



Canada's International Health System Performance Over 50 Years

Examining Potential Years of Life Lost



Canadian Institute
for Health Information
Institut canadien
d'information sur la santé

Production of this document is made possible by financial contributions from Health Canada and provincial and territorial governments. The views expressed herein do not necessarily represent the views of Health Canada or any provincial or territorial government.

All rights reserved.

The contents of this publication may be reproduced unaltered, in whole or in part and by any means, solely for non-commercial purposes, provided that the Canadian Institute for Health Information is properly and fully acknowledged as the copyright owner. Any reproduction or use of this publication or its contents for any commercial purpose requires the prior written authorization of the Canadian Institute for Health Information. Reproduction or use that suggests endorsement by, or affiliation with, the Canadian Institute for Health Information is prohibited.

For permission or information, please contact CIHI:

Canadian Institute for Health Information
495 Richmond Road, Suite 600
Ottawa, Ontario K2A 4H6

Phone: 613-241-7860

Fax: 613-241-8120

www.cihi.ca

copyright@cihi.ca

ISBN 978-1-77109-510-5 (PDF)

© 2020 Canadian Institute for Health Information

How to cite this document:

Canadian Institute for Health Information. *Canada's International Health System Performance Over 50 Years: Examining Potential Years of Life Lost*. Ottawa, ON: CIHI; 2020.

Cette publication est aussi disponible en français sous le titre *Performance du système de santé canadien à l'international sur 50 ans : regard sur les années potentielles de vie perdues*.

ISBN 978-1-77109-511-2 (PDF)

Table of contents

Acknowledgements.....	4
Executive summary.....	6
Introduction	8
Our approach.....	9
Study results	12
How did Canada perform on overall PYLL relative to OECD comparator countries between 1960 and 2010?	12
Canada's PYLL performance over 50 years: Overall, 1960 to 2010.....	12
How did Canadian men and women perform on overall PYLL relative to men and women in OECD comparator countries?.....	16
Canada's PYLL performance over 50 years: Men and women, 1960 to 2010.....	17
How did Canada perform on PYLL for main causes of death relative to OECD comparator countries?.....	20
Canada's PYLL performance over 50 years: Main causes of death, 1960 to 2010	21
Canada's PYLL performance over 50 years: Cancer, 1960 to 2010	22
Canada's PYLL performance over 50 years: External causes, 1960 to 2010.....	27
Canada's PYLL performance over 50 years: Ischemic heart disease, 1960 to 2010.....	31
Canada's PYLL performance over 50 years: Cerebrovascular disease, 1960 to 2010	34
Conclusions	39
Appendix A: Methodological details.....	42
Appendix B: Text alternative for images	47
References	54

Acknowledgements

The Canadian Institute for Health Information (CIHI) wishes to acknowledge and thank members of the project team from the Canadian Population Health Initiative for their dedication and contributions to *Canada's International Health System Performance Over 50 Years: Examining Potential Years of Life Lost*. Team members included Michele (Arthur) Bender, Deborah Cohen, Harshani Dabere, Ezra Hart, Jean Harvey, Kelly Hogan, Mohamed Kharbouch, Gobinaa Manoharan, Maisam Najafizada, Annie Sebold, Thushara Sivanandan and Karen Weir.

We would also like to thank the CIHI Advisory Council on Population Health for its ongoing guidance and support, and to extend our gratitude to colleagues from across the organization for their guidance and expertise over the course of the project.

We would like to express our appreciation to the members of the expert advisory group, who provided invaluable advice throughout the planning and development of this report:

- **Ross Baker**
Professor, Institute of Health Policy, Management and Evaluation, University of Toronto
- **Raisa Deber**
Professor, Institute of Health Policy, Management and Evaluation, University of Toronto
- **Niek Klazinga**
Professor of Social Medicine, Academic Medical Centre, University of Amsterdam, and Visiting Professor, Institute of Health Policy, Management and Evaluation, University of Toronto
- **Doug Manuel**
Senior Scientist, Ottawa Hospital Research Institute, and Professor, Department of Family Medicine, University of Ottawa
- **Cory Neudorf**
Chief Medical Health Officer, Saskatoon Health Region

Please note that the analyses and conclusions in this document do not necessarily reflect those of the individuals or organizations mentioned above.

For more information, please contact

Canadian Population Health Initiative
Canadian Institute for Health Information
495 Richmond Road, Suite 600
Ottawa, Ontario K2A 4H6
Email: cphi@cihi.ca

Executive summary

International comparisons can facilitate cross-country learning to improve health system performance. This study helps paint a picture of Canada's health system performance relative to that of 17 other high-income countries by comparing trends in mortality over a 50-year period (1960 to 2010). Data from the Organisation for Economic Co-operation and Development (OECD) was used to study potential years of life lost (PYLL). PYLL is a measure of premature mortality that provides an estimate of the additional time a person would have lived had he or she not died prematurely (before age 70).¹

This study addressed the following questions:

How did Canada perform on overall PYLL relative to OECD comparator countries between 1960 and 2010?

This study demonstrated that, like all other countries included in the analysis, Canada made substantial improvements in PYLL, experiencing a reduction of 6,000 absolute potential years of life lost per 100,000 population between 1960 and 2010. However, relative to other peer countries over the 50-year period, Canada maintained a middle-of-the-pack performance. This finding suggests that although Canada is making progress in absolute terms, it is keeping pace with the international median in relative terms.

How did Canadian men and women perform on overall PYLL relative to men and women in OECD comparator countries?

In terms of overall PYLL, Canadian men and women showed similar patterns of middle-of-the-pack performance in earlier decades; more recently, though, Canada's performance for men and women moved in different directions. From the 1990s to 2010, Canada's men were consistently ahead of the international median relative to men in the comparator countries. Conversely, Canada's women lost ground from the 1990s and in 2010 lagged behind the international median relative to other women.

There continued to be a sex gap in Canada for PYLL overall. In 2010 in Canada, men lost almost twice as many potential years of life as women. This sex gap was predominant for certain causes of death. In 2010, absolute PYLL rates for deaths due to external causes were higher among Canadian men than Canadian women, with a male-to-female ratio of almost 3:1. A similar pattern existed for PYLL rates for ischemic heart disease, with a male-to-female ratio of 4:1.

How did Canada perform on PYLL for main causes of death relative to OECD comparator countries?

Canada's relative PYLL performance stratified by specific causes of death can help shed light on areas where Canada did well over the 50 years studied, and areas where Canada has room for improvement compared with other countries.^{2, 3} For PYLL among men due to cancer, Canada performed ahead of the international median. PYLL for cancer among Canadian women tells a different story: on this front, Canada performed behind the international median. For PYLL due to external causes of death (e.g., traffic accidents, falls, accidental poisonings, intentional self-harm), Canada had a middle-of-the-pack performance for both sexes, losing some ground in the last decade of analysis. For PYLL for men and women due to ischemic heart disease, Canada performed behind the international median across the 50-year period. And finally, for PYLL due to stroke, Canadian men and women fared well; on this front, Canada consistently performed well ahead of the international median for both sexes.

These findings suggest that Canada has room for improvement on ischemic heart disease and deaths due to external causes for both sexes, and for cancers in women. Ischemic heart disease, cancers and external causes are large contributors to all-cause PYLL at the population level, so improvements in these areas have the potential to improve Canada's overall performance on the international stage.

Canada has much to learn from all peer countries as we strive to achieve optimal health status for the population. However, international comparisons are complex. Further policy analysis must take into account a range of factors, such as health and health care systems, as well as the broader social and economic drivers that influence country-level health system performance and population health outcomes.

Introduction

In recent years, the international literature has created significant mainstream and policy interest in Canada's health system performance on the international stage.^{4–7} International comparisons are useful for informing health policy debates and cross-country learning to improve health system performance.^{8, 9}

Some studies have shown that, over time, Canada has been holding its position as a middle-of-the-pack performer among peer countries,^{2, 5, 10, 11} while other studies have suggested that Canada's health system performance has been declining.^{5, 12, 13} Many of these studies have received widespread media attention, giving rise to a concern about the state of Canada's health systems and whether they are keeping pace with those in comparator countries. Given the inconsistency in findings across the literature, a number of important questions remain about Canada's position in the health system performance rankings over time.

This study examined Canada's performance relative to 17 other high-income countries over time. By comparing trends in mortality over a 50-year period (1960 to 2010) using the mortality outcome measure potential years of life lost (PYLL), the analysis addressed the following questions:

- How did Canada perform on overall PYLL relative to OECD comparator countries between 1960 and 2010?
- How did Canadian men and women perform on overall PYLL relative to men and women in OECD comparator countries?
- How did Canada perform on PYLL for main causes of death relative to OECD comparator countries?

Our approach

Population mortality outcome measure: PYLL was selected as the primary indicator for this analysis. PYLL is a measure of premature mortality that provides an estimate of the additional time a person would have lived had he or she not died prematurely (before age 70).^{1, 14} For this indicator, the fewer years of life lost the better. As such, smaller values are desirable. PYLL was selected as the metric for this study as it reflects one of the primary goals of health systems around the world: to improve health outcomes at the population level.^{15, 16}

Min–max normalization method: Min–max normalization was used to create a relative position for each country on a scale between 0 and 100 for each year, whereby the top performer was given the position 0 (fewest years of life lost) and the bottom performer was given the position 100 (most years of life lost). Using this approach, Canada was positioned relative to the top- and bottom-performing countries in each year over the study period.^{10, 17, 18}

Data and data source: This study used publicly available mortality data from the OECD.¹⁹ PYLL data for all comparator countries was available between 1960 and 2010.

Comparator countries: 18 comparator countries were included in this analysis: Australia, Belgium, Canada, Denmark, Finland, France, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

In this report, we pay particular attention to Australia's performance. Canada and Australia are often compared because they have similar populations, age and sex profiles, urban consolidations within large rural geographies, and universal health care systems with similar federated divisions of power between central and provincial/state governments.^{20, 106} This focus on Australia provides a useful point of comparison and may provide potential insights for decision-makers in Canada's health systems.^{21–23, 106}

Organization of the report: This report measures PYLL performance in both relative and absolute terms. In each section, we use a line graph to articulate relative performance for all comparator countries. The absolute performance for each country in 2010 is presented along the right-hand side of the figure.

In each figure, Canada's relative position over time is represented by a red line. For reference, we also include the top-performing country (purple with diamonds) and the country in the bottom position (grey with circles), as well as the median line (dotted black line), which represents the median (50th percentile) in any given year. Finally, in each graph we present Australia's relative performance (teal with squares) as a point of interest.

Please see Appendix A for methodological details.

What is relative performance using min–max normalization?

International comparison studies that focus on health system performance often rank top and bottom performers on a scale from first to last place. This approach can be thought of as a race, in which the runner at the front of the group is tagged in first place and the runner at the back is tagged in last place at any given time during the race. All other runners in the race are given a ranking between first and last position. However, ranking each runner provides only part of the story about how well the runners are performing.

Scenario A

Traditional rank order approach



Scenario B

Min–max relative position approach



The relative positions of the runners in each race in the above scenarios are very different. In both cases, the runners would be given the same rankings in first, second and third place. However, in scenario B, it is clear that the runner in second place is actually performing much better than the second-place runner in scenario A. Min–max normalization is a method that allows the reader to more clearly understand where each of the runners is in the race according to overall rank but also in terms of their position relative to one another. This race analogy is used throughout the report to facilitate interpretation of results.

What is potential years of life lost?

Although the precise method for calculating PYLLs is somewhat complex, conceptually speaking, PYLLs are quite simple (see Appendix A for detailed methodology).

People who die prematurely can be thought of as having lost *years of potential life*. The age at which death is determined to be premature can vary. Some studies measure early death based on an average life expectancy, while others use an arbitrary cut-off age. In this study, we applied the OECD's definition for PYLL, which is any death occurring before age 70.¹ This means that a person who dies of a heart attack at age 50 will have lost 20 years of potential life.

What is PYLL?



The calculation for PYLL in a given country is the sum of the total years of potential life lost in 1 year among those who died prematurely (before age 70). The indicator is then expressed as a rate per 100,000 population.¹ Since fewer years of potential life lost is ideal, low numbers of PYLL in a country are considered desirable, while high numbers of PYLL are considered undesirable.

The impact of a death that occurs earlier in life is often considered more significant to society than deaths that occur later in life.³ The PYLL indicator puts more emphasis on deaths that occur in young people. PYLLs are frequently used for health system performance studies because they reflect the burden of premature death on society, and because the data is available for many countries over a long period of time.^{1, 15, 24}

It should be noted that PYLL is one of many different measures of health system performance internationally. PYLL was selected as the metric for this study as it reflects the broadest goal of health systems around the world: to help improve on health outcomes at the population level.^{15, 16} However, like all health system performance indicators, PYLL provides only one perspective of health system performance around the world.

