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Describing the population health burden of depression: health-adjusted life expectancy by depression status in Canada

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Abstract

Introduction: Few studies have evaluated the impact of depression in terms of losses to both premature mortality and health-related quality of life (HRQOL) on the overall population. Health-adjusted life expectancy (HALE) is a summary measure of population health that combines both morbidity and mortality into a single summary statistic that describes the current health status of a population.

Methods: We estimated HALE for the Canadian adult population according to depression status. National Population Health Survey (NPHS) participants 20 years and older (n = 12 373) were followed for mortality outcomes from 1994 to 2009, based on depression status. Depression was defined as having likely experienced a major depressive episode in the previous year as measured by the Composite International Diagnostic Interview Short Form. Life expectancy was estimated by building period abridged life tables by sex and depression status using the relative risks of mortality from the NPHS and mortality data from the Canadian Chronic Disease Surveillance System (2007–2009). The Canadian Community Health Survey (2009/10) provided estimates of depression prevalence and Health Utilities Index as a measure of HRQOL. Using the combined mortality, depression prevalence and HRQOL estimates, HALE was estimated for the adult population according to depression status and by sex.

Results: For the population of women with a recent major depressive episode, HALE at 20 years of age was 42.0 years (95% CI: 40.2–43.8) compared to 57.0 years (95% CI: 56.8–57.2) for women without a recent major depressive episode. For the population of Canadian men, HALE at 20 was 39.0 years (95% CI: 36.5–41.5) for those with a recent major depressive episode compared to 53.8 years (95% CI: 53.6–54.0) for those without. For the 15.0-year difference in HALE between women with and without depression, 12.3 years can be attributed to the HRQOL gap and the remaining 2.7 years to the mortality gap. The 14.8 fewer years of HALE observed for men with depression equated to a 13.0-year HRQOL gap and a 1.8-year mortality gap.

Conclusion: The population of adult men and women with depression in Canada had substantially lower healthy life expectancy than those without depression. Much of this gap is explained by lower levels of HRQOL, but premature mortality also plays a role.

Keywords: life expectancy, healthy life expectancy, mortality, health-related quality of life, depression

Highlights

• Men and women in Canada who have depression live a substantially higher proportion of their life in an unhealthy state compared to their counterparts without depression.
• This gap in healthy life expectancy between Canadians with and without depression is primarily associated with losses in quality of life.
• Emotional state, cognitive state and pain are the key attributes associated with losses in quality of life for Canadians experiencing a recent major depressive episode.
• Based on observations from past studies of the Canadian household population, the burden of depression on healthy life expectancy at a population level appears to be greater than that associated with other chronic conditions such as diabetes, hypertension and obesity.

Introduction

Depression contributes significantly to the burden of disease throughout the world, including in Canada. It is estimated that over 298 million people worldwide are living with depression. In 2012, about 3.2 million Canadians over the age of 15 (11.3%) reported having experienced symptoms consistent with a major depressive episode in their lifetime, while the prevalence of such an episode in the previous 12 months was 4.7% in this population. Women and young people aged 15 to 24 years experienced the highest prevalence of a 12-month major depressive episode. Depression has an important impact on health-related quality of life (HRQOL), functioning, mortality due to intentional injury and health care utilization.
addition to these direct negative outcomes, depression has also been demonstrated to increase risk for coronary heart disease, stroke and cancer and a decline in physical functioning. Potential mechanisms for the relationship between depression and physical disease include immune and endocrine dysregulation and inflammatory processes. Depression has also been associated with an increased risk of mortality in general community populations, as well as in patient populations with chronic illnesses such as coronary heart disease, cancer, diabetes and stroke. There are likely reciprocal effects between depression and disease, with depression being a risk factor for, and a sequela of, disease.

Summary measures of population health using the Global Burden of Disease methodology have ranked depression very high on the list of health conditions contributing to the global and national burden of disease, particularly in terms of losses due to disability. Major depressive episode is the second leading cause of years lived with disability globally as well as in the United States, the United Kingdom, China and Canada.

Less well documented is the association of depression with life expectancy and healthy (or disease-free) life expectancy. Understanding both life expectancy and healthy life expectancy among people who have depression will help to better characterize its disease burden. A recent systematic review and meta-analysis concluded that people living with a mood disorder have a mortality rate twice as high as those without a mood disorder, and potential years of life lost due to mental disorders ranged from 1.4 to 32 years, with a median of 10.1 years. Jia et al. reported that adults living with depression in the United States experienced a 28.9 year loss of quality adjusted life expectancy (QALE) at age 18 compared to those without depression. Results from the few existing studies on healthy or disease-free life expectancy and depression are not consistent. A number of these studies are restricted to older adults and thus cannot be generalized to the entire population. These studies also use a measure of functional health restricted to activities of daily living, which do not consider attributes such as pain, emotion and cognition.

The objective of our study was to estimate period life expectancy (LE) and health-adjusted life expectancy (HALE) of Canadian adults (aged 20 years and older) according to depression status. Note that the period approach to estimating LE and HALE adopted in this paper is a summary measure of population health for a given period. Period life expectancy estimates the hypothetical life expectancy of an individual were they to experience the age- and sex-specific mortality rates in a given period. This should not be confused with projected life expectancy based on modeling or cohort life expectancy based on the actual mortality experience of a specific cohort. In a similar fashion, period HALE is a hypothetical estimate reflecting an individual’s healthy life expectancy were they to experience the age- and sex-specific mortality and age- and sex-specific HRQOL levels at a given point in time.

These estimates are useful to better understand the population health impact of a condition. They are also useful for informing policy and programs, and for making decisions about the relative burden of specific health conditions. Because of the varied course of depression, with both chronic and episodic cases included in the population studied, the estimates in this study should not be applied to predict the expected health course of any individual.

Methods

Data sources

To estimate HALE, several types of data are necessary: all-cause mortality rates by depression status, depression prevalence and HRQOL estimates by depression status. All-cause mortality rates for the Canadian adult population with and without depression were estimated based on a methodology that partitions rates for total population into mortality rates by disease categories using a mortality relative risk or hazard ratios and a prevalence of those categories. The methodology is described in detail in our previous study.

We used data from the following three sources:

- National Population Health Survey (NPHS), for estimating depression prevalence and HRQOL by depression status;
- Canadian Community Health Survey (CCHS), for estimating depression prevalence and HRQOL by depression status; and
- Canadian Chronic Disease Surveillance System (CCDSS), for actual age- and sex-specific all-cause mortality rates in the Canadian population, which were then partitioned into those associated with depression and those not associated with depression, based on the mortality HR estimated using the NPHS and depression prevalence estimated from CCHS.

The NPHS is a longitudinal survey conducted by Statistics Canada of 17276 Canadians of all ages living in households in the 10 provinces. The NPHS has a biennial follow-up spanning the years 1994/95 to 2010/11 and includes death clearance against the Canadian Mortality Database. These data were used to estimate mortality HR associated with depression required for estimating all-cause mortality rates for people with and without depression. Our study population at baseline included 12 373 participants aged 20 years and older.

The CCHS is an annual cross-sectional survey, conducted by Statistics Canada, of a sample of approximately 65000 Canadians aged 12 years and older living in households in the provinces and territories. Our study used a two-year CCHS sample (2009–2010) and included 103815 participants aged 20 years and older. We used these data to estimate the prevalence of depression, as well as to attribute depression status in estimating all-cause mortality rates (see “Analysis” section for more detail). We also obtained Health Utilities Index (HUI) scores by depression status from the CCHS. We estimated depression prevalence and HUI scores from the CCHS because the data were more recent, and the larger sample size allowed for more accurate estimation of depression and HUI scores.

We used CCDSS all-cause mortality data for the period of 2007–2009 in the study. The CCDSS collects administrative data that include death and population counts by sex and five-year age groups for all residents of all ages in all provinces and territories, who use the public health care systems. Both mortality and population size information come from provincial and territorial health insurance databases.
that cover about 97% of the Canadian population. Data are collected from all Canadian provinces and territories and summarized by the Public Health Agency of Canada.\textsuperscript{24}

**Measures**

Depression is measured in the CCHS and NPHS using the Composite International Diagnostic Interview Short Form (CIDI-SF) instrument. The CIDI is a structured diagnostic interview, based on diagnostic criteria from the *International Classification of Diseases (ICD-10)* and the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*, that is administered by trained interviewers. The short form of the Interview is based on a subset of CIDI questions that could still reliably reproduce prevalence estimates.\textsuperscript{25} The CIDI-SF interview produces scores that give predicted probabilities of depression. For this study, respondents with a predicted probability of 0.9 and above were considered to have experienced a major depressive episode during the previous year. The CIDI-SF was optional content on the 2009–2010 CCHS, and not all provinces and territories chose to include this module. Estimates of depression are based on partial provincial and territorial coverage that includes five provinces (Prince Edward Island, Quebec, Saskatchewan, Alberta and British Columbia) and two territories (Nunavut and Northwest Territories).

HRQOL is measured using the Health Utilities Index Mark 3 instrument in the CCHS. The HUI is a preference-based measure of HRQOL based on responses to questions about functioning for the following eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain.\textsuperscript{26} Single-attribute utility scores range from 0.0 (lowest level of functioning) to 1.0 (full functional capacity). The eight attributes are combined into an overall score that ranges from 1.00 (perfect health) through 0.00 (death) to –0.36 (the worst possible health state; from a preference perspective, some health states are considered worse than death and are consequently assigned negative scores). A change of 0.03 or more in overall HUI scores and 0.05 or more in single-attribute utility scores is considered clinically important.\textsuperscript{27}

The HUI has been widely used, and its validity and reliability in a variety of applications is supported.\textsuperscript{27,28} A study assessing the sensitivity to depression outcomes of several multiattribute utility indexes found HUI to be able to discriminate well between levels of severity in the two depression instruments being evaluated.\textsuperscript{29} The HUI score is used as a morbidity measure in the estimation of HALE. Depression typically has a negative impact on the emotional state, including sustained negative affect and difficulties experiencing positive affect.\textsuperscript{30} In order to assess whether HRQOL differences are due exclusively to changes in the HUI emotion attribute, we compared HUI scores (all ages combined) by depression status for each of the eight attributes.

