The Effect of Wait Times on Mortality in Canada

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Summary

Wait times for health care in Canada have lengthened considerably over the past two decades. Across 12 major medical specialties, the estimated typical wait time has risen from 9.3 weeks in 1993 to 18.2 weeks in 2013. These inordinately long waits, among the longest in the developed world, have become a defining feature of the Canadian healthcare experience.

Waiting for medically necessary care is not a benign process and can have important consequences both for patients and for those who care for and rely upon them. Delayed access to medical care may subject patients to increased pain, suffering, and mental anguish. Waiting for health care can also have broader economic consequences such as increased absenteeism, reduced productivity, and reduced ability to work for the individual waiting as well as for family members and friends who are concerned for them or may be called to assist them with activities of daily living. Waiting may also lead to poorer outcomes from care, if not a requirement for more complex treatments, as a result of deterioration in the patients' condition while they wait for treatment. Such deterioration may also result in permanent disability.

Beyond these serious personal and economic consequences lies the risk of death resulting from delayed medical care. In the 2005 Chaoulli decision, Justices of the Supreme Court of Canada noted that patients in Canada die as a result of waiting lists for universally accessible health care. Numerous studies have demonstrated the negative impact of wait times on patient outcomes for a variety of specific diseases and medical conditions. Studies also point to the reality that wait times can have an impact on general health and well-being, which may also result in untimely demise. The unanswered question in the discussion so far has been how many died due to delays in receiving timely care?

It is the answer to this question—the relationship between delayed access to medical services and mortality rates at the population level—that is the focus of our study. Understanding the association between wait times for medical care and death at the population level is critical if we are to more fully understand the consequences of the lengthy delays Canadians endure when accessing medically necessary care.

In this study, we employ an ordinary least squares (OLS) model with fixed effects (FE) to analyse panel data for 10 Canadian provinces, covering the years from 1993 to 2009. The primary dependent variable we focus on is all-cause mortality, although we also conduct a secondary investigation examining potentially avoidable mortality. The explanatory (independent) variables considered for this study broadly fall into three categories. The first category encompasses healthcare resources and includes wait times, total healthcare expenditures, and the proportion of primary care doctors as a percentage of total doctors. The second category encompasses lifestyle risk factors that are captured by the percentage of the population below Statistics Canada's low-income cut-off (LICO). The third set of variables accounts for background characteristics through gross domestic product (GDP) and the percentage of the population over 65.

The variation of mortality between provinces across time is identified by estimating the equation:

$$Mortality_{it} = a_i + \beta\ Total\ Wait_{it} + \gamma_1\ (lag)Real\ total\ health\ expenditure\ per\ capita_{it} + \gamma_2\ Proportion\ of\ primary\ care\ doctors_{it} + \gamma_3\ (lag)Real\ GDP\ per\ capita_{it} + \gamma_4\ Percentage\ of\ population\ below\ LICO_{it} + \gamma_5\ Percentage\ of\ population\ above\ 65_{it} + \varepsilon_{it}$$

where $Mortality_{it}$ is a measure of either all-cause mortality or potentially avoidable mortality, a_i are province-level fixed effects, and ε_{it} is the error term. The subscripts i and t refer to provinces and time, respectively. β is the coefficient for total wait time, and γ_{1-5} are coefficients for the other explanatory variables.

The estimates from this model suggest that there exists a positive relationship between delayed medical care and mortality at the aggregate level, and that the increases in waiting times between 1993 and 2009 may have resulted in a higher rate of mortality than would have been expected otherwise.

This finding is strongest for female all-cause mortality, for which a one-week increase in the wait from referral by a general practitioner to receipt of treatment is associated with an increase of approximately three female deaths per 100,000 population. There is also a significant and positive relationship between the wait time to receive medically necessary cardiovascular surgery after referral from a general practitioner and avoidable female mortality. Specifically, a one-week increase in the wait from referral by a GP to receipt of elective cardiovascular surgery is associated with an increase of approximately 0.18 "avoidable" female deaths per 100,000 population.

These results allow us to estimate the number of Canadian lives that may have been lost to increases in wait times between 1993 and 2009, a period during which wait times for medically necessary elective care lengthened considerably. We find that, over this 16-year period, increases in wait times for

medically necessary elective treatment may be associated with 44,273 additional female deaths (with a 95% confidence interval from 25,456 to 63,090). This represents approximately 2.5% of total female deaths during the period or 1.2% of total mortality (male and female) during the period.

Further, over a 15-year period from 1994 to 2009 changes in wait times for cardiovascular care are associated with approximately 662 potentially avoidable deaths (with a 95% confidence interval from 35 to 1,289). This represents approximately 0.16% of avoidable female deaths during the period or 0.06% of total avoidable mortality (male and female) during the period. This may largely be a reflection of the fact that, in a number of provinces, wait times for cardiovascular surgery have improved during the 15-year period, resulting in potential reductions in avoidable mortality.

While numerous studies have shown a relationship between delayed access to medical care and death, the overall impact on mortality rates of prolonged delays in obtaining medically necessary care in Canada has not been assessed. Such an assessment undertaken in this study reveals that increases in wait times for medically necessary care in Canada between 1993 and 2009 may have resulted in between 25,456 and 63,090 (with a middle value of 44,273) additional deaths among females. This estimated increase in the Canadian mortality rate associated with waiting for medical treatment was likely unnecessary and is the result of a health-policy regime that imposes longer wait times on Canadians than are found in the universal-access health-care systems of other developed nations.

1 Introduction

Waiting has come to be a defining characteristic of the Canadian healthcare experience. Canadians in need of medical attention can expect to face delays at nearly every step in the healthcare process, from getting appointments with a family doctor, to diagnostic imaging, to specialist appointments, and finally to treatment. These widespread, systemic delays have important consequences for patients, their friends and families, and the economy.

Delayed access to medical care increases exposure to pain and suffering, and imposes on Canadians some measure of mental anguish, strained personal relationships, and lost productivity at work and leisure. Delays may also have a negative impact on friends and family, either from concern about the untreated medical condition, or from an increased reliance upon them of the person waiting for the necessities of daily life. To the extent an untreated medical condition results in an inability to work, wait times can also have a financial impact on individuals and their families. Similarly, for children, to the extent an untreated condition limits educational achievement or the ability to participate in school and extra-curricular activities, wait times can result in reduced opportunity.

Waiting for health care also has broader economic consequences. Increased absenteeism, reduced productivity, and reduced ability to work caused by untreated medical conditions and waiting can reduce overall economic activity. One estimate pegged the economic cost of excess waiting for health care in 2007 (waiting beyond lengthy target wait times) for just four medical services[1] at $14.8 billion, with another $4.4 billion in resulting reductions in governmental revenues (Centre for Spatial Economics, 2008).

Waiting for health care can also result in poorer medical outcomes. The advance of disease during delay can mean having to undergo longer, more complex, and more intensive treatments than were required when the problem was first identified. Advance of disease can also lead to an

1. Specifically, waiting for MRI exams, cataract surgery, coronary artery bypass graft surgery, and total joint (hip and knee) replacement beyond those wait times considered "acceptable" according to the Wait Time Alliance for Timely Access to Health Care (30 days, 112 days, 42 days, and 182 days, respectively).

increased risk of adverse events and potentially worse results from care, including an increased risk of permanent disability. In some cases, the advance of disease might be so significant as to render effective treatment no longer possible.

Transcending these personal and economic consequences is the risk of increased mortality associated with waiting for health care. In some cases, this is the result of deterioration in the underlying illness such as the spread of cancer or a heart attack as a result of an untreated cardiac condition. In others, this is a less direct result of either restrictions in the activities of daily living (reduced sight for example) or a reduction in mental and emotional well-being.

The Supreme Court of Canada, in its 2005 Chaoulli decision, recognized that wait times can be fatal :

> Access to a waiting list is not access to health care. As we noted above, there is unchallenged evidence that in some serious cases, patients die as a result of waiting lists for public health care. Where lack of timely health care can result in death, s. 7 protection of life itself is engaged. The evidence here demonstrates that the prohibition on health insurance results in physical and psychological suffering that meets this threshold requirement of seriousness. (2005 SCC 35, at para 123)

While several academic studies have demonstrated the negative consequences of wait times on patient outcomes for a variety of specific diseases and medical conditions, the overall impact on mortality rates of prolonged delays in obtaining medically necessary care in Canada has not been assessed. This unanswered question is the focus of our study.

More specifically, it is our intention in this study to undertake a new empirical analysis seeking to determine what relationship, if any, exists between lengthy wait times for access to medically necessary care in Canada and mortality. In pursuing this new model at the population level, with a focus on broad measures of both waiting and mortality, we are exploring a little-researched facet of the relationship between access to health care and mortality. In a manner, we are building on studies that have found a negative relationship between waiting and mortality at the individual and disease/procedure level and studies that have found a positive relationship between healthcare resources and mortality at the broad level, seeking to understand if delayed access to medical resources broadly also has an impact on mortality and if so to what extent. To our knowledge, there currently exists no comparable study that examines the impact of wait times on mortality rates in Canada.

The next section provides a broad overview of studies that have examined the relationship between waiting for health care and increased mortality. A discussion of our approach to estimating the broad relationship between waiting for health care and mortality as well as the difficulties in doing so is undertaken in the third section. The fourth section presents the results of our statistical analysis. Following this is a section considering the implications of these findings, including an estimate of how many lives may have been lost to delays in receiving medical care in Canada follows.

2 A Review of the Literature

A large number of studies have examined the consequences of waiting for health care. For the most part, these have focused on the risk of mortality when waiting for treatment of potentially fatal conditions that may deteriorate rapidly over time or be associated with serious adverse events. In addition, some studies have also examined the consequences of delay for less-fatal conditions, including joint replacement and cataract surgery. The brief overview of studies below demonstrates that waiting can impose a considerable risk of loss of life.[2]

Wait times and mortality from heart-related conditions

Sobolev et al. (2006a) examined the effect of wait times on patients set to receive coronary artery bypass surgeries (CABG). The results indicated that treatment delays can lead to an increased risk of death for all patients, including those whose condition was assessed as being of low severity during the planning phases of treatment. In a similar vein, Sobolev et al. (2006b) assessed the consequences of assigning CABG candidates to less urgent priority categories and found that "longer delays in the nonurgent group contributed to a higher proportion of patients dying before surgery from all causes as compared with the semiurgent group" (2006b: 685). More recently, Sobolev et al. (2013) again emphasised the fact that "queuing patients according to urgency of treatment contributes to a higher proportion of preoperative death among CABG candidates in the less urgent category" (2013: 10).

The importance of rapid access to treatment for cardiac surgery patients is supported by Cesena et al. (2004), who found that most of the adverse events for such patients occur within a short period of time. Specifically, they found that 72.1 percent of all complications in their study occurred within 120 days. This suggests certain individuals may be capable of waiting; however, those who are not, are likely to experience adverse events early in the waiting process.

2. For a more comprehensive review of studies looking at the adverse consequences associated with increased wait times see Day, 2013.

Though governments have established benchmarks for medically acceptable wait times in select areas, these governmental standards are often considerably longer than the thresholds for reasonable wait times set by medical professionals (see, for example, Barua and Esmail, 2013). In an attempt to evaluate the effect of this difference in definitions of acceptable timing, Sobolev et al. (2012) analyzed patient outcomes in the context of targets set out by the province of British Columbia (6 weeks for semi-urgent, 12 weeks non-urgent) compared to those set out by the Canadian Cardiac Society (CCS) (2 weeks for semi-urgent, 6 weeks non-urgent). The study reported that in-hospital postoperative death was one third as likely for patients who underwent surgery within the CCS target times compared with those who received treatment later than the guidelines set out by the province, while patients treated within the governmental target experienced less protection from mortality than those treated within the shorter target (this finding was not statistically significant).[3]

Wait times and mortality from cancer-related conditions

In addition to evidence of the link between surgical waits for coronary artery bypass surgery (CABG) and mortality, research investigating the link between treatment queues and mortality from cancer has also been published.

Fortin et al. (2002) studied the effect of delaying radiotherapy treatment on the outcome of patients who had early head and neck tumors. The authors found that when analyzing the effect of delay on patients in the early stage of disease, control of tumors was compromised if treatment started more than 40 days after initial evaluation by a radiation oncologist. Further, progression of tumors was highly correlated with both wait times and poor outcomes. It was noted, however, that delays had no measurable effect on mortality when analyzing patients with advanced stages of disease.

Waaijer et al. (2003) also examined the effect of wait times on tumor growth, finding the increase in tumour growth during the 34-day average delay between the diagnostic computed tomography (CT) scan and the planning CT scan ranged from 11% to 235% (averaging 70%). The study noted that the additional wait between the planning CT and the start of treatment lengthened the waiting time from identification of disease to treatment by nearly 50%.

Focusing specifically on patients with lung cancer, Christensen et al. (1997) examined the relationship between preoperative diagnostic delays and the stage of the tumour at the time of surgery. Their results indicated that "even a few months delay in diagnosis and treatment has a significant

3. This study not only highlights the risk of prolonged waiting but also points to a potentially fatal disconnect between the targets set by provincial governments and those by medical practitioners.

influence on the stage of lung cancer" (1997: 883)—a result consistent with the finding that the size of cancerous tumors double in size every 4.3 months. While the authors note that the delay caused by the patient not seeking medical attention contributes to adverse outcomes, the delays doctors face in having access to technology crucial for the diagnosis of cancer must be shortened.

