2001:31), suggesting an advantage to segregation. However, while the public resource needs of certain segregated areas may be easily identified, they cannot be easily met if a weak tax base exists. Deaton also recommends that issues of social cohesion and trust be considered when explaining his findings of higher white mortality in states that are more racially mixed, suggesting the importance of the psychosocial hypothesis. Critical questions remain around these issues of racial composition, economic segregation, and consequently racial segregation, such as the relative importance of the distribution of public resources compared to the psychosocial effects of racial composition and economic segregation. Canada differs from the U.S. in its population composition and distribution, but even more importantly, in its population categorization. There is a greater emphasis on the social construct of ethnic identity in Canada, as opposed to the biological construct of race often featured in U.S. studies. In addition, U.S. research involving "race" that fails to distinguish between the black and Hispanic populations is inadequate. While higher mortality is associated with the black population, the Hispanic population, which is primarily immigrant, appears to be protected by sociocultural traits that result in lower mortality (Dowling, 1996:301). Similar distinctions would be required in Canadian research. A white/non-white dichotomy or Canadian/non-Canadian distinction in ethnic identity is not only ethnocentric, but clearly inadequate.

c) The appropriate geographic level of analysis

A third possible explanation for the apparent absence of an income inequality/health relationship in Canada lies in the appropriateness of the geographic scale selected for this study. This thesis focused specifically on provinces for three reasons. First, provinces represent an important organizational level at which many policy decisions are implemented that have an impact on income (e.g.. taxation) and health (e.g. hospital and home care services). Second, income data can easily be grouped by province. And third, aggregated data are readily available at this level for all of the health outcomes under study. Ideally, the driving force behind the level of aggregation should be based in the mechanism theorized to relate income inequality to health. Wilkinson's suggested pathway, which links income inequality to health outcomes through social cohesion and chronic stress, implicates a geographic region such as the "local" community, where local is defined as the community within a person's regular sphere of influence. From this perspective, the province is too broad an area for the mechanism to take effect. Deaton et al. refers to "reference groups" that may be defined as contiguous geographic areas (e.g. local community), birth cohorts, organizations, or other groups (1999a:6). His discussion acknowledges that information on an individual's reference group is rarely available, and that we cannot even assume that people relate to clearly defined groups. Such reference groups or spheres of influence not only differ by individual, but are likely to differ systematically as higher income people exercise greater mobility in their employment, recreation and access to services (Jordan et al., 1994:467). In addition, they may change with life stages (child rearing, employment, retirement) and events (church attendance,

accessing hospital care, onset of chronic illness). Further inspiration for this issue of aggregation is provided by urban geographers, such as Kevin Lynch, who pioneered work on mental maps, which define spheres of influence (Jordon et al., 1994:466; Knox, 1987:150). The issue remains, however, that more work is required to establish the robustness of the income inequality/health relationship at different levels of geographic aggregation, as "it is not clear at what ecological level income inequality can be expected to be meaningful" (Kennedy et al. 1998:917).

One future possibility lies at the health region level, of which there are over 130 in Canada (Statistics Canada, 2001). These may be a more local and viable alternative than aggregation at the provincial level. The Health Indicators project (Statistics Canada and CIHI) plans to include health status indicators and non-medical determinants of health, as well as information on resources which could help assess both the psychosocial and neo-material pathways between income inequality and health. However, a risk of aggregating to a smaller geographic level is that these areas may be more homogenous. If there is no income inequality in a geographic area, there is no exposure to study. Or, as Wilkinson has argued, income is a more important determinant of health in small geographical areas while income inequality is more important in larger geographical areas (cited in Deaton et al., 1999a:13).

Three possible reasons for the absence of an income inequality/health relationship have been reviewed. The statistical artefact argument presented by Gravelle has been refuted

based on empirical studies. The suggestion that the relationship is unique to the U.S. is plausible, given the differences between Canada and the U.S. in exposure level, privatization (public resource distribution), economic segregation and racial composition. These factors could be explored at an international level to establish whether Canada or the U.S. is the outlier. And finally, the question of geographical aggregation was discussed. There simply may not be sufficient variability in exposure at a provincial level to detect a relationship.

Another avenue that must be considered when explaining the lack of association between income inequality and health relates to methodological issues and limitations. Concerns regarding the measurement of exposure and outcome variables are discussed in the following section.

5.2 Methodological Issues and Limitations

The major limitation of this thesis lies in the small number of data points. The ten data points were sufficient for an exploratory view of income inequality and health in Canada, but quite limiting in terms of multiple regression or any other analyses beyond descriptive statistics. This limitation was understood and outlined prior to the commencement of this thesis and therefore was not unexpected. Despite the limitation to ten data points, regression analysis was attempted. Although the models became unstable with the introduction of a second independent variable, the results suggest this would be a worthwhile approach with a greater number of data points. Approaching this topic from

the health region level would provide a more adequate number of cases, although one would be limited in the health outcome measures available at that geographic level. It is worth reiterating that even when Ross et al. (2000) used 53 metropolitan areas for their study, they did not detect an association between income inequality and mortality in Canada.

The detection of an income inequality/health relationship relies on the valid measurement of a number of concepts. These concepts include the amount of social hierarchy, measured by the width of the income distribution, the different types of income, and the measurement of health. It has been demonstrated in this thesis that measures chosen to operationalize these concepts have an impact on the income inequality/health relationship.

5.2.1 Income

This thesis revealed two major issues relating to income. The first revolves around the type of income that forms the basis for analysis, while the second relates to the use of income as a proxy measure for social hierarchy.

As listed in the classification of income sources (Appendix B), there are a number of different types of income, or income concepts. Total income, for example, includes earnings, investment income and government transfers, prior to the equalizing effects of taxation; income after tax reflects disposable income; and earnings focuses on wage

earners, excluding self-employment income. Market income provides an "upstream" value for a family's income, that is, it reflects the original level of income (and therefore income inequality) that exists prior to remedial action by the government. Income after tax is a "downstream" or post-modification income. Income inequality based on the former illustrates the original width of income distribution while the latter (income after tax) quantifies the government's success at modifying the income distribution. The popularity of using income after tax may rest on the idea that social hierarchy is based on a family's ability to purchase goods, many of which are markers of social status. However, the level of a family's market income will determine the extent to which they will need to rely on government intervention, which is presumably another marker of social status. Thus, it is unclear which income concept best forms the basis for a valid measure of social hierarchy and, unfortunately, income inequality differs tremendously depending on the income concept chosen. It is essential that researchers explicitly state the income concept they are using, and the theoretical basis for their decision. At the very least, comparison between studies using different income concepts could then be avoided.

The second major issue relates to the use of income (versus education, for example) as a proxy measure of social status. This was illustrated by the failure of the decile ratio to perform in a meaningful way, when negative incomes were involved. To recap, decile ratios, based on market income, were not interpretable due to negative incomes. These negative incomes were potentially a function of negative rental incomes or large investment losses. These families may have been at the upper end of the social hierarchy,

and yet were categorized with the poorest families in Canada. Wilkinson addresses this (1996:104) suggesting that survey data for the lowest income group tend to be unreliable because people report low or negative incomes when they are living on capital or savings. This results in a group of "people with low declared incomes and yet high living standards" who would naturally have higher levels of social status and health, on average, than those with truly low incomes, leading to the potential underestimation of the income inequality-health relationship. While possible solutions include restricting analyses to cases with zero or positive incomes, or substituting zero incomes for negative ones, these approaches fail to address the larger issue regarding the validity of income as a proxy for social status, and hence income inequality as a proxy measure for the social stratification within a community. One possible solution is to estimate wealth inequality. Wealth, which includes property, assets and other resources of monetary value in addition to income, has advantages such as a greater degree of stability than income alone. However, while these benefits would suggest that wealth reflects hierarchy more accurately, it is far more difficult to measure.

5.2.2 Measures of income inequality

The modeling exercise presented in Appendix C established the Gini coefficient as a more sensitive measure than the Robin Hood index or decile ratio. However, the empirical evidence demonstrated the equivalency of the Gini coefficient and RHI. The decile ratio, on the other hand, was not consistent with the former two measures, showing the smallest increase in income inequality between 1981 and 1996, out of all three

measures. This was not unexpected as the incomes of only 20% of economic families (top 10% and bottom 10%) are utilized in the calculation of this measure. It should not come as a surprise, then, that the relationship between income inequality and health may differ depending on the measure of income inequality.

Prior to exploring the income inequality/health relationship, the choice of measure needs to be justified on theoretical grounds. In a recent study comparing this relationship in Canada and the U.S., Ross et al. (2000:898) used the "median share" as a measure of income inequality[17]. In a personal communication (April 6, 2001) Ross explained the choice of measure on the basis of changes in the income distribution. In other words, she selected a bottom sensitive measure because the change in income inequality was the result of changes at the lower end of the income distribution. This suggests that the choice of measure should be preceded by an investigation into the income distribution. Perhaps if changes in income inequality were due solely to movement in the top and/or bottom 10% of the distribution, the decile ratio would be the preferred choice of indicator.

Love (1979:27) approached this question somewhat differently by stipulating a list of conditions against which to assess the available income inequality measures.

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[17] The "median share" is the proportion of household income accruing to the less well off 50% of households within a defined area (e.g. province, metropolitan area, etc.). If there was no inequality, households situated in the "bottom" half of the income distribution would have accrued 50% of the total income for a median share value of 0.50 (Ross et al., 2000:899).

Interestingly, the "condition of transfer" would eliminate the Robin Hood index and the decile ratio as suitable measures. This condition states that the income inequality measure should be responsive (indicate less equality) to the transfer of income from a richer to a poorer income unit (e.g. person, economic family), when the rank of the units remains the same (Love and Wolfson, 1976:23). The decile ratio is not sensitive to income transfers between families in the middle 80% of the distribution, while the Robin Hood index remains unchanged when transfers take place entirely above or below the mean.