**Analysis**

Relative risks of mortality by depression status for women and for men were approximated by HRs. The HRs were estimated by fitting sex-specific discrete-time proportional models with a complementary log-log function using the completed NPHS data. We defined people with depression as those with a high probability (0.9) of having had a major depressive episode in the 12 months prior to data collection in at least one NPHS cycle, according to a method described by Simpson et al.\textsuperscript{31} The first episode defined a case date. Respondents were followed up for mortality events every two years and a variable for each cycle was included in the model (cycle 1–cycle 9) as a time-interval measure. The sex-specific models were adjusted by age. As the HRs were used to estimate only all-cause mortality rates associated with depression, we did not adjust the models for any other comorbidities, socioeconomic status or other determinants of health. Because of the complex sample design of this survey, we used the bootstrapping method to calculate variance and produce 95% confidence intervals (CIs) for HR.\textsuperscript{32} Age- and sex-specific depression prevalences, required for decomposing total mortality rates by depression status, were estimated using the CCHS 2009–2010. Mean HUI estimates by age, sex and depression status were also calculated. Bootstrapping was used to generate 95% CI.\textsuperscript{33} In our study, total mortality rates by sex and 5-year age groups were estimated from CCDSS data for the period of 2007–2009. In this study, age- and sex-specific mortality rates for people with depression and for those without depression were estimated by decomposing mortality rates for the total population following the methodology we described in our previous study.\textsuperscript{34}

We used the Chiang method\textsuperscript{35} to generate period (2007–2009) sex-specific abridged life tables by depression using 14 standard age groups (20–24, 25–29, ..., 80–84, ≥ 85 years). The Gompertz function was used to provide an accurate estimate of LE for the last open-ended 85-years-plus age interval in order to close the life table, as described by Hsieh.\textsuperscript{33} The modified Sullivan method\textsuperscript{34} was used for HALE estimation. According to this method the “life-years lived” was adjusted by the HUI.

\[
L'_x = L_x \times \text{HUI}_x
\]

where \(L'_x\) is adjusted life-years lived in age-interval \(x\), \(L_x\) is life-years lived in age-interval \(x\) and \(\text{HUI}_x\) is Health Utilities Index Mark 3 for people in age-interval \(x\).

The variance of LE and HALE was estimated using bootstrap methodology. Statistics Canada’s surveys provide 500 bootstrap weights for variance estimation to account for complex survey designs.\textsuperscript{21,23} Using those weights, 500 sets of HR estimates from NPHS and 500 sets of prevalence of depression and HUI estimates from CCHS were generated and all unique combinations of those estimates used to obtain mortality rates to build 250 000 life tables by depression and sex. This allowed estimating LE and HALE variance, building CIs around point estimates and conducting z tests to determine the statistical significance of the differences in LE and HALE. The 95% CIs were built based on the normality assumption. Due to the nature of the study population (adults 20 years and older), LE and HALE results were estimated at age 20 years and not birth.

The Arriaga decomposition, or partitioning, method\textsuperscript{35} (adapted for the Sullivan method\textsuperscript{34}) was applied to quantify which part of HALE differences according to depression status can be attributable to differences in premature mortality and which are attributable to loss of HRQOL (morbidity). For each age group, the change in HALE between the comparison groups is partitioned into the following components:
Based on analysis of the NPHS data, there were 2154 deaths over the 16-year follow-up period. Mortality risk was significantly higher for those who experienced a major depressive episode (age-adjusted HR = 1.43; 95% CI: 1.22–1.68). This significant risk persisted when we restricted analyses to women only (age-adjusted HR = 1.55; 95% CI: 1.28–1.87), while the risk for men was nonsignificant (age-adjusted HR = 1.28; 95% CI: 0.98–1.68) (data not shown).

Unadjusted HRQOL values (as measured by HUI scores) varied by age, sex and depression status (see Table 2). HUI scores were considerably lower in all age groups for men and women who had experienced a major depressive episode during the preceding 12 months compared to those who had not experienced such an episode. According to definitions of disability categories based on global HUI scores developed by Feng et al., men and women with depression experienced on average moderate disability (HUI < 0.89) at all age groups, whereas only older (≥ 55 years) men and women without depression fell into this category. Similarly, men with depression on average experienced severe disability (HUI < 0.70) at age 40 years while women experienced this at age 45 years; average HUI scores for men and women without depression did not drop below this threshold at any age group in our study.

An assessment of each of the eight HUI attributes by sex (all ages combined) showed that depression was associated with a clinically meaningful lower score (i.e. a difference of 0.05 or higher) for the emotion, pain and cognition attributes (Table 2).

Both LE and HALE for women with depression were lower than for those without depression; LE for men with depression was not significantly lower whereas HALE was (Table 3). LE at age 20 was 4.1 years (95% CI: 1.1–7.1) lower for women with depression compared to those without, whereas HALE at age 20 was 15.0 years (95% CI: 13.2–16.8) lower for women with depression. For men, the gap in LE at age 20 between those with and without depression was 2.7 years (95% CI: 0.0–5.4), whereas HALE at age 20 for men with depression was 14.8 years (95% CI: 12.3–17.4) lower. LE and HALE at age 65 were lower for both men and women with depression. Women with depression had an LE at age 65 that was 3.2 years (95% CI: 1.8–4.6) lower and a HALE at age 65 that was 6.7 years (95% CI: 5.3–8.1) lower than women without depression. LE at age 65 years for men with depression was 2.1 years (95% CI: 0.1–4.1) lower than that of men without depression. HALE at age 65 years was 6.0 years (95% CI: 3.8–8.2) less for men with depression compared to those without depression.

An assessment of the individual contribution of loss of HRQOL and premature mortality to differences in HALE at age 20 indicated that, for the 15.0-year difference in HALE between women with and without depression, 12.3 years could be attributed to HRQOL losses and the remaining 2.7 years to mortality losses. The 14.8 fewer years of HALE for men with depression equated to a 13.0-year HRQOL gap.
and a 1.8-year mortality gap (data not shown).

We found large differences between adult Canadians with and without depression in terms of the percentage of their life spent in an unhealthy state (calculated as \([LE - HALE]/LE\); see Figure 1). Both men and women with depression spent almost three times as much of their life expectancy at age 20 in poor health when compared to those without depression (31% vs. 12% for females and 32% vs. 11% for males). These large differences persisted across age groups: based on LE and HALE at age 65, men and women with depression were still living approximately twice as long in poor health as men and women of the same age without depression (40% vs. 19% for women and 43% vs. 17% for men).

### Discussion

In this study, we found significantly lower LE at age 20 for women, and HALE at age 20 for both women and men, among Canadians reporting symptoms consistent with a major depressive episode in the previous 12 months. We found this across age groups, although gaps in the proportion of life expectancy spent in an unhealthy state were greater among men and younger age groups with depression. Although direct comparisons with other health problems need to be interpreted with caution, we found that losses of HALE associated with depression in the Canadian adult population were larger than those observed for obesity class 2 and above,22 and for diabetes and hypertension19 in the same population. In addition, while those studies found a greater loss of HALE among women than men, we demonstrated approximately equal losses for both sexes.

Our results align with those of Jia et al.,17 who reported a 28.9-year QALE loss at age 18 for adults with depression, which is substantively larger than the approximately

### TABLE 2

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Women without depression</th>
<th>Women with depression</th>
<th>Men without depression</th>
<th>Men with depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–24</td>
<td>0.93 (0.92–0.94)</td>
<td>0.82 (0.77–0.87)</td>
<td>0.93 (0.92–0.94)</td>
<td>0.74 (0.65–0.83)</td>
</tr>
<tr>
<td>25–29</td>
<td>0.94 (0.93–0.95)</td>
<td>0.81 (0.76–0.85)</td>
<td>0.93 (0.92–0.94)</td>
<td>0.81 (0.76–0.87)</td>
</tr>
<tr>
<td>30–34</td>
<td>0.93 (0.93–0.94)</td>
<td>0.74 (0.65–0.84)</td>
<td>0.93 (0.92–0.94)</td>
<td>0.78 (0.71–0.85)</td>
</tr>
<tr>
<td>35–39</td>
<td>0.93 (0.92–0.94)</td>
<td>0.74 (0.64–0.84)</td>
<td>0.93 (0.92–0.94)</td>
<td>0.80 (0.74–0.87)</td>
</tr>
<tr>
<td>40–44</td>
<td>0.91 (0.90–0.92)</td>
<td>0.73 (0.68–0.78)</td>
<td>0.91 (0.89–0.92)</td>
<td>0.68 (0.60–0.77)</td>
</tr>
<tr>
<td>45–49</td>
<td>0.91 (0.89–0.92)</td>
<td>0.63 (0.54–0.71)</td>
<td>0.92 (0.90–0.93)</td>
<td>0.67 (0.58–0.76)</td>
</tr>
<tr>
<td>50–54</td>
<td>0.90 (0.89–0.91)</td>
<td>0.69 (0.63–0.75)</td>
<td>0.91 (0.90–0.91)</td>
<td>0.66 (0.59–0.73)</td>
</tr>
<tr>
<td>55–59</td>
<td>0.88 (0.87–0.89)</td>
<td>0.71 (0.65–0.77)</td>
<td>0.88 (0.87–0.89)</td>
<td>0.59 (0.49–0.70)</td>
</tr>
<tr>
<td>60–64</td>
<td>0.88 (0.87–0.89)</td>
<td>0.68 (0.62–0.75)</td>
<td>0.90 (0.89–0.91)</td>
<td>0.62 (0.52–0.72)</td>
</tr>
<tr>
<td>65–69</td>
<td>0.87 (0.86–0.88)</td>
<td>0.59 (0.49–0.69)</td>
<td>0.88 (0.87–0.89)</td>
<td>0.60 (0.49–0.71)</td>
</tr>
<tr>
<td>70–74</td>
<td>0.86 (0.85–0.88)</td>
<td>0.67 (0.58–0.77)</td>
<td>0.87 (0.85–0.88)</td>
<td>0.63 (0.45–0.81)</td>
</tr>
<tr>
<td>75–79</td>
<td>0.81 (0.78–0.83)</td>
<td>0.66 (0.54–0.78)</td>
<td>0.83 (0.81–0.85)</td>
<td>0.69 (0.59–1.00)</td>
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<tr>
<td>80–84</td>
<td>0.79 (0.77–0.82)</td>
<td>0.48 (0.16–0.81)</td>
<td>0.79 (0.76–0.82)</td>
<td>0.36 (–0.01–0.73)</td>
</tr>
<tr>
<td>≥ 85</td>
<td>0.72 (0.69–0.75)</td>
<td>0.52 (0.37–0.67)</td>
<td>0.74 (0.70–0.78)</td>
<td>0.44 (0.10–0.79)</td>
</tr>
</tbody>
</table>

**HUI attribute**

- **Vision**: 0.99 (0.99–0.99)
- **Speech**: 1.00 (1.00–1.00)
- **Pain**: 0.97 (0.97–0.97)
- **Mobility**: 0.99 (0.99–0.99)
- **Hearing**: 1.00 (1.00–1.00)
- **Emotion**: 0.99 (0.99–0.99)
- **Dexterity**: 1.00 (1.00–1.00)
- **Cognition**: 0.98 (0.98–0.98)

**Abbreviations**: CI, confidence interval; CIDI-SF, Composite International Diagnostic Interview Short Form; HUI, Health Utilities Index.