Of course, not all studies of delays in cancer treatment have found an increased risk of mortality. Coates et al. (1999) identify a potential problem in trying to establish a link between wait times and mortality for cancer. Depending on the study, it may appear that a greater incidence of mortality is associated with shorter wait times. This paradox occurs because late stage cancers are treated more immediately and often, if a cancer has progressed far enough, no cure can be provided. Thus, high rates of mortality may be correlated with short waits, while lower rates of mortality may be correlated with prolonged wait times. The prioritisation of late-stage cancers before early stages in the presence of waiting lists has led some medical professionals to question the status quo. Specifically, Kulkarni et al. (2009) argue that lower, more curable stages should receive priority for treatment since patients with later stage cancers may gain less from rapid treatment.

The broader negative consequences of wait times

Studies also show that the association between adverse events and waiting times applies beyond cancer and cardiovascular procedures to those conditions where the link may be less obvious. For example, delays in treatment for hip fractures have also been linked to increased mortality (Simunovic et al., 2010). The resulting manifestation of extreme pain, loss of mobility, and the loss of independence associated with this condition have also been shown to diminish individual's willingness to live (Doruk et al., 2004).

The same may be true for other debilitating and painful, but not likely fatal conditions. While these may not lead directly to increased mortality, to the extent they indirectly do so or lead to shorter life spans as a result of decreased value of life and non-medical adverse events among other causes, they are important to consider.

For example, long wait times for hip replacement surgery can lead to further deterioration and poorer outcomes after treatment (see, for example, Vergara et al., 2011; Garbuz et al., 2006). Long waits for knee replacement have been linked to greater pain (in the non-operated knee), functional limitations, and a reduced health-related quality of life (Desmeules et al., 2012). Longer delays can also lead to poorer outcomes, including a lower likelihood of improvements in physical function and pain following spinal surgery (Braybrook et al., 2007).

Waits for cataract surgery are also associated with negative effects for those needing care. Patients enduring extended waits for cataract surgery

experience reduced quality of life; are at greater risk of falls, accidents, and motor-vehicle crashes; endure further vision loss, and potentially poorer post-treatment vision (Hodge et al., 2007; Conner-Spady et al., 2007; Boisjoly et al., 2010).

Delays for these conditions and others that are not necessarily painful or life threatening also bring potentially considerable personal costs. Wait times have the potential to cause and extend pain and suffering, mental anguish, lost productivity at work and leisure, and strained personal relationships, not to mention the possibility of lost income or economic opportunity. Wait times may also impose loneliness potentially through decreased mobility (both outside and within the home) or increased risk of embarrassment (from falls, incontinence, etc.). Other potentially serious and longevity-reducing consequences include reductions in general health, chronic addiction to painkillers and narcotics, and increased risk of depression while waiting for care (Day, 2013).

While some studies identify no significant health consequences from waiting, this may say less about the consequences of delayed care and more about how well clinical prioritization is working and the availability of effective safety valves for those who experience deterioration. In general, however, the literature examined suggests that waiting for health care, particularly when the untreated medical condition can be fatal and has the potential to progress, can result in untimely demise.[4] Further, even outside these areas of care, wait times can result in reductions in mental and emotional well-being that may have linkages to early mortality. Further, processes of care may be affected by wait times and limited access to medical resources, which may have consequences for patients in the healthcare system (Day, 2013). The question then is not whether wait times are fatal but how many Canadians may have lost their lives because of lengthy waits for medically necessary treatment.

4. Day (2013) summarizes a large number of studies identifying adverse health outcomes from waiting both in cancer and heart care and in other areas, including emergency treatment.

3 Measuring the Relationship between Waiting and Mortality in Canada

The purpose of our study is to develop a model to investigate, at an aggregate level, whether wait lists in Canada have an impact on mortality and, if they do, to estimate the magnitude of this association. Creating a model that allows for measurement of this relationship is neither simple nor straightforward. While a number of studies exist examining the consequences of waiting at the disease level (often using data for individuals), little research has looked into the broader relationship between waiting and death. There are, however, several studies examining the relationship between healthcare resources and population mortality on which we were able to base our approach.

The main features of our approach are based on the model developed in Or (2001), which assesses the relationship between healthcare resources and mortality across 21 developed countries over 25 years.[5] Or's model is estimated for men and women separately using a feasible generalized least squares (GLS) method. One of its main conclusions is that "the impact of health care, as measured by doctors per capita, on premature mortality appears to be relatively large and significant for both men and women" (2001: 21). For explaining the causes of death, Or's model includes a series of indicators that can be categorized into four key areas.

1 **The level of medical care inputs** Measured by the number of active physicians per 1,000 population, who represent a "key input for the production of health care in any health system" (Or, 2001: 20). This choice of including a non-monetary measure of medical care inputs (instead of the more commonly used measures like total health expenditure) was made because of the difficulty of accurately comparing monetary measures among countries. Specifically, "the relationship between the prices of health services and economy-wide prices,

5 The mortality related variables examined were premature mortality, life expectancy at 65, perinatal mortality, infant mortality, potential years of life lost (PYLL)-heart diseases, and PYLL-cancer. All variables except perinatal and infant mortality were separated by sex.

and the composition of the type of health services being provided, is likely to vary considerably across countries" (2001: 14). This would, of course, be less of an issue when creating a model examining effects within a single country.

2 **Medical care institutions and characteristics** These include the mode of financing care (public/private), the principal method for paying doctors (fee-for-service, salaries, and capitation), referral practice (gate keepers), and methods for paying hospitals (global budgets, bed-day payments, and fee-for-service).

3 **Individual lifestyle risk factors** Measured by alcohol consumption per capita and tobacco consumption per capita.

4 **Background variables** The primary background variable is real GDP per capita, which can capture varying levels of nutrition, housing, and schooling. A variable controlling for occupation (represented by the share of white-collar workers in the work force) is also included, as is a measure of different levels of pollution across countries (represented by NO_x emissions per capita).

These four groups of the major determinants of health/mortality serve as our primary guide for inclusion of explanatory variables.

The details of Or's model are also comparable with other studies that attempt to measure the relationship between health-system characteristics and population health outcomes/mortality. For example, Starfield et al. (2005) examine the relationship between doctor supply and mortality at the US county level between 1996 and 2000. The study's primary finding is "the greater the supply of primary care physicians, the lower the total and heart disease mortality rates" (2005: 99). On the other hand, higher specialist-to-population ratios were not associated with reductions in mortality. While this model uses slightly different controls, it retains a similar rationale for inclusion with regards to the major determinants of health. For example, Starfield et al. use a variety of measures to control for differences in socioeconomic status (SES)[6] and variations in income.

Both Or (2001) and Starfield et al. (2005) include (and generally focus on) broad measures of mortality in order to represent health outcomes. For example, Starfield et al. use all-cause mortality as a dependent variable[7] as it is "among the most commonly used health status indicators, especially in studies on income inequality and health" (2005: 1). On the other hand, Or's

6 Starfield et al (2005) included independent variables representing per-capita income, education, and unemployment, as well as the percentages of the population that live in a metropolitan statistical area, are elderly, are African American, or have incomes below 100% of the federal poverty level.

7. Starfield et al. (2005) also examine heart disease and cancer mortality statistics.

choices of dependent variables are largely a result of the fact that there exist few, well-developed, internationally comparable measures of health. She does, however, recognize that such measures "provide no information on the non-fatal consequences of diseases" though still providing "reliable and useful information to describe the health status of populations" (2001: 8).

While our approach in estimating the relationship between mortality and wait times for medical services is founded on the studies above, we depart from their approach in two notable[8] ways.

1. The first distinction is that Or also includes a measure of life expectancy in order to complement the measures of mortality used in her paper. We have chosen not to look at life expectancy because our time period and geographical span are smaller, and thus contain far less variation for such a variable. Further, such a dependent variable may depend significantly on independent contributing factors at a point much farther back in time (for which we do not have data) and whose impact is cumulative over years, if not decades.[9]

2. A second notable difference between our approach and that used by Or (2001) relates to the inclusion of variables controlling for differences in health system characteristics. As our analysis focuses on Canadian provinces, in which these policies do not differ meaningfully over the time period observed, we have chosen to exclude policy variables in our analysis. We will however capture the cumulative effect of such characteristics between provinces through the Fixed Effects treatment used in our analysis (discussed below).

Thus, our model of mortality in Canadian provinces includes measures of medical care inputs, individual lifestyle risk factors, and background characteristics, in addition to wait times.

Data

Dependent variables

Our examination of the relationship between waiting and mortality is principally focused on all-cause mortality. In addition, we also examine the relationship between waiting times and avoidable mortality. All mortality measures are from Statistics Canada's CANSIM database.

8. Several smaller modifications related to the structure of our data and focus of our investigation were also made. Further discussion of these modifications can be found in the sections below discussing data and methods.
9. It is of course also possible that the crude mortality rates examined in our model may also reflect the impact of lifestyle factors at much earlier time periods.

All-cause mortality

The principal dependent variable examined in this study is all-cause mortality, measured in deaths per 100,000 population (**figures 1, 2, and 3**).We focus on this broad measure of mortality because wait times can have less obvious and farther reaching consequences for the health of the population than just those directly related to the untreated medical condition. Indeed, narrower definitions of mortality may run the risk of excluding some of the deaths resulting from waiting for health care because they may appear in mortality statistics as non-health-related events or be lost to age limitations[10] imposed on more narrowly-defined Canadian mortality measures.

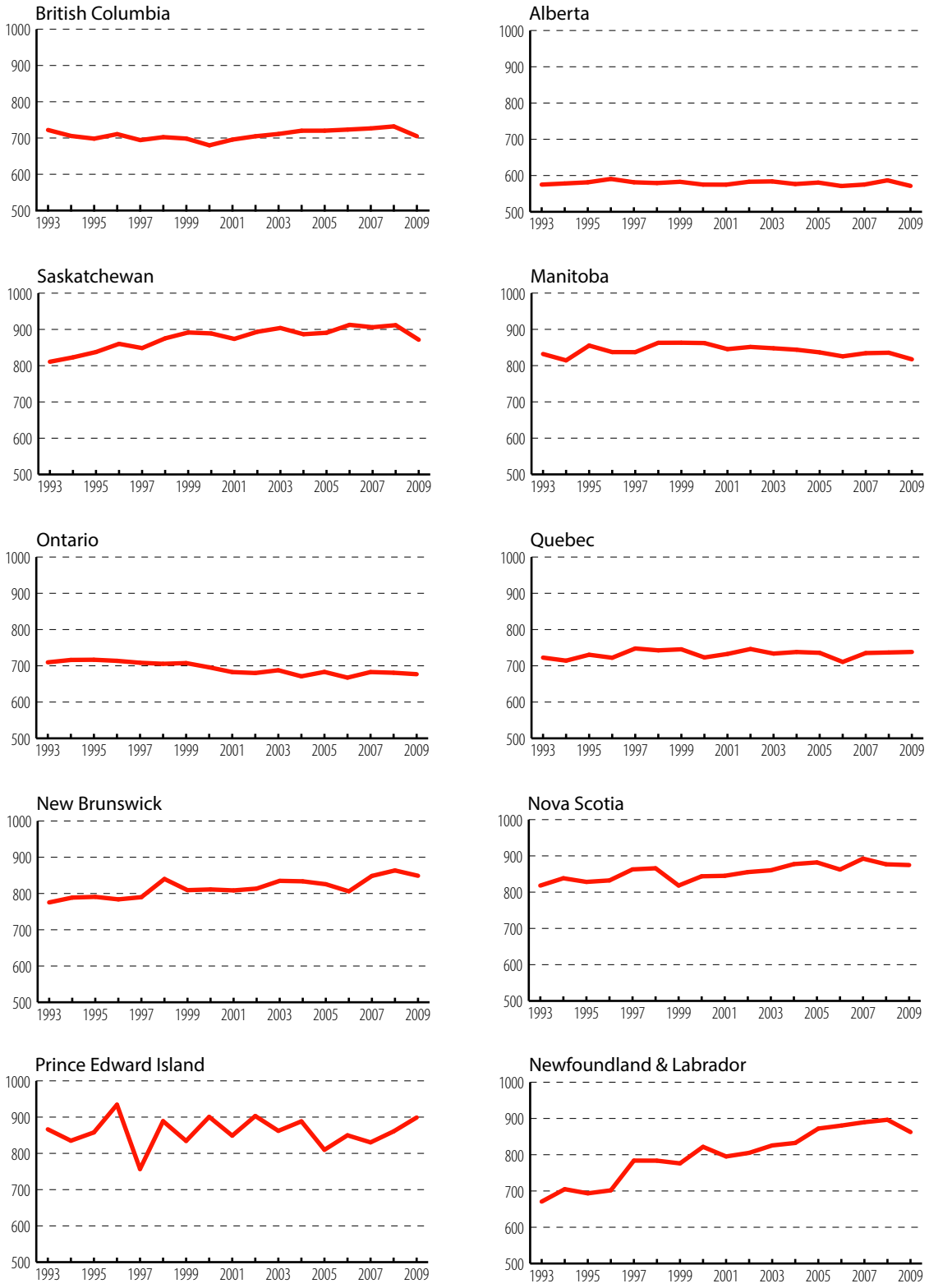
For example, research has demonstrated that reduction in sight is a significant contributor to motor-vehicle accidents (Kotecha, Spratt and Viswanathan, 2008; Owsley et al., 1999). Further, Conner-Spady et al. (2007) find that prolonged waits for cataract surgery puts patients at greater risk of motor vehicle crashes (among other effects) and that long wait times are associated with a decline in visual acuity, which is negatively associated with better outcomes from treatment. If these additional motor vehicle accidents caused by delayed care result in death (either of the visually impaired driver or others), they may not be counted in some narrower definitions of medically treatable mortality, even though the underlying cause is related to the inability of the medical system to treat cataracts in a timely fashion.