Study results

How did Canada perform on overall PYLL relative to OECD comparator countries between 1960 and 2010?

Findings

All countries included in the analysis showed sizable improvements in PYLL over the 50-year period. Canada showed a 66% improvement in PYLL between 1960 and 2010, representing a reduction of 6,000 absolute potential years of life lost per 100,000 population. In 1960, Canada experienced 9,113 years of life lost per 100,000 population. This dropped to 3,113 potential years of life lost per 100,000 in 2010.

Between 1960 and 2010, there was an 80% decrease in the variability in PYLL performance between top- and bottom-performing countries. This finding suggests that the race for first place is much tighter than it was 50 years ago.

Over the 50 years studied, Canada maintained its position as a middle-of-the-pack performer. Between 2000 and 2010, countries such as Australia, which traditionally mirrored the Canadian trajectory, began to accelerate in performance relative to other OECD countries.

Canada's PYLL performance over 50 years: Overall, 1960 to 2010

What does it mean in absolute terms?

We examined PYLL in absolute numbers for all comparator countries across the 50-year period. Between 1960 and 2010, Canada's performance in terms of PYLL improved by 66%, representing a reduction of 6,000 potential years of life lost per 100,000 population. In 1960, Canada experienced 9,113 potential years of life lost per 100,000 population. In 2010, this dropped to 3,113 per 100,000 population.

Figure 1 All-cause PYLL, 1960 to 2010: Changes in absolute rates

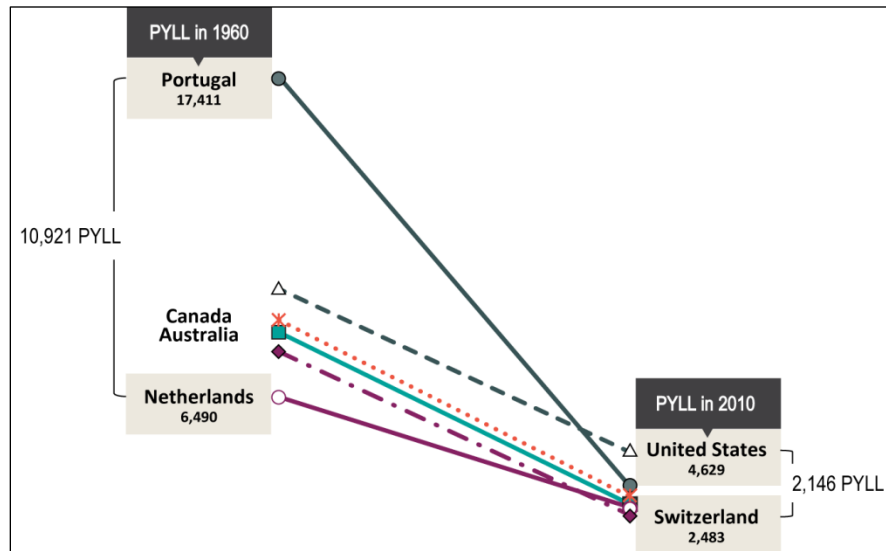


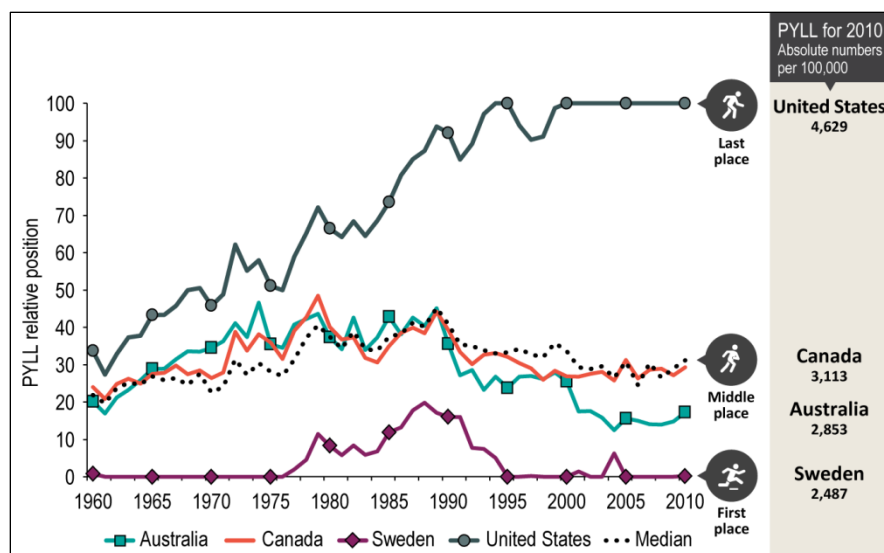
Figure 1 demonstrates that the variability in performance among countries decreased substantially over 50 years. In 1960, there was a difference of 10,921 potential years of life lost per 100,000 population between the Netherlands, the first-place country, and Portugal, the last-place country. By 2010, that difference had been reduced to 2,146 potential years of life lost per 100,000 between Switzerland, the first-place country, and the United States, the last-place country. This 80% decrease in the performance range for PYLL suggests that the gap between the first- and last-place performers among the 18 OECD countries is much smaller than it was 50 years ago.

What does it mean in relative terms?

In Figure 2, we examine the relative position of each of the comparator countries for all-cause PYLL across time. While Switzerland held first place in 2010, Sweden was the top performer across the majority of the 50 years. The United States slowly lost ground from the 1960s and in 2010 held the bottom position. As of 2010, there was an absolute difference of 2,142 years of life lost between Sweden and the U.S.

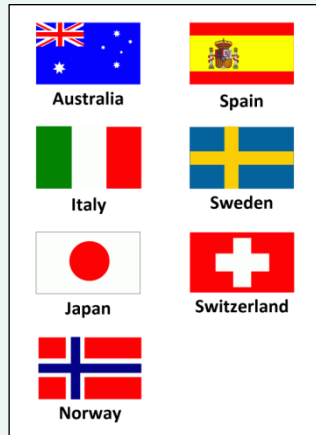
Canada was a middle-of-the-pack performer over the 50-year study period. Throughout the 1960s, Canada was closely aligned with the international median. Through the 1970s, Canada fell slightly behind, but it regained its position around the median line through the 1980s and maintained this position for the rest of the study period. In 2010, Canada lost 3,113 potential years of life per 100,000, which was 626 more years of life lost than the top performer, Sweden.

Figure 2 All-cause PYLL, 1960 to 2010: Relative positions



Across the 50 years, Canada and Australia performed similarly as middle-of-the-pack performers. In the last decade of analysis, however, Australia's performance accelerated. In 2010, Australia lost 2,853 potential years of life per 100,000 prematurely, a difference of 260 fewer years of life lost than Canada. This finding may point future health policy research toward the country-wide health, social and economic strategies that Australia adopted over the 50 years, as well as the specific factors that influenced its acceleration in performance between 2000 and 2010.^{21, 106}

Which countries moved ahead in the race in recent decades?



Over the 50 years studied, countries such as Sweden and Japan were consistently top performers for PYLL on the international stage. However, a number of other countries made promising strides toward first place, too, particularly over the last decade of analysis. These countries included Australia, Italy, Spain, Norway and Switzerland, all of which showed moderate to dramatic acceleration in performance between 2000 and 2010.

What is driving the acceleration in performance among these countries? Unfortunately, there is no simple answer. Health systems and the health of populations are highly complex. There is no single health policy, health system model or health financing scheme that can guarantee the best results for PYLL on the international stage.⁵

PYLL is affected by a range of factors, both in the health system and in the broader social and economic context. While health policy analysis has examined the impact of investments in primary and secondary prevention, primary care, acute care and care integration strategies,^{5, 13, 22, 23} broader social policy analysis has considered socio-economic inequalities, economic and employment conditions, education and the political landscape, among other factors.^{15, 25–27} Each of these factors influences overall health status in any given country. There are also lag effects between the time a policy is implemented and the measurable health outcome within the population that must be considered.^{28, 29} As Canada strives to optimize its health system performance in the coming years, policy analysis will need to consider these complexities of top-performing and accelerating countries over time.^{5, 30}

How did Canadian men and women perform on overall PYLL relative to men and women in OECD comparator countries?

Findings

For overall PYLL, Canadian men and women experienced similar patterns of middle-of-the-pack performance in earlier decades. However, in more recent decades, Canada's performance for men and women moved in different directions. From the 1990s to 2010, Canada's men consistently performed ahead of the international median relative to men in other countries (although they lost some ground and moved back to the median line in 2009 and 2010). Canada's women lost ground from the 1990s, and by the end of the study period they consistently lagged behind the international median relative to those for women in other countries.

A sex gap in premature mortality still exists in absolute PYLL overall. In 2010 in Canada, men lost almost twice as many potential years of life as women overall.

Canada's PYLL performance over 50 years: Men and women, 1960 to 2010

On the international stage, it can be useful to understand how women within a country fare when compared with women from comparator countries; the same holds true for men. These sex-specific comparisons can help to explain Canada's overall performance internationally and can inform health policy in Canada. In order to determine whether men and women performed differently on international PYLL performance over time, we examined Canada's relative position on all-cause PYLL stratified by sex. Figures 3 and 4 present Canada's international PYLL performance by sex over 50 years. Across the 50-year time period, Sweden was a front-runner for PYLL for men, and Japan was a front-runner for PYLL for women. For both sexes, the U.S. held the last position for at least the last decade of the analysis.

Figure 3 PYLL relative position, men, 1960 to 2010:
All causes

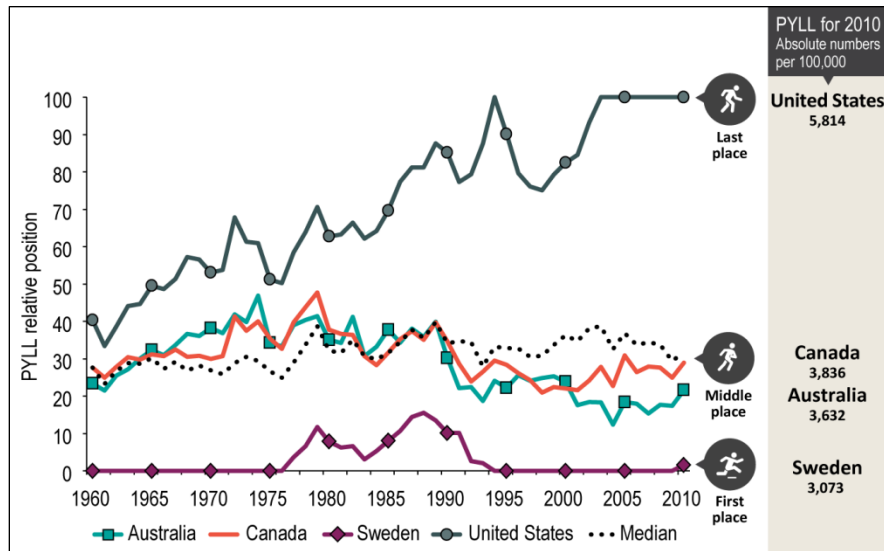
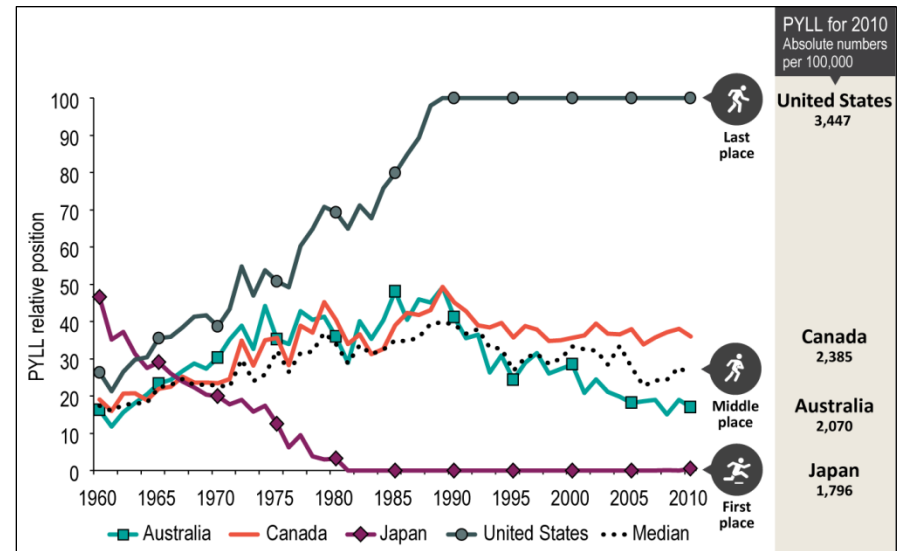


Figure 4 PYLL relative position, women, 1960 to 2010:
All causes



Between 1960 and 1990, Canada's men and women performed similarly, closely following the median line. However, in recent years, Canada's relative performance for men and women began to show different patterns. From 1990 to 2010, Canada's men tended to hold positions ahead of the international median relative to other men, although they lost some ground and moved back to the median line in 2009 and 2010. From 1990 to 2010, Canada's women fell behind the international median relative to other women. This finding suggests that in the last decade of analysis, Canada's women did not keep pace relative to women in OECD comparator countries for female premature mortality.