**Note**: Light shading signifies moderate disability (global HUI score of 0.70–0.88); dark shading signifies severe disability (global HUI score < 0.70); no shading represents either no disability (global HUI score = 1.00) or mild disability (global HUI score = 0.89–0.99).

* Based on responses to CIDI-SF, indicative of having experienced a major depressive episode in the previous year.

* Clinically meaningful difference in attribute-specific HUI score between those with and without depression.
Studies of older adults, Canada, 2009/10

Table 2

<table>
<thead>
<tr>
<th>Age group, years</th>
<th>Women without depression</th>
<th>Women with depression</th>
<th>Men without depression</th>
<th>Men with depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life expectancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–24</td>
<td>64.9 (64.8–65.0)</td>
<td>60.8 (59.0–62.6)</td>
<td>60.4 (60.3–60.5)</td>
<td>57.7 (55.0–60.4)</td>
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<tr>
<td>65–69</td>
<td>22.4 (22.3–22.5)</td>
<td>19.2 (17.8–20.6)</td>
<td>19.1 (19.1–19.1)</td>
<td>17.0 (15.0–19.0)</td>
</tr>
<tr>
<td>Health-adjusted life expectancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–24</td>
<td>57.0 (56.8–57.2)</td>
<td>42.0 (40.2–43.8)</td>
<td>53.8 (53.6–54.0)</td>
<td>39.0 (36.5–41.5)</td>
</tr>
<tr>
<td>65–69</td>
<td>18.1 (17.9–18.3)</td>
<td>11.4 (10.0–12.8)</td>
<td>15.8 (15.6–16.0)</td>
<td>9.8 (7.6–12.0)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; CIDI-SF, Composite International Diagnostic Interview Short Form; HALE, health-adjusted life expectancy.

* Based on responses to CIDI-SF, indicative of having experienced a major depressive episode in the previous year.

15-year loss of HALE at age 20 for adults with depression that we report. This may be explained both by real differences in the health experience of the Canadian and US populations and by methodological differences between our studies. Moreover, the hazard ratio for mortality associated with depression we observed (HR = 1.43) is somewhat smaller than the relative risk of mortality of 2.08 for adults with depression reported in the meta-analysis by Walker et al. Studies of older adult populations report a lower life expectancy for participants with depression. Both Chiao et al. and Pérès et al. report life expectancy at 65 years old as lower by approximately one year for participants with depression, whereas Reynolds et al. found that life expectancy at age 70 of individuals with depression in the absence of other chronic diseases was reduced by approximately three years. While these studies found decreases in health expectancy in their participants living with depression, the magnitude of these decreases is less than what we found in our study, except for male participants in the Reynolds et al. study. The larger differences may be due to the fact that our measure of HRQOL included attributes not found in the Activities-of-Daily-Living measure of disability used in those three studies.

We found that a large portion of the lower HALE in participants with depression was due to lower levels in HRQOL. A comparison of each HUI attribute (Table 2) demonstrated that, although there is a clinically meaningful difference between men and women with and without depression for the emotion attribute, there are also meaningful differences for the pain and cognition attributes. Although the association between pain and depression is well documented, the relationship is complex and causal pathways are not thoroughly understood: data support both a model where depression leads to changes in the individual that increase their vulnerability to pain, as well as scenarios where pain symptoms are a risk factor for future depression. Cognitive dysfunction has also been found in a large proportion of patients with depression and has been demonstrated to exist early on in the course of depression; it may even precede diagnosis.

In addition to the expected lower values of HALE associated with lower HRQOL, we also found that a considerable amount of the decrease could be attributed to premature mortality. While our results found women demonstrated the largest losses of life expectancy, other studies on mortality risk and life expectancy according to depression status found that men had the greater mortality risk or loss of life expectancy. However, most of these studies tended to focus on elderly or older adult populations that likely have a different risk profile than the full adult population. Indeed, Shah et al. assessed both sex and age differences in the association of depression with mortality and found significant depression-age-sex interactions: mortality risk increased for men as age increased above 55 years while the inverse was found for women. Further study should be undertaken in non-elderly populations in order to better understand this phenomenon.
Strengths and limitations

Our study benefitted from comprehensive data used to estimate LE and HALE across the age spectrum of adults in Canada. The survey data we used are from large, population-based samples of the Canadian household population: the NPHS allowed us to follow the mortality experience of over 12,000 adult Canadians for 16 years, a longer period than any of the other studies evaluating the association of depression status with life expectancy and/or healthy life expectancy.

Our study has several limitations. When estimating mortality risk, we only considered the first observed episode of probable depression based on the CIDI-SF and did not include depression status at subsequent follow-up. This could have led to misclassification of subjects whose depression status changed.

The definition of depression used in this study (predicted probability of major depressive episode of 0.9) is consistent with the recommended use of the CIDI-SF instrument and corresponds to reporting five to nine symptoms consistent with depression, including one of two cardinal symptoms. This measure was developed for the National Comorbidity Survey in the United States. A 0.9 predicted probability is a high threshold that likely results in more false negatives than false positives, and thus will underestimate, rather than overestimate the burden of depression in Canada.

The CIDI-SF is an optional item in the CCHS and, as such, does not include responses from all Canadian provinces and territories, which may limit the representativeness of our results. We assessed the impact of the missing jurisdictions using an earlier CCHS cycle (2000/01) that included major depressive episode results for all provinces and territories. Age- and sex-specific major depressive episode prevalences from this cycle did not change appreciably when we removed the jurisdictions missing from the 2009/10 cycle, suggesting that representativeness of our study population was not affected by the missing jurisdictions. It should also be pointed out that our measure of depression, recent major depressive episode, does not adequately capture losses in healthy life expectancy specific to longer-term, chronic depression.

The CCHS is a household survey, and by excluding other populations, such as those living in institutions and long-term care facilities, it is possible that the prevalence of depression does not reflect that of the entire Canadian population. There may be differential non-response on the NPHS and CCHS: people with depression may be less likely to respond, resulting in an underestimation of the prevalence of depression. However, this would mean that our estimates are conservative, and that the true burden of depression may be higher than we report.

Our study aimed to describe the association between depression and healthy life expectancy and did not seek to understand the modifying influence of socioeconomic status or of other health conditions. However, in describing the mortality and morbidity of people with depression, it would be inappropriate to adjust for comorbid conditions. The influence on healthy life expectancy of health conditions that are comorbid with depression is unclear. While Perez et al. only found significant differences in healthy life expectancy between those with and without depression among those reporting three or more chronic conditions, Reynolds et al. found large, significant differences in healthy life expectancy when comparing those with depression to those without in the absence of chronic diseases. Further study is needed to determine the impact of these risk factors and other potentially positive modifying effects, such as social participation, on healthy life expectancy.

Finally, the approach to summarizing population health in this study represents the life and healthy life expectancy experience by a population at a given point in time, based on age- and sex-specific mortality and HRQOL estimates. These period estimates of life expectancy and HALE should only be interpreted as summary measures of population health, and not as the life and healthy life expectancies of any real individual.

Conclusion

This study demonstrates that, at the Canadian population level, women who have recently experienced a major depressive episode have a significantly lower period life expectancy and HALE at age 20 years than those who have not; for men, period HALE at age 20 is significantly lower for those who recently experienced a major depressive episode. Losses in HALE due to lower HRQOL are considerable and, while not as large, losses due to increased mortality risk also contribute to this difference, particularly among women. These findings demonstrate a high burden of depression in the Canadian population.

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Data used in this study were accessed through sharing agreements with Statistics Canada and the Canadian provinces and territories. Other researchers can access Statistics Canada data through the Data Liberation Initiative of Statistics Canada.

References


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**Research, Policy and Practice**

Public Health Agency of Canada Agence de la santé publique du Canada
Developing indicators for evaluation of age-friendly communities in Canada: process and results

H. Orpana, PhD (1,2); M. Chawla, MPH (3); E. Gallagher, PhD (4); E. Escaravage, MSc (3)

This article has been peer reviewed.

Abstract

Introduction: In 2006, the World Health Organization launched the Global Age-Friendly Cities Project to support active aging. Canada has a large number of age-friendly initiatives; however, little is known about the effectiveness and outcomes of age-friendly community (AFC) initiatives. In addition, stakeholders report that they lack the capacity and tools to develop and conduct evaluations of their AFC initiatives. In order to address these gaps, the Public Health Agency of Canada developed indicators to support the evaluation of AFC initiatives relevant to a wide range of Canadian communities. These indicators meet the varied needs of communities, but are not designed to evaluate collective impact or enable cross-community comparisons.

Methods: An evidence-based, iterative consultation approach was used to develop indicators for AFCs. This involved a literature review and an environmental scan. Two rounds of key expert and stakeholder consultations were conducted to rate potential indicators according to their importance, actionability and feasibility. A final list of indicators and potential measures were developed based on results from these consultations, as well as key policy considerations.