In addition, Rashid (1998:14) and Love (1979:78) pointed out that levels of income inequality may change due to shifts in the demographic structure of the population, as opposed to changes in actual incomes. For example, increases in the proportion of elderly families, characteristic of an aging population, and increases in female lone-parent families are two examples of demographic changes that result in more families being located at the lower end of the income distribution, thereby increasing the level of income inequality. Alternatively, an increase in dual-earner families may locate more families at the upper end of the distribution, which would also increase income inequality. Ironically, Love suggested that government transfers could drive the demographic changes that in turn have an impact on income inequality. The availability of government transfers, such as employment insurance and pensions, may allow for the break up of economic family units; for example, elderly parents could establish separate households from their children, and so on. This phenomenon is referred to as "undoubling" (Love,

1979:25,75) and it raises the issue of the "family unit" when assessing income inequality. Love has discussed this extensively in his 1979 work *Income Distribution and Inequality in Canada*. The advantage of the census family unit is that it controls for many of the changes such as those stated above. That is, elderly parents living with an adult married child, comprise one economic and two census families. If the elderly parents established a separate household, they would remain as two census families and change from one to two economic families. Suffice it to say, the definition of family unit will have an impact on changes in income inequality. Economic family income inequality will always be lower than that based on the more restrictive census family. One's choice, however, is usually dictated by the availability of data rather than theoretical choice (Love, 1979:23).

5.2.3 Measures of health

Studies in the U.S. have provided evidence for the association between income inequality and health, based on a number of different health outcomes. Eight of these health outcomes were selected for this thesis, six of which are mortality based measures, and as such, do not represent the multidimensional nature of health. In fact, they do not represent the positive state of health at all, but rather, the presence of death. This approach has traditionally been used to overcome the difficulty in operationalizing the elusive concept of health (Spasoff, 1999). An alternative to these mortality measures lies in composite measures of health that introduce morbidity into the health outcome (Spasoff, 1999; Wolfson, 1999b). These include variants of life expectancy such as "disability-free life expectancy (DFLE), disability-adjusted life expectancy (DALE) and

health-adjusted life expectancy (HALE)" (Wolfson, 1999b:4), as well as quality-adjusted life years (QALY) and disability-adjusted life years (DALY) (Spasoff, 1999). It makes sense to use these measures given Wilkinson's proposed pathway that identifies chronic stress as the link between income inequality and health. The population may suffer from debilitating, stress induced illnesses that do not result in death.

An additional difficulty relating to mortality measures in Canada lies in the relatively small number of cause-specific deaths, such as suicide, homicide, and external cause mortality. When presented using standardized mortality ratios, they can be quite unstable due to the small numbers. For example, in 1986, females in Prince Edward Island had a suicide SMR of 129%. While a 29% excess in suicide appears high, it is based on one excess death. That is, 3 suicide deaths were expected while 4 actually took place. Total mortality is the most comprehensive of the mortality measures, along with life expectancy, due to larger numbers and greater accuracy compared to cause-specific mortality. That is, total mortality is not affected by the misclassification of cause of death, which may be the case when specific causes are stigmatized (e.g. suicide).

Infant mortality is a questionable marker of population health in developed countries that are reaching the lower limits of infant mortality. It may be a more suitable measure for international use, where there is greater variation. The exclusion of the territories in this thesis eliminated the major source of variation in a number of health outcomes, including infant mortality. Analysis at the health region level, with the inclusion of the territories,

may offer greater opportunities for an income inequality/health relationship to emerge. Infant mortality can also be a somewhat ambiguous measure for the same reasons as low birth weight. That is, "progress in perinatal care can cause the infant mortality rate to rise, as pregnancies that formally would have ended in miscarriages or stillbirths result in low-weight live births with precarious survival chances" (Nault, 1997:45). Caution should be exercised when using infant mortality rates after 1995. In 1996, changes to the law in Ontario allowed municipalities to change an administrative fee to parents for the birth registration process. The fee, which ranges from $10 to over $27, acted as a deterrent to birth registration, decreasing the denominator, and thereby resulting in over estimates of infant mortality. Bienefeld et al. found an association between non-registration and younger mothers, low birth weight babies, short gestation, and multiple births (2001:13). Because this change took place in mid 1996, the impact on this thesis is expected to be negligible. However, when using infant mortality as a health outcome measure in the future, the effect of the provincial fee for registration should be considered.

One other point concerning mortality measures is that the rates for men and women tend to be quite different. For example, suicide, homicide and total mortality rates for males were consistently higher than those for females. Thus, when presenting these health outcomes for Canada and the provinces as a whole, they did not necessarily reflect either sex accurately. This suggests that the assessment of health outcomes by sex might be beneficial. A useful exploration would be to link Rashid's work on income inequality by

family type (1998) to health outcomes by sex.

A final limitation arises from the difficulty (if not impossibility) of establishing health outcomes specifically for economic families. Consequently, in this thesis there is a "mismatch" between income inequality and some health outcome measures. Income inequality is based on economic family units while most health outcomes are for the whole population (families and unattached individuals). As mentioned earlier, economic families encompass the majority of the population so that the impact of this mismatch is considered minimal. In addition, because unattached individuals consistently have higher levels of income inequality, their exclusion may lead to the under estimation of an income inequality/health relationship. The greatest concern with the approach taken lies with the possibility that certain health outcomes are more likely to occur in the unattached individual population. In the extreme situation where the health outcome only occurred among unattached individuals, a spurious relationship would exist between family income inequality and the particular health outcome. An alternative approach would have been to evaluate income inequality for the whole population. However, combining economic families and unattached individuals into one group results in a poor representation of both groups.

5.3 Policy Implications

The inverse relationship between income inequality and health has been documented using international comparisons, as well as with U.S. state level data. To date, this

relationship has not been very evident in Canada. It must be assumed (and this is a large assumption) that the tools for detecting such a relationship are adequate, so that if an association exists, we have the means to identify it. Therefore, if the income inequality/health relationship is not found in Canada, it is either because levels of income inequality are sufficiently low to prevent a significant impact, or because intervening factors modify the impact on health. If the first scenario is true, then it will only be a matter of time before a relationship between income inequality and health surfaces. Income inequality is rising, somewhat slowly if income after tax is considered and quite quickly when based on market income. This would suggest that income equalizing policies be identified and nurtured in Canada. The second scenario, suggesting there is a relationship in Canada but one in which the impact of income inequality is minimized, suggests that protective policies be identified and promoted. Protective policies are those that relate to the existence and equal distribution of public resources, including access to good educational opportunities and comprehensive health care, irrespective of one's ability to purchase these services. In other words, guard the social safety net from the threat of erosion, and simultaneously prevent the privatization of public resources. It must be remembered, however, that enhancing the social safety net to negate the impact of income inequality is a downstream approach, and surely more costly in economic and human terms than minimizing inequality in the first place.

Policy initiatives that protect and enhance the social safety net align themselves with the neo-material hypothesis that links income inequality to health. From the psychosocial

perspective, policy initiatives need to be aimed at the width of the income distribution or the degree of social stratification within a community. Only by reducing the relative differences will social cohesion increase and the associated levels of chronic stress decrease.

Pederson et al. (1988), who criticize the traditionally narrow approaches taken when conceptualizing health, state that health policy has been dominated by, and at times mistaken for, medical care policy. Instead of a fragmented approach where economic, social, and health policy are developed as separate and competing domains, they recommend an integrated approach in the development of healthy public policy (1988:15). This idea has been promoted by the World Health Organization, which states that health should be on the agenda of all policy makers, not just those directly representing health (Spasoff, 1999). This fits well with the concept of metapolicy, that is, "policy on how to make policy" (Pederson et al., 1988:14). Decision makers who establish policies that have an impact on levels of income inequality must do so in the context of the social, health and economic consequences.

5.4 Recommendations for Future Research

1. Reassess the income inequality/health relationship, utilizing the 130 health regions in Canada to increase the sample size.

2. Ensure that income concept (market income, income after tax, etc.) is explicitly stated and justified on theoretical grounds.

3. Base the selection of an income inequality measure on an investigation of changes in the income distribution.

4. Investigate the impact of economic segregation, racial and ethnic composition, and other factors that distinguish Canada from the U.S.

5. Choose health outcome measures that better operationalize the concept of health, that is, measures that include morbidity (QALY, DALY, healthy life expectancy, etc.).

6. Reinvestigate the income inequality/health relationship in the Canadian context over the next decade to assess the impact of more right-wing policies (increased privatization of health services, decreased investment in public resources, etc.)

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APPENDICES

APPENDIX A

International dollars and purchasing power parity (PPP)

GNP per capita: The gross national product divided by midyear population. Gross national product is equal to GDP [gross domestic product] plus net receipts of primary income (employee compensation and property income) from nonresident sources. PPP GNP is gross national product converted to international dollars using purchasing power parity rates. An **international dollar** has the same purchasing power over GNP as a U.S. dollar has in the United States. (World Bank)

E-mail communication with the World Bank, January 16, 2001.
From: Bmurek@worldbank.org

Purchasing power parity (PPP) uses "a conversion rate that reflects how many goods the local money buys *within the country* instead of how many dollars it will buy in the exchange market".

http://www.worldbank.org/data/ppp/sld004.htm
(July 1, 2001)

PPP addresses problems associated with exchange rates. That is, exchange rates:

* do not reflect relative price levels in the countries, so they provide inconsistent estimates of income levels
* do not move with changes in relative prices, so comparisons are not consistent over time

http://www.worldbank.org/data/ppp/sld003.htm
(July 1, 2001)

APPENDIX B

Classification of income sources [18]

Total income
- Market income
  - Earnings
    - Wages and salaries
    - Net Self-Employment income
      - Net farm self-employment income
      - Net non-farm self-employment income including Net partnership income
    - Investment Income (total, not taxable)
      - Interest (including interest from outside Canada)
      - Dividends
      - Other investment income including Net rental income
    - Pension Income
      - Retirement pensions, superannuation and annuities
      - RRSP annuities and RRIF withdrawals (but not RRSP withdrawals)
  - Government transfers
    - Old Age Security
    - Guaranteed Income Supplement/Spouse's Allowance
    - Canada Pension Plan/Quebec Pension Plan benefits
    - Child Tax Benefit
    - Employment Insurance benefits
    - Workers' Compensation
    - GST credit
    - Provincial tax credits
    - Social assistance and Provincial income supplements
    - Veterans' Pension
    - Other income from Government sources
  - Other income
    - Alimony, separation allowance, child support
    - Money from outside household

(Income tax payable)

Income After tax

Note: While capital gains and RRSP withdrawals are income sources that are taxable, neither is included in the concept of total income.

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[18] This classification has been reproduced in its entirety from: *Income Trends in Canada 1980-1997, User's Guide.* Statistics Canada, Income Statistics Division, Catalogue 75F0002MIE-00001, January 2000, Pp. 24. Ottawa: Minister of Industry, 1999.