When compared with Australia, Canada's performance for men and women tells an interesting story. Canada's and Australia's men both tended to hold positions ahead of the median from the early 1990s onward. Canada's women, however, fell behind the median, while Australia's women moved well ahead of the median over the last 20 years of analysis. These findings point to an opportunity for further research to better understand Australia's health strategies that are focused on women and how these strategies might have contributed to the difference in female PYLL performance between Canada and Australia.

- In 2010, Canadian men lost 3,836 potential years of life per 100,000 — 204 more years of life lost than Australia's men, and 763 more years of life lost than Sweden's. Sweden was a consistent top-performing country for men.
- In 2010, Canadian women lost 2,385 potential years of life per 100,000 — 315 more years of life lost than Australia's women, and 589 more years of life lost than Japan's. Japan was a consistent top-performing country for women.

What about the sex gap in Canada?



Many population-based mortality studies have focused on the mortality gap between men and women as a primary point of comparison. The literature examining the sex gap in Canada generally demonstrates that men fare worse on overall mortality rates when compared with women.^{14, 31} However, the literature suggests that this gap is narrowing. In the last 20 years, men have experienced a faster decline in preventable mortality than women (55% decrease in men compared with 43% in women).¹⁴ The trend has been similar for life expectancy. Decady and Greenburg studied the trend for 90 years and found that the life expectancy gap between the sexes was the largest in the 1970s (with a gap of approximately 7.4 years) but has, in more recent decades, begun to narrow (reaching a gap of approximately 4 years from 2010 to 2012).³¹

The results of our analysis demonstrated that Canada continued to have higher PYLL for men than for women. In 2010, in absolute terms, Canadian men lost 3,836 years of life per 100,000 population, compared with 2,385 years of life per 100,000 for Canadian women. This represents a difference of 1,452 more years of life lost per 100,000 in men than in women, a ratio of approximately almost 2:1.

How did Canada perform on PYLL for main causes of death relative to OECD comparator countries?

Findings

Between 1960 and 2010, Canada experienced a reduction in absolute rates of PYLL for each of the 4 main causes of death included in this study: cancer, external causes, ischemic heart disease (IHD) and cerebrovascular disease (CVD). But Canada's performance relative to peer countries varied by sex over the 50 years. Table 1 summarizes Canada's relative performance by sex for the 4 disease-specific PYLLs studied.

Table 1 Canada's relative performance on PYLL by main causes of death for men and women, 1960 to 2010

Cancer	External causes	Ischemic heart disease	Cerebrovascular disease
Canadian women consistently lagged behind the international median relative to other women. Canadian men consistently performed ahead of the international median relative to other men.	Canadian men and women fared similarly, hovering at or just slightly behind the international medians for their sexes.	Canadian men and women consistently performed behind the international medians for their sexes.	Canadian men and women consistently performed well ahead of the international medians for their sexes.

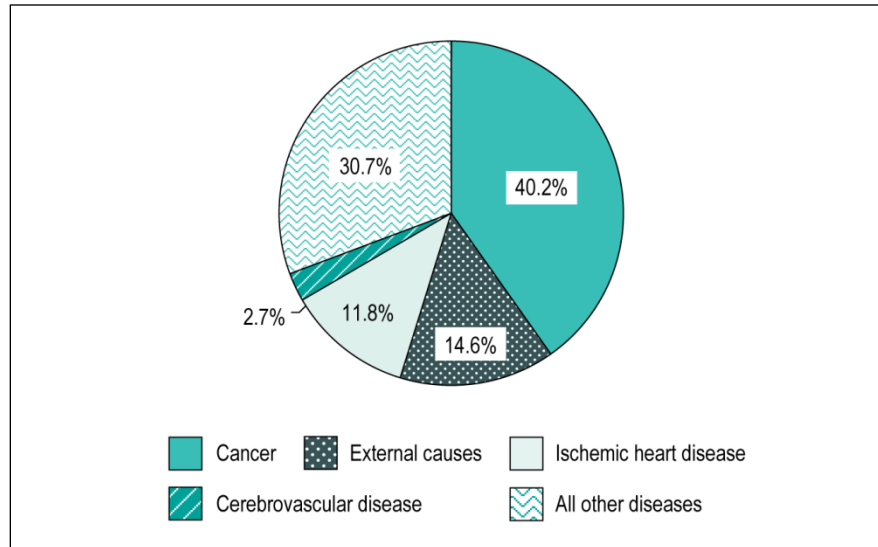
In 2010, a sex gap persisted between men and women in Canada for some causes of death. Table 2 describes the sex gap for the 4 causes of death studied.

Table 2 Canada's men–women sex gap, 2010

Cancer	External causes	Ischemic heart disease	Cerebrovascular disease
A 1:1 cancer PYLL ratio between men and women	An almost 3:1 external causes PYLL ratio between men and women	A 4:1 IHD PYLL ratio between men and women	An almost 1:1 CVD PYLL ratio between men and women

Canada's PYLL performance over 50 years: Main causes of death, 1960 to 2010

Figure 5 Leading burden of disease for premature mortality in Canada, 2010



Note

All other diseases (30.7% of premature deaths) include deaths due to diabetes, other heart disease, chronic lower respiratory diseases, chronic liver disease and cirrhosis, and others.

Source

Statistics Canada. [Table 102-0551: Deaths and mortality rate, by selected grouped causes, age group and sex, Canada, annual](#). CANSIM database. Accessed July 18, 2016.

PYLL can be used to examine premature mortality according to major causes of death.^{1, 13} This approach emphasizes the specific causes of death that have contributed to Canada's health system performance on the international stage^{3, 24} and can point to the areas where Canada has been doing well and areas where there is room for improvement. The following section examines disease-specific PYLL for the leading causes of death in Canada before age 70. Overall, 4 leading causes of death contribute to more than half of all premature deaths in Canada (Figure 5). In 2010, these leading causes were cancer (40.2% of premature deaths), external causes (14.6%), IHD (11.8%) and CVD (2.7%).

Canada's PYLL performance over 50 years: Cancer, 1960 to 2010



Cancer (neoplasms) refers to a group of diseases in which the body's cells multiply excessively within a particular area and can spread to surrounding tissue. There are more than 100 types of cancer, usually named for the tissue/organ where the cancer cells originate.³² Cancers are largely considered genetic diseases in which errors in the DNA that cause excessive cell division are either inherited or triggered through environmental exposures. Cancer-causing agents include chemicals in tobacco smoke or polluted air, radiation from the sun or radon, and a host of others.^{33, 34} While certain risk factors such as genetics and aging cannot be avoided, low exposure to toxic chemicals, modifications to sedentary lifestyles and obesity, low alcohol consumption, and diets high in fruits and vegetables are considered important cancer prevention strategies.³⁴

Canada experienced a reduction of more than 40% in PYLL due to cancer over the 50 years studied (from 1,427 PYLL per 100,000 in 1960 to 847 PYLL per 100,000 in 2010). Improvements in screening and prevention strategies, early diagnosis and technological advances in cancer treatments have been cited as key facilitators for reducing cancer mortality around the world.^{35–37}

Figures 6 and 7 present Canada's relative performance for PYLL for men and women due to cancer over the 50 years studied. Across the time period, Sweden was a front-runner for PYLL among men due to cancer, and Japan was a front-runner for women. Portugal's PYLL for cancer gradually fell to last place for men, and Denmark was a last-place performer for women.

Figure 6 PYLL relative position, men, 1960 to 2010: Cancer

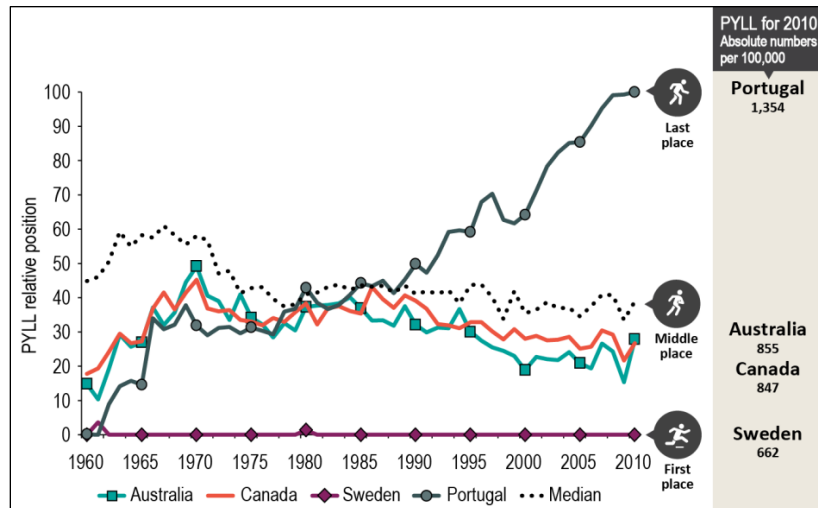
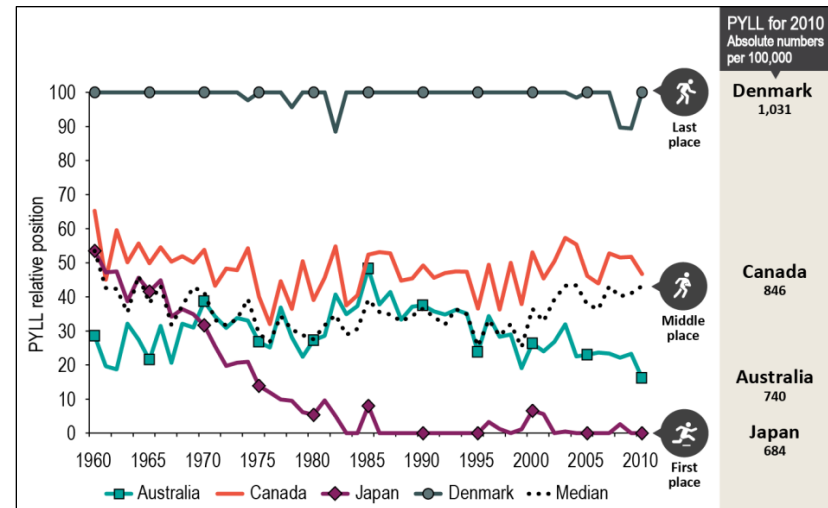


Figure 7 PYLL relative position, women, 1960 to 2010: Cancer



In terms of relative position, Canada's performance between the sexes is quite divergent. Across the 50 years, Canadian men performed well relative to men in OECD comparator countries and maintained a consistent position ahead of the international median. Canadian women lagged behind the international median across the full 50 years. Canadian women did not keep pace with those in Australia. While Australian women accelerated toward first place over the last decade of analysis, Canadian women remained behind the international median.

Generally speaking, these findings are consistent with other literature examining Canada's international performance for cancer. In one study, Canada's overall cancer mortality rate was in the middle range (most consistently earning a B grade) over a number of decades.³⁸ A CIHI study in 2013, which found Canada's international performance on general cancer screening and cancer care to be relatively good, found a marked difference in cancer mortality performance between the sexes.² Female lung cancer mortality in particular was almost double that of peer OECD countries in 2013, with 43 female deaths per 100,000 in Canada compared with 26.5 per 100,000 (OECD female average).² These findings collectively suggest that Canada's women are not keeping pace relative to women in OECD comparator countries in terms of female cancer mortality, and they may point to the need for renewed attention on health policy focused on women and cancer.

- In 2010, Canadian men lost 847 potential years of life per 100,000 due to cancer — 8 fewer years of life lost than Australia's men and 185 more years of life lost than Sweden's. Sweden was a consistent top-performing country for men.
- In 2010, Canadian women lost 846 potential years of life per 100,000 due to cancer — 106 more years of life lost than Australia's women and 162 more years of life lost than Japan's. Japan was a consistent top-performing country for women.

What about the cancer sex gap?



The absolute numbers for Canada in 2010 do not point to a sex gap in PYLL due to cancer. Canada continued to lose equal numbers of potential years of life for men and women. In 2010, Canadian men lost 847 potential years of life per 100,000, and Canadian women lost 846 potential years of life per 100,000 — a 1:1 ratio.