Results: Thirty-nine indicators emerged across eight AFC domains plus four indicators related to long-term health and social outcomes. All meet the intended purpose of evaluating AFC initiatives at the community level. A user-friendly guide is available to support and share this work.

Conclusion: The AFC indicators can help communities evaluate age-friendly initiatives, which is the final step in completing a cycle of the Pan-Canadian AFC milestones. Communities are encouraged to use the evaluation results to improve their AFC initiatives, thereby benefiting a broad range of Canadians.

Keywords: age-friendly, evaluation, aging, community, Canada

Introduction

In 2006, the World Health Organization (WHO) kick-started the Global Age-Friendly Cities Project by bringing together representatives from cities around the world who were interested in supporting healthy aging.1 This consultation identified eight key areas of community life where communities could become more age-friendly: outdoor spaces and buildings, transportation, housing, social participation, respect and social inclusion, civic participation and employment, communication and information, and community support and health services. Canada was a key partner in developing this approach and four Canadian cities took part in consultations that shaped the development of the model. Noting that Canada’s context includes a significant number of rural and remote communities, the federal, provincial and territorial ministers responsible for seniors sponsored a companion project that resulted in a document entitled Age-Friendly Rural and Remote Communities: A Guide.2

As part of its national leadership role to promote the development of age-friendly communities, the Public Health Agency of Canada (PHAC) developed pan-Canadian age-friendly community (AFC) milestones in collaboration with key partners. These milestones describe the steps needed to apply the AFC model in Canada as follows:

1. Establish an advisory committee that includes the active engagement of older adults;
2. Secure a local municipal council resolution to actively support, promote and work towards becoming age-friendly;

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3. Establish a robust and concrete plan of action that responds to the needs identified by older adults in the community;

4. Demonstrate commitment to action by publicly posting the action plan; and

5. Commit to measuring activities, reviewing action plan outcomes and reporting on them publicly.3

Over 900 Canadian communities are currently working to become age-friendly. A number of jurisdictions and non-governmental organizations have reported that they lacked the capacity and tools to complete the fifth milestone, which is to conduct effective evaluations. In 2009, PHAC convened a meeting with key stakeholders and researchers in age-friendly communities to discuss evaluation of the AFC initiative as a whole. During this meeting, the need for indicators and data to assist community stakeholders was also identified.

In 2011, in response to mounting interest from provinces, municipalities, non-governmental organizations and Canadian researchers, PHAC undertook a rigorous process to develop a set of AFC indicators. These indicators form a menu that communities can choose from according to their unique local issues and capacities.

In this article, we describe the process undertaken by PHAC, the rationale and principles underlying the AFC indicators project and the progress to date in establishing AFC indicators.

**Methods and results**

**Indicator identification and prioritization process**

The process PHAC used to develop this set of indicators was adapted from previous, accepted methods that have been used to develop other indicator frameworks in public health.4,5,6 Generally, the development of indicators includes establishing the purpose of the indicators; designing the conceptual framework that can be based on theory, policy and/or data;4 and selecting or creating the indicators.5

The purpose of this indicator development process was to identify a menu of indicators that communities undertaking age-friendly initiatives could choose from in order to support their evaluation and monitoring activities. The overarching conceptual framework was the WHO’s Age-Friendly Cities framework, which identifies eight domains on which communities can focus to support the healthy aging of their residents.1

An Age-Friendly Indicators Working Group was established to provide input into the development of the AFC Indicators project. This Working Group, which met regularly throughout the project, comprised officials from PHAC; representatives of provincial, territorial and municipal governments; researchers; members of non-governmental organizations and seniors.

**Literature review and environmental scan**

The first step was to identify potential indicators through a literature review. We searched the following databases for peer-reviewed literature published between 1990 and 2012: Web of Science, AgeLine, Cochrane Injuries Group trials register, CINAHL Database, MEDLINE, Health Source and Social Sciences Citation Index. Only English and French publications related to adults aged 65 years and older were retained. The search included the following terms and their combinations: seniors, elderly, older persons, evaluation, age-friendly cities/communities/hospitals/businesses, senior-friendly communities, elder-friendly communities, visitable housing, built environment, housing, housing modification, building codes, stairs, sidewalks, transportation, social environment/inclusion, respect, employment, volunteering, outcomes, improvement, indicators of success, falls, accidents, motor vehicle accidents, road traffic accidents, communication, community support and health services.

First, we screened titles for relevance. Articles that were clearly out of scope, for example, articles about clinical care for a specific disease, were rejected at this stage. We then reviewed the abstracts for the remaining articles and included those that reported on or implied information about indicators or measures to do with age-friendly communities. Most of these articles focussed on process evaluations or short-term outcomes of the work undertaken by communities. We found no reports of completed long-term outcome evaluations of any age-friendly initiatives. From an initial list of over 2000 documents, 23 articles were identified as relevant.

We also conducted a scan of existing AFC evaluation activities in Canada and abroad. We emailed key stakeholders in provinces, territories and selected municipalities about their activities and asked respondents to provide copies of any evaluation tools. The keywords “age-friendly” and “evaluation” were used to identify programs abroad and other relevant grey literature via the Google search engine. We retained documents from this search if they included information about existing age-friendly initiatives and/or community-based evaluations as well as information to do with indicators or measures; we found five community reports through this Internet search.7-10 A review of our files together with the online search resulted in 20 additional documents based on our criteria.

Overall, 43 documents and articles were selected for review: 12 from the United States,11-13 three multi-country international,1,14,24-26 two from France,19,20 two from Australia,28-30 two from the Netherlands,30,31 and one from the United Kingdom.32 Twenty-one documents originated in Canada: five documents were from British Columbia,33-35 five from Quebec,2,7,28-30 four from Ontario,3,10,42-44 one from Manitoba,4 five from Saskatchewan4 and five were national in scope.44-46

Two qualitative researchers reviewed the articles and reports, and made detailed notes on potential indicators of age-friendliness based on article contents, within each of the eight WHO-identified domains.1 This theory-driven, or deductive, approach to collecting qualitative data generated an initial list of 241 potential indicators. The two qualitative researchers worked together to develop sub-themes within each domain by grouping similar indicators together and identifying codes (or labels) that captured the common underlying concepts (see Table 1). This is an example of inductive, or data-driven, coding.49 The research team (made up of four members with expertise in qualitative or quantitative methods as well as content expertise in georontology and AFC) reviewed the list of potential indicators for duplication, relevance and clarity. Based on consensus, they grouped some similar concepts into a single...
TABLE 1
Potential indicators for evaluating age-friendly communities in Canada and sub-themes

<table>
<thead>
<tr>
<th>Domain</th>
<th>Initial sub-themes</th>
<th>Initial number of potential indicators</th>
<th>Final number of indicators$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor spaces and buildings</td>
<td>Walkability&lt;br&gt;Actual and perceived accessibility&lt;br&gt;Injuries&lt;br&gt;Crime prevention</td>
<td>53</td>
<td>7 (4 with high agreement and frequent use in the literature; 3 with moderate agreement and frequent use)</td>
</tr>
<tr>
<td>Transportation</td>
<td>Transportation options and public transit&lt;br&gt;Age-friendly streets and parking</td>
<td>28</td>
<td>6 (1 with high agreement and frequent use; 5 with moderate agreement and frequent use; 1 with low agreement but frequent use and concordance with WHO indicators. 2 of these indicators were subsequently incorporated into 1)</td>
</tr>
<tr>
<td>Housing</td>
<td>Housing availability&lt;br&gt;Housing programs and resources&lt;br&gt;Ability to age in place&lt;br&gt;Housing support awareness</td>
<td>46</td>
<td>6 (2 with high agreement and frequent use; 3 with moderate agreement and frequent use; 1 with low agreement but considered to be a measure of impact)</td>
</tr>
<tr>
<td>Social participation</td>
<td>Engagement in social activities&lt;br&gt;Opportunities for participation&lt;br&gt;Accessibility of participation&lt;br&gt;Opportunities</td>
<td>24</td>
<td>6 (4 with high agreement and frequent use; 2 with moderate agreement and frequent use)</td>
</tr>
<tr>
<td>Respect and social inclusion</td>
<td>Availability of intergenerational activities&lt;br&gt;Sense of belonging</td>
<td>13</td>
<td>2 (both with high agreement)</td>
</tr>
<tr>
<td>Civic participation, volunteering and employment</td>
<td>Unemployment and employment&lt;br&gt;Training and support&lt;br&gt;Accessibility</td>
<td>22</td>
<td>4 (3 with high agreement and frequent use; 1 with moderate agreement but frequent use)</td>
</tr>
<tr>
<td>Communication and information</td>
<td>Assistance availability&lt;br&gt;Usability of information materials</td>
<td>21</td>
<td>3 (1 with high agreement and frequent use; 2 with moderate agreement and frequent use)</td>
</tr>
<tr>
<td>Community support and health services</td>
<td>Primary care physician&lt;br&gt;Supportive health services&lt;br&gt;Community services</td>
<td>30</td>
<td>5 (4 with high agreement and frequent use; 1 with moderate agreement and frequent use)</td>
</tr>
<tr>
<td>Health and social outcomes for seniors</td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>241</td>
<td>43</td>
</tr>
</tbody>
</table>

Abbreviation: WHO, World Health Organization.

Note: The first eight age-friendly domains listed are those identified by the World Health Organization. $^a$ “Health and social outcomes” was added by the research team to represent the longer-term outcomes of an age-friendly community.

$^a$High agreement was assigned to indicators that scored 89.5% or higher for both criteria. Moderate agreement reflected indicators that were scored at least 79.5% for both criteria but less than 89.5% for at least one. Low agreement was assigned to indicators that scored lower than 79.5% for at least one of the two criteria. These cut-offs created categories that approximated tertiles, giving equal weight to actionability and feasibility.

We also developed a list of potential criteria based on reviewed literature and shared this with the Age-Friendly Indicators Working Group. The list of criteria included the following: evidence-based, reflecting burden, representative, available, amenable to change, understandable, repeatable, important, sound, viable, direct, objective, useful, attributable, practical and adequate. The research team identified important/relevant, actionable and feasible as the most important criteria for selecting indicators, and confirmed this with the Working Group.