APPENDIX C

Modeling exercise exploring the sensitivity of the Gini coefficient and Robin Hood index to different redistributions of income

The following modeling exercise used fictitious income distributions with 13 income groups, each containing 7.7% of the population. The income groups are the same as those found in the Statistics Canada publication *Income after tax, distributions by size in Canada* for 1981. Calculations for the Gini coefficients follow Appendix Figure C2.

a) Gini Coefficient

The Gini coefficient quantifies the area between the Lorenz curve and the diagonal line of equality as a proportion of the entire area under the diagonal. This area can be derived geometrically by a series of rectangles and triangles, although this cumbersome process is equivalent to the following formula from Shryock (1976:98) which yields identical results:

$$G_i = (\sum_{i=1}^{n} X_i Y_{i+1}) - (\sum_{i=1}^{n} X_{i+1} Y_i)$$

Where: X_i = cumulative proportion of families
Y_i = cumulative proportion of income

A base model was established with a high Gini coefficient (Appendix Table C1, Appendix Figure C1). Model 1 simulates the redistribution of a percentage of income from the top group to the lower four groups (a redistribution between "extreme" groups), while Model 2 illustrates the change in Gini coefficient when a comparable percentage of income is redistributed around the middle nine groups of the income distribution (a redistribution among "middle" groups). This exercise empirically demonstrates that the Gini coefficient is not a middle-sensitive measure; it is more sensitive to income transfers at either end of the distribution.

Appendix Table C1 Modeling exercise: percent change in Gini coefficient

Model	Income Redistributed	Gini coefficient	Base - $Gini_i$ (Absolute change)	% Change (Relative change)
Base	-	0.472	-	-
1 (extreme)	10.4%	0.299	0.173	- 37%
2 (middle)	11.0%	0.375	0.097	- 21%

Please see Appendix Figure C2 for the Lorenz curves associated with these models.

b) Robin Hood Index

Overall, the Robin Hood index appears to be a less sensitive measure of income inequality than the Gini coefficient. That is, the equalizing redistributions of income found in Models 1 and 2 do not reduce the Robin Hood index to the same extent as the Gini coefficient.

Appendix Table C2 Modeling exercise: percent change in Robin Hood index

Model	Income Redistributed	Robin Hood Index	Base - RHI_i (Absolute change)	% Change (Relative change)
Base	-	32%	-	-
1 (extreme)	10.4%	22%	10%	- 32%
2 (middle)	11.0%	29%	3%	- 12%

The RHI was calculated by summing the percentage of income for each income group where the percentage exceeded the mean (7.7%) and subtracting from this product the number of income groups that exceeded the mean multiplied by 7.7%. In the base model, for example, 5 groups exceeded 7.7%. By subtracting (5 x 7.7%) from the sum of the percentages for these groups, one is left with the percent of income that would need to be redistributed below the mean to reach perfect income equality. (Kennedy et al., 1996:1007)

Calculations

Base Model: RHI = (8.5 + 8.8 + 9.6 + 13.1 + 30.8) - (5 x 7.7)
= 70.8 - 38.5
= 32.3

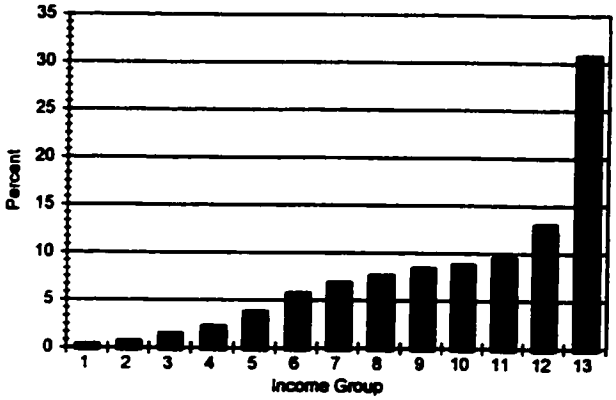
Model 1: RHI = (8.5 + 8.8 + 9.6 + 13.1 + 20.4) - (5 x 7.7)
= 60.4 - 38.5
= 21.9

Model 2: RHI = (13.1 + 30.8) - (2 x 7.7)
= 43.9 - 15.4
= 28.5

Appendix Figure C1 Income distributions used to model the sensitivity of the Gini coefficient and the Robin Hood index

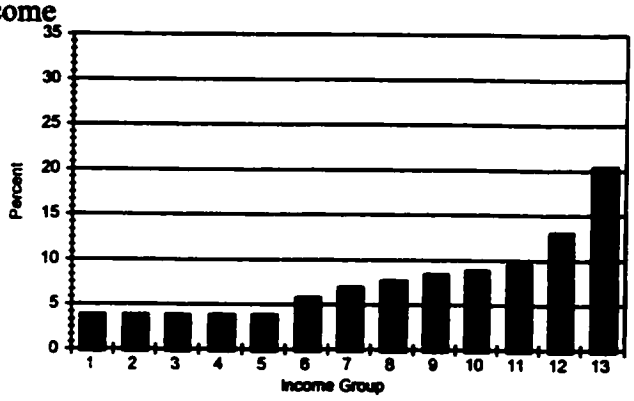
Base Model: Fictitious income distribution portraying high inequality

Gini: 0.472
RHI: 32%



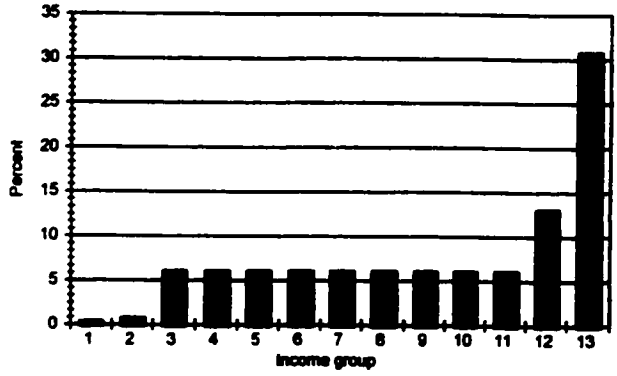
Model 1: 10.4% of total income redistributed from top income group to bottom 4 income groups so that each of the bottom 5 groups has 3.8% of the total income

Gini: 0.299
RHI: 22%

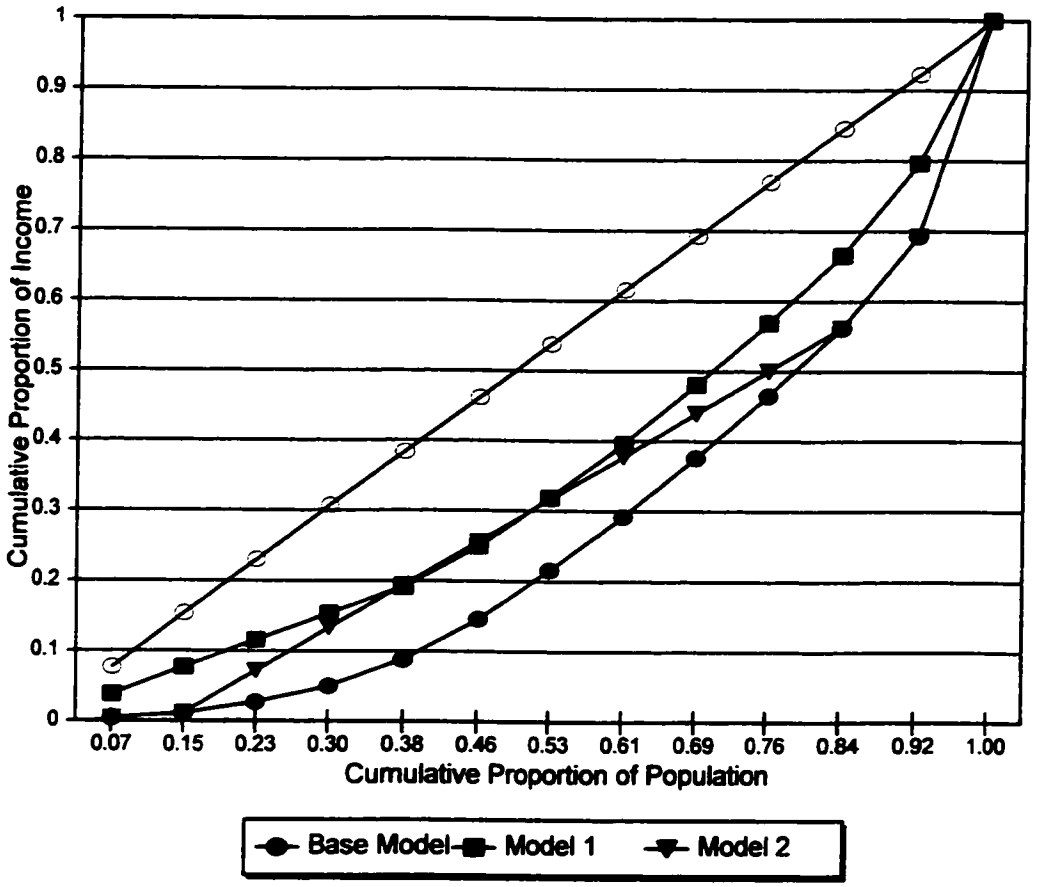


Model 2: 11.0% of income redistributed among middle 9 income groups so that each groups has 6.1% of the total income

Gini: 0.375
RHI: 29%



Appendix Figure C2 Lorenz curves associated with the modeling exercise demonstrating the sensitivity of the Gini coefficient and the Robin Hood index



Gini Coefficient Calculations: **Base Model**

Income Group	Income After Tax Group	# Families	Percent of Families	Proportion of Families	Income	Percent of Income	Proportion of Income	Cumulative Proportion		Xi(Yi+1)*	Yi(Xi+1)*	Gini
								Families X	Income Y			
1	Less than 5,000	10	7.7	0.077	$5	0.4	0.004	0.077	0.004			
2	5,000 - 6,999	10	7.7	0.077	$10	0.8	0.008	0.154	0.012	0.0009	0.0006	
3	7,000 - 9,999	10	7.7	0.077	$20	1.5	0.015	0.231	0.027	0.0041	0.0027	
4	10,000 - 11,999	10	7.7	0.077	$30	2.3	0.023	0.308	0.050	0.0115	0.0083	
5	12,000 - 14,999	10	7.7	0.077	$50	3.8	0.038	0.385	0.088	0.0272	0.0192	
6	15,000 - 16,999	10	7.7	0.077	$75	5.8	0.058	0.462	0.146	0.0562	0.0408	
7	17,000 - 17,999	10	7.7	0.077	$90	6.9	0.069	0.538	0.215	0.0994	0.0787	
8	18,000 - 19,999	10	7.7	0.077	$100	7.7	0.077	0.615	0.292	0.1574	0.1325	
9	20,000 - 21,999	10	7.7	0.077	$110	8.5	0.085	0.692	0.377	0.2320	0.2024	
10	22,000 - 24,999	10	7.7	0.077	$115	8.8	0.088	0.769	0.465	0.3222	0.2899	
11	25,000 - 29,999	10	7.7	0.077	$125	9.6	0.096	0.846	0.562	0.4320	0.3938	
12	30,000 - 34,999	10	7.7	0.077	$170	13.1	0.131	0.923	0.692	0.5858	0.5183	
13	35,000 and over	10	7.7	0.077	$400	30.8	0.308	1.000	1.000	0.9231	0.6923	
Total		130	100.0	1.000	$1,300	100.0	1.000			2.8518	2.3796	0.472