PYLL due to lung cancer: A closer look

Lung cancer is among the top contributors to premature cancer mortality in Canada.^{14, 33} Canadian PYLLs due to lung cancer in men and women show marked differences in performance internationally. Since the early 1960s, Canadian women have moved increasingly closer to last place relative to other women, while men have consistently remained close to the international median.

Figure 8 PYLL relative position, men, 1960 to 2010: Lung cancer

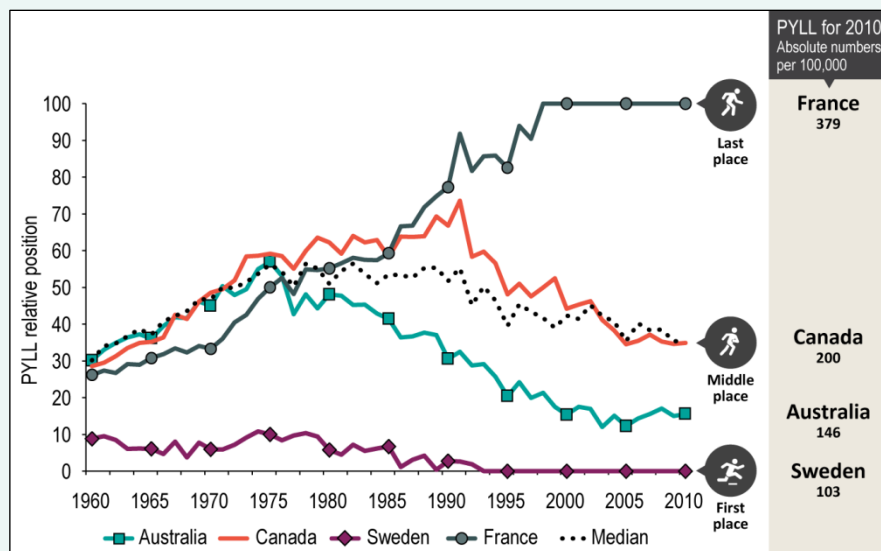
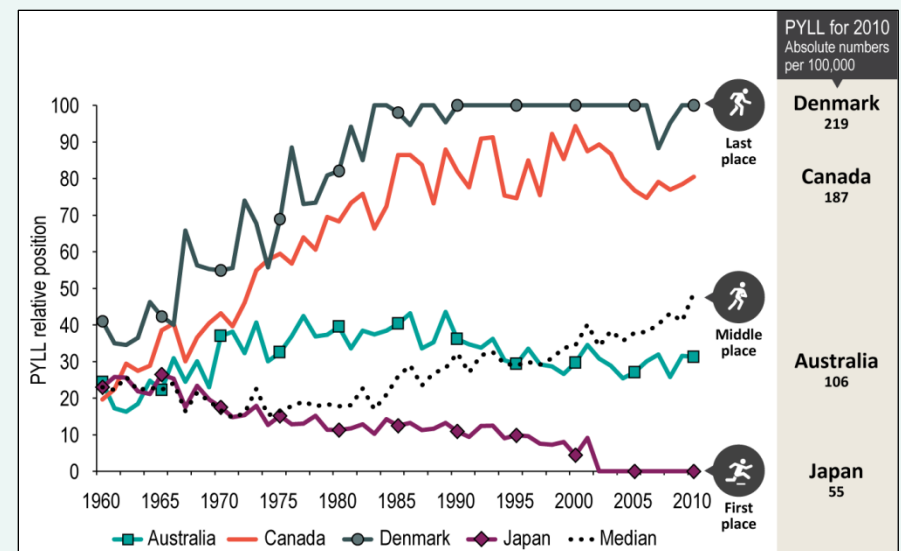


Figure 9 PYLL relative position, women, 1960 to 2010: Lung cancer



The relationship between lung cancer and smoking is well established, with early research published by Doll and Hill in 1950.³⁹ Lung cancer due to smoking takes many years to develop, with lag times ranging between 20 and 30 years.^{40, 41} Canada's lung cancer mortality performance likely reflects sex-specific smoking trends of the past. Smoking rates among men were high in the 1960s and 1970s, followed by marked reductions in the 1980s and 1990s. Smoking rates among women, on the other hand, peaked 2 decades later. This lag effect may help explain the PYLL performance for lung cancer among Canadian women observed today.^{2, 42}

Multifaceted tobacco control strategies focused on both prevention and treatment have been successful in reducing lung cancer mortality. Comprehensive tobacco control programs in Australia, Finland, Norway, Portugal, Canada and Italy have included strategies such as increasing the price of tobacco through excise taxes, banning the use of tobacco in public places, controlling sales to minors, providing smoke-free health promotion and education, and offering smoking cessation programs.^{43–45} Italy was among the first to introduce comprehensive smoke-free legislation in all public places in 2005.^{43, 46} Australia took the lead in 2012 by introducing plain cigarette packaging to limit the marketability of tobacco products.⁴⁷ In the 1990s, Sweden began introducing self-help and health education programs specifically targeted at pregnant and young women in order to reduce uptake of tobacco among new female smokers.^{48, 49}

In addition to smoking, other well-known factors have been associated with lung cancer. Exposure to radon (an invisible, odorless gas that occurs naturally in the soil and rocks) is the second leading cause of lung cancer in Canada.⁵⁰ In 2007, the Canadian government set annual maximum-acceptable concentration levels of indoor air radon at 200 becquerels per cubic metre.⁵¹ Given the variability of soil and rock radon concentrations across the country, however, it is estimated that more than 20% of homes may still be above the national guidelines.^{51, 52} Asbestos is another well-known cancer-causing substance that can exist in industrial substances and building materials. In 2015, Health Canada revised its official position on asbestos, stating that exposure to asbestos in any form is dangerous and can lead to cancer and other diseases.⁵³

Canada's PYLL performance over 50 years: External causes, 1960 to 2010



External causes represent a collection of deaths caused by events that are generally unrelated to a particular disease condition,^{54–56} including traffic accidents, falls, accidental poisonings and intentional self-harm.^{55, 57} National safety policies focused on efforts to reduce traffic volume and driving speeds, fall prevention strategies in seniors, mental health strategies and self-awareness campaigns are considered important to reduce the number of premature deaths due to external causes.^{58–62}

Canada experienced a reduction of more than 50% in PYLL due to external causes over the 50 years studied (from 1,681 PYLL per 100,000 population in 1960 to 826 PYLL per 100,000 in 2010). In recent decades, improvements in a variety of national safety policies have led to reductions in premature mortality due to external causes.^{63, 64}

Figures 10 and 11 present Canada's relative international performance for PYLL for men and women due to external causes over the 50 years. Across the time period, the Netherlands was a front-runner for PYLL for men due to external causes, and Italy was a front-runner for women. For both sexes, the U.S. was the last-place performer for at least the last decade of analysis.

Figure 10 PYLL relative position, men, 1960 to 2010:
External causes

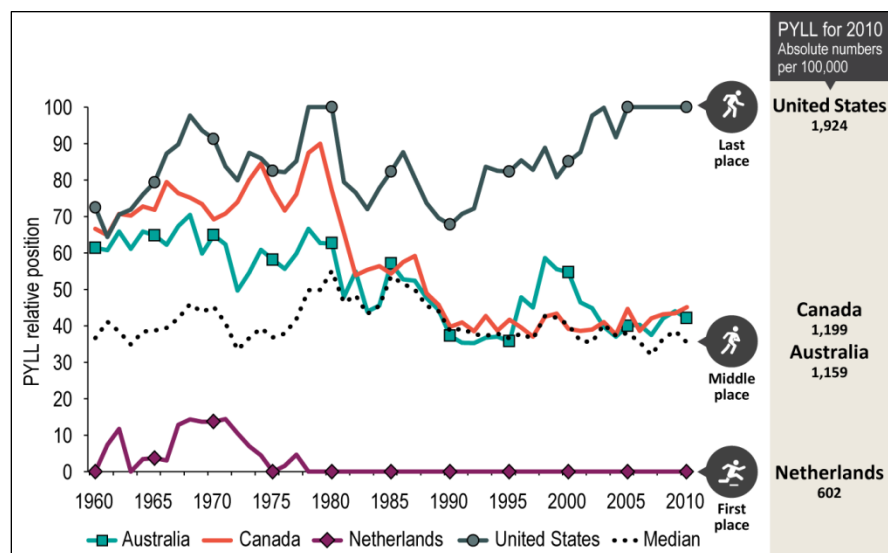
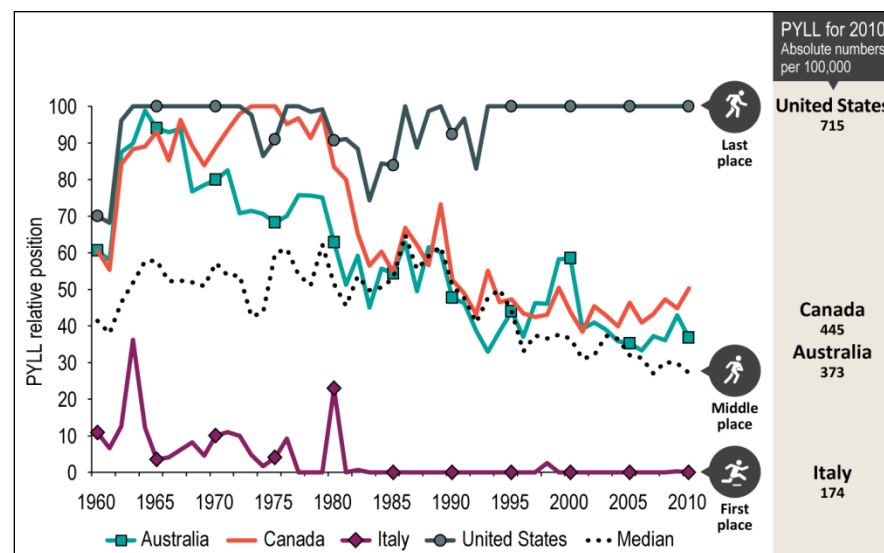


Figure 11 PYLL relative position, women, 1960 to 2010:
External causes



In terms of relative position, Canada's performance between the sexes has been fairly consistent. For both sexes, Canada made substantial progress from the 1960s to the mid-1980s, maintained its middle-of-the-pack position until 2000 and then fell behind the international median in the last decade of analysis. Canada's performance between the sexes was also similar to Australia's; however, from 2000, Canadian women fell behind Australian women.

These results are consistent with other literature examining Canada's international performance for deaths due to external causes. In one study in 2013, CIHI found that Canadian mortality rates for traffic accidents and self-harm (2 major categories of external causes of death) were generally average — performing just above or below the OECD average.² Murray et al. found that Canada performed well on falls (another category of external causes of death) in 2010, but fared poorly on traffic accidents in terms of years of life lost.¹³ These results point to a middle-of-the-pack performance for deaths due to external causes in general. But given the variability of conditions captured by the broad category of external causes and the typical ages at which these deaths occur, these results also point to the need for more detailed analysis in order to attract increased health policy attention and a deeper examination of strategies within the international community to help drive improvements to Canada's relative position.

- In 2010, Canadian men lost 1,199 potential years of life per 100,000 due to external causes — 40 more years of life lost than Australia's men and 597 more years of life lost than the Netherlands'. The Netherlands was a consistent top-performing country for men.
- In 2010, Canadian women lost 445 potential years of life per 100,000 due to external causes — 72 more years of life lost than Australia's women and 271 more years of life lost than Italy's. Italy was a consistent top-performing country for women.

What about the external causes sex gap?

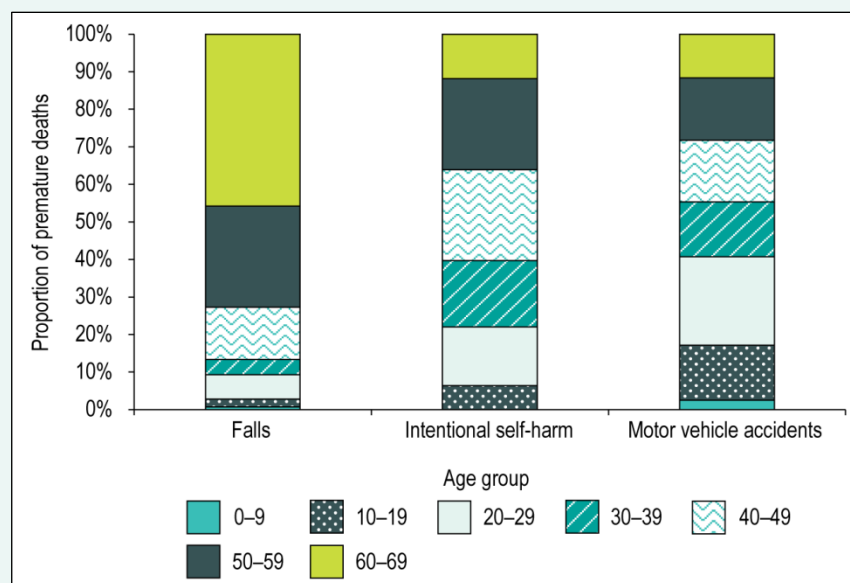


The absolute numbers in Canada for 2010 point to a sex gap in PYLL due to external causes. Canada's men continued to lose many more potential years of life than women did. In 2010, Canadian males lost 754 more years of life per 100,000 population than women, a ratio of almost 3:1.