Indicator prioritization through stakeholder engagement and consultation

The second phase of the indicator selection process included two targeted stakeholder consultations aimed at reducing the list of potential indicators. These
consultations were conducted using an online survey platform developed using FluidSurvey.

**Consultation #1:** The first consultation targeted 789 known stakeholders, including provincial and territorial representatives, municipal representatives, members of non-governmental organizations, researchers and project staff or volunteers on age-friendly projects. We identified stakeholders through existing contact lists, by the Age-Friendly Reference Group and the Age-Friendly Indicators Working Group. Respondents rated the 194 potential indicators according to their importance for measuring the age-friendliness of communities on a scale of 1 to 4, where 1 was “unimportant,” 2 “of little importance,” 3 “important,” and 4 “very important.”

A total of 191 people responded to the first consultation survey (24% response rate). All provinces were represented, except for New Brunswick, although there were few respondents from Prince Edward Island and Saskatchewan. There were no respondents from the Territories. All of the intended stakeholder groups were represented. The majority of the respondents were female (70%), replied in English (61%) and were less than 55 years old (59%). Stakeholders lived in various sizes of community: 65% lived in centres of between 1000 and 29 999 inhabitants; 9% in centres of between 30 000 and 99 999 inhabitants; and 23% in centres of 100 000 inhabitants or more.

Table 2 shows the characteristics of respondents for the first and second consultations.

The average importance rating for each indicator (on a scale of 1 to 4) ranged from a low of 2.58 to a high of 3.69. Of the top five rated indicators, three were related to enhanced health and community services and included the following:

1. Existence of programs for caregiver support (3.69 on a scale of 1 to 4) (Supportive health services)
2. Availability of low-cost food programs (3.67) (Community services)
3. Level of unmet home-care need (3.66) (Community services)
4. Existence of regulations and standards for nursing home (3.64) (Community services)
5. Number of affordable options for transportation (3.64) (Transportation options and public transit)

Based on rankings by mean importance score, the top 50% of indicators in each sub-domain were retained for further analysis. The data were also stratified by community size to examine them separately for small/medium and large communities. In the few instances where the top 50% of indicators by mean importance score were not the same in both small/medium and large communities, we added indicators to ensure inclusion of the top 50% for both of these groups. This process reduced the number of indicators to 129. A number of indicators with similar concepts were subsequently combined, reducing the list to 109.

Of the 191 respondents to the first consultation survey, 93 indicated that they would be interested in participating in a subsequent consultation survey.

**Consultation #2:** The aim of the second consultation survey was to further streamline the list of 109 potential indicators according to the criteria of “actionability” and “feasibility” as defined below.

For an indicator to be actionable, it can be influenced by the local or regional community, government or private sector and is likely to show change in response to action. This criterion was also used at the Age-Friendly Indicator Development Group Global Age-friendly Cities meeting58 and by the Canadian Injury Indicators Development Team.59 It is also similar to Daniel’s60 idea of changeability.

For an indicator to be feasible, data for it is measured (e.g. from a survey or administrative data) or described (e.g. with a photo or story) in a realistic manner without obstacles to collection or use. Such data can also be used to add richness and bring a program’s results to life.53 In addition, data collection methods are easy and realistic.52

Because of the response fatigue observed in the first consultation survey, the second consultation survey response choices were simplified to “yes,” “no” and “don’t know or no opinion.” Two questions concerning the preferred data collection methods for evaluation and the design of a forthcoming PHAC-produced guide were also included in this consultation.

This second survey was sent via the online survey platform to the 93 respondents to the first survey who had indicated that they would participate in a subsequent round. Of these, 49 people responded (52% response rate). As shown in Table 2, 80% of respondents were female, and 92% responded in English. Most regions in Canada as well as a wide range of stakeholder groups were represented.

We calculated the proportion of respondents who considered a given indicator actionable or feasible. Three categories were created in order to group indicators based on actionability and feasibility. High agreement was assigned to indicators that scored 89.5% or higher for both criteria. Moderate agreement reflected indicators that scored at least 79.5% for both criteria but less than 89.5% for at least one. Low agreement was assigned to indicators that scored lower than 79.5% for at least one of the two criteria. These cut-offs created categories that approximated tertiles, giving equal weight to actionability and feasibility.

A total of 38 indicators achieved high agreement, 47 achieved moderate agreement and 24 achieved low agreement.

**Indicators**

Utilizing a combination of level of agreement, frequency of appearance of concept in peer-reviewed literature and grey literature, perceived concordance with the proposed WHO indicators, and whether the indicator was a measure of impact, we selected the final list of indicators (see Table 1).

All four long-term health and social outcomes indicators were retained due to their concordance with the framework proposed by WHO at the time. This resulted in a final list of 43 indicators, shown in Table 3 by domain and theme within each domain.

Respondents were also asked for suggestions on developing a tool or guide to evaluate their age-friendly initiatives. The following themes emerged from analyzing their input:
TABLE 2
Characteristics of respondents to consultation surveys 1 and 2 used in the process of selecting indicators for evaluating age-friendly communities in Canada

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Consultation 1 (n = 191)</th>
<th>Consultation 2 (n = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Male</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Age group, years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 55</td>
<td>59</td>
<td>37</td>
</tr>
<tr>
<td>55–64</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>65–74</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>≥ 75</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Language of survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>61</td>
<td>92</td>
</tr>
<tr>
<td>French</td>
<td>39</td>
<td>8</td>
</tr>
<tr>
<td><strong>Stakeholder group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior (≥ 55 years)</td>
<td>36</td>
<td>45</td>
</tr>
<tr>
<td>Family member or caregiver to a senior</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Service provider in health or social services</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Service provider in transportation, housing, or other community services</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Policy or decision maker</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>Educator or researcher</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Municipal employee</td>
<td>45</td>
<td>32</td>
</tr>
<tr>
<td>Elected official</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Member or chair of age-friendly community planning group</td>
<td>—</td>
<td>47</td>
</tr>
<tr>
<td>Member of other senior-related community group</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Level of experience with or knowledge of age-friendly initiatives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No experience or no knowledge</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Limited experience or knowledge</td>
<td>48</td>
<td>34</td>
</tr>
<tr>
<td>Extensive knowledge of and/or experience with age-friendly initiatives</td>
<td>49</td>
<td>62</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Province or territory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Quebec</td>
<td>39</td>
<td>13</td>
</tr>
<tr>
<td>Ontario</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Manitoba</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Alberta</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>British Columbia</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td><strong>Community size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small population centre, consisting of a population of between 1000 and 29 999</td>
<td>65</td>
<td>51</td>
</tr>
<tr>
<td>Medium population centre, consisting of a population of between 30 000 and 99 999</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Large population centre, consisting of a population of 100 000 and over</td>
<td>23</td>
<td>32</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**Note:** Percentages may not add up to 100 due to rounding.

* Respondents could belong to more than one stakeholder group.
## TABLE 3
List of indicators for age-friendly communities

<table>
<thead>
<tr>
<th>Domain</th>
<th>Theme</th>
<th>Indicator</th>
</tr>
</thead>
</table>
| 1 Outdoor spaces and public buildings | Walkability | 1. Number of rest places and distance between rest places.  
2. Number of accessible washrooms.  
3. Crosswalks are safe (e.g. with appropriate crossing times, mid-block crosswalks on long streets, median rest stops, good visibility).  
4. Sidewalks, trails and walkways exist and are in safe condition (e.g. have smooth surfaces, curb cuts, separate bike lanes, are wide, well lit, clear of ice and snow). |
| Actual and perceived accessibility | 5. Public buildings have adequate access to and manoeuvrability around buildings (e.g. access at ground level, level entry, wheelchair ramps, automatic doors, wide aisles to accommodate scooters and wheelchairs). |
| Injuries | 6. Number of falls and other injuries of seniors (occurring in public places). |
| Crime prevention | 7. Availability of crime prevention strategies, courses and programs for seniors (including focus on fraud and elder abuse). |
| 2 Transportation | Transportation options and public transit | 8. Availability of a range of affordable options for transportation (e.g. public/private partnerships, volunteer driving program, park and go, shuttles).  
9. Proportion (or number) of buses that are accessible, clean and with destination and number clearly displayed.  
10. Bus stops/shelters are safe and accessible (e.g. with seating, well lit, covered, snow removed, close to seniors’ residences).  
11. Proportion of people ≥ 65 years who have access to and use public transportation. |
| Age-friendly streets and parking | 12. Streets have clear and appropriate street signage and lane markers.  
13. Parking lots and spaces are kept clear of snow and ice. |
| Housing availability | 14. Availability of affordable housing that is appropriately located, well-built, well-designed, secure and for which waiting times are short.  
| Housing programs and resources | 16. Availability of programs for increasing accessibility, safety and adaptability of housing (e.g. hand rails, ramps, smoke detectors).  
17. Availability of a resource listing age-friendly home maintenance, support and care-giving services. |
| Ability to age in place | 18. Proportion of people ≥ 65 years who want to remain in their current residence and are confident they will be able to afford to do so. |
| Housing support awareness | 19. Awareness of rent subsidy or other programs (e.g. home loans) among seniors. |
| 4 Social participation | Engagement in social activities | 20. Proportion of people ≥ 65 years who engage in social activities at least once a week (e.g. meet with friends/neighbours; take part in civic, spiritual or cultural activities; volunteer or work). |
| Opportunities for participation | 21. Availability of recreation and learning programs specifically for seniors (e.g. computer courses, community gardens, crafts, games, exercise classes).  
22. Availability of intergenerational recreation and social programs.  
23. Availability of opportunities for social participation in leisure, social, cultural and spiritual activities with people of all ages.  
| Accessibility of participation opportunities | 25. Public venues for community-based activities are accessible (e.g. adapted washrooms, a ramp to enter the building, better lighting, temperature control). |
| 5 Respect and social inclusion | Availability of intergenerational activities | 26. Availability of intergenerational family activities.  
27. Level of sense of belonging in the community. |
| Sense of belonging |  |
| 6 Civic participation and employment | Unemployment and employment | 28. Level of unemployment and employment among seniors. |
| Training and support | 29. Availability of support for volunteers (e.g. training, transportation, reimbursement of expenses, method of appreciation).  
30. Availability of training opportunities related to the accommodation of seniors’ needs in the workplace. |
| Accessibility | 31. Municipal buildings/meetings are accessible. |
| 7 Communication and information | Assistance availability | 32. Availability of assistance to seniors for filling out forms.  
33. Availability of a live person option on telephone calls. |
| Usability of information materials | 34. Materials for the public are produced in large print, plain language and/or with age-friendly considerations. |

Continued on next page
During the second consultation survey, respondents were asked for ideas about the kinds of data collection methods that would be most practical for use in evaluating age-friendly initiatives. Fewer than 60% of the respondents rated the following as “very practical” or “practical”: face-to-face interviews (54%), telephone interviews (51%), stories (58%) and photographs or videotaping (56%). All the other methods (online questionnaire, paper and pencil questionnaire, observations and audits, information gathered for other purposes, administrative data, use of secondary data analysis) were rated as very practical or practical by at least 75% or more of the respondents. The most practical methods were thought to be focus groups (100%), paper-and-pencil questionnaires (91%) and use of administrative data (87%).