* due to the limitations of Quattro Pro, "i" and "i+1" do not appear as subscripts as they should

Gini = sum(XiYi+1) - sum(Xi+1Yi)
= 2.8518 - 2.3796
= 0.472

Gini Coefficient Calculations: **Model 1**

Income Group	Income After Tax Group	# Families	Percent of Families	Proportion of Families	Income	Percent of Income	Proportion of Income	Cumulative Proportion Families X	Cumulative Proportion Income Y	Xi(Yi+1)	Yi(Xi+1)	Gini
1	Less than 5,000	10	7.7	0.077	$50	3.8	0.038	0.077	0.038			
2	5,000 - 6,999	10	7.7	0.077	$50	3.8	0.038	0.154	0.077	0.0059	0.0059	
3	7,000 - 9,999	10	7.7	0.077	$50	3.8	0.038	0.231	0.115	0.0178	0.0178	
4	10,000 - 11,999	10	7.7	0.077	$50	3.8	0.038	0.308	0.154	0.0355	0.0355	
5	12,000 - 14,999	10	7.7	0.077	$50	3.8	0.038	0.385	0.192	0.0592	0.0592	
6	15,000 - 16,999	10	7.7	0.077	$75	5.8	0.058	0.462	0.250	0.0962	0.0888	
7	17,000 - 17,999	10	7.7	0.077	$90	6.9	0.069	0.538	0.319	0.1473	0.1346	
8	18,000 - 19,999	10	7.7	0.077	$100	7.7	0.077	0.615	0.396	0.2133	0.1964	
9	20,000 - 21,999	10	7.7	0.077	$110	8.5	0.085	0.692	0.481	0.2959	0.2743	
10	22,000 - 24,999	10	7.7	0.077	$115	8.8	0.088	0.769	0.569	0.3941	0.3698	
11	25,000 - 29,999	10	7.7	0.077	$125	9.6	0.096	0.846	0.665	0.5118	0.4817	
12	30,000 - 34,999	10	7.7	0.077	$170	13.1	0.131	0.923	0.796	0.6737	0.6142	
13	35,000 and over	10	7.7	0.077	$265	20.4	0.204	1.000	1.000	0.9231	0.7962	
Total		130	100.0	1.000	$1,300	100.0	1.000			3.3737	3.0743	0.299

Gini = sum(XiYi+1) - sum(Xi+1Yi)
= 3.3737 - 3.0743
= 0.299

Gini Coefficient Calculations: **Model 2**

Income Group	Income After Tax Group	# Families	Percent of Families	Proportion of Families	Income	Percent of Income	Proportion of Income	Cumulative Proportion Families X	Cumulative Proportion Income Y	Xi(Yi+1)	Yi(Xi+1)	Gini
1	Less than 5,000	10	7.7	0.077	$5	0.4	0.004	0.077	0.004			
2	5,000 - 6,999	10	7.7	0.077	$10	0.8	0.008	0.154	0.012	0.0009	0.0006	
3	7,000 - 9,999	10	7.7	0.077	$79	6.1	0.061	0.231	0.073	0.0112	0.0027	
4	10,000 - 11,999	10	7.7	0.077	$79	6.1	0.061	0.308	0.134	0.0309	0.0224	
5	12,000 - 14,999	10	7.7	0.077	$79	6.1	0.061	0.385	0.195	0.0600	0.0514	
6	15,000 - 16,999	10	7.7	0.077	$79	6.1	0.061	0.462	0.256	0.0985	0.0899	
7	17,000 - 17,999	10	7.7	0.077	$79	6.1	0.061	0.538	0.317	0.1464	0.1378	
8	18,000 - 19,999	10	7.7	0.077	$79	6.1	0.061	0.615	0.378	0.2036	0.1951	
9	20,000 - 21,999	10	7.7	0.077	$79	6.1	0.061	0.692	0.439	0.2703	0.2618	
10	22,000 - 24,999	10	7.7	0.077	$79	6.1	0.061	0.769	0.500	0.3464	0.3379	
11	25,000 - 29,999	10	7.7	0.077	$79	6.1	0.061	0.846	0.562	0.4320	0.4234	
12	30,000 - 34,999	10	7.7	0.077	$170	13.1	0.131	0.923	0.692	0.5858	0.5183	
13	35,000 and over	10	7.7	0.077	$400	30.8	0.308	1.000	1.000	0.9231	0.6923	
Total		130	100.0	1.000	$1,300	100.0	1.000			3.1090	2.7338	0.375

Gini = sum(XiYi+1) - sum(Xi+1Yi)
= 3.1090 - 2.7338
= 0.375

APPENDIX D

Data

Canada	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	20.3	21.0	20.9	21.5
Decile Ratio	8.1	8.1	7.8	8.4
Gini Coefficient	0.290	0.299	0.297	0.305
Market Income				
Robin Hood Index	25.8	28.1	29.5	30.4
Decile Ratio	57.9	104.1	143.5	166.3
Gini Coefficient	0.371	0.402	0.419	0.431
Health Outcomes				
Total Mortality (/100,000 pop.)	819	785	726	690
Life Expectancy at Birth	75.4	76.7	77.8	78.6
External Cause Mortality				
ASMR (/ 100,000 pop.)	65	55	48	46
SMR (percent)	137	114	100	95
Homicide				
ASMR (/ 100,000 pop.)	2.33	2.02	2.27	1.79
SMR (percent)	101	88	100	79
Suicide				
ASMR (/ 100,000 pop.)	14	15	13	14
SMR (percent)	108	111	100	104
Self-Rated Health (percent)	-	25.0	25.6	24.7
Infant Mortality (/ 1,000 live births)	9.6	7.9	6.4	5.6
Low Birth Weight (percent)	6.0	5.5	5.6	5.8
Covariates				
Median Income (constant 1997$)	43,887	42,147	41,679	41,137
Low Income Cut-Offs (percent)	13.1	13.5	13.0	14.5
Smoking (percent)	32.7	30.1	28.3	24.6

Newfoundland	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	20.9	20.7	20.6	21.1
Decile Ratio	7.6	6.8	7.4	7.1
Gini Coefficient	0.297	0.289	0.291	0.295
Market Income				
Robin Hood Index	30.5	35.4	35.7	35.3
Decile Ratio	450.0	119.5	-845.4	-840.2
Gini Coefficient	0.430	0.479	0.492	0.482
Health Outcomes				
Total Mortality (/100,000 pop.)	811	821	803	738
Life Expectancy at Birth	75.3	76.3	76.8	77.8
External Cause Mortality				
SMR (percent)	128	74	69	78
Homicide				
SMR (percent)	8	31	62	48
Suicide				
SMR (percent)	36	33	56	52
Self-Rated Health (percent)	-	20.6	22.3	25.8
Infant Mortality (/ 1,000 live births)	9.7	8.0	7.8	6.6
Low Birth Weight (percent)	-	-	5.6	6.1
Covariates				
Median Income (constant 1997$)	37,503	31,939	34,025	32,650
Low Income Cut-Offs (percent)	18.1	21.3	16.4	16.1
Smoking (percent)	33.7	33.3	30.3	27.4

Prince Edward Island	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	20.0	18.9	19.2	19.4
Decile Ratio	6.7	5.7	6.3	6.2
Gini Coefficient	0.286	0.269	0.275	0.273
Market Income				
Robin Hood Index	29.4	29.8	31.4	30.3
Decile Ratio	97.4	195.4	160.9	105.6
Gini Coefficient	0.416	0.424	0.438	0.423
Health Outcomes				
Total Mortality (/100,000 pop.)	752	800	792	777
Life Expectancy at Birth	76.7	76.0	76.7	77.3
External Cause Mortality				
SMR (percent)	78	115	119	96
Homicide				
SMR (percent)	38	0	70	34
Suicide				
SMR (percent)	59	87	132	69
Self-Rated Health (percent)	-	18.8	22.5	21.1
Infant Mortality (/ 1,000 live births)	13.2	6.8	6.9	4.7
Low Birth Weight (percent)	5.6	4.9	4.5	5.3
Covariates				
Median Income (constant 1997$)	35,190	34,759	36,243	36,140
Low Income Cut-Offs (percent)	15.8	9.3	9.6	11.3
Smoking (percent)	30.3	29.4	29.8	27.5

Nova Scotia	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	19.9	21.2	19.8	21.2
Decile Ratio	7.5	7.7	6.5	8.1
Gini Coefficient	0.284	0.300	0.278	0.296
Market Income				
Robin Hood Index	27.7	30.9	30.2	32.2
Decile Ratio	121.5	268.4	173.2	-117.6
Gini Coefficient	0.394	0.439	0.424	0.446
Health Outcomes				
Total Mortality (/100,000 pop.)	876	828	754	730
Life Expectancy at Birth	74.7	76.1	77.3	77.8
External Cause Mortality				
SMR (percent)	123	96	97	100
Homicide				
SMR (percent)	32	80	88	74
Suicide				
SMR (percent)	86	83	95	97
Self-Rated Health (percent)	-	16.4	19.6	18.8
Infant Mortality (/ 1,000 live births)	11.5	8.4	5.7	5.6
Low Birth Weight (percent)	5.6	5.6	5.7	5.4
Covariates				
Median Income (constant 1997$)	36,433	36,256	36,443	34,346
Low Income Cut-Offs (percent)	15.9	14.1	12.7	15.4
Smoking (percent)	34.2	32.3	29.2	29.0