Researchers have also investigated the link between the timeliness of hip fracture repair and survival. The evidence suggests that shorter times spent waiting between fracture and surgery lead to significant reductions in mortality (Simunovic et al., 2010; Doruk, 2004). This reduction in mortality has been attributed to a quicker return of mobility, a reduction in pain, and a general reestablishment of the will to live. Had the fall victim endured delayed treatment and subsequently died six months after their operation, the official cause of death may fail to recognize the original fall and lack of timely medical intervention.

Numerous other studies, particularly on the consequences of waiting for less fatal but nevertheless debilitating conditions, point to indirect risks of mortality. For example, Freeman et al. (2009) found those with very poor visual ability were at relatively higher risk of depression while waiting in comparison with those who had higher visual ability, despite the temporary nature of the impairment. Similarly, untreated medical conditions may leave patients housebound or facing severe limitations in daily activity (see for example, Derrett et al., 1999). These consequences of waiting may increase the rate of deterioration in general physical and mental health and lead to earlier demise. Indeed, Steptoe et al. (2012) note that isolation, which can be one consequence of poor health, is associated with increased all-cause mortality at older ages.

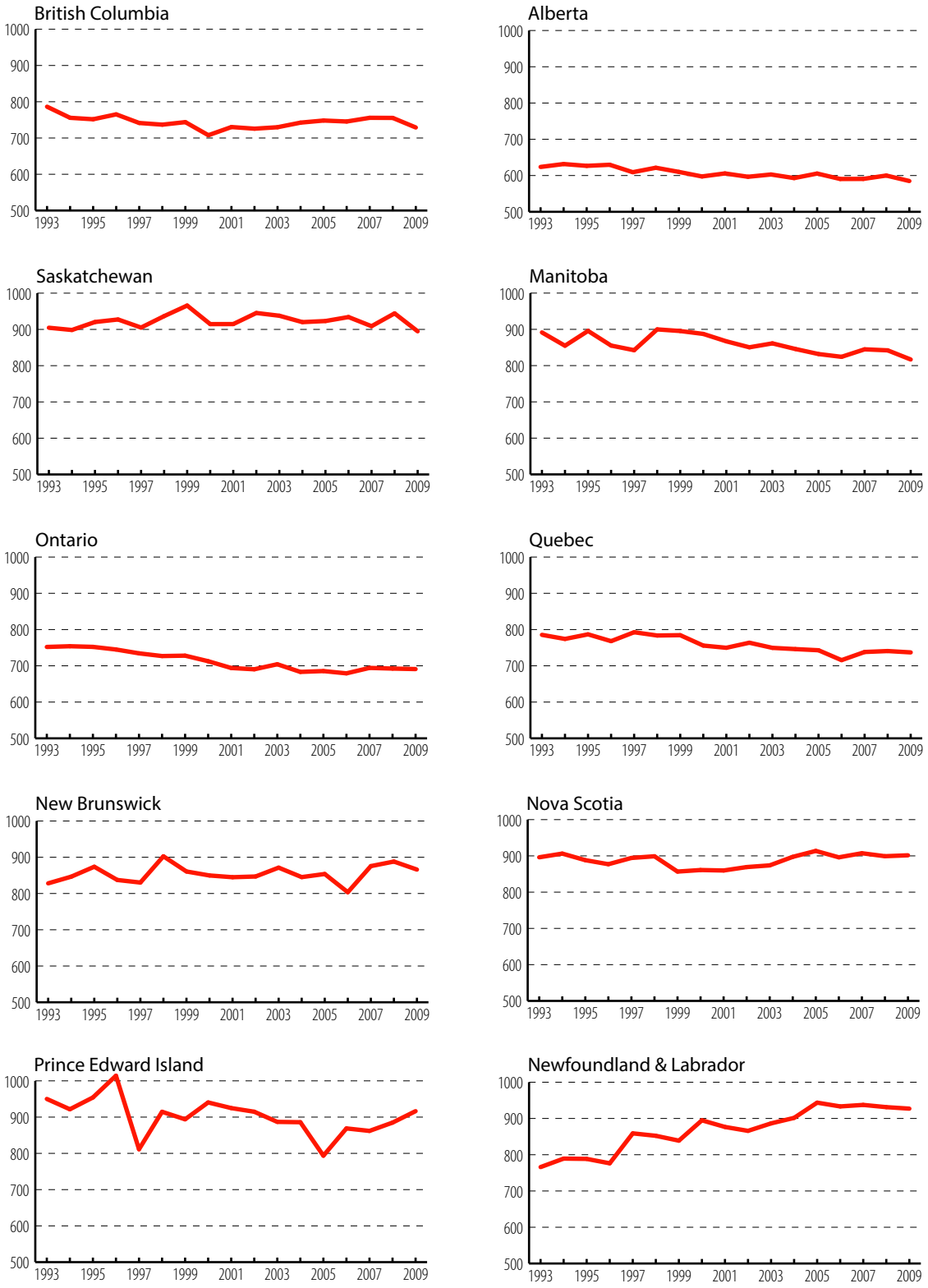
10. For example, avoidable, preventable, and treatable mortality rates exclude persons over the age of 75.

Figure 1: All-Cause Mortality (deaths/100,000), Males and Females, 1993–2009



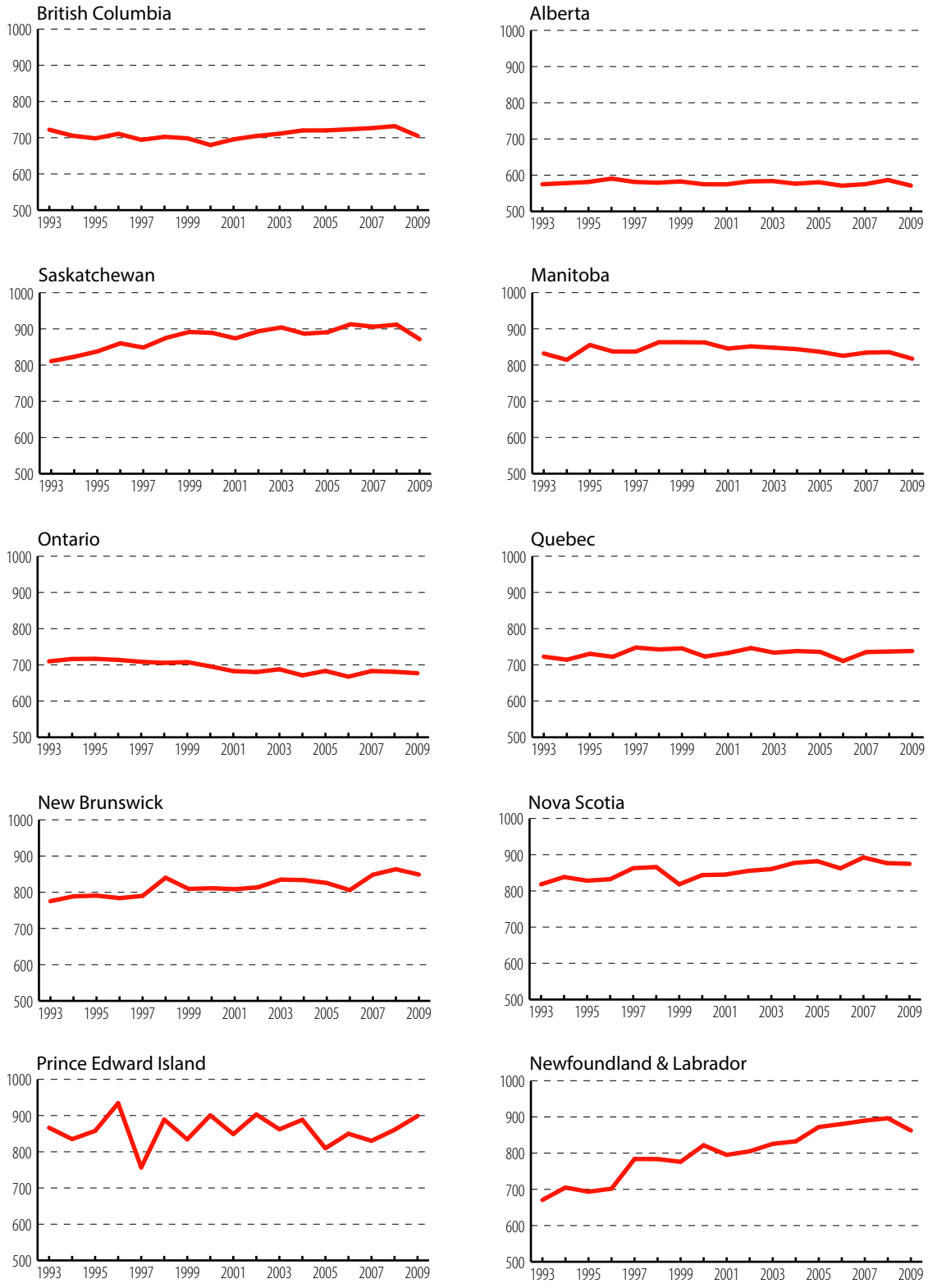
Sources: CANSIM tables 102-0504 and 051-0001; calculations by authors.

Figure 2: All-Cause Mortality (deaths/100,000), Males, 1993–2009



Sources: CANSIM tables 102-0504 and 051-0001; calculations by authors.

Figure 3: All-Cause Mortality (deaths/100,000), Females, 1993–2009



Sources: CANSIM tables 102-0504 and 051-0001; calculations by authors.

Further, as pointed out in the introduction, delayed care can mean longer and more complex medical interventions. To the extent that this increases the risk of adverse outcome or medical error, this can also result in an increased rate of mortality. Such mortality may be classified as medical misadventure or other mortality that is not medically treatable according to some definitions of population health measures, but that in part finds its cause in delayed medical treatment.

These are but a few examples of the way in which lengthy wait times for medical care can increase mortality outside of that which would be captured by amenable or medically avoidable mortality. There is also the question of indirect effects of waiting resulting from the signaling effect wait times have on potential demanders of health care. Lengthy wait times may result in individuals seeking medical care after symptoms of a condition have worsened rather than waiting for treatment of relatively minor symptoms. That may result in advance of disease beyond that which is treatable and may increase their risk of poor outcome or adverse event (discussed above) particularly for conditions where relatively minor symptoms may reflect more serious underlying conditions.

Finally, lengthy wait times and limited access to medical resources may also have a negative impact on medical practice by impeding important processes or altering decision making. This may happen, for example, through avoidance of diagnostic testing, shortened medical consultations, rushed delivery of treatment or surgery, and shortened observation periods. All of these have the potential to result in an increase in the rate of all-cause mortality (Day, 2013). These manifold possibilities point to the importance of looking at a broad measure of mortality to fully capture the mortality consequences of waiting.

Potentially avoidable mortality

According to the Canadian Institute for Health Information, this indicator

> refers to untimely deaths that should not occur in the presence of timely and effective health care or other public health practices, programs and policy interventions. It is based on the understanding that, in some instances, death can be avoided either by preventing disease onset (also known as incidence reduction) or by averting or delaying death after a condition has developed (also known as case-fatality reduction). (CIHI, 2012a: 3)

The measure is, however, "limited to causes of death where mechanisms of mortality reduction are known" (CIHI, 2012a: 3) and excludes persons over the age of 75. This is a particularly important limitation in light of the fact that waiting times for medical services may be longer for older Canadians than for younger Canadians for a number of reasons, including physician assessments

of foregone income and length of life at risk playing a role in determining who will be prioritized for treatment (Esmail, 2009). Rates for avoidable mortality in Canada between 1993 and 2009 are presented in **figures 4**, **5**, and **6**.

As seen in **figure 7** (p. 20), avoidable mortality is also a fairly "narrow" measure including less than one third of all-cause mortality. A complete list of medical conditions included in the avoidable mortality indicator can be found in Appendix B. Nevertheless, we include this measure in our estimation approach in order to examine whether our estimated impacts of explanatory variables on mortality are broadly consistent between measures, and to see whether there is also a relationship between waiting and 'avoidable' mortality for those under age 75.

Independent (explanatory) variables

The explanatory variables considered for this study fall broadly into three categories, following examinations by both Or (2001) and Starfield et al. (2005). The first category includes those variables directly related to healthcare resources (wait times, total healthcare expenditures, and the proportion of primary care doctors as a percentage of total doctors). The second category represents individual lifestyle risk factors (percentage of the population below Statistics Canada's low-income cut-off), and the third includes a set of variables accounting for background characteristics (gross domestic product, percentage of the population over 65).