Results of both consultations were summarized, translated into French and shared with all participants.

Based on feedback from the consultation surveys and guidance from the Age-Friendly Communities Reference Group, a range of measures were identified as potential tools for communities wishing to implement age-friendly indicators in their evaluation activities. For each indicator, one or more of five potential approaches to measurement were identified: assessment tools, accessibility tools, existing data, program inventories and surveys. Qualitative and quantitative approaches were included. Tools and existing data were identified for communities wishing to evaluate their activities. Subsequently, a user-friendly guide, Using Indicators in Your Age-Friendly Community Initiative, (available from PHAC at http://www.phac-aspc.gc.ca/seniors-aines/indicators-indicateurs-eng.php) was developed to share the indicators, proposed measurement approaches and useful tools with communities.

**Discussion**

Note that the initial indicator lists were based on the literature on AFCs available when the review was conducted in 2012. At that time it was clear that the peer-reviewed and grey literature on AFCs had the following limitations: insufficient attention to specialized populations, such as ethnic groups, First Nations, and Lesbian, Gay, Bisexual, Transgender and Questioning (LGBTQ) populations; the heavy use of focus groups to seek community input (which may disadvantage those with mobility issues); a lack of consideration of specialized settings, such as nursing homes or hospitals; and finally, little emphasis on family cohesion and integration as key elements in community age-friendliness.

Since then, the literature on AFCs has grown considerably. As noted in the introduction, WHO initiated a process to identify core indicators for use by the Global Network of Age-Friendly Cities and Communities in 2011, shortly after PHAC initiated the project described in this article; WHO published a guide in 2015. There is considerable concordance between the indicators suggested by WHO and the menu proposed by PHAC, which is not surprising as both projects informed one another and were developed in parallel. Concepts in common include walkability; accessibility of public spaces and buildings, of public transportation and vehicles, and of public transportation stops; affordability of housing; engagement in volunteer activity, paid employment, and sociocultural activity; availability of information, health and social services; and quality of life. A recent realist review of the age-friendliness of cities in the European Healthy Cities Network clustered the eight WHO domains into three groups: physical environment, social environment and municipal services. Using a realist synthesis, the researchers mapped contexts; interventions; short-, mid- and long-term outcomes; and the goal of age-friendly programs. Again, the concepts identified based on existing programs using information from European cities is highly concordant with that developed through the present process, confirming our results and demonstrating transferability of our findings to other Western contexts.

### TABLE 3 (continued)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Theme</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Community support and health services</td>
<td>Primary care physician</td>
<td>35. Proportion of seniors who have a primary care physician.</td>
</tr>
<tr>
<td></td>
<td>Supportive health services</td>
<td>36. Availability of prevention programs to do with health issues that are highly relevant to seniors.</td>
</tr>
<tr>
<td></td>
<td>Community services</td>
<td>37. Availability of end-of-life support for seniors, their families and caregivers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>38. Availability of low-cost food programs (e.g. meals on wheels, wheels to meals, food bank).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39. Availability of assistance for activities of daily living (e.g. yard work, shopping, snow removal, garbage collection).</td>
</tr>
<tr>
<td>Health and social outcomes for seniors</td>
<td>Health-related quality of life</td>
<td>40. Level of health-related quality of life.</td>
</tr>
<tr>
<td></td>
<td>Satisfaction with life</td>
<td>41. Level of satisfaction with life in general.</td>
</tr>
<tr>
<td></td>
<td>Loneliness</td>
<td>42. Level of loneliness.</td>
</tr>
<tr>
<td></td>
<td>Satisfaction with social relationships</td>
<td>43. Level of satisfaction with social relationships.</td>
</tr>
</tbody>
</table>

**Note:** The 43 indicators described in Using Indicators in Your Age-Friendly Community Initiative are listed here. Communities may use this stand-alone list as a menu from which to pick and choose indicators that are most relevant to their age-friendly activities.
Strengths and limitations

The process we describe in this article was developed to yield a set of indicators, relevant to the Canadian context, that would be acceptable and helpful for communities undertaking age-friendly initiatives. Because of this, a number of methods were adopted to ensure that the process was sound and of high quality. The initial stage, reviewing the literature and identifying potential indicators, was based on qualitative methods. The credibility, transferability, dependability and confirmability of this initial step were central to the process.56

- The credibility of these analyses is supported by the qualitative expertise of the research team, the research team’s review of coding and the use of consensus to agree on grouping similar concepts into a single indicator.
- Transferability to countries similar to those described in the document review is likely. However, the identified indicators are not transferable to low- or middle-income or non-Western countries.
- Dependability is supported by describing our methods to identify indicator concepts using both deductive and inductive processes.
- Confirmability was supported through triangulation, by using multiple qualitative researchers during the document review process and by maintaining detailed notes during the process of identifying and reducing the initial lists of indicators.

Several factors limit the generalizability of the findings of the two consultation surveys. First, consultations were conducted with known stakeholders and may not be representative of a cross section of those with an interest in seniors and/or age-friendly work. For example, the general public was not consulted, and all stakeholders would have had some degree of familiarity with age-friendly initiatives. As a result, few respondents were aged over 75 years, and few identified themselves as belonging to a visible minority group. The most vulnerable and marginalized members of society, including those who were homeless, living at low income, living with dementia, living in institutions or without Internet access are missing from our sample.

Second, the response rates for each survey were fairly low and as a result, the final number of respondents was limited. Third, a pattern of response fatigue was identified because the proportion of missing data increased towards the end of both surveys, and a few participants commented that the surveys were excessively time consuming. Responses were visually screened for response sets (i.e. respondents entering the same response for all questions); no patterns of response set were identified.

The fact that the definitions for both criteria (actionable and feasible) included more than one concept may have confused some of those completing the second survey and caused uncertainty in interpreting the results. If a respondent answered “very actionable” to an indicator, it was not clear whether this was because they felt the appropriate level of government was involved or because the indicator was responsive to a change of policy or a new program or activity. Similarly, if an indicator was rated as “very feasible,” did the respondent mean that the data were both qualitative and quantitative or that data could be collected with ease? Future consultations should separate criteria so that only one issue is evaluated per question.

Conclusion

The number of communities engaging in age-friendly projects is increasing across Canada and many are ready to conduct evaluations of their activities. There is a strong interest in identifying shared ways to measure progress towards becoming age-friendly, the fifth pan-Canadian AFC milestone. In this article, we reported on PHAC’s process to identify and select potential AFC indicators. From an initial list of 241 indicators, we created a list of 43 indicators based on actionability and feasibility.

Acknowledgements

We would like to acknowledge the contributions of Danielle Maltais and Dawn Nickel to this project.

References


41. Rochman J, Tremblay DG. Le soutien à la participation sociale des aînés et le programme « ville amie des aînés » au Québec. Note de recherche de l’Alliance de recherche université-communauté sur la gestion des âges et des temps sociaux, Télés-Université/Université de Québec à Montréal. Montréal (QC): University of Québec; 2010.


Estimating chronic disease rates in Canada: which population-wide denominator to use?

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This article has been peer reviewed.

Abstract

Introduction: Chronic disease rates are produced from the Public Health Agency of Canada’s Canadian Chronic Disease Surveillance System (CCDSS) using administrative health data from provincial/territorial health ministries. Denominators for these rates are based on estimates of populations derived from health insurance files. However, these data may not be accessible to all researchers. Another source for population size estimates is the Statistics Canada census. The purpose of our study was to calculate the major differences between the CCDSS and Statistics Canada’s population denominators and to identify the sources or reasons for the potential differences between these data sources.

Methods: We compared the 2009 denominators from the CCDSS and Statistics Canada. The CCDSS denominator was adjusted for the growth components (births, deaths, emigration and immigration) from Statistics Canada’s census data.

Results: The unadjusted CCDSS denominator was 34,429,804, 3.2% higher than Statistics Canada’s estimate of population in 2009. After the CCDSS denominator was adjusted for the growth components, the difference between the two estimates was reduced to 431,323 people, a difference of 1.3%. The CCDSS overestimates the population relative to Statistics Canada overall. The largest difference between the two estimates was from the migrant growth component, while the smallest was from the emigrant component.

Conclusion: By using data descriptions by data source, researchers can make decisions about which population to use in their calculations of disease frequency.

Keywords: Canadian Chronic Disease Surveillance System, denominator, census, population estimates Canada, disease surveillance, measures of disease frequency, administrative health data

Introduction

Many countries, including Canada, Australia, France and Italy, have administrative health databases that are established and/or supported by governments that provide universal medical care. Administrative health data refer to data routinely collected through the administration of health care services. These data can be used for health service planning, reporting performance evaluations, clinical decision making and answering research questions. Administrative data can also be used to conduct disease surveillance. Measures of disease frequency, such as prevalence, incidence and mortality rates, can be used to describe the burden of disease among a population. With this information, policy, public health and health economics professionals can make informed decisions. Therefore, it is important that researchers choose appropriate denominators to calculate these measures. Calculations of incidence, prevalence and mortality rates are composed of the numerator and denominator. Improper selection of the total population can lead to biased estimates of the rates of occurrence of disease and death. Estimates of populations are often the most appropriate estimate available of the number of people at risk for an outcome.