New Brunswick	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	21.5	19.5	20.3	21.0
Decile Ratio	8.6	7.1	6.6	7.7
Gini Coefficient	0.307	0.278	0.283	0.297
Market Income				
Robin Hood Index	31.0	30.5	31.9	32.8
Decile Ratio	-628.8	-567.9	347.7	-241.0
Gini Coefficient	0.438	0.428	0.441	0.459
Health Outcomes				
Total Mortality (/100,000 pop.)	830	807	730	708
Life Expectancy at Birth	75.1	76.3	77.7	78.2
External Cause Mortality				
SMR (percent)	142	116	99	92
Homicide				
SMR (percent)	117	99	92	42
Suicide				
SMR (percent)	89	105	98	97
Self-Rated Health (percent)	-	19.0	20.8	20.0
Infant Mortality (/ 1,000 live births)	10.9	8.3	6.1	4.9
Low Birth Weight (percent)	6.1	5.1	5.6	5.1
Covariates				
Median Income (constant 1997$)	35,493	35,821	36,071	34,875
Low Income Cut-Offs (percent)	18.5	14.4	12.4	13.5
Smoking (percent)	34.6	28.1	26.5	26.8

Quebec	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	19.9	20.7	20.4	21.1
Decile Ratio	7.6	7.4	7.6	7.8
Gini Coefficient	0.286	0.293	0.291	0.297
Market Income				
Robin Hood Index	26.5	28.8	30.6	31.7
Decile Ratio	109.7	300.0	-495.1	176.6
Gini Coefficient	0.381	0.410	0.435	0.447
Health Outcomes				
Total Mortality (/100,000 pop.)	852	836	756	709
Life Expectancy at Birth	74.9	76.0	77.3	78.4
External Cause Mortality				
SMR (percent)	138	109	103	106
Homicide				
SMR (percent)	92	89	98	84
Suicide				
SMR (percent)	126	133	122	155
Self-Rated Health (percent)	-	30.1	25.0	26.8
Infant Mortality (/ 1,000 live births)	8.5	7.1	5.9	4.6
Low Birth Weight (percent)	6.7	6.2	5.9	5.9
Covariates				
Median Income (constant 1997$)	40,290	38,345	37,513	36,944
Low Income Cut-Offs (percent)	16.2	16.7	15.7	17.1
Smoking (percent)	39.0	35.3	33.2	29.6

Ontario	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	19.4	20.3	20.7	21.2
Decile Ratio	7.5	7.6	7.7	8.1
Gini Coefficient	0.278	0.291	0.294	0.302
Market Income				
Robin Hood Index	23.9	25.8	28.3	29.2
Decile Ratio	29.7	43.9	87.0	91.2
Gini Coefficient	0.346	0.375	0.403	0.419
Health Outcomes				
Total Mortality (/100,000 pop.)	823	781	727	686
Life Expectancy at Birth	75.7	76.9	77.9	78.8
External Cause Mortality				
SMR (percent)	114	95	83	84
Homicide				
SMR (percent)	78	60	77	66
Suicide				
SMR (percent)	97	94	75	77
Self-Rated Health (percent)	-	24.7	27.4	25.0
Infant Mortality (/ 1,000 live births)	8.8	7.2	6.3	5.7
Low Birth Weight (percent)	5.8	5.4	5.7	6.0
Covariates				
Median Income (constant 1997$)	46,614	46,871	46,120	45,812
Low Income Cut-Offs (percent)	10.9	9.8	11.2	13.3
Smoking (percent)	30.1	28.0	26.0	21.8

Manitoba	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	21.2	20.8	20.1	20.8
Decile Ratio	10.4	7.9	7.1	7.7
Gini Coefficient	0.303	0.295	0.285	0.294
Market Income				
Robin Hood Index	27.1	28.5	29.7	30.1
Decile Ratio	173.0	99.2	91.6	297.7
Gini Coefficient	0.388	0.404	0.417	0.424
Health Outcomes				
Total Mortality (/100,000 pop.)	822	780	718	696
Life Expectancy at Birth	75.5	76.6	77.6	78.2
External Cause Mortality				
SMR (percent)	147	120	100	98
Homicide				
SMR (percent)	154	188	148	176
Suicide				
SMR (percent)	111	112	96	82
Self-Rated Health (percent)	-	21.3	22.3	21.2
Infant Mortality (/ 1,000 live births)	11.9	9.2	6.4	6.7
Low Birth Weight (percent)	5.5	5.3	5.4	5.5
Covariates				
Median Income (constant 1997$)	41,208	38,746	36,974	39,267
Low Income Cut-Offs (percent)	15.8	17.0	18.8	15.0
Smoking (percent)	29.4	29.7	26.8	23.1

Saskatchewan	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	22.7	23.0	20.2	20.7
Decile Ratio	10.7	11.6	8.1	8.4
Gini Coefficient	0.323	0.322	0.287	0.294
Market Income				
Robin Hood Index	28.6	31.0	29.2	30.7
Decile Ratio	150.0	-165.1	99.3	157.8
Gini Coefficient	0.409	0.432	0.412	0.429
Health Outcomes				
Total Mortality (/100,000 pop.)	739	729	678	668
Life Expectancy at Birth	76.0	77.1	78.2	78.5
External Cause Mortality				
SMR (percent)	160	135	116	103
Homicide				
SMR (percent)	146	107	93	132
Suicide				
SMR (percent)	140	108	100	110
Self-Rated Health (percent)	-	18.1	20.5	16.9
Infant Mortality (/ 1,000 live births)	11.8	9.0	8.2	8.4
Low Birth Weight (percent)	5.6	4.9	5.1	5.0
Covariates				
Median Income (constant 1997$)	41,348	37,496	37,133	37,310
Low Income Cut-Offs (percent)	14.4	16.4	14.0	13.8
Smoking (percent)	27.3	27.6	29.6	26.0

Alberta	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	19.9	20.9	21.5	21.3
Decile Ratio	8.4	8.0	8.3	8.4
Gini Coefficient	0.287	0.296	0.306	0.305
Market Income				
Robin Hood Index	24.0	26.8	28.4	28.4
Decile Ratio	28.8	49.8	55.9	44.0
Gini Coefficient	0.347	0.381	0.407	0.407
Health Outcomes				
Total Mortality (/100,000 pop.)	805	752	690	671
Life Expectancy at Birth	75.5	76.8	78.1	78.7
External Cause Mortality				
SMR (percent)	153	146	124	114
Homicide				
SMR (percent)	130	111	131	89
Suicide				
SMR (percent)	118	138	140	130
Self-Rated Health (percent)	-	22.3	23.9	25.5
Infant Mortality (/ 1,000 live births)	10.6	9.0	6.7	6.2
Low Birth Weight (percent)	6.4	5.5	5.8	6.1
Covariates				
Median Income (constant 1997$)	49,660	45,111	43,437	43,377
Low Income Cut-Offs (percent)	9.5	12.3	13.0	13.0
Smoking (percent)	32.7	28.3	27.6	24.5

British Columbia	1981	1986	1991	1996
Income Inequality				
Income After Tax				
Robin Hood Index	20.0	21.0	19.5	20.9
Decile Ratio	8.2	8.5	7.1	9.4
Gini Coefficient	0.086	0.301	0.280	0.297
Market Income				
Robin Hood Index	24.9	27.7	26.9	28.5
Decile Ratio	42.6	132.1	52.0	69.9
Gini Coefficient	0.355	0.399	0.383	0.406
Health Outcomes				
Total Mortality (/100,000 pop.)	762	716	681	661
Life Expectancy at Birth	76.1	77.7	78.4	79.0
External Cause Mortality				
SMR (percent)	174	131	124	89
Homicide				
SMR (percent)	171	111	148	71
Suicide				
SMR (percent)	111	111	106	78
Self-Rated Health (percent)	-	25.1	28.7	24.4
Infant Mortality (/ 1,000 live births)	10.2	8.5	6.5	5.1
Low Birth Weight (percent)	5.2	4.8	4.9	5.2
Covariates				
Median Income (constant 1997$)	48,351	42,675	45,300	43,671
Low Income Cut-Offs (percent)	11.4	14.8	10.4	13.9
Smoking (percent)	28.3	26.5	24.8	21.1

APPENDIX E

Detailed references for population counts, health outcome and covariate data

1. POPULATION COUNTS

1981 & 1986 Statistics Canada. *The Nation: Age, Sex and Marital Status, Population and Dwelling Characteristics*. Catalogue 93-101. Ottawa: Minister of Supply and Services Canada, September 1987. Table 3: Population by Five-Year Age Groups and Sex, for Canada, Provinces and Territories, 1981 and 1986. Pp. 3-1 to 3-4.

1991 Statistics Canada. *The Nation: Age, Sex and Marital Status*. Catalogue 93-310. Ottawa: Minister of Industry, Science and Technology, 1992. Table 4: Population by Single Years of Age and Sex, for Canada, Provinces, Territories and Census Metropolitan Areas, 1991 - 100% Data. Pp. 108-123.

1996 Statistics Canada, Health Statistics Division. *Nation Series (computer file)*. Catalogue. 92-F0020-XCB. Ottawa: Ministry of Industry, 1998.

In the above publications, the sum of the age specific population figures for males and females do not necessarily equal the total population figures due to rounding. For the purpose of calculating outcome measures, the sums of the age specific figures were used. Consequently the population total figures used in this thesis do not always equal the published ones. However, the discrepancy between the thesis figures and the published ones is small enough to be deemed insignificant.

2. HEALTH OUTCOMES

2.1 Total Mortality

1981 Statistics Canada, Health Division, Vital Statistics and Disease Registries Section. *Vital statistics, Volume 1, Births and deaths, 1981.* Catalogue 84-204. Ottawa: Minister of Supply and Services Canada, 1983. Table 18: Deaths by Single Year of Age and Sex, Canada and Provinces, 1981. Pp. 32-45.

1986 Statistics Canada, Health Division, Vital Statistics and Health Status Section. *Vital statistics, Volume 1, Births and deaths, 1986.* Catalogue

84-204. Ottawa: Minister of Supply and Services Canada, 1988. Table 18: Deaths by Single Year of Age and Sex, Canada and Provinces, 1986. Pp. 46-59.

1991 Statistics Canada, Canadian Centre for Health Information. *Deaths, 1991.* Catalogue 84-211. Ottawa: Minister of Industry, Science and Technology, 1994. Table 3: Deaths by Single Year of Age and Sex, Canada and Provinces, 1991. Pp. 5-12.

1996 Statistics Canada, Health Statistics Division. *Nation Series (computer file).* Catalogue. 92-F0020-XCB. Ottawa: Ministry of Industry, 1998.

2.2 Life Expectancy at Birth

1981 Statistics Canada. *Life tables, Canada and Provinces, 1980-1982.* Catalogue 84-532. Ottawa: Information Canada.

1986-1996 Statistics Canada, Health Statistics Division. *Vital Statistics Compendium, 1996.* Catalogue 84-214. Ottawa, Ministry of Industry, November 1999. Table 6.4: Life expectancy at birth by sex, Canada and provinces, 1986-1996. Pp. 54.