Age and PYLL due to external causes: A closer look

PYLL due to external causes captures a variety of conditions that tend to affect age groups differently within the population. 3 major categories of deaths due to external causes are falls, intentional self-harm and motor vehicle accidents. Some of these external causes predominantly affect younger age groups. As a result, their overall impact on PYLL at the population level can be more pronounced.

Figure 12 Proportion of premature deaths due to falls, self-harm and motor vehicle accidents, by age group, 2010



Source

Statistics Canada. [Table 102-0551: Deaths and mortality rate, by selected grouped causes, age group and sex, Canada, annual](#). CANSIM database. Accessed July 18, 2016.

Motor vehicle accidents tend to affect younger age groups, with more than 50% of these deaths occurring among those younger than 40. In particular, 20- to 29-year-olds represent the largest age group (23.5%) affected, with 10.3 deaths per 100,000. Since motor vehicle accidents occur with higher frequency among youth and young adults, these deaths contribute substantially to the PYLL at the population level. On the other hand, approximately 46% of premature deaths due to falls occur among those age 60 to 69, at a rate of 7.5 deaths per 100,000. Because these deaths occur in older age groups, they contribute fewer potential years of life lost at the population level.

Deaths due to intentional self-harm peak in middle age, with about 48% of premature deaths occurring among those in the age ranges 40 to 49 and 50 to 59. These age groups experience similar rates of death, at 16.7 and 17.7 deaths per 100 000, respectively. While these deaths occur in middle age and do not contribute as many years of life lost per person, the high number of deaths due to self-harm between age 30 and 60 markedly contributes to the PYLL.

Since the 1960s, Canada has seen a substantial reduction in deaths due to external causes overall; however, external causes remain the second leading cause of premature deaths in Canada.⁶⁵ In light of the varied conditions that comprise the external causes category and the age groups affected, care must be taken in interpreting results.

Efforts to reduce the impact of premature mortality within the Canadian population should include policies and programs targeted at the appropriate age groups.

Canada's PYLL performance over 50 years: Ischemic heart disease, 1960 to 2010



Ischemic heart disease (IHD), otherwise known as coronary artery disease, is a condition in which a narrowing or blockage of blood vessels reduces the supply of blood to the heart.⁶⁶ A reduction of oxygenated blood to the heart can result in angina pectoris, acute myocardial infarction (heart attack), heart failure and sudden cardiac death. While some risk factors for IHD such as genetics and age cannot be modified, other factors like sedentary lifestyles, smoking, fatty diets and stress are considered modifiable via primary and secondary prevention.^{66, 67}

Canada experienced a reduction of almost 85% in PYLL due to IHD over the 50 years studied (from 1,471 PYLL per 100,000 per population in 1960 to 230 PYLL per 100,000 in 2010). Advances in pharmaceuticals (e.g., management of hypertension and cholesterol) and medical treatments, as well as public health–driven population-wide reductions in smoking and other behaviours have contributed to the substantial decline in IHD mortality in Canada.^{68–70}

Figures 13 and 14 present Canada's relative international performance for PYLL due to IHD for men and women over the 50 years. Across the time period, Japan was a top performer in terms of PYLL among men due to IHD, and France was a top performer among women. In 2000, Greece moved from one of the best performers to the last-place position for PYLL among men due to IHD. The U.S. was the last-place performer for women from the early 1990s.

Figure 13 PYLL relative position, men, 1960 to 2010: IHD

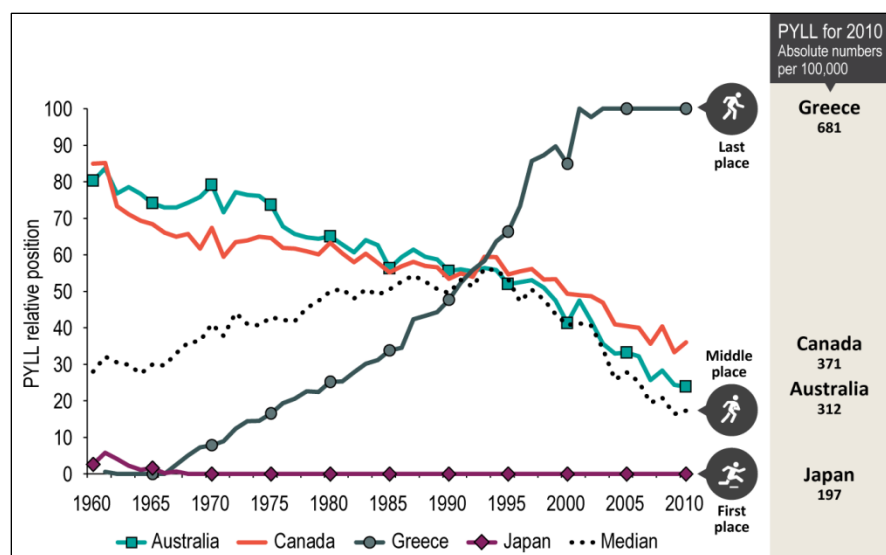
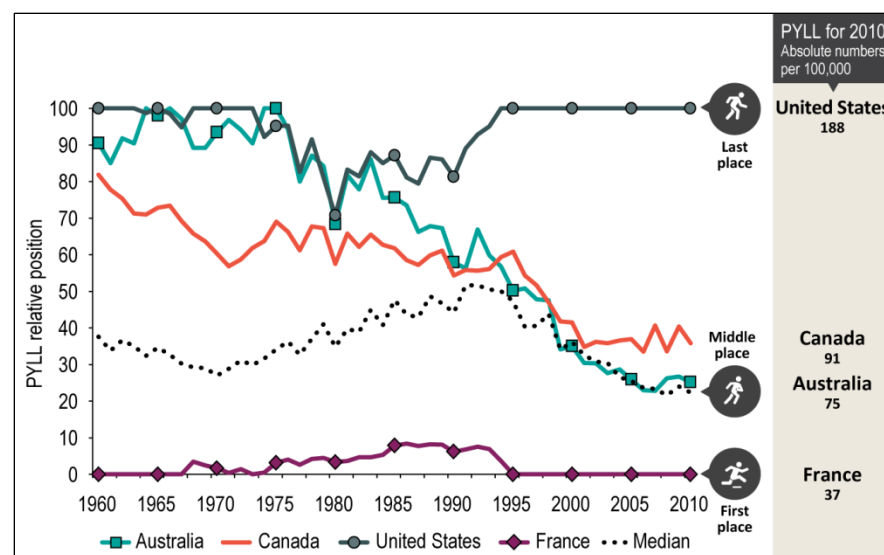


Figure 14 PYLL relative position, women, 1960 to 2010: IHD



For both sexes, Canada's PYLL performance for IHD consistently lagged behind the international median. Substantial progress was made between the 1960s and the 1980s as Canada's relative position approached the middle of the pack; however, between 1990 and 2010, Canada remained behind the international medians for both sexes. Canada's performance between the sexes was similar to Australia's across the time period studied. However, between 2000 and 2010, Australia consistently outperformed Canada, with Australian women meeting the international median and remaining there in the last decade of analysis.

These relative performance results suggest that, in spite of substantial absolute improvements in premature deaths due to IHD over the 50 years, Canada has struggled to keep pace with other countries for both sexes. The performance literature examining circulatory diseases in Canada has yielded variable results, perhaps due to the wide range of indicators used to assess performance. One study that focused on mortality rates for circulatory diseases in general found Canada to be performing well relative to its peers in 2009 (ranking 4 out of 16 countries).¹⁰ CIHI found that Canada performed well (at the 75th percentile) in 2011 on the indicator 30-Day In-Hospital Mortality for Acute Myocardial Infarction.² On the other hand, Murray et al. found that Canada performed poorly on IHD among a set of OECD comparator countries for years of life lost (ranking 12 out of 19 countries in 2010).¹³ These mortality studies have variable results because they did not use the same indicators to measure heart disease performance and because the methodologies applied to establish ranked performance were different. Given the variability in the literature, Canada's back-of-the-pack relative position for PYLL due to IHD may point to the need for further analysis and increased health policy attention focused on IHD for both sexes.

- In 2010, Canadian men lost 371 potential years of life per 100,000 for IHD — 59 more years of life lost than Australia's men and 174 more years of life lost than Japan's. Japan was a consistent top-performing country for men.
- In 2010, Canadian women lost 91 potential years of life per 100,000 for IHD — 16 more years of life lost than Australia's women and 54 more years of life lost than France's. France was a consistent top-performing country for women.

What about the IHD sex gap?



The absolute numbers in Canada for 2010 point to a sex gap in PYLL due to IHD. In 2010, Canadian men lost 280 more potential years of life per 100,000 than Canadian women, a ratio of approximately 4:1.

Canada's PYLL performance over 50 years: Cerebrovascular disease, 1960 to 2010



Cerebrovascular disease (CVD), otherwise referred to as stroke or cerebrovascular accident, is the result of a blockage of blood flow to the brain, usually due to a blood clot or a burst blood vessel.^{71, 72} Common stroke symptoms include numbness, confusion, difficulty speaking or understanding speech, dizziness, severe headache and unconsciousness.⁷³ The effects of stroke generally manifest in various parts of the body, depending on which part of the brain is affected. There are a number of different causes of cerebrovascular disease. Risk factors that cannot be modified include genetics and aging. Those that can be changed include hypertension, smoking, obesity and diabetes.^{71, 74–76}

Canada has seen a decrease of more than 80% in PYLL due to CVD over the 50 years studied (from 332 PYLL per 100,000 population in 1960 to 60 PYLL per 100,000 in 2010). Preventive efforts and medical treatments, including medication for hypertension, lifestyle changes and surgery, have contributed to the reduction of overall mortality due to CVD in recent decades.^{73, 77, 78}

Figures 15 and 16 present Canada's relative international performance in terms of PYLL for men and women due to CVD over the 50 years. Across the time period, Switzerland was a top performer for CVD for both sexes. In 2010, Japan held the last-place position for CVD in both sexes.

Figure 15 PYLL relative position, men, 1960 to 2010: CVD

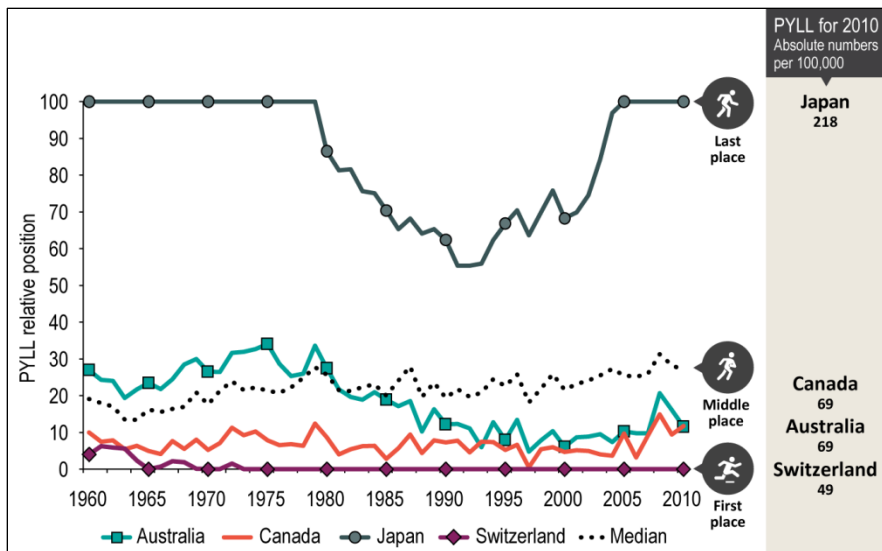
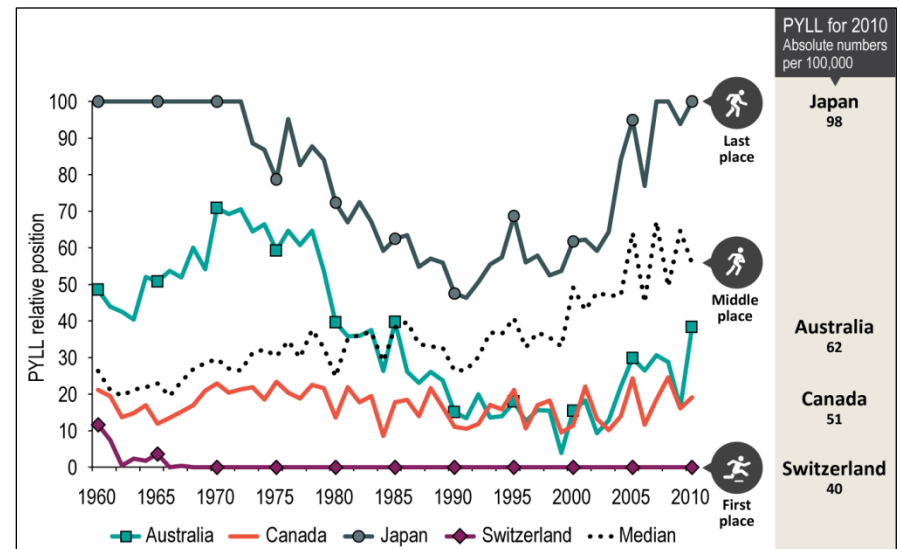


Figure 16 PYLL relative position, women, 1960 to 2010: CVD



Canada's performance for both sexes was among the best of the 18 countries studied for CVD across the 50 years, with both sexes consistently performing close to the first-place position. Canada's performance between the sexes was substantially better than that of Australia through the 1960s and 1970s; however, Australia accelerated ahead of the international median in the mid-1980s and by the end of the study period performed similarly to Canada as one of the top performers for PYLL due to CVD.