Wait times

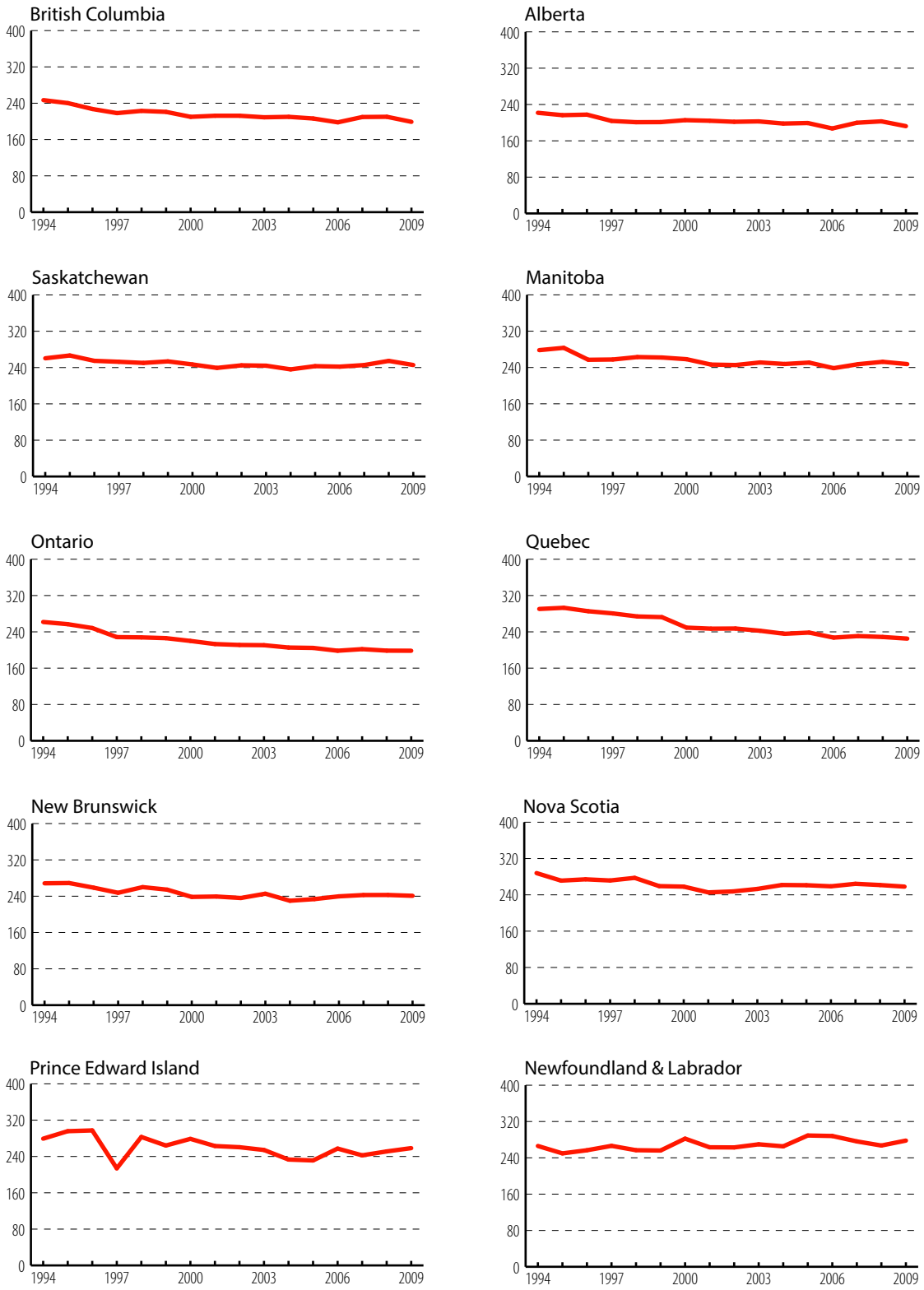
Because of our interest in broad measures of mortality, we primarily focus on the broadest measure of waiting available in order to capture as best possible both the direct and clear relationships between waiting for medically necessary care and mortality, and the indirect, but important, consequences of excessive delay and limited access to services generally.

The wait-times measures used in our model are from the Fraser Institute's *Waiting Your Turn* series, which provides Canada's only national, comparable, and comprehensive measurement of wait times for medically necessary elective[11] procedures back to 1993.[12] Specifically, the wait times measures used in our model are the total wait times, from GP referral to treatment by a specialist, for each province in each year.

11. The measure does not include wait times for emergent and urgent treatment, except in the cases of radiation oncology, medical oncology, internal medicine, and neurosurgery, which may include more urgent wait times. See Barua and Esmail, 2013.

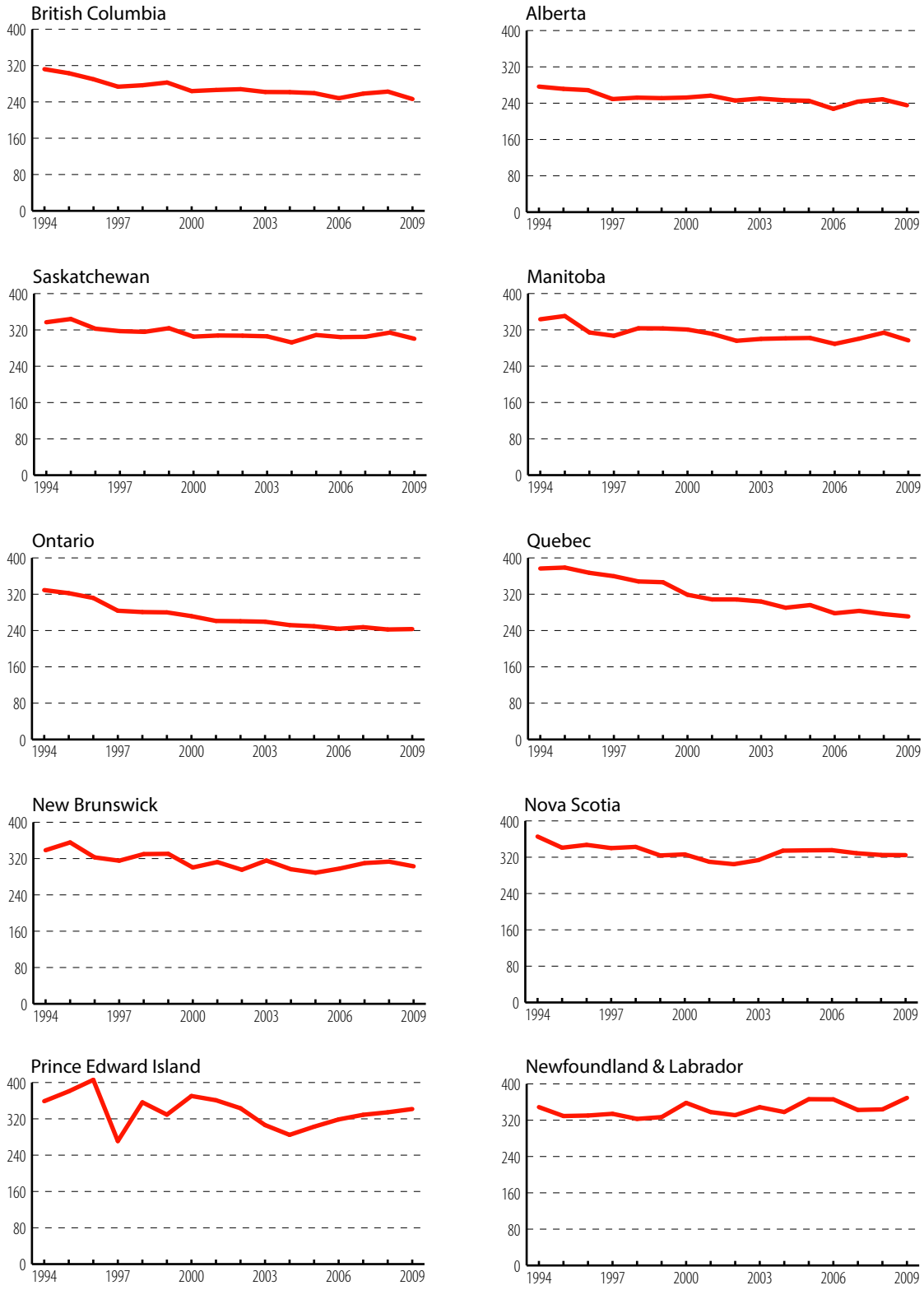
12. The Fraser Institute's wait time series is annual from 1993 to the present except for 2000–2002, for which only two measurements are available (2000-01 and 2001-02). We assigned these wait-time measurements, after consideration of the survey period and patient experiences, to 2001 and 2002, respectively, and used linear interpolation to replace missing data for the year 2000. We have also used this approach for the cardiovascular surgery wait time data in instances where it was not available from the survey.

Figure 4: Potentially Avoidable Mortality (deaths/100,000), Males and Females, 1994–2009



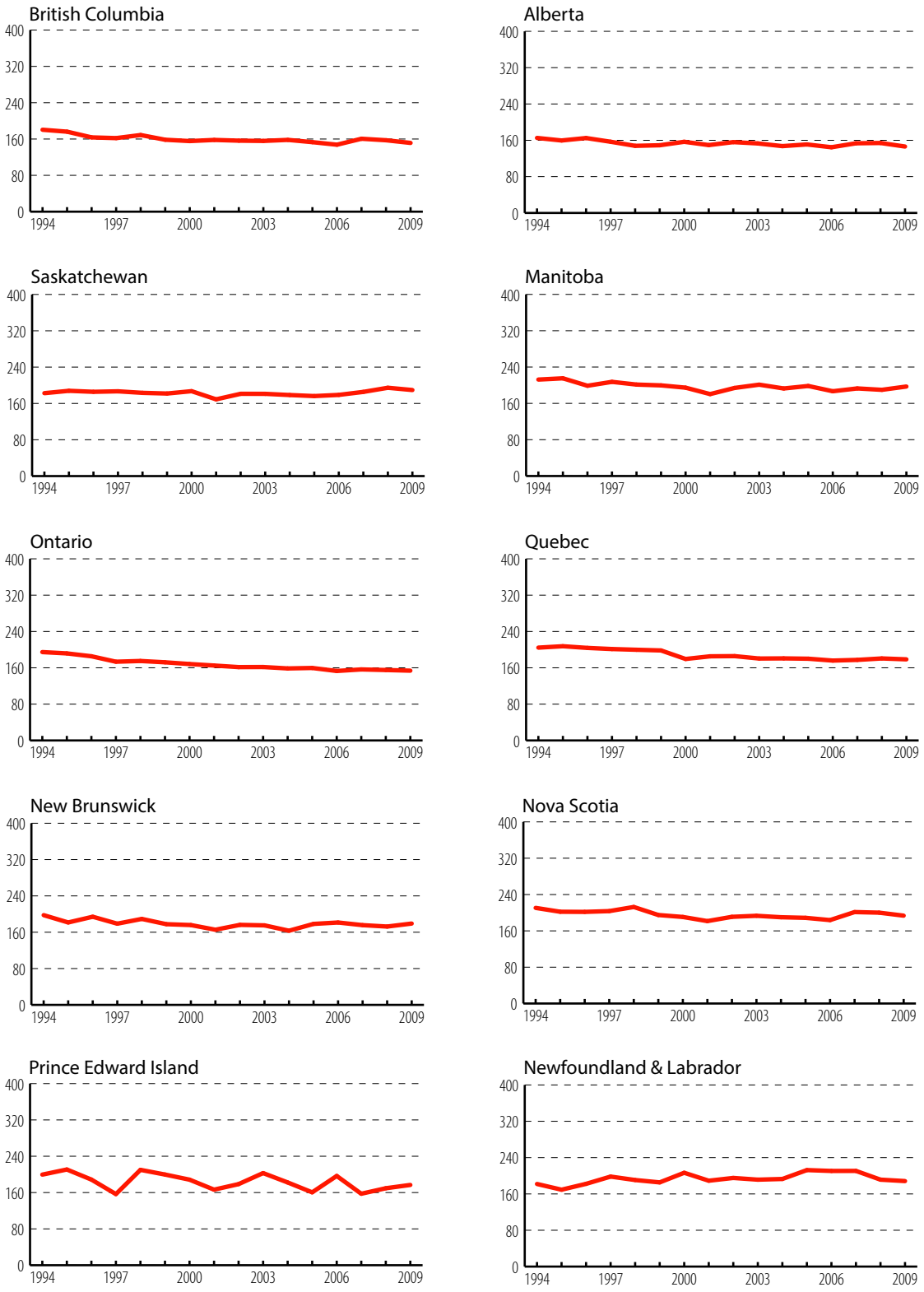
Sources: CANSIM table 102-4312.

Figure 5: Potentially Avoidable Mortality (deaths/100,000), Males, 1994–2009



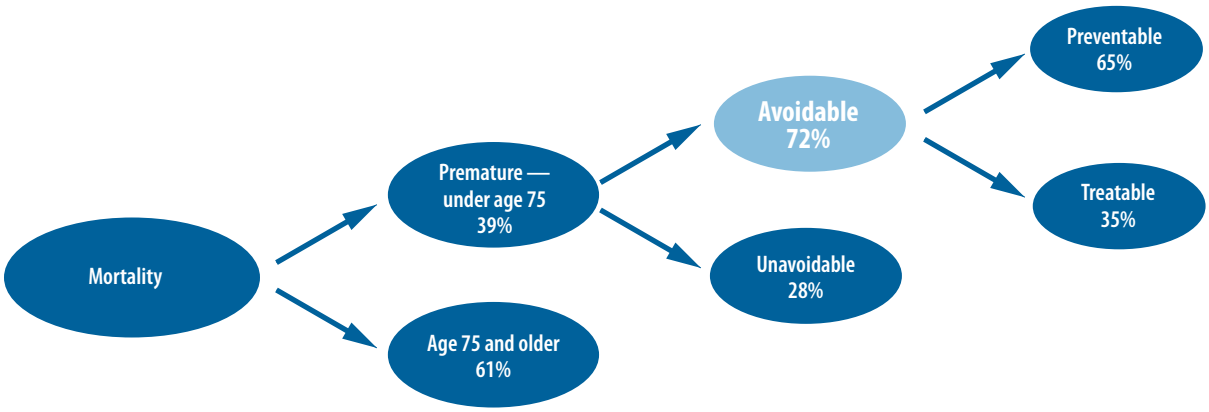
Sources: CANSIM table 102-4312.

Figure 6: Potentially Avoidable Mortality (deaths/100,000), Females, 1994–2009



Sources: CANSIM table 102-4312.

Figure 7: Distribution of mortality by indicator



Source: based on the figure "Potentially avoidable mortality" (©2012 CIHI) on p. 11 of CIHI, 2012a.

The total measure of waiting for each province is the sum of the provincial median wait times for specialist consultations and for treatments after consultation. The provincial median wait for treatment is a procedure-weighted average of the median of survey-reported wait times for procedures in 12 major medical specialties:[13] plastic surgery, gynaecology, ophthalmology, otolaryngology, general surgery, neurosurgery, cardiovascular surgery, orthopaedic surgery, urology, internal medicine, and radiation and medical oncology. The provincial wait for consultations is calculated using the same methodology, but with the median of survey responses measured at the specialty level rather than the procedure level.