2.3 Mortality from External Causes, Injury & Poisoning

1981 Statistics Canada, Health Division, Vital Statistics and Disease Registries Section. *Causes of Death: Provinces by sex and Canada by sex and age, 1981.* Catalogue 84-203. Ottawa: Minister of Supply and Services Canada, 1982.

1986 Statistics Canada, Health Division, Vital Statistics and Health Status Section. *Causes of Death, Vital statistics, Volume IV, 1986.* Catalogue 84-203. Ottawa: Minister of Supply and Services Canada, 1988.

1991 Statistics Canada & Canadian Centre for Health Information. *Causes of Death, 1991.* Catalogue 84-208. Ottawa: Minister of Industry, Science and Technology, 1993.

1996 Statistics Canada. *Health Statistics at a Glance.* Electronic resource. Catalogue 82-F0075-XCB. Ottawa, 1999. Internet URL: http://www.uottawa.ca/library/dataserv/hlthind.html. URL verified: 000913.

2.4 Homicide

As for **Mortality from External Causes, Injury & Poisoning**

2.5 Suicide

As for **Mortality from External Causes, Injury & Poisoning**

2.6 Self-Rated health

1981 not available

1986 Health and Welfare Canada. *Canada's Health Promotion Survey: Technical Report* [1985]. Ottawa: Ministry of Supply and Services Canada, 1988. Health Status, Table 3: Self-assessed health status, by province, age 15+, Canada, 1985:190.

Health Promotion Survey, 1985. Electronic data file from Carleton University, Library Data Centre.

1991 Health and Welfare Canada. *Canada's Health Promotion Survey 1990: Technical Report*. Ottawa: Ministry of Supply and Services Canada, 1993. Table 3-2: Self-rated health status, by province and sex, age 15+, Canada, 1990: 33.

Health Promotion Survey, 1990. Electronic data file from Carleton University, Library Data Centre.

1996 ACPH (Federal, Provincial and Territorial Advisory Committee on Population Health). *Statistical Report on the Health of Canadians*. Ottawa: Minister of Public Works and Government Services Canada, 1999. Table 53: Self-rated health status, by age and sex, by province, age 12+, Canada, 1996-97:219.[19]

National Population Health Survey, 1996-97. Electronic data file from Carleton University, Library Data Centre.

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[19] The source of data for this report is the National Population Health Survey (NPHS), 1996-97, special tabulations. Respondents are aged 12+ years. Data from the NPHS were used to establish self-rated health 15+years. The results were compared with those found in this report to establish the validity of the calculated results.

2.7 Infant Mortality

1981 Statistics Canada, Health Division, Vital Statistics and Disease Registries Section. *Vital statistics, Volume 1, Births and deaths, 1981.* Catalogue 84-204. Ottawa: Minister of Supply and Services Canada, 1983. Table 22: Infant Death Rates by Age and Sex, Canada and Provinces, 1981:54-5.

1986-1996 Statistics Canada, Health Statistics Division. *Vital Statistics Compendium, 1996.* Catalogue 84-214. Ottawa, Ministry of Industry, November 1999. Table 5.3: Infant deaths and infant mortality rates, Canada, provinces and territories, 1986-1996:40.

2.8 Low Birth Weight

1981 Statistics Canada, Health Division, Vital Statistics and Disease Registries Section. *Vital statistics, Volume 1, Births and deaths, 1981.* Catalogue 84-204. Ottawa: Minister of Supply and Services Canada, 1983. Table 12: Live Births by Birth weight and Sex, Canada and Provinces, 1981:18.

1986-1996 Statistics Canada, Health Statistics Division. *Vital Statistics Compendium, 1996.* Catalogue 84-214. Ottawa, Ministry of Industry, November 1999. Table 4.9: Number and percentage of live births with low Birth weight (under 2,500 grams), Canada, provinces and territories, 1986-1996:31.

3. COVARIATES

3.1 Median Income

1981-1996 Statistics Canada, Income Statistics Division. *Income Trends in Canada: 1980-1997.* CD-ROM 13F0022XCB. Ottawa: Minister of Industry, 1999. Table: Income after tax, distribution of Economic Families, Canada, provinces & CMAs, 1980-1997, current and constant (1997) dollars.

3.2 Low Income Cut-Offs (LICOs)

1981-1996 Statistics Canada, Income Statistics Division. *Income Trends in Canada: 1980-1997.* CD-ROM 13F0022XCB. Ottawa: Minister of Industry, 1999. Table: Before-tax LICOs: Prevalence by age and sex for EF and UI, 1986 and 1992 bases, Canada, provinces and CMAs, 1980-1997.

3.3 Smoking

1981 Millar, W.J. *Smoking Behaviour of Canadians, 1981*. Ottawa: Health and Welfare Canada, Health Promotion Directorate, Health Services and Promotion Branch, 1983.

1986 Health and Welfare Canada. *Canada's Health Promotion Survey: Technical Report* [1985]. Ottawa: Ministry of Supply and Services Canada, 1988. Tobacco Use, Table 3: Smoking status, by province, age 15+, Canada, 1985:28.

1991 Health and Welfare Canada. *Health Promotion Survey, 1990.* Electronic data file from Carleton University, Library Data Centre.

1996 Statistics Canada. *National Population Health Survey, 1996-97.* Electronic data file from Carleton University, Library Data Centre.

APPENDIX F

Data problems arising from national surveys

a) Self-Rated Health

A variety of national surveys were identified that provide self-rated health data. They are listed in the following table.

Appendix Table F1 National surveys containing self-rated health data, 1981-1996

Study year	Survey year	Survey name
1981	-	-
1986	1985	Health Promotion Survey (HPS)
	1985	General Social Survey, Cycle 1
1991	1990	Health Promotion Survey
	1991	General Social Survey, Cycle 6
1996	1996	National Population Health Survey
	1996	General Social Survey, Cycle 11

A number of problems arose when attempting to establish levels of self-rated health for the four time points in the study period from the available surveys.

1. A survey was not identified to cover the 1981 time point. Although the 1977 Canada Health Survey (CHS) was available, the survey year was considered too far from the study year. In addition, the most suitable variable identified in the CHS (labeled *Feel healthy enough* (HEAL208) with response categories *often, sometimes* and *never*) was deemed a poor choice against which to compare variables from the other surveys. Consequently, this thesis lacks self-rated health data for 1981.

2. Half of the surveys containing self-rated health data did not coincide exactly with the study years. That is, the Health Promotion Surveys (1990 and 1985) and the first cycle of the General Social Survey (1985) were conducted earlier than the study time points of 1991 and 1986. While this is not considered a major problem, readers should be aware that other health outcome, covariate and income inequality data may have been collected in different years from the self-rated health data.

3. The major problem encountered with the self-rated health data pertains to inconsistent results obtained from what are presumably comparable national surveys. That is, one would expect that surveys measuring the level of self-rated health for the

same areas and time periods would yield the same, or at least similar, results. Unfortunately this was not the case.

The self-rated health variable in this thesis represents the percentage of people in Canada and the provinces who rate their health as "excellent". Surveys covering the same time period yield quite different results. For example, in the 1985 Health Promotion Survey (HPS) 25.0% of Canadians rated their health as excellent compared to 32.5% in the General Social Survey, Cycle 1 (GSS1). Similar discrepancies can be found in other years. In 1990 the HPS 25.6% of Canadians were in the excellent category while the GSS6 reports 23.7% in this category. Results in the provinces are even more varied.

Discrepancies exist not only in the absolute percentages, but also in the relative rankings of the provinces. When the provinces are ranked for each survey, Spearman correlation coefficients demonstrate this incongruity:

Appendix Table F2 Spearman correlation coefficients for provincial rankings of self-rated health: comparison of various health surveys, 1985, 1991 and 1996

Study year	Survey and year	Spearman correlation coefficient
1996	NPHS 1996	0.378
	GSS11 1996	
1991	HPS 1990	0.606
	GSS6 1991	
1986	HPS 1985	0.688
	GSS1 1985	

Correlations between the surveys are low to moderate. A number of areas were examined in an attempt to explain the lack of agreement between surveys. They are summarized in the following table.

Appendix Table F3 Comparison of selected features in the HPSs, the GSSs and the NPHS, 1985-1996				
Survey	Sample size	Age of respondents	Survey question	Answer categories
NPHS 1996	70,884	15+	Respondents general health	5
GSS11 1996	12,756	15+	How would you describe your state of health?	5
HPS 1990	13,792	15+	Compared to others your age, your health is...	5
GSS6 1991	11,924	15+	Respondents state of health compared to others	5
HPS 1985	10,491	15+	Health compared to others same age	5
GSS1 1985	11,200	15+	How would you describe your state of health?	4

The sample sizes are large, the age of respondents the same, and the questions appear comparable. The only area that appears problematic is that the 1985 surveys have different numbers of response categories. In each survey (except GSS1) the same answer categories are used: *excellent, very good, good, fair* and *poor*. The GSS1 uses *excellent, good, fair* and *poor*. This leads to higher numbers in each category. That is, the percent of the population rating their health as excellent is consistently higher for each province in the GSS1 compared to the HPS85.

Two major concerns remain. First, is it possible under the circumstances to analyze the health of Canadians using self-rated health as an outcome variable? It is difficult to have confidence in either the percentages or the provincial rankings when national surveys covering the same time periods produce such different results. And secondly, if analyses are to take place, which group of surveys should be used? It is most logical to group the General Social Surveys together leaving the Health Promotion and National Population Health Surveys together. When this is done, the following Spearman correlation coefficients result:

Appendix Table F4	Spearman correlation coefficient matrix for provincial rankings of self-rated health: comparison of the HPSs and the NPHS, 1985-1996	
HPS 1990	0.879	
NPHS 1996	0.754	0.624
	HPS 1985	HPS 1990

Appendix Table F5	Spearman correlation coefficient matrix for provincial rankings of self-rated health: comparison of the GSSs, 1985-1996	
GSS6 1991	0.433	
GSS11 1996	0.555	0.223
	GSS1 1985	GSS6 1991

Intuitively, one would expect a high correlation between the surveys for different years. That is, assuming that absolute levels of self-rated health fluctuate within the provinces while the relative levels of self-rated health between the provinces remain fairly constant. Based on this assumption, data from the Health Promotion Surveys and National Population Health Survey were used to establish levels of self-rated health. However, the reader is warned to view the results with caution.

b) Smoking Prevalence

A variety of national surveys were identified that provide smoking prevalence data for the relevant study years. They are listed in the following table.