These findings are consistent with other literature examining Canada's premature mortality performance at the population level. Murray et al. found Canada to be the strongest performer for PYLL due to stroke in 2010 based on a different set of comparator countries.¹³ Canada's results on stroke at the patient level, however, have not been as strong. A CIHI study in 2013 found that while Canada's overall stroke mortality performance was among the best in the comparator set, performance on in-hospital mortality for patients with ischemic stroke was relatively poor.² Regardless of this variability, it is important to note that in absolute terms the total number of potential years of life lost for stroke is fairly small. Therefore, given that CVD makes up a relatively small proportion of the total years of life lost for all-cause PYLL in Canada, Canada's strong performance in the area of stroke is unlikely to have a significant impact on Canada's overall PYLL performance.

- In 2010, Canadian men lost 69 potential years of life per 100,000 for CVD — the same number of years of life lost as Australia's men and 20 more years of life lost than Switzerland's. Switzerland was a consistent top-performing country for men.
- In 2010, Canadian women lost 51 potential years of life per 100,000 for CVD — 11 fewer years of life lost than Australia's women and 11 more years of life lost than Switzerland's. Switzerland was a consistent top-performing country for women.

What about the CVD sex gap?



The absolute numbers in Canada for 2010 do not point to a substantial sex gap in CVD PYLL. In 2010, Canadian men lost 18 more potential years of life per 100,000 than Canadian women, a ratio of almost 1:1.

A glimpse at Australia: Are there lessons for Canada?

Many factors influence PYLL at the population level, both within and outside of the health care system. Given Australia's acceleration in PYLL performance in recent years, it can be useful to consider the range of policies and programs that have been implemented in that country. Table 3 provides a snapshot of various policy activities in Australia led by national and state governments. Policies range from supporting early childhood education to improving access to affordable drug therapies. It should be noted that health policies may not be directly responsible for current population health outcomes. Instead, present-day outcomes are more likely to have been influenced by health policies of the past. Further work that explores Australia's policy evaluation literature across time may help shed light on approaches that support improved health outcomes for Canada in the future.

Table 3 Snapshot of policy activities within and outside Australia's health care system

Within the health care system	Outside the health care system
 Since 1960, the Pharmaceutical Benefits Scheme has provided all Australian residents with a health card to access prescription medications at a subsidized cost, with further reduction in prices for vulnerable people. The program establishes safety net expenditure thresholds for prescription drugs that, if reached, create further subsidization or no cost for the rest of year.⁷⁹	 Established in 2003, the national Budget Based Funded Programme is a component of the Child Care Services Support Programme that provides funding for the operation of early learning and child care services in rural/remote and indigenous communities across Australia. Families can access services, such as care outside school hours and overnight or playgroups, at a minimal cost.⁸⁰
 The Australian National Health Priority Areas initiative directs collective attention to diseases that are a significant burden to the health care system. It aims to monitor health outcomes and identify cost-effective interventions. The first set of priority areas were established in 1996 and included cardiovascular health, cancer control, injury prevention and control, mental health and diabetes.⁸¹ Since then, 4 other conditions have been added.⁸²	 Since 2006, Australia has required cigarette packages to include pictorial and written health warnings.⁴⁷ In 2012, it moved beyond health warnings to implement plain packaging regulations.⁸³ All tobacco products sold in Australia are now packaged with a single dull colour and brand names are in a standard font.⁸⁴
 In 2013, the National Primary Health Care Strategic Framework was unveiled, which aims to "better integrate health care across care settings."⁸⁵ Since then, 31 Primary Health Networks have been developed that coordinate general practitioners, allied health professionals and community services to achieve better health outcomes for patients, with a particular focus on Aboriginal people, seniors and recipients of mental health services.⁸⁶	 The New South Wales parliament passed legislation in 2010 that requires large chain restaurants to display calories for each item on menu boards; in 2013, the legislation expanded to include supermarket ready-to-eat meals. This information must be displayed beside the product using the same font size as the price or name of the product.⁸⁷
 The Australian government aims to support continuity of care for elderly people, whether living independently or in long-term care facilities, by offering guidance on how to access subsidized services, such as domestic assistance, allied health services or nursing home accommodations. To help elderly people and their families navigate these services, the government developed a website called My Aged Care, which provides information on service providers and health care costs.⁸⁸	 In 2007, the Health in All Policies approach was implemented in South Australia. This approach brings together multiple sectors to consider population health during policy development to create a better community and improve health.⁸⁹ One initiative that emerged from this approach is the Active Transport project involving South Australia Health and the Department of Planning, Transport and Infrastructure, which are assisting in the development and adoption of a new South Australia cycling strategy.⁹⁰

Conclusions

International comparisons are useful for cross-country learning and for informing public debate about Canada's performance on the international stage.^{8,9} But given the variability of Canadian health system performance results in the literature, public opinion on the issue has been somewhat divided. According to an Ipsos poll in 2015, 75% of the Canadian public surveyed believed their health care system to be among the best in the world. However, two-thirds of Canadians also expressed concern that Canada was falling behind relative to peer countries.⁹¹ The objective of this study was to better understand Canada's relative performance over 50 years on a key mortality outcome measure: potential years of life lost. This report helps clarify in what areas Canada is performing well and where Canada has room for improvement, by examining Canada's relative and absolute performance on the international stage.

How did Canada perform on overall PYLL relative to OECD comparator countries between 1960 and 2010?

This study demonstrated that, like all other countries included in the analysis, Canada made substantial improvements in overall PYLL over 50 years, with a reduction of 6,000 years of life lost per 100,000 population between 1960 and 2010. Relative performance analysis demonstrated that Canada maintained a middle-of-the-pack performance over the 50 years. This finding suggests that while Canada is making progress on PYLL in absolute terms, it is keeping pace with the international median in relative terms.

Canada's health systems have great potential to be among the best in the world with their publicly funded universal health care model — physician and hospital care provided at no cost at the point of care.^{5, 92} Given Canada's consistent middle-of-the-pack performance over the 50 years studied, the findings suggest that there is room for improvement. A number of countries, including Australia, Italy, Spain, Norway and Switzerland, made promising strides forward, particularly over the last decade of analysis. Like Canada, many of these countries provide universal models of health care. This leads to questions about what strategies beyond the scope of health care have been adopted in these countries and the ways in which social policy, education, health promotion efforts and disease prevention have helped to optimize health system performance results.

How did Canadian men and women perform on overall PYLL relative to men and women in OECD comparator countries?

In earlier decades, Canadian men and women experienced similar patterns of middle-of-the-pack performance in terms of overall PYLL. In more recent decades, Canada's performance for men and women moved in different directions. From the 1990s to 2010, Canada's men consistently performed ahead of the international median relative to men in other countries. Canada's women, however, lost ground from the 1990s and by 2010 lagged behind the international median relative to women in comparator countries.

How did Canada perform on PYLL for main causes of death relative to OECD comparator countries?

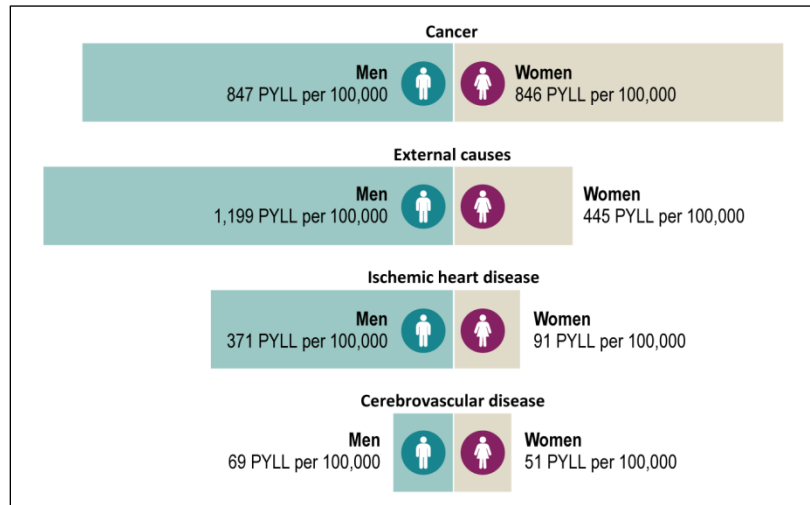
Figure 17 Canada's relative performance for main causes of death, men and women

	 Men	 Women
Cancers	Consistent position ahead of the international median	Consistent position behind the international median
External causes	Middle-of-the-pack performance	Middle-of-the-pack performance, but losing ground
Ischemic heart disease	Consistent position behind the international median	Consistent position behind the international median
Cerebrovascular disease	Consistent position ahead of the international median	Consistent position ahead of the international median

Canada's relative PYLL performance stratified by specific causes of death can help shed light on areas where Canada did well over the 50 years studied and where there is room for improvement compared with other countries.^{3, 5, 92} In terms of PYLL due to cancer, a different pattern in performance between the sexes emerged: men performed ahead of the international median and women consistently performed behind the international median. For external causes of death, both sexes showed average performance, losing some ground in the last decade of analysis. In terms of PYLL due to IHD, both sexes performed behind the median across the 50-year period. And finally, for CVD, Canada consistently performed well for both sexes relative to comparator countries.

These findings suggest that there are opportunities for Canada to improve PYLL for IHD and external causes for both sexes, and for cancers in women. Given that IHD, cancers and external causes are large contributors to all-cause PYLL, actions to improve in these areas have the potential to improve the health of Canada's populations and accelerate Canada's health system performance on the international stage.

Figure 18 Sex gap profile for PYLL, 2010:
Causes of death



The Canadian sex gap

This study identified causes of death for which a sex gap persists in Canada.

In 2010, absolute PYLL rates for deaths due to external causes were higher for Canadian men than for Canadian women, with a male-to-female ratio of almost 3:1. A similar pattern existed for PYLL rates for IHD, with a male-to-female ratio of 4:1. The sex gap was negligible for cancer and CVD.

Canada has much to learn from its peer countries as it strives to achieve optimal health status for its population. However, international comparisons are complex. An in-depth analysis of the health policies and social and economic drivers of population health within high-performing countries over time may be useful as Canada strives to optimize its health system performance on the international stage. Future international comparison studies may also include an examination of Canada's relative performance over 50 years on a variety of other health system performance measures.^{2, 14, 92} Comparative analyses at the provincial/territorial level are also warranted.

Appendix A: Methodological details

Health system performance

Variability in health outcomes at the population level can, in part, be attributed to a country's health system performance.

Health systems range in their design, content and management strategies, which then translate into health outcomes, system responsiveness and fair financing.¹⁶ Performance in sub-components of health systems, including clinical care, prevention and public health, all contribute to the overall result in outcomes at the population level.^{16, 30} By quantifying variation in different aspects of health system performance, decision-makers can identify factors and articulate policies in order to drive improvements in population health.