One source of denominator estimates is Statistics Canada. Statistics Canada conducts a census every five years and collects data from citizens (including permanent residents), non-permanent residents and their families living in Canada. Most of the population self-enumerates by completing census surveys by mail or electronically. The objective of the census is to provide information about the demographic and
social characteristics of the Canadian population. Estimates are then derived from the census and adjusted for under- and overcoverage.

Another source for denominator estimates is the Public Health Agency of Canada’s (PHAC) Canadian Chronic Disease Surveillance System (CCDSS). The CCDSS is a network of federal and provincial/territorial health insurance surveillance systems supported by PHAC. Denominator estimates are based on the number of people who hold valid health insurance at any given time during the fiscal year. The CCDSS is used to determine the number of Canadians living with chronic disease via interactions with the health care system, based on diagnostic and procedural codes; it adds to the breadth of information about disease burden in Canada. The system includes aggregate information for the following chronic diseases: diabetes, hypertension, ischemic heart disease, acute myocardial infarction, heart failure, mental illness, osteoporosis, asthma, chronic pulmonary disease, multiple sclerosis and parkinsonism.

This study is the first to compare the CCDSS denominator derived from national administrative health data with estimates of population from Statistics Canada. However, an Alberta Health and Wellness provincial-level study compared Alberta population counts, as covered under the Alberta Health Care Insurance Plan (AHCIP) Registry, and the 2006 census. The study showed that the 2006/07 AHCIP Registry was underestimated by 0.0988% (3249/3 287 101) compared to Statistics Canada’s estimate of population. However, as of June 2015, the AHCIP estimate was higher than those from Statistics Canada. PHAC conducted a similar analysis in 2012, comparing the CCDSS denominator (fiscal year 2006/2007) and Statistics Canada’s estimate of population (census year 2006), and found an overestimate for the CCDSS denominator of about 3.9% (955 358/24 258 902). However, this difference was difficult to interpret as data for Quebec and Newfoundland and Labrador were excluded for data quality reasons; Statistics Canada estimates were used instead. For Quebec, the data for Canadians without the disease were not available at the Institute National de Santé Publique du Québec (INSPO), and for Newfoundland and Labrador the health insurance cards prior to 2008 did not have an expiration date, resulting in duplicate records in the medical care plan database.

The purpose of our study was to calculate the major differences between the CCDSS and Statistics Canada’s estimate of population and to identify the sources or reasons for the potential differences between the CCDSS and Statistics Canada population denominators. Our objective was to inform researcher and analyst decisions about which estimate of population or denominator to use in disease frequency calculations.

Methods

Data sources

The CCDSS uses provincial/territorial administrative databases to track chronic diseases among Canadians. The CCDSS was developed by linking three administrative databases with individuals’ unique lifetime identifiers. The three databases include the (1) health insurance registry file; (2) fee-for-service and some shadow-billed physician services file; and (3) hospital files that capture hospital-based acute care interactions through diagnostic and procedural codes. These health data bases were records of health care interactions for residents who are eligible to receive provincial/territorial health care. The health insurance file contains demographic information, including a unique lifetime identifier, linking the three databases together.

This health insurance registry also included a record for anyone who was alive and eligible to receive health care at any point in the fiscal year. Therefore, people who have died are captured in the year of their death. The federal government funds programs to provide subgroups of the population (First Nations and Inuit people, refugee protection claimants, eligible veterans, federal penitentiary inmates and serving members of the Canadian forces and the RCMP (Royal Canadian Mounted Police) with health services and benefits that are not insured by provincial/territorial governments. These include coverage for dental and vision care, medical supplies and certain drugs. First Nations and Inuit people still hold provincial health insurance and were captured by the CCDSS through the health insurance registry file.

Generally, members of the Canadian forces, RCMP and inmates of federal prisons are not captured by the CCDSS (approximately 110 000 people per year). The CCDSS denominator counts were obtained from each province’s and territory’s data submissions to PHAC as of November 2015, up to the 2009/2010 fiscal year. Data from this fiscal year were used as they were the latest available at the time of analyses. The aggregate datasets were composed of residents with valid health care insurance at any point during the fiscal year and included residents who died within the same year, by disease and demographic variables, such as age and sex.

Statistics Canada’s estimates of population

Statistics Canada’s estimates of population are derived from census data. Although Statistics Canada aims to enumerate the Canadian population on census day by collecting data at a single point in time (a cross-sectional view of the population) the census misses and over-counts some fraction of the population (2.7% (868 657/32 500 000)). Some people may not be counted because they were away during the enumeration period or lived in a collective dwelling that provides care or assistance services, while others were counted more than once (e.g. students living away from home who were enumerated by themselves and their parents). This is described as under- and over-counting.

Statistics Canada conducts postcensal coverage studies using a representative sample of people to determine the number of people missed or counted more than once during enumeration. The results of these studies are combined with the census estimates to produce current estimates of population, using postcensal and intercensal estimates. Intercensal estimates are estimates of the population during the period between two censuses. These adjustments render near complete estimates of population coverage.

Study cohorts

We compared the CCDSS denominator from fiscal year 2009/10 with Statistics Canada’s estimate of population for 2009 by age group. The age-at-reference date for the CCDSS denominator was March 31 and July 1 for the Statistics Canada estimate of population. The CCDSS denominator was adjusted for the growth components (births, deaths, emigration
and immigration) using files from census data (Table 1).23 The CCDSS denominator data included interprovincial migration (i.e., residents who migrate between provinces and territories were counted more than once), whereas Statistics Canada’s estimates of population were already adjusted for interprovincial migration, net immigration and deaths.24

We ran analyses using SAS Enterprise Guide version 4.1 (SAS Institute Inc., Cary, NC, USA). To illustrate the differences between the CCDSS and Statistics Canada’s estimate of population, our analyses were conducted with and without the growth components for the CCDSS denominator. See Table 2 for a summary of the data definitions by source.

### Statistical methods

The overall percent difference between the CCDSS denominator and Statistics Canada’s estimate of population, for Canada and by province/territory, was calculated as

\[
\frac{\text{CCDSS denominator} - \text{Statistics Canada’s estimate of population}}{\text{Statistics Canada’s estimate of population}} \times 100.
\]

To examine the largest impact on the rates, among all age groups, using both data sources, we compared diabetes prevalence, incidence and mortality rates that were calculated using the CCDSS denominator and Statistics Canada’s estimate of population. We used the CCDSS data to count the number of all-cause deaths across the provinces/territories. We calculated rates for estimates of population from both data sources for the population denominator:

- Diabetes prevalence = \[
\frac{\text{Total number of individuals with a case date during the capture period or prevalent cases}}{\text{Total number of individuals with valid health insurance during the capture period}} \times 100
\]
- Diabetes incidence = \[
\frac{\text{Total number of incident cases}}{\text{Total number of individuals with valid health insurance during the capture period or prevalent cases}} \times \text{Statistics Canada’s estimate of population} \times 100
\]
- All-cause mortality = \[
\frac{\text{Total number of CCDSS deaths}}{\text{Total CCDSS population}} \times 100000 \quad \text{or} \quad \text{All-cause mortality} = \frac{\text{Total number of CCDSS deaths}}{\text{Statistics Canada’s estimate of population}} \times 100000
\]

These rates were calculated using SAS macros (pre-programmed codes), and the counts randomly rounded.25 Mortality data for Statistics Canada’s estimate of population were obtained from vital statistics files for 2009 (to match the CCDSS 2009/10 fiscal year).23 To assess the impact of mortality rates with both sources of denominators on the life expectancy calculation, we compared the CCDSS denominator life expectancy by sex and age group for each disease tracked by the CCDSS to Statistics Canada’s estimate of population life expectancy. We stratified the CCDSS data by sex and 18 standard age groups (1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, ≥ 85) years. Next we created a life table for the number of people who had a diagnostic code for a disease and the number of people who did not. The Gompertz function was used to provide an accurate estimate of life expectancy for the last open-ended age interval (≥ 85), to close the life table.24–26

Since disease status was not available for infants younger than one year, the 2004 to 2006 sex-specific death rates for the Canadian population, from Statistics

### Table 1

<table>
<thead>
<tr>
<th>Growth component</th>
<th>Adjustment</th>
<th>Magnitude of the adjusted result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Births</td>
<td>379 373/3</td>
<td>126 457</td>
</tr>
<tr>
<td>Deaths</td>
<td>237 138/3</td>
<td>79 046</td>
</tr>
<tr>
<td>Immigrants</td>
<td>270 581/3</td>
<td>90 193</td>
</tr>
<tr>
<td>Emigrants</td>
<td>52 335/3</td>
<td>17 445</td>
</tr>
<tr>
<td>Net non-permanent residents</td>
<td>34 531</td>
<td>34 531</td>
</tr>
<tr>
<td>Migrants</td>
<td>Out: (259 234 × 1.5) –</td>
<td>302 440</td>
</tr>
<tr>
<td></td>
<td>In: (259 234)/3</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviation:** CCDSS, Canadian Chronic Disease Surveillance System.

**Notes:** CCDSS adjusted denominator (n = 33 779 692) = CCDSS count (n = 34 429 804) minus births (n = 126 457) minus deaths (n = 79 046) minus immigrants (n = 90 193) minus emigrants (n = 17 445) minus net non-permanent residents (n = 34 531) minus in-and-out-migrants (n = 302 440).

After CCDSS adjustment, the difference between the two denominators is 431 296 (1.3%).