Appendix Table F6 National surveys containing smoking prevalence data, 1981-1996

Study year	Survey year	Survey name
1981	1981	Smoking Behaviour of Canadians Survey
1986	1985	Health Promotion Survey
	1985	General Social Survey, Cycle 1
	1986	Smoking Behaviour of Canadians Survey
1991	1990	Health Promotion Survey
	1991	General Social Survey, Cycle 6
1996	1996	National Population Health Survey
	1996	General Social Survey, Cycle 11

Two problems arose when attempting to establish prevalence of smoking for the four time points in the study period from the available surveys.

1. As mentioned with the self-rated health data, half of the surveys containing smoking data did not coincide exactly with the study years. That is, the Health Promotion Surveys (1985 and 1990) and the first cycle of the General Social Survey (1985) were conducted earlier than the study time points of 1991 and 1986. This is not considered a major problem but one that the reader should be aware of.

2. The major problem encountered with the smoking data was the inconsistent results between national surveys covering the same or similar time periods. For example, in 1985, 28.2% of Canadians, aged 15 years and over, were regular smokers according to the Smoking Behaviour of Canadians Survey, whereas the Health Promotion Survey and GSS1 indicate that over 30% were regular smokers. Some of the provinces show even more variability such as Manitoba. The 1986 Smoking Behaviour of Canadians Survey reports that 27.7% of the population, aged 15 years and over, were regular smokers compared to 29.7% from the Health Promotion Survey and 32.9% from the GSS1. It is difficult to have confidence in the surveys with this variability or even select which survey to use.

To some extent this problem has been addressed in a paper from Statistics Canada (Gilmore, 2000). Gilmore highlights the potential for inaccuracy at the survey question stage. Data collection is believed to be very accurate when the first smoking question addresses present behaviour, such as "At the present time, do you smoke cigarettes daily,

occasionally, or not at all?". This question format has been endorsed by the Workshop on Data for Monitoring Tobacco Use (Gilmore, 2000:6). However, some surveys first enquire about past behaviour as in "Have you ever smoked cigarettes?". It is believed that some occasional smokers, or those just beginning to experiment with cigarettes, may inappropriately answer no to this question about past behaviour and consequently screen themselves out from further classification (Gilmore, 2000:7). This impacts on estimations of occasional and current (daily + occasional) smokers. However, the percent of regular or daily smokers is believed to be quite accurate. Thus, Gilmore states for example, that the percent of daily smokers can be compared with caution between the 1990 HPS and the NPHS cycles, even though the question formats are different. However, this still does not address the variation in percentages of daily smokers between surveys of the same year.

The decision was made to use the same surveys as for self-rated health, in addition to the Smoking Behaviour of Canadians Survey, 1981. These surveys have moderately high Spearman Correlation Coefficients compared to the General Social Surveys:

Appendix Table F7	Spearman correlation coefficient matrix for provincial rankings of smoking prevalence: comparison of the SBCS, the HPSs and the NPHS, 1981-1996		
HPS 1985	0.706		
HPS 1990	0.405	0.709	
NPHS 1996	0.706	0.700	0.836
	SBCS 1981	HPS 1985	HPS 1990

Appendix Table F8	Spearman correlation coefficient matrix for provincial rankings of smoking prevalence: comparison of the SBCS and the GSSs, 1981-1996		
GSS1 1985	0.601		
GSS11 1996	0.524	0.009	
GSS6 1991	0.720	0.681	0.409
	SBCS 1981	GSS1 1985	GSS11 1996

The choice of surveys was based on the assumption that while the percentages of regular smokers will vary over time, the relative rankings of the provinces will remain largely unchanged. Thus the group of surveys with the higher Spearman Correlation Coefficients was chosen. However, the reader is warned to view the results with caution.

APPENDIX G

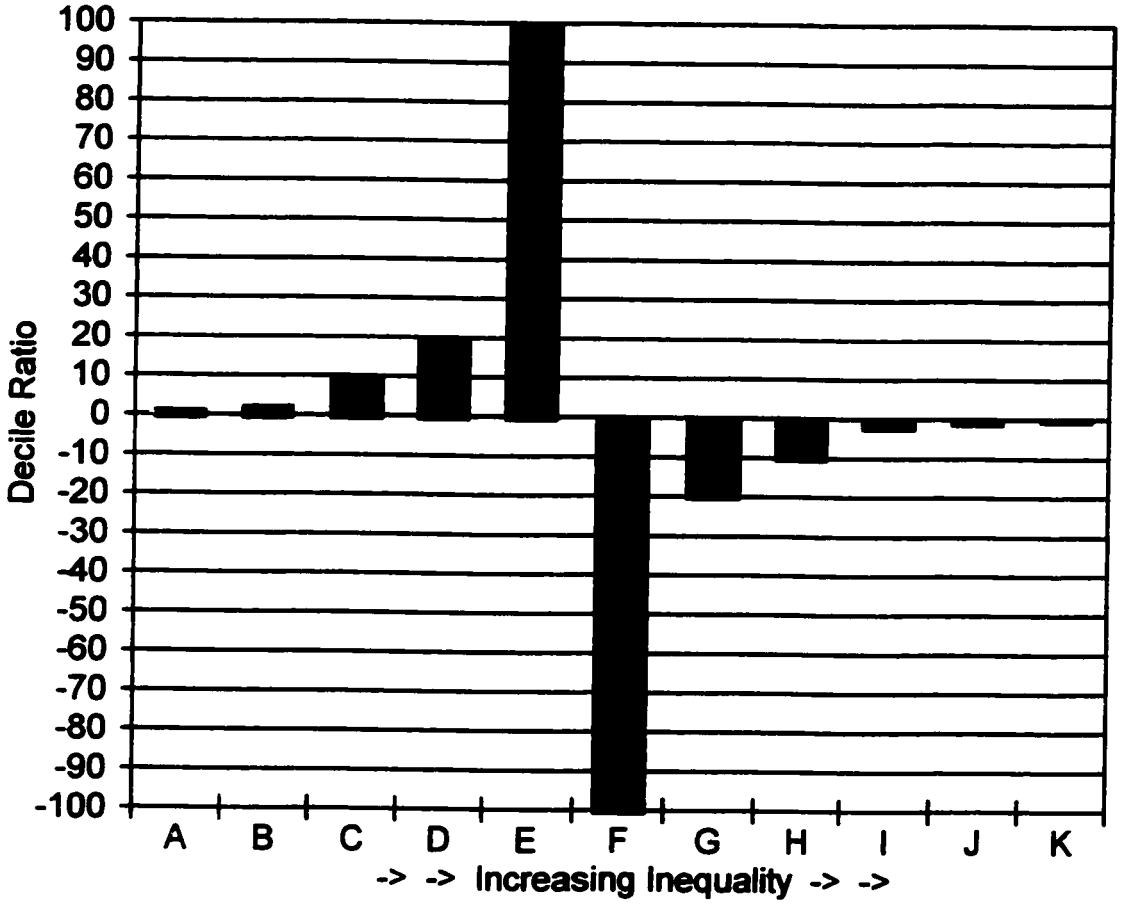
Negative earnings, investment income and the difficulties encountered when interpreting negative decile ratios

Custom tabulations for measures of income inequality were produced by Statistics Canada for the purpose of this thesis. These tabulations were based on data from the Survey of Consumer Finances and the Survey of Labour and Income Dynamics (Appendix D). When decile ratios based on market income were calculated, a number of negative values resulted. As mentioned in the text, these negative values were most likely the result of negative investment or self-employment income. To illustrate, in the 1997 Survey of Consumer Finances, there were 25,110 economic families. Of these families, 108 had negative total earnings and 158 had negative investment income. The lowest investment income was -$60,202. When the sum of these negative incomes is large enough, they cancel out the positive incomes of families in the bottom decile of the income distribution. Consequently the first decile as a whole has a negative income value and a negative decile ratio results. The sample data below and the following bar chart illustrate the difficulties of comparing and interpreting decile ratios when some of them are negative (Table G1) (Figure G1).

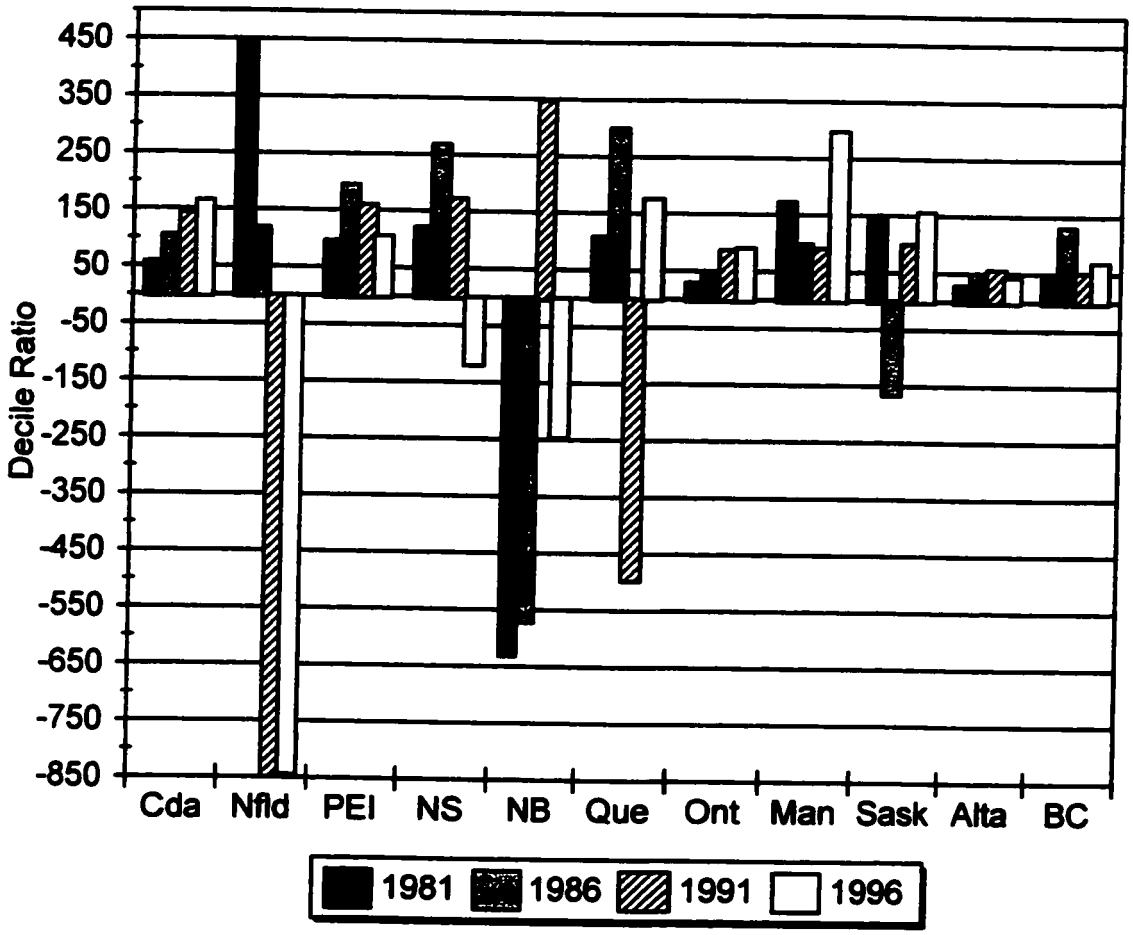
To begin, the decile ratios increase in size as inequality increases. When the sum of incomes in the bottom decile is zero, a decile ratio of infinity is obtained. When income inequality increases even more and the lowest decile has a negative income, the decile ratios become negative. As the value of the bottom decile continues to decrease, the decile ratio approaches but never reaches zero. As Appendix Figure G1 illustrates, decile ratios based on negative incomes are difficult to interpret, hard to compare with decile ratios based on positive incomes and lack intuitive meaning when displayed graphically. The bar chart based on market income using decile ratios for Canada and the provinces over the study period reinforces this point (Figure G2). Consequently, although the Gini coefficient and Robin Hood index have been presented using both income after tax and market income, the presentation of decile ratios have been limited to those based on income after tax.