Potential years of life lost

PYLL was selected as the primary indicator for this analysis. PYLL is a measure of premature mortality that provides an estimate of the additional time a person would have lived had he or she not died prematurely (before age 70).^{1, 3, 14} For this indicator, the fewer lives lost the better, so smaller values represent stronger performance. PYLL was calculated for this study using the OECD formula, as follows:

$$PYLL_{it} = \sum (l - a)(d_{at} \div p_{at})(p_a \div p_n) \times 100,000$$

Where

a = age

l = the upper age limit (70 years)

d_{at} = the number of deaths at age a

p_{at} = the number of persons age a in country i at time t

p_a = the number of persons age a in the reference population (2010)

p_n = the total number of persons in the reference population (2010)

It should be noted that other sources of PYLL indicators in Canada (e.g., Statistics Canada) have used age 75 rather than 70 as the cut-off for PYLL. As a result, there will be some differences in findings when PYLL data from the OECD is compared with data from Statistics Canada and provincial ministries.

Mortality indicators often serve as a central index of population health status,^{3, 93, 94} but PYLLs go beyond traditional mortality indicators by accounting for age at death, rather than merely the occurrence of death itself.³ This indicator gives more weight to deaths that occur in young people. PYLLs are used worldwide because they can provide population estimates for all-cause premature mortality as well as estimates for specific causes of death to reflect their proportional burden on society.³

There is no single measure that summarizes the health or health care system of a country. PYLL is a health status indicator. It was selected as the metric for this study because it reflects the broadest goal of all health systems around the world — to improve the health of the populations they serve.^{15, 16, 95} Although it can be difficult to distinguish the burden of disease that is directly attributable to the health system from that which is attributable to other factors, PYLLs have the advantage of providing a broad measure of population health status, and of being available for a large number of countries over a long period of time.^{15, 19, 94}

International comparisons and ranking systems

International health system performance comparisons and corresponding interpretations are complex. International comparison methodologies using ranking systems have received considerable criticism within the literature.^{11, 96–99} Simple ranking systems can unintentionally oversimplify complex phenomena, be fraught with normative assumptions and fail to adequately acknowledge the important differences between countries' health systems, population demographics, and social and economic realities.^{98, 100, 101} Further, ranking systems use ordinal scaling (the ordering of values), which can falsely imply a meaningful difference between country performance in the absolute values.^{101, 102} Nonetheless, international rankings continue to be dominant within the literature and widely reported in the media. In spite of their limitations, international rankings have a pragmatic appeal because they help to make complex issues accessible for a broad audience.^{98, 102}

Min–max normalization method

To address the ordinal scaling challenge within traditional rank order methods, a min–max normalization method was used in this study. Min–max normalization is a parametric technique in which the relative position of the value of a variable is computed by comparing it with its minimum and maximum observed values using the following formula:

$$Z_i = \left(\frac{x_i - \min(x)}{\max(x) - \min(x)} \right) \times 100$$

Where

x_i = the observed value

$\max(x)$ and $\min(x)$ = the maximum and minimum observed values of the initial variable

Min–max normalization is a method of adjusting absolute values measured on different scales to a notionally common scale.¹⁰³

Min–max normalization was used to create a relative position score for each country between 0 and 100 for each year, whereby the top performer was given the position 0 (fewest lives lost) and the bottom performer was given the position 100 (most lives lost).

Min–max normalization performs a linear transformation on the original data values.^{17, 18} Using this approach, Canada's performance was positioned relative to the top and bottom performers each year over the period of study.

Data source

Data for this study was taken from the Organisation for Economic Co-operation and Development.¹⁹ At the time of analysis, data for potential years of life lost (all causes; neoplasm; malignant neoplasms of trachea, bronchus and lung; external causes; IHD; and CVD for both sexes, for males and for females) was available from 1960 to 2010 for all comparator countries in the analysis. Linear extrapolation using simple average estimates was used to replace the missing values of potential years of life lost, but note that missing values were minimal (approximately 1%). Data points that were extrapolated or that contain breaks in the time series are not indicated in the report figures.

Time period

We elected to study Canada's international performance over a 50-year period. Population mortality outcomes change at a slow pace, and long time frames are required to understand trends. Given that the data was taken from the OECD, we used the longest time period possible for which data was available at the time of the analysis. This resulted in a 50-year study period between 1960 and 2010.

Potential years of life lost: Comparator countries

At the time of analysis, there were 34 member countries of the OECD.¹⁰⁴ To determine the comparator countries to be included in this study, 4 landmark reports that focused on international health system performance were consulted.^{2, 10, 12, 13} Countries were selected for inclusion if they were among the 34 OECD member countries and were included in at least 1 of the 4 landmark reference studies. Finally, an assessment of data availability for each country over the 50-year span was performed. 18 countries were included in the final set: Australia, Belgium, Canada, Denmark, Finland, France, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Limitations

A number of limitations warrant consideration:

- International Classification of Disease (ICD) coding for disease classification has changed over time. Numerous iterations of ICD-7 to ICD-10 have been used in developing PYLL by burden of disease over the 50-year period. ICD revisions are considered breaks in the time series.¹⁰⁵ The difference in coding between versions may have some impact on results.¹⁰⁷
- Data collected over 50 years from 18 different countries is expected to have some data quality challenges. In order to address this to the best of our ability, we used data from only 1 organization, the OECD, to ensure as much as possible that the data collection and processing methodologies were consistent.
- There is no single population-level health indicator that can be used to perfectly assess health system performance at the country level. Dozens of indicators are used to examine different aspects of health system performance on the international stage, including population health outcomes indicators, disease-specific indicators, health care system indicators and indicators focused on the non-medical determinants of health. The PYLL indicator was selected because it aligned with the broadest goal of all health systems around the world — to improve the health of the populations they serve. It was also available for a large number of countries over a long time period.

- This study did not conduct an in-depth analysis of Canadian performance at the provincial or territorial level. Canada has a somewhat decentralized health care system, with primary responsibility for health care administration residing at the provincial level. Performance at the provincial level was considered beyond the scope of this study, but future research that examines performance at a more granular within-country level may be warranted.
- Many health system factors and broader social and economic factors influence health at a population level. This study did not conduct an in-depth policy analysis in each of these areas. This was considered beyond the scope of the current work, but future research examining policy both within and outside of the health system will be useful to help inform Canadian decision-makers.

Appendix B: Text alternative for images

Text alternative for What is PYLL? image

PYLL is demonstrated using 3 people. Person A dies at age 50. He loses 20 potential years of life. Person B dies at age 40. He loses 30 potential years of life. Person C dies at age 65. He loses 5 potential years of life.

Data table for Figure 1: All-cause PYLL, 1960 to 2010: Changes in absolute rates

Country	PYLL
Portugal	17,411 in 1960
Netherlands	6,490 in 1960
United States	4,629 in 2010
Switzerland	2,483 in 2010

Data table for Figure 2: All-cause PYLL, 1960 to 2010: Relative positions

Country	PYLL for 2010: Absolute numbers
United States	4,629
Canada	3,113
Australia	2,853
Sweden	2,487

Data table for Figure 3: PYLL relative position, men, 1960 to 2010: All causes

Country	PYLL for 2010: Absolute numbers
United States	5,814
Canada	3,836
Australia	3,632
Sweden	3,073

Data table for Figure 4: PYLL relative position, women, 1960 to 2010: All causes

Country	PYLL for 2010: Absolute numbers
United States	3,447
Canada	2,385
Australia	2,070
Japan	1,796

Data table for Figure 6: PYLL relative position, men, 1960 to 2010: Cancer

Country	PYLL for 2010: Absolute numbers
Portugal	1,354
Australia	855
Canada	847
Sweden	662

Data table for Figure 7: PYLL relative position, women, 1960 to 2010: Cancer

Country	PYLL for 2010: Absolute numbers
Denmark	1,031
Canada	846
Australia	740
Japan	684

Text alternative and data table for Figure 8: PYLL relative position, men, 1960 to 2010: Lung cancer

In 2010, France was the last-place country and Sweden was the first-place country. Over the 50 years, Canadian men remained close to the international median while Australian men moved closer to first place.

Country	PYLL for 2010: Absolute numbers
France	379
Canada	200
Australia	146
Sweden	103

Text alternative and data table for Figure 9: PYLL relative position, women, 1960 to 2010: Lung cancer

In 2010, Denmark was the last-place country and Japan was the first-place country. Canadian women fell behind the median in the 1960s and made a dramatic sweep toward last place over the 50 years. Australian women remained relatively close to the international median over the 50 years.

Country	PYLL for 2010: Absolute numbers
Denmark	219
Canada	187
Australia	106
Japan	55

Data table for Figure 10: PYLL relative position, men, 1960 to 2010: External causes

Country	PYLL for 2010: Absolute numbers
United States	1,924
Canada	1,199
Australia	1,159
Netherlands	602

Data table for Figure 11: PYLL relative position, women, 1960 to 2010: External causes

Country	PYLL for 2010: Absolute numbers
United States	715
Canada	445
Australia	373
Italy	174

Data table for Figure 13: PYLL relative position, men, 1960 to 2010: IHD

Country	PYLL for 2010: Absolute numbers
Greece	681
Canada	371
Australia	312
Japan	197

Data table for Figure 14: PYLL relative position, women, 1960 to 2010: IHD

Country	PYLL for 2010: Absolute numbers
United States	188
Canada	91
Australia	75
France	37

Data table for Figure 15: PYLL relative position, men, 1960 to 2010: CVD

Country	PYLL for 2010: Absolute numbers
Japan	218
Canada	69
Australia	69
Switzerland	49

Data table for Figure 16: PYLL relative position, women, 1960 to 2010: CVD

Country	PYLL for 2010: Absolute numbers
Japan	98
Australia	62
Canada	51
Switzerland	40

Data table for Figure 18: Sex gap profile for PYLL, 2010: Causes of death

Cause of death	Men	Women
Cancer	847 PYLL per 100,000	846 PYLL per 100,000
External causes	1,199 PYLL per 100,000	445 PYLL per 100,000
Ischemic heart disease	371 PYLL per 100,000	91 PYLL per 100,000
Cerebrovascular disease	69 PYLL per 100,000	51 PYLL per 100,000

OECD formula used to calculate PYLL

PYLL for a specific country and year is equal to the sum of years of life lost at age a up to age 70, multiplied by the number of deaths at age a divided by the number of persons at age a , multiplied by the 2010 reference population weight for age a , multiplied by 100,000.

Formula used to calculate min–max normalization

Relative position equals the observed value minus the minimum observed value of the initial variable, divided by the maximum minus the minimum observed values of the initial variable, multiplied by 100.

References

1. Organisation for Economic Co-operation and Development. [*OECD Health Statistics 2015: Definitions, Sources and Methods*](#). 2015.
2. Canadian Institute for Health Information. [*Benchmarking Canada's Health System: International Comparisons*](#). 2013.
3. Gardner JW, Sanborn JS. [*Years of potential life lost \(YPLL\) — What does it measure?*](#). *Epidemiology*. July 1990.
4. Coyne JS, Hilsenrath P. [*The World Health Report 2000: Can health care systems be compared using a single measure of performance?*](#). *American Journal of Public Health*. January 2002.
5. Health Canada. [*Unleashing Innovation: Excellent Healthcare for Canada*](#). 2015.
6. Papanicolas I, Kringos D, Klazinga NS, Smith PC. [*Health system performance comparison: New directions in research and policy*](#). *Health Policy*. September 2013.
7. Whitman G. [*WHO's Fooling Who?: The World Health Organization's Problematic Ranking of Health Care Systems*](#). 2008.
8. Anderson G, Hussey PS. [*Comparing health system performance in OECD countries*](#). *Health Affairs*. May 2001.
9. Lopez AD, Mathers CD. [*Measuring the global burden of disease and epidemiological transitions: 2002–2030*](#). *Annals of Tropical Medicine and Parasitology*. 2006.
10. The Conference Board of Canada. [*How Canada performs: International ranking — Health*](#). Accessed April 15, 2016.
11. Veillard J, Moses McKeag A, Tipper B, Krylova O, Reason B. [*Methods to stimulate national and sub-national benchmarking through international health system performance comparisons: A Canadian approach*](#). *Health Policy*. September 2013.
12. Davis K, Stremikis K, Squires D, Schoen C. [*Mirror, Mirror on the Wall: How the Performance of the U.S. Health Care System Compares Internationally*](#). 2014.
13. Murray CJL, Richards MA, Newton JN, et al. [*UK health performance: Findings of the Global Burden of Disease Study 2010*](#). *The Lancet*. March 2013.
14. Canadian Institute for Health Information. [*Health Indicators 2012*](#). 2012.