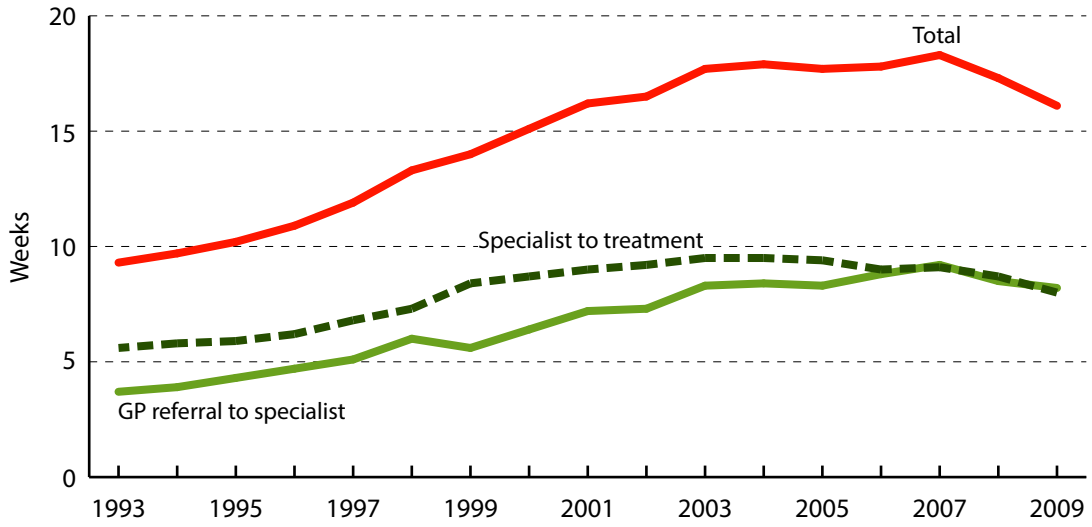
Looking more closely at the wait times data, one can see a gradual but sizable deterioration in the timeliness of medical services nationally in the first decade of our analysis, with a levelling off and late improvement in the second decade of our analysis (see **figure 8**). Further, as seen in **figure 9**, there is considerable variation in wait times among provinces, with several distinct trends appearing among the provinces (Fraser Institute annual *Waiting Your Turn* survey, 1990, 1992–2013, various authors).

Real total healthcare expenditure

In a departure from the model in Or (2001), we use total healthcare expenditure (in constant dollars, lagged by 1 year) in order to represent the level of healthcare inputs in each province. We make this departure in methodology for two principal reasons.

13. Note that, in the secondary investigation examining the narrower measure of potentially avoidable mortality, we restrict the variable representing wait times for medically necessary elective care across 12 specialties to only the wait time for elective cardiovascular surgery. (Further details on page 32 and Appendix D).

Figure 8: Median Wait Times for Care, Canada, 1993–2009



Source: Fraser Institute annual *Waiting Your Turn* survey, 1990, 1992–2013, various authors.

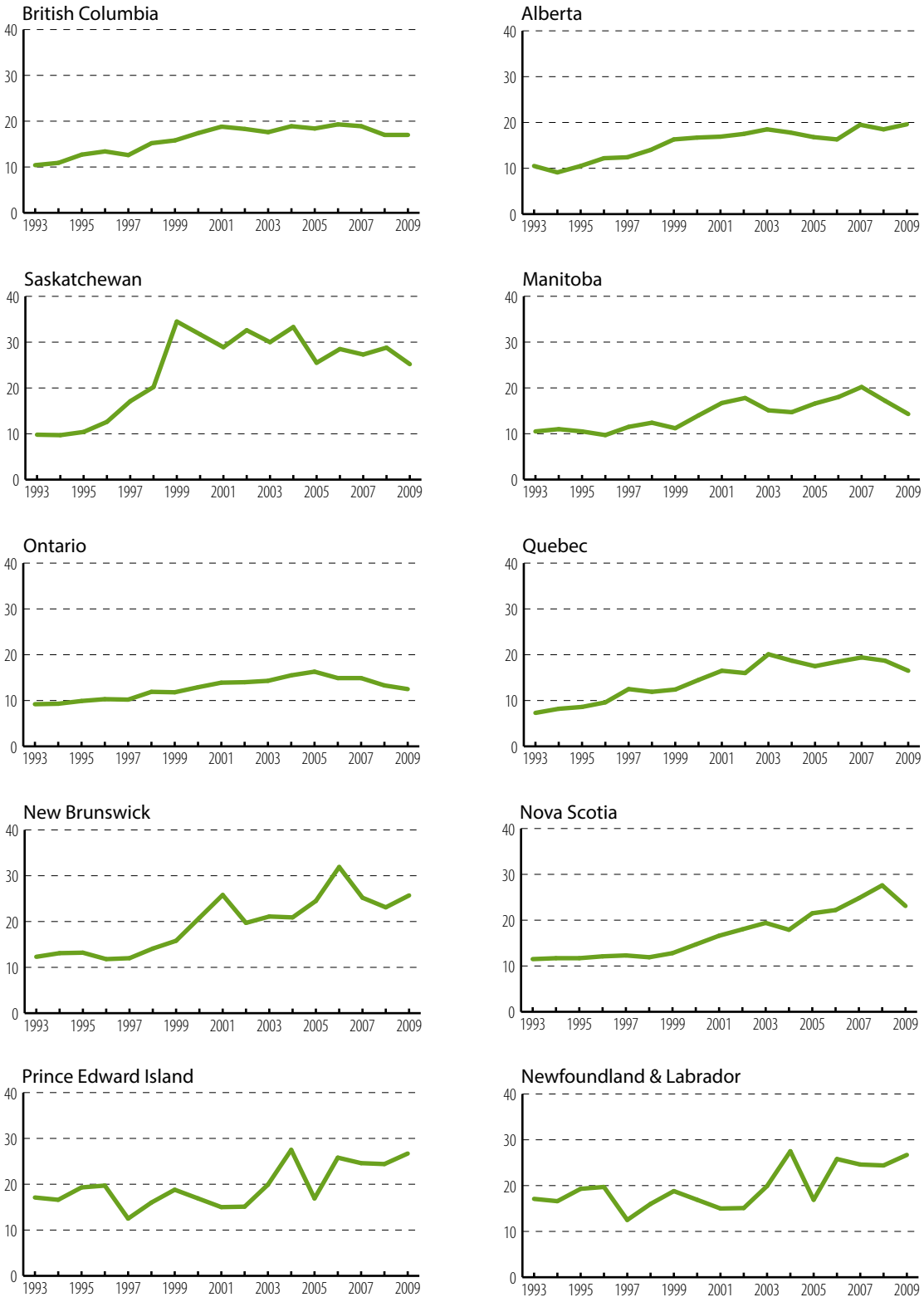
1 Or et al. (2005) note that doctors per capita is "arguably a second best choice for measuring health care resources" and that "[r]eal health expenditure may provide a better approximation of total health resources used in a country." Their primary reason for choosing doctors was because "appropriate real health expenditure comparisons are not available currently because reliable and accurate, health-care-specific, purchasing power parity (PPP) conversion rates are lacking for OECD countries" (2005: 538). This is less of a concern with our provincial health expenditures data.

2 Several studies have encountered difficulties when incorporating such a measure in models examining the determinants of mortality.[14] One possible reason is that there may be an endogeneity issue when examining the relationship between mortality and doctors per capita.[15] Indeed, a set

14. See Richardson and Peacock, 2003, and Young, 2001 for more detail.

15. For example, when examining Canadian data, Pierard (2009: 8) noted: "Endogeneity between the number and type of physicians and health status of the individuals in a province is theoretically possible. Physicians may go to the provinces where there is the highest need for their services, e.g., psychiatrists could decide to move to the provinces with the highest number of psychiatric patients. However, public policy so far has been geared towards enticing physicians to choose to practice in areas where there are relatively few physicians per capita, not where there are relatively many health problems per capita. Furthermore, these public policies have focused on intra-provincial physician migration and not inter-provincial migration". Upon confirming the hypothesis of endogeneity in certain instances using a Smith-Blundell test, the author attempted to minimize its effect by lagging physician supply by one year (and hypothesizing that the effects lasts for two years).

Figure 9: Median Wait Time (Weeks) for Care, GP Referral to Treatment, by Province, 1993–2009



Source: Fraser Institute annual *Waiting Your Turn* survey, 1990, 1992–2013, various authors

of preliminary investigations conducted using physician spending as an instrumental variable for doctors in two-stage least-squares regressions broadly confirmed[16] this suspicion. In an effort to minimize any effects of potential endogeneity between healthcare expenditures and mortality, we lag real total healthcare expenditures by one year, while acknowledging that this may not mitigate the issue entirely.

Proportion of primary care doctors

There is evidence to support the notion that primary care doctors are instrumental in improving—or perhaps more important than specialists in reducing—mortality rates. For example, Starfield et al. found that "the greater the supply of primary care physicians, the lower the total and heart disease mortality rates" and noted that "[i]t appears that it is the relative roles of primary care physicians and specialists rather than their number that makes the difference in health outcomes" (2005: 99). Similarly, Pierard found that "[t]he per capita supply of general practitioners is associated with better health outcomes" while "[a] higher per capita supply of specialists is associated with worse health outcomes" (2009: 22).

For this reason, and in light of the fact that the overall level of medical inputs is accounted for in real total healthcare expenditures, we include the proportion of primary-care doctors as a percentage of all doctors. The inclusion of this variable alongside expenditures is thus intended to capture both a "level" effect (real total healthcare expenditure) and a "pattern" effect (proportion of primary care doctors) of healthcare resources on mortality.

Percentage of population below low-income cut-off (LICO)

Variables controlling for modifiable risky behaviours and health-seeking and health-promoting behaviours are central to any model measuring mortality. Measures of socioeconomic status (SES), and particularly low SES, are frequently used as proxies of modifiable health behaviour.[17] It has been established that those in a state of low SES are more likely to be heavy drinkers, smokers, and have poor, calorie dense, diets, among other issues (Cawley and Ruhm, 2011; Binkley, 2010). More recently, a report from Statistics Canada concluded that Canadians in lower-income brackets had

16. The implemented endogeneity test was defined as the difference of two Sargan-Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressor(s) are treated as endogenous, and one for the equation with the larger set of instruments, where the suspect regressors are treated as exogenous. The null hypothesis that the specified endogenous regressors (ie. physicians per capita) can be treated as exogenous was rejected in most cases.

17. Individual variables (such as alcohol and tobacco consumption, obesity rates, etc.) were not used due to issues of data availability, relevance, and quality.

higher mortality rates across a multitude of causes, particularly those causes more closely associated with risky behaviours (Tjepkema et al., 2013).[18]

We use the proportion of the male or female population (all ages) below Statistics Canada's after-tax low-income cut-offs (LICO)[19] in our model as a measure of the relative socioeconomic status of each province's population. To calculate LICO, Statistics Canada employs data from the Family Expenditure Survey and the Survey of Household Spending. The average amount of after-tax income spent on food, shelter, and clothing are calculated, with 20% added to this amount to calculate the low-income cut-off. Thus, if average expenditure on these items consumed 40% of after-tax income, any family spending more than 60% of their after-tax income on food, shelter, and clothing would be considered to be below the low-income cut-off (below LICO). As per Statistics Canada's recommendation, we use an after-tax measure of LICO since "the before-tax income only partly reflects the entire redistributive impact of Canada's tax/transfer system, by only including the effect of transfers but not the effect of income taxes" and "the purchase of necessities is made with after-tax income" (Giles 2004: 4).

The use of LICO as a measure of poverty has been thoroughly criticized (see, for example, Sarlo, 1992, 2001, 2013). The bulk of this criticism correctly centers on the notion that LICO is a relative rather than absolute measure of poverty. As a relative measure, LICO remains "unrelated to the actual cost of acquiring necessities" (Sarlo, 2001: 14). Further criticism stems from the fact that the 20% additional expenditure above the average is entirely arbitrary and could be a result of political choices rather than a natural measure of some significance (Sarlo, 1992). Clearly, LICO has weaknesses in measuring deprivation or absolute poverty.

Our purpose is to include a measure representing relatively riskier behaviours in provincial populations rather than poverty. We assume that LICO reasonably serves as a proxy measure for lower socioeconomic status and those health-seeking and health-promoting behaviours associated with it.

Real gross domestic product (GDP) per capita

The general economic well-being of a population (as measured by real GDP) is an important consideration when examining changes in mortality. Apart from serving as a general "background variable", it also acts as a measure of

18. Binkley notes that "low income consumers make less healthy choices because they face lower costs in terms of forgone future utility" (2010: 972). This suggests that a measure of low SES may well capture the many health-related and health-supportive behaviours (including increased risky behaviour generally) that can affect mortality. The SES indicator may also serve to capture other external linkages to mortality that are unrelated to our focus. For example, the prevalence of suicide and the risk of being a victim of crime increases with decreased SES (Page et al., 2006; Burrows and Laflamme, 2010; Wohlfarth et al., 2001).

19. Base year 1992

the living standards in each province—which may, in turn, be associated with health outcomes in a variety of ways. Indeed, higher incomes and greater wealth are generally associated with better nutrition, schooling, housing, and environmental and working conditions (Or, 2001; Or, Wang, and Jamison, 2005). Further, income is regularly used as a proxy for socioeconomic status (SES) in other studies examining relationships between certain variables and health (Adams et al., 2003; Smith, 2003).