Appendix Table G1 Demonstration of problems with negative decile ratios (fictitious data)				
Place	Top Decile ($\sum$ income)	Bottom Decile ($\sum$ income)	Decile Ratio	
A	$100	$100	1	Equality
B	$100	$50	2	increasing Inequality ↓
C	$100	$10	10	↓
D	$100	$5	20	↓
E	$100	$1	100	↓
	$100	$0	∞	↓
F	$100	-$1	-100	↓
G	$100	-$5	-20	↓
H	$100	-$10	-10	↓
I	$100	-$50	-2	↓
J	$100	-$100	-1	↓
K	$100	-$200	-0.5	

Appendix Figure G1 Graphical representation of the fictitious data demonstrating problems with negative decile ratios (Appendix Table G1)



Appendix Figure G2 Income inequality (decile ratio) based on market income, Canada and provinces, 1981-1996



APPENDIX H

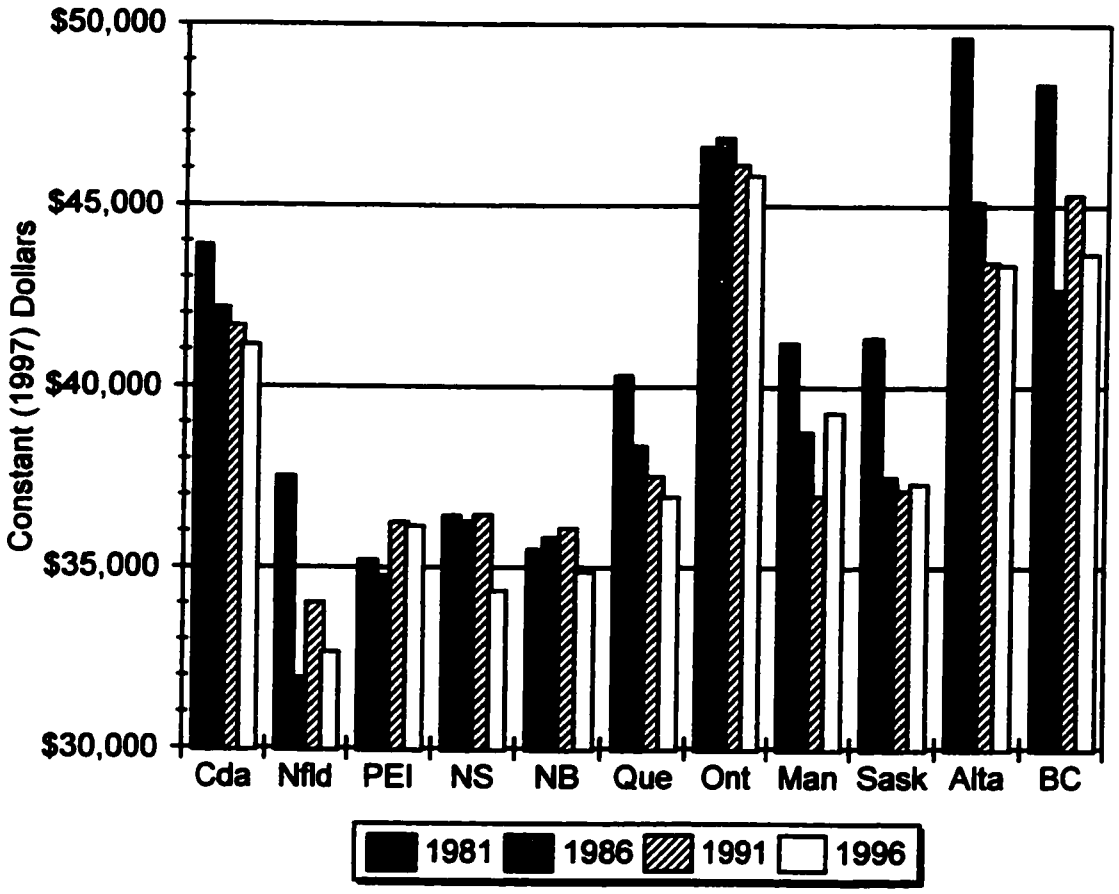
Detailed Results for Covariates

Between 1981 and 1996, the median after tax income, expressed in constant 1997 dollars, decreased in Canada and the provinces (Appendix Figure H1). Ontario, Alberta and BC stood out with median incomes that were consistently higher than the Canadian level. For six of the provinces, there were substantial drops in median income in the early 1980s.

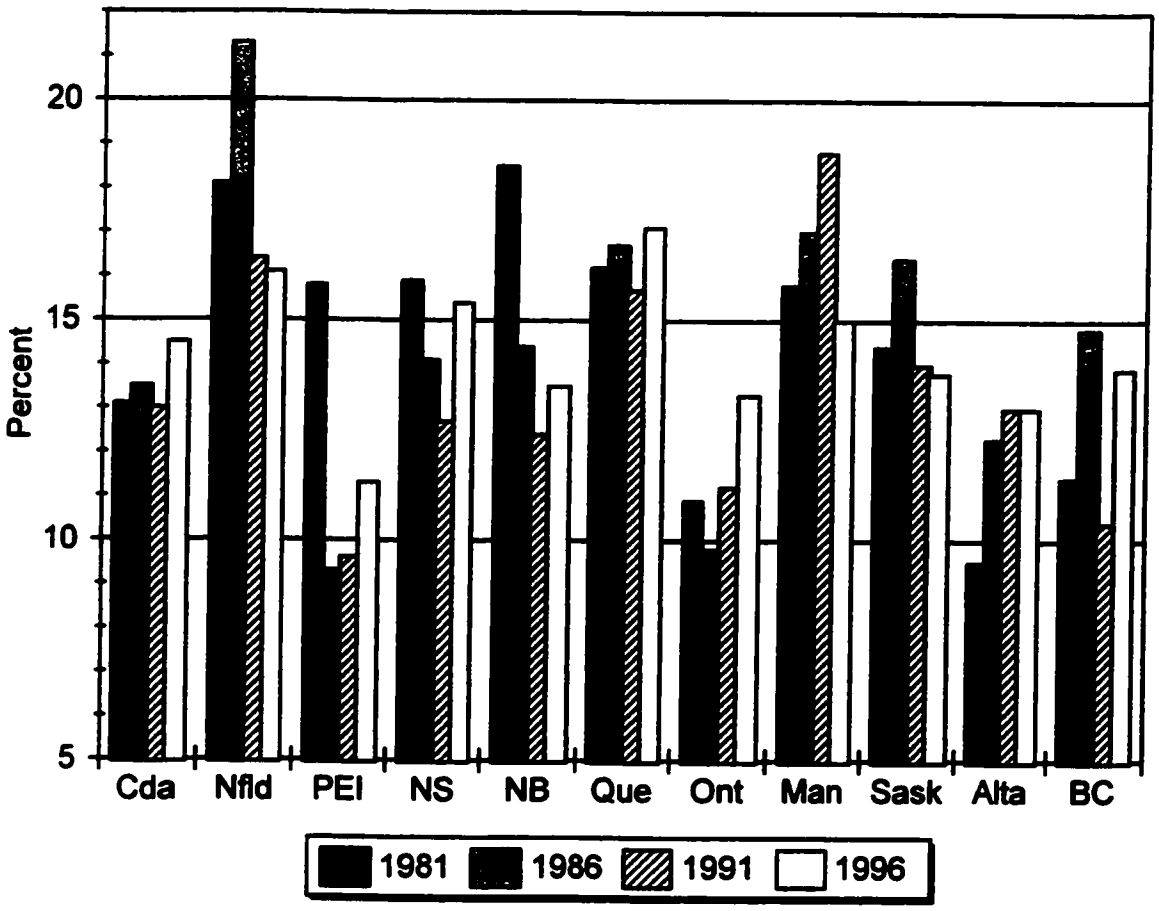
In Canada as a whole, there was an overall increase in the proportion of economic families living below Statistics Canada's LICOs, between 1981 and 1996 (Appendix Figure H2). Although Ontario, Alberta and BC had lower levels than most other provinces, there appeared to be a movement towards provincial homogeneity. There were increases in those provinces that had lower proportions of their populations living below the LICOs, and decreases in provinces with higher proportions. In Canada, the increases coincided with the recessions, with a decrease between 1986 and 1991. This pattern, however, was not reflected in most provinces.

The percent of daily smokers in Canada and the provinces, aged 15-years and over, decreased during the study period (Appendix Figure H3). Most notable was Quebec, with the highest prevalence of daily smokers throughout the study period. For Canada and a number of the provinces, there were particularly large drops during the recessions in the early 1980s and again in the early 1990s.

Appendix Figure H1 Median income in constant (1997) dollars for economic families, Canada and provinces, 1981-1996



Appendix Figure H2 Percent of economic families living below the before tax LICOs (1992 base), Canada and provinces, 1981-1996



Appendix Figure H3 Prevalence of regular (daily) smokers, aged 15-years and over, Canada and provinces, 1981-1996