15. Nolte E, Bain C, McKee M. [Chapter 2.1: Population health](#). In: Smith PC, Mossialos E, Papanicolas I, Leatherman S, eds. *Performance Measurement for Health System Improvement: Experiences, Challenges and Prospects*. 2009.
16. Murray CJL, Frenk J. [A framework for assessing the performance of health systems](#). *Bulletin of the World Health Organization*. 2000.
17. Tchouaket EN, Lamarche PA, Goulet L, Contandriopoulos AP. [Health care system performance of 27 OECD countries](#). *International Journal of Health Planning and Management*. April–June 2012.
18. National Round Table on the Environment and the Economy. [Measuring Up: Benchmarking Canada's Competitiveness in a Low-Carbon World](#). 2010.
19. Organisation for Economic Co-operation and Development. [OECD.Stat — Health status](#). Accessed April 2, 2015.
20. Philippon DJ, Braithwaite J. [Health system organization and governance in Canada and Australia: A comparison of historical developments, recent policy changes and future implications](#). *Healthcare Policy*. August 2008.
21. Esmail N. [Health Care Lessons From Australia](#). 2013.
22. Russell G, Mitchell G. [Primary care reform: View from Australia](#). *Canadian Family Physician*. March 2002.
23. Snowdon A, Schnarr K, Hussein A, Alessi C. [Measuring What Matters: The Cost vs. Values of Health Care](#). 2012
24. Murray CJL, Lopez AD. [Mortality by cause for eight regions of the world: Global Burden of Disease Study](#). *The Lancet*. May 1997.
25. Mackenbach JP, Kulhánová I, Menvielle G, et al. [Trends in inequalities in premature mortality: A study of 3.2 million deaths in 13 European countries](#). *Journal of Epidemiology and Community Health*. 2015.
26. Navarro V, Muntaner C, Borrell C, et al. [Politics and health outcomes](#). *The Lancet*. September 2006.
27. Raphael D. [The political economy of health promotion: Part 2, national provision of the prerequisites of health](#). *Health Promotion International*. 2011.
28. Blakely TA, Kennedy BP, Glass R, Kawachi I. [What is the lag time between income inequality and health status?](#). *Journal of Epidemiology and Community Health*. 2000.

29. Mellor JM, Milyo J. [Is exposure to income inequality a public health concern? Lagged effects of income inequality on individual and population health](#). *Health Services Research*. February 2003.
30. Canadian Institute for Health Information. [A Performance Measurement Framework for the Canadian Health System](#). 2012.
31. Decady Y, Greenberg L. [Ninety years of change in life expectancy](#). Accessed July 19, 2016.
32. National Cancer Institute. [What is cancer?](#). Accessed January 15, 2016.
33. Canadian Cancer Society. [Canadian Cancer Statistics 2015](#). 2015.
34. World Health Organization. [World Cancer Report](#). 2008.
35. Jemal A, Center MM, DeSantis C, Ward EM. [Global patterns of cancer incidence and mortality rates and trends](#). *Cancer Epidemiology, Biomarkers and Prevention*. August 2010.
36. Siegel RL, Miller KD, Jemal A. [Cancer statistics, 2015](#). *CA: A Cancer Journal for Clinicians*. January–February 2015.
37. World Health Organization. [Cancer prevention](#). Accessed January 15, 2016.
38. The Conference Board of Canada. [How Canada performs: International ranking — Health](#). Accessed January 15, 2016.
39. Doll R, Hill AB. [Smoking and carcinoma of the lung](#). *British Medical Journal*. September 1950.
40. Hirsch FR, Bunn PA, Mulshine JL, Kato H, eds. [IASLC Textbook of Prevention and Early Detection of Lung Cancer](#). 2005.
41. Lopez AD, Collishaw NE, Piha T. [A descriptive model of the cigarette epidemic in developed countries](#). *Tobacco Control*. 1994.
42. Cancer Care Ontario. [Cancer fact: Lung cancer mortality differences between men and women influenced by smoking trends](#). Accessed July 9, 2016.
43. Gallus S. [Second-hand smoke in Italy](#). *European Journal of Paediatric Dentistry*. December 2015.
44. Pierce JP, White VM, Emery SL. [What public health strategies are needed to reduce smoking initiation?](#). *Tobacco Control*. 2012.
45. World Health Organization. [National Cancer Control Programmes: Policies and Managerial Guidelines](#). 2002.
46. Giraldi G, De Ruggiero GF, Marsella LT, d'Alessandro EDL. [Environmental tobacco smoke: Health policy and focus on Italian legislation](#). *La Clinica Terapeutica*. 2013.

47. Australian Department of Health. [Health warnings](#). Accessed May 1, 2016.
48. Kaleta D, Usidame B, Polańska K. [Tobacco advertisements targeted on women: Creating an awareness among women](#). *Central European Journal of Public Health*. 2011.
49. Samet JM, Yoon SY, eds., World Health Organization. [Gender, Women and the Tobacco Epidemic](#). 2010.
50. Health Canada. [Radon: Is It in Your Home?](#). 2014.
51. Health Canada. [Cross-Canada Survey of Radon Concentrations in Homes: Final Report](#). 2012.
52. Gue L. [Revisiting Canada's Radon Guideline](#). 2015.
53. Health Canada. [Health risks of asbestos](#). 2015.
54. Chandran A, Hyder AA, Peek-Asa C. [The global burden of unintentional injuries and an agenda for progress](#). *Epidemiologic Reviews*. 2010.
55. Chen Y, Mo F, Yi QL, Jiang Y, Mao Y. [Unintentional injury mortality and external causes in Canada from 2001 to 2007](#). *Chronic Diseases and Injuries in Canada*. March 2013.
56. Wilkins K. [Causes of death: How the sexes differ](#). *Health Reports*. 1995.
57. World Health Organization. [International Statistical Classification of Diseases and Related Health Problems 10th Revision](#). 2016.
58. Herman M, Gallagher E, Scott V. [The Evolution of Seniors' Falls Prevention in British Columbia](#). 2006.
59. Scott VJ, Peck SHS, Kendall PRW. [Prevention of Falls and Injuries Among the Elderly: A Special Report From the Office of the Provincial Health Officer](#). 2004.
60. Scott VJ. [World Health Organization Report: Prevention of Falls in Older Age](#). 2007.
61. World Health Organization. [World Report on Road Traffic Injury Prevention](#). 2004.
62. World Health Organization. [Public Health Action for the Prevention of Suicide: A Framework](#). 2012.
63. Rockett IRH, Regier MD, Kapusta ND, et al. [Leading causes of unintentional and intentional injury mortality: United States, 2000–2009](#). *American Journal of Public Health*. November 2012.

64. World Health Organization. [*Preventing Injuries and Violence: A Guide for Ministries of Health*](#). 2007.
65. Statistics Canada. [Table 102-0551: Deaths and mortality rate, by selected grouped causes, age group and sex, Canada, annual](#). Accessed May 2, 2016.
66. Heart and Stroke Foundation. [What is heart disease?](#). Accessed April 15, 2016.
67. Tanuseputro P, Manuel DG, Leung M, Nguyen K, Johansen H. [Risk factors for cardiovascular disease in Canada](#). *Canadian Journal of Cardiology*. October 2003.
68. Harkins C, Shaw R, Gillies M, et al. [Overcoming barriers to engaging socio-economically disadvantaged populations in CHD primary prevention: A qualitative study](#). *BMC Public Health*. 2010.
69. Luepker RV. [Decline in incident coronary heart disease: Why are the rates falling?](#). *Circulation*. February 2008.
70. Manuel DG, Leung M, Nguyen K, Tanuseputro P, Johansen H. [Burden of cardiovascular disease in Canada](#). *Canadian Journal of Cardiology*. August 2003.
71. Truelsen T, Begg S, Mathers C. [The Global Burden of Cerebrovascular Disease](#). 2016.
72. WHO MONICA Project Principal Investigators. [The World Health Organization MONICA project \(monitoring trends and determinants in cardiovascular disease\): A major international collaboration](#). *Journal of Clinical Epidemiology*. 1988.
73. Heart and Stroke Foundation. [Signs of stroke](#). Accessed April 15, 2016.
74. Donnan GA, Fisher M, Macleod M, Davis SM. [Stroke](#). *The Lancet*. May 2008.
75. Royal College of Physicians. [National Clinical Guideline for Stroke](#). 2012.
76. World Health Organization. [CVD prevention and control: Missed opportunities](#). Accessed April 15, 2016.
77. Klag MJ, Whelton PK. [The decline in stroke mortality: An epidemiologic perspective](#). *Annals of Epidemiology*. 1993.
78. Lackland DT, Roccella EJ, Deutsch AF, et al. [Factors influencing the decline in stroke mortality: A statement from the American Heart Association/American Stroke Association](#). *Stroke*. 2014.
79. Biggs A. [The Pharmaceutical Benefits Scheme — An overview](#). Accessed May 2, 2016.
80. Australian Government. [Programmes for indigenous families](#). Accessed May 2, 2016.

81. Dewar J. [The National Health Priority Areas initiative](#). Accessed May 2, 2016.
82. Australian Institute of Health and Welfare. [National health priority areas](#). Accessed May 2, 2016.
83. Australian Department of Health. [Plain packaging of tobacco products](#). Accessed May 2, 2016.
84. Australian Department of Health. [Tobacco plain packaging — Your guide](#). Accessed May 2, 2016.
85. Australian Department of Health. [National Primary Health Care Strategic Framework](#). 2013.
86. Australian Department of Health. [PHN background](#). Accessed May 2, 2016.
87. New South Wales Department of Primary Industries. [kJ labelling nutrition information](#). Accessed May 2, 2016.
88. Australian Department of Social Services. [My Aged Care](#). Accessed March 28, 2016.
89. South Australia Health. [Health in All Policies: The South Australian approach](#). Accessed May 2, 2016.
90. South Australia Health. [Active transport — Cycling Strategy health lens](#). Accessed May 2, 2016.
91. Ipsos. [Nearly two in three Canadians \(64%\) worried that the health care system is falling behind](#). Accessed May 2, 2016.
92. Marchildon GP. [Canada: Health System Review](#). 2013.
93. Etches V, Frank J, Di Ruggiero E, Manuel D. [Measuring population health: A review of indicators](#). *Annual Review of Public Health*. 2006.
94. Or Z. [Exploring the Effects of Health Care on Mortality Across OECD Countries](#). 2001.
95. World Health Organization. [The World Health Report 2000 — Health Systems: Improving Performance](#). 2000.
96. Almeida C, Braveman P, Gold MR, et al. [Methodological concerns and recommendations on policy consequences of the World Health Report 2000](#). *The Lancet*. May 2001.
97. Navarro V. [The new conventional wisdom: An evaluation of the WHO report, Health Systems: Improving Performance](#). *International Journal of Health Services*. 2001.
98. Paruolo P, Saisana M, Saltelli A. [Ratings and rankings: Voodoo or science?](#). *Journal of the Royal Statistical Society: Series A (Statistics in Society)*. 2013.

99. Richardson J, Wildman J, Robertson IK. [A critique of the World Health Organisation's evaluation of health system performance](#). *Health Economics*. May 2003.
100. Deber R. [Why did the World Health Organization rate Canada's health system as 30th? Some thoughts on league tables](#). *Longwoods Review*. 2004.
101. Forde I, Morgan D, Klazinga NS. [Resolving the challenges in the international comparison of health systems: The must do's and the trade-offs](#). *Health Policy*. September 2013.
102. Canadian Institute for Health Information. [Making Sense of Health Rankings](#). 2008.
103. Zhou P, Ang BW, Poh KL. [Comparing aggregating methods for constructing the composite environmental index: An objective measure](#). *Ecological Economics*. September 2006.
104. Organisation for Economic Co-operation and Development. [Members and partners](#). Accessed January 11, 2016.
105. Janssen F, Kunst AE. [ICD coding changes and discontinuities in trends in cause-specific mortality in six European countries, 1950–99](#). *Bulletin of the World Health Organization*. December 2004.
106. Australian Institute of Health and Welfare. [International comparisons of premature mortality](#). Accessed August 2, 2016.
107. Organisation for Economic Co-operation and Development. [Glossary of statistical terms](#). Accessed January 11, 2016.



CIHI Ottawa

495 Richmond Road
Suite 600
Ottawa, Ont.
K2A 4H6

613-241-7860

CIHI Toronto

4110 Yonge Street
Suite 300
Toronto, Ont.
M2P 2B7

416-481-2002

CIHI Victoria

880 Douglas Street
Suite 600
Victoria, B.C.
V8W 2B7

250-220-4100

CIHI Montréal

1010 Sherbrooke Street West
Suite 602
Montréal, Que.
H3A 2R7

514-842-2226

cihi.ca

23080-1020