It should be noted that increases in income and GDP may not always be associated with lower rates of mortality. Increased economic prosperity may also lead to changes in mortality rates associated with increased labour supply in high-risk industries and less healthy diets (Ruhm, 2000; Egan et al., 2013). In either event, incorporating a measure of the background effect of income and wealth is important when examining aggregated mortality trends for populations. For these reasons, we include inflation-adjusted provincial gross domestic product in each preceding year (again in order to minimize endogeneity) in our model.

Age

Our analysis includes the percentage of the population over 65, which can be expected to be related to higher rates of mortality in a population. The inclusion of such a variable is important when using raw mortality data and is consistent with previous empirical research (Berger and Messer, 2002). When examining avoidable mortality (which does not include data for individuals over 75), we adjust this indictor to measure the percentage of the population between 0 and 75 years old that is over 65.

Exclusions from our model

While the selection of the majority of our variables above is guided by other work in related areas, two specific categories of variables employed by Or (2001) and Or et al. (2005) have been left out of our model.

Air pollution

Or (2000, 2001) includes an independent variable for NO_x emissions, based on some international evidence that higher levels of air pollution are correlated with increased mortality (see, for example, Derrienic et al., 1989; Sunyer et al., 1991; Dockery and Pope, 1994). Recent evidence however, suggests that it may be unnecessary to control for differences in air quality across Canada when examining aggregate mortality rates. For example, Shin et al. (2008; cited in Wood, 2012) note that although ambient levels of NO_x have been decreasing mortality has continued to rise.[20] Further, Wood concludes

20. Wood (2012) suggests that results given by Shin et al. (2008) may indicate that the effects on health are caused by "co-pollutants" released along with NO_x.

that "concentrations of ground-level ozone and ultrafine particulate matter, the two air pollutants of most concern for human health, have been declining across Canada since 2000" (Wood, 2012: cover).[21] Going back further to 1993, air quality in Canada, across a multitude of air pollutants, has been steadily improving (Jones, Fredricksen, and Wates, 2002). For many of the pollutants included in these studies by Wood and Jones et al., levels were well below the strictest national and international recommendations for minimal to no health effects from agencies such as the World Health Organization (WHO). Based on these findings and a lack of comprehensive data for our period of study, we have chosen not to include NO_x emissions in our Canadian model.

Diagnostic technology

Numerous studies have indicated the importance of advances in medical technology in reducing mortality and improving health status (see, for example, Esmail and Wrona, 2008; Lichtenberg, 2006, 2010). Or, Wang, and Jamison, adapting Or's 2001 model, included MRI and CT per capita to account for the role of medical technology and health across countries, noting that the process of technological diffusion and access to technologies can vary (Or, Wang and Jamison, 2005).[22] This is also true for Canada's provinces (Esmail and Wrona, 2008).

While we do not dismiss the importance of these variables, including them in our model, in addition to measures of income, wait times, and medical resources, may be both unnecessary, and problematic. While fewer technologies and innovations may lead to increased delay, the availability of these technologies and access to them appear to be related to the level of medical resources generally (spending) in Canadian provinces. We specifically note high correlations between these variables and total healthcare expenditure. In order to minimize the impact of multicollinearity, and given that they may already be represented by the inclusion of real total healthcare expenditures, we have chosen to exclude these variables from our model.

21. During the period in question, average concentrations of ground-level ozone have consistently hovered around the Canadian standard for minimal to no health effects, while average concentrations of particulate matter between the years 2000 and 2009 were well below the Canadian standard and below the stricter provincial standard in British Columbia (Wood, 2012).

22. Or, Wang, and Jamison (2005) further make a distinction in their model between "conventional" technologies (CT scanners) and "front-line" or intensive technologies (MRI machines).

Table of Variables

Dependent variables

All-cause mortality: deaths per 100,000 population, data from 1993–2009

Sources: CANSIM tables 102-0504, 051-0001; calculations by authors.

Potentially avoidable mortality: potentially avoidable deaths per 100,000 population, data from 1994–2009

Source: CANSIM Table 102-4312

Independent variables

Total wait (overall): sum of procedure-weighted averages of median wait times from GP to specialist and specialist to treatment across 12 major medical specialties, in weeks (used for all-cause mortality)

Source: Fraser Institute annual *Waiting Your Turn* survey.

Total wait (cardiovascular): sum of procedure-weighted median wait times from GP to specialist and specialist to elective cardiovascular treatment, in weeks (used for potentially avoidable mortality)

Source: Fraser Institute annual *Waiting Your Turn* survey.

Real total healthcare expenditure (previous year/lagged one year): total healthcare expenditure per capita in the preceding year, adjusted for inflation using the total healthcare implicit price index. 2002 base.

Sources: CIHI, 2012c; calculations by authors.

Proportion of primary care doctors: family medicine physicians, as a percentage of the sum of family and specialist physicians (all figures per 100,000 Population).

Sources: Canadian Institute of Health Information, *Supply, Distribution and Migration of Canadian Physicians, 2010*: tables 23.1, 23.2: calculations by authors.

Percentage of population below low-income cut-off (LICO) (separated for males and females): percentage of the population (all ages) below the low income cut-offs after tax, 1992 base

Source: CANSIM table 202-0802.

Real gross domestic product (GDP) per capita (previous year/lagged one year): gross domestic product per capita in the preceding year, 2002 price levels.

Source: Statistics Canada, *Provincial and Territorial Economic Accounts: Data Tables*, Catalogue No. 13-018-XWE

Age (separated for males and females): percentage of the population 65 and older

Sources: CANSIM table 051-0001; calculations by authors.

Regression Approach

We employ an ordinary least squares (OLS) model with fixed effects (FE) to analyse panel data for ten Canadian provinces, covering the years 1993 to 2009. Examining data in this format is advantageous as it allows for the effects on mortality to be considered among all provinces and across time and allows for province-specific characteristics to be captured by the provincial fixed-effect term. Two groups of regressions—all-cause and avoidable mortality—are run in order to test the effect of wait times on mortality. Consistent with previous studies on mortality, separate regressions are performed using gender-specific variables where possible.[23] All analyses are performed using Stata 10 (StataCorp, 2007).

The variation of mortality between provinces across time is identified by estimating the equation:

$$Mortality_{it} = \alpha_i + \beta\ Total\ Wait_{it} + \gamma_1\ (lag)Real\ total\ health\ expenditure\ per\ capita_{it} + \gamma_2\ Proportion\ of\ primary\ care\ doctors_{it} + \gamma_3\ (lag)Real\ GDP\ per\ capita_{it} + \gamma_4\ Percentage\ of\ population\ below\ LICO_{it} + \gamma_5\ Percentage\ of\ population\ above\ 65_{it} + \varepsilon_{it}$$

where $Mortality_{it}$ is a measure of either all-cause mortality or potentially avoidable mortality, α_i are province-level fixed effects, and ε_{it} is the error term. The subscripts i and t refer to provinces and time, respectively. β is the coefficient for total wait time, and γ_{1-5} are coefficients for the other explanatory variables.

Our specific statistical approach is ordinary least squares (OLS). Within this model, we include an underlying assumption that each province has its own, time-invariant, unique individual characteristics that are important in explaining differences in mortality between provinces. For this reason we employ a fixed-effects model for our analysis.

While this method of estimation is different from the feasible generalized least squares GLS method used in Or (2001), it is similar to that used to measure the factors (including health care resources) underlying international differences in premature mortality in Or (2000). A key difference between these two papers is the inclusion of institutional variables in the 2001 paper. In that paper, in the process of applying a fixed-effects treatment for comparison with the earlier study, Or notes: "[t]he institutional dummies are dropped for these estimations, since they are highly collinear with the country dummies that are included in a Fixed Effect Model" (2001: 36). This collinearity may be one of the reasons for the change in estimation approach (OLS with

23. Results from preliminary regressions examining combined mortality rates indicated that the ratio of females in the population was a significant factor in explaining rates of mortality, providing further support for estimating gender-specific regressions.

fixed effects to GLS) between the two studies. Since our approach does not include institutional variables, we are able to follow the approach of the earlier paper with a provincial fixed-effects model.

Robust[24] standard errors are employed where possible.[25] The results of an F-test are examined in order to see whether all the coefficients in the model are other than zero. Variance inflation factors (VIF) are repeatedly examined to ensure the absence of significant multicollinearity. Wooldridge tests are used to detect the presence of serial-correlation (Wooldridge, 2011; Drukker, 2003). If present,[26] an ar(1)[27] process is used to control for first-order autocorrelation.

24. Huber/White/sandwich estimators.

25. It is not employed in models where Stata's fixed-effect model for AR1 correction (xtregar) is used

26. The presence of autocorrelation is tested for by using David Drukker's xtserial command for Stata.

27. Stata's fixed-effect model for AR1 correction (xtregar) corrects for autocorrelation using the Cochrane-Orcutt method.

4 Results

All-cause mortality

As discussed above, our primary analysis focuses on all-cause mortality. Estimates for the fixed-effects regressions on this variable are shown in **table 1**. The results indicate a significant and positive relationship between the wait time to receive medically necessary elective treatment after referral by a general practitioner and all-cause female mortality. Specifically, a one-week increase in the wait from referral by a general practitioner to receipt of treatment is associated with an increase of approximately three female deaths per 100,000 population. A significant relationship was not noted for male mortality.

Table 1: Regression results, dependent variable: all-cause mortality

All-cause Mortality	Male	Female
Total wait (overall)	1.26	3.05***
(Lag) real GDP per capita	−0.0032	0.0011
(Lag) real total health spending per capita	−0.0155	0.0010
Proportion of primary care doctors	−6.90***	−3.90**
Percent below LICO	−2.34	1.46
Percent above 65	7.99	19.88*
Observations	170	170
Provinces	10	10
Prob > F	0.0053	0.0000

Note: The r-square (r^2) statistics reported when using Stata's xtreg command are not an appropriate representation of goodness-of-fit of the model. Instead, the r^2 reported by using the areg command may be more informative (Gould, 1996). For males, the adjusted r^2 is 0.9246, while it is 0.9346 for females. While the two methods generate identical coefficients, they may differ in the reported standard errors when the robust or cluster options are used. We have chosen to remain with the "xtreg" command with the robust option as it generates slightly larger standard errors for our model, and is thus more conservative with regards to the estimated levels of significance. Further, our reliance on "xtreg" allows us to readily move between models with and without an AR process ("xtregar") as opposed to manually imposing an AR process on "areg".

Significance: *** p <0.01; ** p <0.05; * p <0.1.

The results also indicate that an increase in the proportion of primary-care doctors (as a percentage of all doctors) is associated with a decrease in mortality rates for both males and females. Finally, the percentage of females over 65 is weakly associated with increases in mortality rates.

Potentially avoidable mortality

A secondary investigation examines potentially avoidable mortality. Estimates for the fixed effects regressions on this variable are shown in **table 2**. The examination of avoidable mortality requires a modified analysis as our measure of wait times, capturing delays across 12 major medical specialties (including medically necessary elective procedures), may be too broad[28] to be appropriately compared with this narrower measure of mortality. A recent analysis by the Canadian Institute of Health Information (CIHI, 2012b) concludes that the primary reason for changes in the rates of avoidable mortality between 1979 and 2008 is "reductions in deaths related to circulatory diseases such as heart disease, which decreased by 72%". Using this information, we choose to restrict our variable representing wait times for medically necessary elective care across 12 specialties to only the wait time for cardiovascular surgery.[29] Additionally, Prince Edward Island was dropped from the model due to a lack of data on cardiovascular wait times from the province.

The results indicate a significant and positive (but small) relationship between the wait time to receive medically necessary cardiovascular surgery after referral from a general practitioner and avoidable female mortality. Specifically, a one-week increase in the wait from referral by a GP to receipt of elective cardiovascular surgery is associated with an increase of approximately 0.18 female deaths per 100,000 population. A weakly significant, positive relationship is also noted for the variable representing the percentage of the population between 0 and 75 years old that is over 65. On the other hand, increases in real GDP per capita and the relative proportion of primary-care doctors are associated with decreases in female mortality.

The F-test indicates that the coefficients representing the impact of all included variables on male mortality are not significantly different from 0. However, and in contrast to all the other examined models, a weak and positive relationship is noted for the proportion of family doctors (as a percentage of all doctors). On the other hand, a significant negative relationship is identified for this variable in our model examining female mortality.

28. This hypothesis was confirmed when no significant association was found between total wait times for medically necessary elective surgery and potentially avoidable mortality using OLS with fixed effects.

29. Sum of the wait time between referral by a general practitioner and specialist consultation, and consultation to "elective" treatment.

Table 2: Regression results, dependent variable: avoidable mortality

Avoidable Mortality	Male (ar1)	Female
Total wait (cardiovascular)	−0.04	0.18**
(Lag) real GDP per capita	0.0015	−0.0026**
(Lag) real total health spending per capita	−0.0129	0.0066
Proportion of primary care doctors	1.28*	−1.91***
Percent below LICO	−0.62	−0.03
Percent above 65	6.97	8.45*
Observations	134	143
Provinces	9	9
Prob > F	0.4702	0.0004

Significance: *** p <0.01; ** p <0.05; * p <0.1.

A note on disease specific analyses

An attempt to examine the effect of wait times on mortality rates for heart disease and cancer mortality, areas where studies using individual-level data have clearly shown a linkage between delay and mortality, was abandoned as the models were inconclusive, usually yielding insignificant and inconsistent estimates. There are two possible explanations for this:

1. mortality rates for acute myocardial infarction (AMI) and malignant neoplasms are only available after the year 2000, severely reducing the number of data points available for analysis in each province;

2. such analyses examining the relationship between wait times and specific mortality rates are likely more appropriate at the individual/record level where triaging and specific patient factors can be accounted for.

Limitations

Bias due to omitted variables is always a concern. We are, however, fairly confident that no serious omissions that would have altered the overall findings with regards to the effect of wait times on mortality have been made.[30] Of note is the fact that the substitution of variables "(lag) real health expenditures per capita" and "percent of primary doctors" by a variable representing "the number of doctors per capita" did not result in any significant change in the overall findings with regards to the effect of wait times on mortality. The inclusion of variables representing the number of MRI and CT scanners per

30. In our testing, coefficients for other variables that potentially omitted variables may be correlated with, sometimes changed

capita[31] resulted in a notable change in significance (from insignificant to significant at the $p < 0.1$ level) for the impact of total wait times on all-cause male mortality. On the other hand, it also resulted in a loss of significance for the impact of the wait time for elective cardiovascular surgery on potentially avoidable female mortality. However, due to the magnitude of missing data for these variables, as well as the potential for multicollinearity, they remain excluded from the present analysis.

This said, multicollinearity between *some* explanatory variables is, to an extent, an accepted feature of our model. The only impact of this problem that we could identify is manifested in the significance of the coefficients of real GDP and total health spending. Each of these was sometimes significant in the absence of the other. However, given that their inclusion or exclusion did not seriously affect the size or significance of the coefficient of the wait times variable, and that there are strong theoretical arguments for including them, we chose to keep both in the model.

It is also possible that our employment of an OLS model with fixed effects may have led to an underestimation of the true impact of wait times on mortality. Background investigations reveal that OLS (without fixed effects) and GLS models generally resulted in larger, and more significant, coefficients for wait times. Indeed, the wait times coefficients for all models[32] were positive and statistically significant when basic OLS was employed. This suggests that the results presented here are likely a conservative estimate of the true relationship.

Finally, it is important to acknowledge that this model is based on large, aggregated, provincial statistics and, as such, is incapable of controlling for individual characteristics on a case-by-case basis.

31. A significant amount of missing data was replaced using linear interpolation for this analysis.

32. All-cause male mortality, all-cause female mortality, potentially avoidable male mortality, and potentially avoidable female mortality.

5 Discussion

Are waiting lists killing Canadians?

Although rationing by waiting is not uncommon in tax-funded healthcare systems with limited cost sharing and constraints on surgical capacity, Canadians endure waiting times for health services that are both historically and internationally high in spite of internationally high levels of health expenditure (Willcox et al., 2007; Barua and Esmail, 2013). The consequences for those waiting for medically necessary care can be devastating. Delayed treatment can mean worsening of conditions, with potentially more complex procedures required at the end of the wait and possibly poorer outcomes from care. Some patients may even deteriorate so far as to no longer qualify for treatment after delay. Waiting can also result in depression, increased exposure to pain and discomfort, indignity associated with increased reliance on others and embarrassing consequences of the untreated medical condition, isolation, mental anguish, and strained personal relationships. Further, waiting can affect investments in education and training, parental involvement and support for school-aged children, and both absenteeism and reduced on-the-job productivity ("presenteeism") in the workforce, not to mention disruptions in work and potential reductions in the ability to earn income (Day, 2013; Globerman, 2013). Beyond these serious consequences of waiting lies the ultimate consequence, death.

Many studies have pointed to a relationship between delayed access to medical services and mortality, and this reality has been recognized by the Supreme Court of Canada (SCC, 2005). While much of that work has focused on wait times for conditions that carry potentially fatal consequences and a non-trivial risk of serious adverse events, there is also much support for the idea that even wait times for treatment of non-fatal conditions can affect survival through both related adverse events and reductions in general health and well-being.

Our broad analysis of waiting times and mortality in the Canadian population, which seeks to capture the broader impact on mortality of delayed access to medically necessary care in Canada, also finds a positive relationship between delayed medical care and mortality at the aggregate level. The estimates from this model suggest that the increases in waiting times between

1993 and 2009 may have resulted in a higher rate of mortality than would have been expected otherwise. This troubling finding is strongest for female all-cause mortality (including not only medical mortality but indirect impacts on mortality and longevity).

There are a few possible explanations for this disparity in the impact of wait times upon males and females .The first two relate to differences in the mortality trends.

1. Over the last three decades there has been a relatively greater increase in the total number of female deaths in comparison to the trend for males (Martel, 2013). One hypothesis is that this may be due to the increased participation in the work force, which may also be accompanied by more accidents but also associated with increased stress, smoking, and drinking (Globe and Mail, 2013).

2. Between 2001 and 2007, "[m]ortality due to falls was the only cause-specific mortality that showed a steady increase … and it was slightly more common in females than males. Fall injury accounted for about one third of all unintentional injury deaths in adults, and was the principal reason for the dramatic increase in mortality due to unintentional injury with age in the elderly" (Chen et al., 2013: 99).

The third explanation is related to possible differences in the ability to obtain necessary medical care in a timely fashion.

3. Women may face longer wait times than men. For example, Carrière and Sanmartin found that "[w]omen were significantly less likely than men to see a specialist within a month. This could result from systemic gender biases in access to health care services" (2010: 6). It has also been noted that, for example, "[w]omen with knee/hip osteoarthritis spend substantial time 'waiting to wait'. Despite reporting greater pain and disability than men, women more often wait to be referred to orthopaedic surgeons, and to be referred to surgery" (Jackson et al., 2006: "Conclusion")

How many Canadians?

The extensive theoretical justification for the causal link between wait times and mortality, both direct and indirect, supports the view that our findings are likely more than simply correlation (Day, 2013). Following this justification, it is possible to use these results to estimate the number of Canadian lives that may have been lost to increases in wait times between the early 1990s and 2009, a period during which wait times for medically necessary care lengthened considerably.

To estimate this number, we begin by calculating the annual change in wait times relative to the first year in our sample (1993) in each province.

We then multiply that number with those total wait times coefficients determined to have a significant association with mortality rates. Finally, we translate the result into estimates of mortality by adjusting for annual population estimates (noting that our coefficients are based on mortality rates per 100,000 population).

The cumulative change in crude mortality is represented by

$$\sum_{t=1994}^{2009} \beta\,(W_t - W_{1993}) \left(\frac{P_t}{100000}\right)$$

where W_t is the wait time in year t; β is the coefficient for the relevant wait time, representing the resulting increased in mortality per 100,000 population per week increase in W; and P_t is the population in year t.

Using this approach, we can estimate a value for the additional all-cause mortality (female) that may be associated with changes in wait times from 1993 to 2009, as well as an upper and lower bound (based on the statistical 95% confidence intervals for our estimates above) for that value. Over the 16-year period, increases in wait times for medically necessary care may be associated with 44,273 additional deaths (with a 95% confidence interval from 25,456 to 63,090) according to our model. This represents approximately 2.55% of total female deaths during the period or 1.24% of total mortality (male and female) during the period.[33]

It is also possible to use this approach to estimate avoidable female mortality (for those with "avoidable" causes of mortality under the age of 75)—a subset of the estimate provided above. Over the 15-year period from 1994[34] to 2009, changes in wait times for cardiovascular care (compared to those in 1994) are associated with approximately 662 potentially avoidable deaths (with a 95% confidence interval from 35 to 1,289). This represents approximately 0.16% of avoidable female deaths during the period or 0.06% of total[35] avoidable mortality (male and female) during the period. This may largely be a reflection of the fact that, in several cases, wait times for cardiovascular surgery have actually improved during the 15-year period, resulting in potential reductions in avoidable mortality associated with waiting.

33. While the finding for males was not significant, this may be the result of a limitation in our ability to capture the relationship either with our particular modeling approach or with the data available. Thus, there may be value in considering this estimated number of lives as a proportion of the total Canadian population in general (both male and female) rather than restricting the discussion of mortality associated with waiting only to females.

34. Median wait times for cardiovascular surgery (by province) were unavailable for the year 1993.

35. As mentioned previously, Prince Edward Island was excluded from the analysis due to a lack of data on cardiovascular wait times in the province.

Wasted lives?

Arguments that mortality associated with delayed access to treatment is the cost of ensuring that all Canadians, regardless of medical history or ability to pay, have access to health care insurance and services is not based in fact. Several developed nations, including Belgium, France, Germany, Japan, Luxembourg, the Netherlands, and Switzerland maintain universal approaches to health care insurance but do not have problems with wait times (Esmail, 2013b). Further, Canadian delays for emergency care, primary care, specialist consultations, and elective surgery are among the longest in the developed world.

According to *The Commonwealth Fund 2010 International Health Policy Survey in Eleven Countries* (Commonwealth Fund, 2010), Canadians were:

- more likely than respondents in Australia, France, Germany, the Netherlands, New Zealand, Norway, Sweden, Switzerland, or the United Kingdom to have waited four hours or more in the emergency room before being treated, and least likely to have waited of less than 30 minutes;
- more likely than respondents in all of these nations to have waited six days or more for access to a doctor or nurse when sick or needing care, and least likely (tied with Norway) to have had a same- or next-day appointment;
- more likely than respondents in all of these nations to have waited two months or more for a specialist appointment, and least likely to have waited less than 1 month;
- more likely than respondents in all of these nations to have waited four months or more for elective surgery, and less likely than all but respondents in Sweden to report waiting less than one month.

The 2013 edition of the *Commonwealth Fund International Health Policy Survey* confirms the findings of the 2010 survey. Specifically, in the 2013 survey, Canadians were more likely to report relatively long waits for primary, specialist, and emergency department care than respondents in any of the other countries that also maintained universal access health insurance (Schoen et al., 2013).

This dismal performance of lengthy wait times is not the result of lower health expenditures in Canada. On the contrary, Canadian health expenditures are among the highest in the developed world. Specifically, in 2009 the Canadian healthcare system was the developed world's most expensive universal-access healthcare system on an age-adjusted basis (older people

require more care). At 12.5% of GDP, Canada's healthcare system outpaced expenditures in the average universal-access nation by some 26% (OECD, 2011; calculations by authors).[36]

The difference between the performance of Canada's provinces and these other developed nations that manage to deliver more timely access to health care services with greater financial efficiency is based in policy. A common characteristic of the nations with relatively short wait times is a relatively high reliance on market incentives and private competition: all have private competition in the delivery of health care, private parallel health-care insurance, cost sharing for universally insured services, and employ a statutory insurance model (rather than government-run tax-funded insurance) for operation of the universal insurance scheme (Esmail, 2013b). On the other hand, lengthy wait times are commonly found in countries with minimal patient payments for services, governmental control of the supply of services, and governmental (tax-funded) health insurance (Wilcox et al., 2007; Esmail, 2013b).[37] But, even in these countries where there are lengthy wait times, strategies to reduce wait times appear to be more successful when they incorporate or mimic market allocation mechanisms (Esmail, 2013b).

Clearly, policy options are available to provincial governments wishing to reduce or even eliminate queues for medical treatment. Yet the focus of Canada's governments has largely been away from these sound approaches towards a very limited focus on the wait time from specialist to treatment—primarily in select "priority" areas—and increased health expenditures. Canada has seen little to no reform of the monopolistic governmental approach with first-dollar (free at the point of access) coverage that led to lengthy queues in the first place. Perhaps not surprisingly, given international evidence on the weakness of this approach, Canada's provinces have not been particularly successful at reducing wait times even within areas of governmental focus (Parliament of Canada, 2008; Health Council of Canada, 2013; Borowitz et al., 2013).

More troubling is that little thought is being given to the potential unintended consequences of the narrowly focused approach to reducing wait times that fails to capture the majority of procedures in the healthcare system or wait times outside the final stage of waiting. This focus on wait times from specialist to treatment, and then only in select areas of care, may have the effect of lengthening wait times in other areas of health care, in part because of the shift of resources towards governmental "priorities".

36. The age-adjustment methodology used here is from Esmail and Walker, 2008. Age-adjustment is based on the percentage of population over age 65 in a given country relative to the average of OECD nations that maintain universal access.

37. In the presence of limited cost sharing and government-controlled supply of hospital services, wait times take the place of price rationing as a means of allocating resources.

Sound approaches to delivering superior (and more timely) universal-access care have been repeatedly presented as a sensible reform option in Canada. Unfortunately, they are routinely dismissed and discouraged with claims that such market-based approaches would take Canada down a path towards non-universality and "American-style" health care. Claims that these positive, effective approaches are tantamount to abandoning the central noble principle of Medicare have clearly dissuaded many Canadians—or at least Canadian politicians—from supporting them. The result is adherence to the status quo, and the associated lengthy queues for treatment that persist in spite of a high level of health expenditure.

Combining the findings of this study with these realities leads to a troubling conclusion: the estimated 44,273 Canadian women who have lost their lives between 1993 and 2009 as a result of lengthy delays in receiving care may have died needlessly[38] because of policy approaches that are inherently flawed and arguments against sound effective policies based in rhetoric rather than fact. These consequences are borne by Canadians while sensible policy options were available to governments interested in markedly reducing wait times cost effectively through more pragmatic approaches to health care policy. A potential reduction in mortality may have been possible had effective policies proven to reduce wait times—such as competition with money following patients—been introduced over the last two decades.

38. Of course, some individuals may die from the medical condition regardless of timely medical intervention.

6 Conclusion

Justices of the Supreme Court of Canada have noted that patients in Canada die as a result of waiting lists for universally accessible health care. Numerous studies point not only to this reality but also to the reality that wait times can have an impact on general health and well-being, which may also result in untimely demise. The unanswered question has been how many died due to limitations in accessing timely care? Our analysis estimates that between 25,456 and 63,090 (with a middle value of 44,273) Canadian women may have died as a result of increased wait times between 1993 and 2009. This estimated increase in the Canadian mortality rate associated with waiting for medical treatment was unnecessary and is the result of a health policy regime that imposes longer wait times on Canadians than are found in the universal-access healthcare systems of other developed nations.

Appendix A: Detailed Results

Table A1: Male All-Cause Mortality

	Coefficient	Standard Error	t	p	Low95	High95
Total wait (overall)	1.260145	0.8830866	1.43	0.187	−0.737536	3.257825
(Lag) real GDP per capita	−0.0031636	0.0030157	−1.05	0.322	−0.0099856	0.0036584
(Lag) real total health spending per capita	−0.0154986	0.0164515	−0.94	0.371	−0.0527145	0.0217172
Proportion of primary care doctors	−6.900257	1.557092	−4.43	0.002	−10.42264	−3.377871
Percent below LICO	−2.340069	2.643709	−0.89	0.399	−8.320555	3.640417
Percent above 65	7.987893	8.073195	0.99	0.348	−10.27494	26.25073

Observations = 170
Groups = 10
Prob > F = 0.0053

Table A2: Female All-Cause Mortality

	Coefficient	Standard Error	t	p	Low95	High95
Total wait (overall)	3.047358	0.5725596	5.32	0.0000	1.752138	4.342577
(Lag) real GDP per capita	0.0011272	0.0033259	0.34	0.742	−0.0063966	0.008651
(Lag) real total health spending per capita	0.0009835	0.0085444	0.12	0.911	−0.0183454	0.0203123
Proportion of primary care doctors	−3.901592	1.597657	−2.44	0.037	−7.515744	−0.28744
Percent below LICO	1.460108	2.23451	0.65	0.53	−3.594706	6.514921
Percent above 65	19.87957	9.957853	2.00	0.077	−2.646656	42.4058

Observations = 170
Groups = 10
Prob > F = 0.0000

Table A3: Male Avoidable Mortality

	Coefficient	Standard Error	t	p	Low95	High95
Total wait (cardiovascular)	−0.0418329	0.1267619	−0.33	0.742	−0.2928342	0.2091684
(Lag) real GDP per capita	0.0014702	0.0013926	1.06	0.293	−0.0012874	0.0042277
(Lag) real total health spending per capita	−0.0128804	0.0084981	−1.52	0.132	−0.0297075	0.0039467
Proportion of primary care doctors	1.284846	0.7394443	1.74	0.085	−0.1793277	2.749019
Percent below LICO	−0.6226609	0.9710961	−0.64	0.523	−2.545528	1.300206
Percent above 65	6.974926	8.428791	0.83	0.41	−9.714922	23.66477

Observations = 134
Groups = 9
Prob > F = 0. 4702
Notes: [1] Observations from Prince Edward Island were dropped. [2] An ar(1) process was used to correct for autocorrelation.

Table A4: Female Avoidable Mortality

	Coefficient	Standard Error	t	p	Low95	High95
Total wait (cardiovascular)	0.1819903	0.0747267	2.44	0.041	0.0096702	0.3543104
(Lag) real GDP per capita	−0.0025528	0.000814	−3.14	0.014	−0.00443	−0.000676
(Lag) real total health spending per capita	0.0066092	0.0043168	1.53	0.164	−0.0033453	0.0165636
Proportion of primary care doctors	−1.908969	0.4996731	−3.82	0.005	−3.061218	−0.756721
Percent below LICO	−0.0267798	0.98977	−0.03	0.979	−2.309194	2.255634
Percent above 65	8.448293	3.663801	2.31	0.05	−0.0004478	16.89703

Observations = 143
Groups = 9
Prob > F = 0. 0004
Note: Observations from Prince Edward Island were dropped.

Appendix B: List of Causes of Death for Avoidable Mortality Indicator

Infections

- Enteritis and other diarrhoeal disease
- Tuberculosis
- Vaccine-preventable diseases
- Selected invasive bacterial infections
- Sepsis
- Malaria
- Meningitis
- Cellulitis
- Pneumonia
- Sexually transmitted infections, except HIV/AIDS
- Viral hepatitis
- HIV/AIDS

Neoplasms

- Lip, oral cavity and pharynx cancer
- Esophageal cancer
- Stomach cancer
- Colorectal cancer
- Liver cancer
- Lung cancer
- Melanoma skin cancer
- Non-melanoma skin cancer
- Malignant neoplasm of breast
- Cervical cancer
- Uterus cancer
- Testicular cancer
- Bladder cancer
- Thyroid cancer
- Hodgkin's disease
- Leukemia
- Benign neoplasms

Diseases of the Circulatory System

- Rheumatic heart disease
- Hypertensive diseases
- Cerebrovascular diseases
- Ischaemic heart disease
- Other atherosclerosis

- Aortic aneurysm
- Venous thromboembolism

Diseases of the Respiratory System

- Chronic obstructive pulmonary disorders
- Asthma and bronchiectasis
- Acute lower respiratory infections
- Upper respiratory infections
- Lung diseases due to external agents
- Adult respiratory distress syndrome
- Pulmonary oedema
- Abscess of lung
- and mediastinum; pyothorax
- Other pleural disorders
- Other respiratory disorders

Diseases of the Digestive System

- Peptic ulcer disease
- Diseases of appendix; hernia; disorders of gallbladder, biliary tract and pancreas
- Chronic liver disease (excluding alcohol-related disease)

Diseases of the Genitourinary System

- Nephritis and nephrosis
- Renal failure
- Obstructive uropathy, urolithiasis and prostatic hyperplasia
- Inflammatory diseases of genito- urinary system
- Disorders resulting from impaired renal tubular function

Infant and Maternal Causes

- Complications of perinatal period
- Congenital malformations, deformations and chromosomal anomalies
- Pregnancy, childbirth and the puerperium

Unintentional Injuries

- Transport accidents
- Falls
- Other external causes of accidental injury
- Drowning
- Fires and flames
- Accidental poisonings

Injuries of Undetermined Intent

- Injuries of undetermined intent

Intentional Injuries

- Suicide and self- inflicted injuries
- Assault

Alcohol and Drug Use Disorders

- Alcohol-related diseases, excluding external causes
- Drug use disorders

Nutritional, Endocrine and Metabolic Disorders

- Nutritional deficiency anaemia
- Thyroid disorders
- Diabetes mellitus
- Adrenal disorders
- Congenital metabolic disorders

Neurological Disorders

- Epilepsy

Disorders of Musculoskeletal System

- Osteomyelitis

Adverse Effects of Medical and Surgical Care

- Drugs, medicaments and biological substances causing adverse effects in therapeutic use
- Misadventures to patients during surgical and medical care
- Medical devices associated with adverse incidents in diagnostic and therapeutic use
- Surgical and other medical procedures as the cause of abnormal reaction

Source: CIHI, 2012a.

To view complete tables, click here.

Appendix C: Correlation Matrices for Included Variables

Table C 1: Variables used for modelling all-cause mortality

Correlation	All-cause male mortality per 100,000 pop.	All-cause female mortality per 100,000 pop.	Total wait (overall)	Lag real GDP per capita
All-cause male mortality per 100,000 pop.	1			
All-cause female mortality per 100,000 pop.	0.8813	1		
Total wait (overall)	0.356	0.5073	1	
Lag real GDP per capita	–0.6538	–0.4459	0.2226	1
Lag real total health spending per capita	–0.0599	0.2491	0.5826	0.5656
Proportion of primary care doctors	0.3798	0.1508	0.2667	–0.3571
Percentage of male population below LICO	–0.2425	–0.4014	–0.6209	–0.2263
Percentage of female population below LICO	–0.1832	–0.3436	–0.6493	–0.2817
Percentage of male population above 65	0.6209	0.7745	0.6197	–0.1488
Percentage of female population above 65	0.6851	0.8507	0.4916	–0.2957

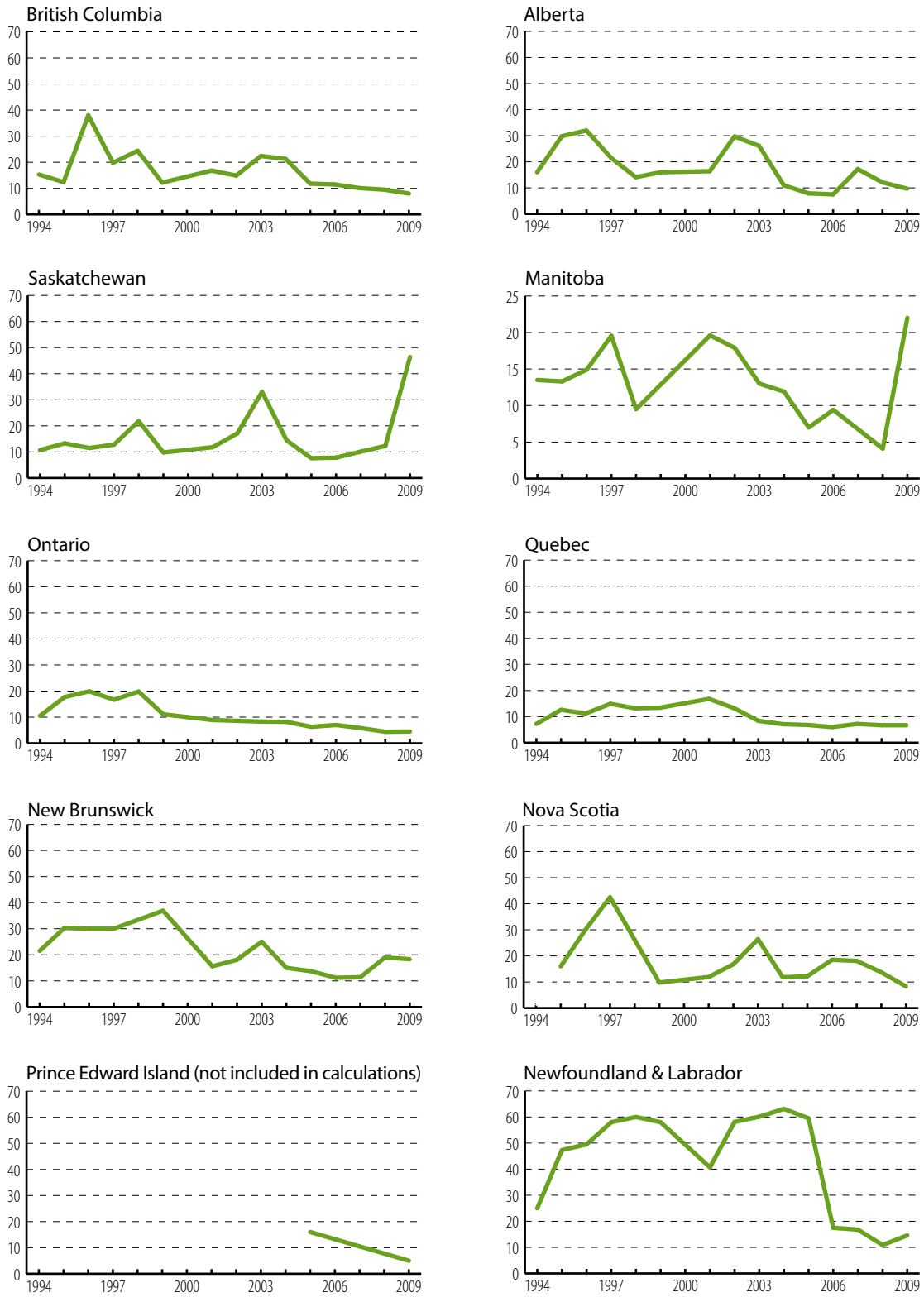
Table C 2: Variables used for modelling avoidable mortality

Correlation	Avoidable male mortality per 100,000 population	Avoidable female mortality per 100,000 population	Total wait (cardiovascular)	Lag real GDP per capita
Avoidable male mortality per 100,000 pop.	1			
Avoidable female mortality per 100,000 pop.	0.8726	1		
Total wait (cardiovascular)	0.3399	0.2317	1	
Lag real GDP per capita	–0.7387	–0.6612	–0.3455	1
Lag real total health spending per capita	–0.3648	–0.2172	–0.3159	0.5469
Proportion of primary care doctors	0.2173	–0.025	0.4881	–0.2795
Percentage of male population below LICO	0.1862	0.1127	0.1914	–0.4328
Percentage of female population below LICO	0.2794	0.2276	0.1555	–0.4766
Percentage of male population age 65–75	0.3201	0.3194	–0.1708	–0.3145
Percentage of female population age 65–75	0.4651	0.4945	–0.2709	-0.481

Lag real total health spending per capita	Proportion of primary care doctors	Percentage of male population below LICO	Percentage of female population below LICO	Percentage of male population over 65	Percentage of female population over 65
1					
–0.1984	1				
–0.5755	–0.167	1			
–0.6388	–0.2026	0.9518	1		
0.5282	0.0977	–0.4327	–0.4224	1	
0.3474	–0.0061	–0.3434	–0.2849	0.9235	1

Lag real total health spending per capita	Proportion of primary care doctors	Percentage of male population below LICO	Percentage of female population below LICO	Percentage of male population aged 65–75	Percentage of female population aged 65–75
1					
–0.2085	1				
–0.6743	0.0153	1			
–0.7323	–0.0607	0.9368	1		
0.351	–0.045	–0.2555	–0.2236	1	
0.0973	–0.1633	–0.0879	0.0113	0.8931	1

Appendix D: Median Wait Time (Weeks) for Elective Cardiovascular Care, GP Referral to Treatment, by Province, 1994–2009



Sources: Fraser Institute annual *Waiting Your Turn* survey, 1990, 1992–2013, various authors; calculations by authors.

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The review process is overseen by the directors of the Institute's research departments who are responsible for ensuring all research published by the Institute passes through the appropriate peer review. If a dispute about the recommendations of the reviewers should arise during the Institute's peer review process, the Institute has an Editorial Advisory Board, a panel of scholars from Canada, the United States, and Europe to whom it can turn for help in resolving the dispute.

Editorial Advisory Board