### Table 2

<table>
<thead>
<tr>
<th>Data sources</th>
<th>PHAC’s CCDSS denominator</th>
<th>Statistics Canada’s estimates of population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate type</td>
<td>Period estimate (Canadians with valid health insurance during the fiscal year)</td>
<td>Point in time estimate (estimate of the number of Canadians from the Census)</td>
</tr>
<tr>
<td>Inclusions</td>
<td>1) Deaths that occur during the fiscal year 2) Canadians who migrate in Canada during the fiscal year (double-counting)</td>
<td>1) A representative sample of Canadians 2) Adjustments for growth components (births, deaths, emigration, and immigration) and those missed (away during enumeration) or double-counted (students away from home)</td>
</tr>
<tr>
<td>Exclusions</td>
<td>Canadians covered under federal insurance</td>
<td>Canadians who are away during enumeration or lived in a collective dwelling, but adjusted for</td>
</tr>
<tr>
<td>Use/role</td>
<td>Is a companion for the CCDSS numerator (Canadians exposed to the health event are included in the denominator)</td>
<td>Is a companion for a numerator consisting of Canadians who were exposed to a health event</td>
</tr>
</tbody>
</table>

**Abbreviations:** CCDSS, Canadian Chronic Disease Surveillance System; PHAC, Public Health Agency of Canada.
Canada, were used to model the mortality experience of infants with and without the disease. The 0- to 1-year sex-specific death rates, used to construct the life table, represented infants without the disease. Infant death rates for the disease were unavailable. Because the 0 to 1 age group experienced a high rate of mortality, we assumed that the number of infants with and without the disease would be about the same.

Results

Our findings show that CCDSS and Statistics Canada estimates of population differ. Specifically, the CCDSS overestimates the population relative to Statistics Canada overall.

The largest difference between the two estimates was contributed by the migrant growth component (302,440), while the smallest was from the emigrant component (17,445) (Table 1). When deaths were included in the CCDSS denominator, we observed 1,081,408 more people in the CCDSS denominator (34,429,804) compared to Statistics Canada’s estimate of population (33,348,396), a +3.2% (1,081,408/33,348,396) difference (Table 3). After the CCDSS denominator was adjusted for the growth components, we observed 431,296 more people in the CCDSS denominator (33,779,692) compared to Statistics Canada’s estimate of population (33,348,396), a +1.3% (431,296/33,348,396) difference (Table 1). The largest difference between the two was observed among the 85-and-older age group (+20.5%; 126,453/617,160) and the smallest among the 20 to 24 age group (−0.8%; 17,757/2,322,497) (Table 3).

By province/territory, the largest difference between the two was observed for Northwest Territories (+13.0%; 5600/42,965), whereas the smallest was for Quebec (+0.5%; 37,595/77,373) (Table 4). A similar pattern was observed after excluding deaths from the CCDSS denominator. However, after adjustment for the growth components, the difference was reduced to 431,296 people (51.3%; 431,296/833,483,96) (Table 1).

For all Canadians, the CCDSS denominator diabetes prevalence rate (7.2%; 2,489,520/34,429,804) was 4.00% (−0.3/7.5) lower than Statistics Canada’s estimate of population (34,429,804/33,348,396).

### Table 3

<table>
<thead>
<tr>
<th>Age groups in years</th>
<th>CCDSS denominator</th>
<th>Statistics Canada’s estimates of population</th>
<th>Percent difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–4</td>
<td>1,540,368</td>
<td>1,464,423</td>
<td>5.2</td>
</tr>
<tr>
<td>5–9</td>
<td>1,845,877</td>
<td>1,798,812</td>
<td>2.6</td>
</tr>
<tr>
<td>10–14</td>
<td>2,009,792</td>
<td>1,972,894</td>
<td>1.9</td>
</tr>
<tr>
<td>15–19</td>
<td>2,264,299</td>
<td>2,250,692</td>
<td>0.6</td>
</tr>
<tr>
<td>20–24</td>
<td>2,304,740</td>
<td>2,322,497</td>
<td>−0.8</td>
</tr>
<tr>
<td>25–29</td>
<td>2,358,661</td>
<td>2,348,492</td>
<td>0.4</td>
</tr>
<tr>
<td>30–34</td>
<td>2,310,455</td>
<td>2,258,092</td>
<td>2.3</td>
</tr>
<tr>
<td>35–39</td>
<td>2,377,282</td>
<td>2,297,458</td>
<td>3.5</td>
</tr>
<tr>
<td>40–44</td>
<td>2,512,797</td>
<td>2,480,011</td>
<td>1.3</td>
</tr>
<tr>
<td>45–49</td>
<td>2,858,523</td>
<td>2,787,129</td>
<td>2.6</td>
</tr>
<tr>
<td>50–54</td>
<td>2,686,876</td>
<td>2,573,413</td>
<td>4.4</td>
</tr>
<tr>
<td>55–59</td>
<td>2,322,492</td>
<td>2,215,710</td>
<td>4.8</td>
</tr>
<tr>
<td>60–64</td>
<td>1,999,094</td>
<td>1,888,212</td>
<td>5.9</td>
</tr>
<tr>
<td>65–69</td>
<td>1,480,822</td>
<td>1,406,971</td>
<td>5.2</td>
</tr>
<tr>
<td>70–74</td>
<td>1,137,703</td>
<td>1,080,535</td>
<td>5.3</td>
</tr>
<tr>
<td>75–79</td>
<td>947,527</td>
<td>909,136</td>
<td>4.2</td>
</tr>
<tr>
<td>80–84</td>
<td>728,883</td>
<td>676,759</td>
<td>7.7</td>
</tr>
<tr>
<td>≥ 85</td>
<td>743,613</td>
<td>617,160</td>
<td>20.5</td>
</tr>
<tr>
<td>All ages</td>
<td>34,429,804</td>
<td>33,348,396</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* CCDSS denominator data were contributed by provinces and territories, as of November 2015 (v2014).
* Statistics Canada’s estimates of population were postcensal (2006 Census).

### Table 4

<table>
<thead>
<tr>
<th>Province/Territory</th>
<th>CCDSS denominator</th>
<th>Statistics Canada’s estimates of population</th>
<th>Percent difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newfoundland and Labrador</td>
<td>537,862</td>
<td>504,141</td>
<td>6.7</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>148,911</td>
<td>139,593</td>
<td>6.7</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>989,707</td>
<td>931,622</td>
<td>6.2</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>755,910</td>
<td>742,506</td>
<td>1.8</td>
</tr>
<tr>
<td>Quebec</td>
<td>7,774,930</td>
<td>7,737,335</td>
<td>0.5</td>
</tr>
<tr>
<td>Ontario</td>
<td>13,563,855</td>
<td>12,928,815</td>
<td>4.9</td>
</tr>
<tr>
<td>Manitoba</td>
<td>1,239,544</td>
<td>1,204,232</td>
<td>2.9</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>1,067,733</td>
<td>1,015,590</td>
<td>5.1</td>
</tr>
<tr>
<td>Alberta</td>
<td>3,711,026</td>
<td>3,621,681</td>
<td>2.5</td>
</tr>
<tr>
<td>British Columbia</td>
<td>4,524,374</td>
<td>4,415,160</td>
<td>2.5</td>
</tr>
<tr>
<td>Yukon</td>
<td>33,745</td>
<td>33,342</td>
<td>1.2</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>48,565</td>
<td>42,965</td>
<td>13.0</td>
</tr>
<tr>
<td>Nunavut</td>
<td>33,642</td>
<td>31,414</td>
<td>7.1</td>
</tr>
<tr>
<td>Canada</td>
<td>34,429,804</td>
<td>33,348,396</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* CCDSS denominator data were contributed by provinces and territories, as of November 2015 (v2014).
* Statistics Canada’s estimates of population were postcensal (2006 Census).
population rate (7.5%; 2 489 520/33 348 396) and 3.03% (−0.2/6.6) lower for incidence rates with the CCDSS denominator (6.4 per 1000; 218 240/34 211 564) and Statistics Canada’s estimates of population (6.6 per 1000; 218 240/33 130 156). The CCDSS denominator total all-cause mortality rate (669.2 per 100 000; 230 408/34 299 804) was 3.1% (−21.7/690.9) lower than Statistics Canada’s estimate of population rate (690.9 per 100 000; 230 408/33 348 396; Table 5). The life expectancy at birth was 82.9 years for the CCDSS denominator and 81.2 years for Statistics Canada’s estimate of population.

Discussion

A difference between the CCDSS denominator and Statistics Canada’s estimate of population is that the latter provides a cross-sectional view of the population at a specific time period (period of enumeration), whereas the CCDSS denominators have been used to provide an estimate of the population exposed, or “at risk,” over an annual period. Although prevalence and incidence rates can be calculated for a single time point, it is more common to calculate these measures for a time period. Researchers should note that using different denominators may affect calculations of prevalence, incidence, mortality rates and life expectancy. For example, a military member who visits the hospital for diabetes will not be captured by the CCDSS, because military members are a subgroup of the population who are federally insured. Therefore, the most appropriate denominator to use for calculating a measure of disease frequency would be Statistics Canada’s estimates. However, the CCDSS denominator is the most appropriate denominator for estimating measures of disease frequency, when using administrative data (i.e. numerator is derived from CCDSS data).

In addition, a researcher may wish to calculate the prevalence of diabetes in 2006 among Canadians. The researcher could obtain the number of diabetes cases that occurred in 2006 from the CCDSS and may decide to use Statistics Canada’s estimates for the denominator (representing the total Canadian population for 2006). However, the risk of outcome for the numerator may not match the Statistics Canada estimates (may not represent this population). Or perhaps an individual with diabetes died before the 2006 census enumeration date, but was registered as a case in the data source before their death. In this scenario, this individual would be accounted for by the numerator, but not in the denominator, thereby resulting in an inaccurate estimate of the prevalence of diabetes in Canada during 2006.

In order to quantify the gaps in missing data in both the CCDSS and Statistics Canada’s estimate of population, further research must be conducted on data quality of the health insurance registries and work to quantify subgroups of the population (i.e. emigrants) that are unaccounted for by either data source.

The CCDSS captures nearly the entire Canadian population through the health insurance registry. We recognize that people who move to a new province or territory during a fiscal year (interprovincial migration) and receive valid health insurance are counted twice in the CCDSS denominator, for a limited period of time.

The difference between the adjusted CCDSS denominator and Statistics Canada’s estimate (431 296 people) may be attributed to the discrepancies of the valid and eligible health numbers defined in the health insurance registries, possibly due to fraud. In addition, the health insurance registries can include inaccurate information about deaths, due to the time and resources required to process this information. Statistics Canada has found it challenging to count Canadians who emigrate for work and who are homeless, but the number of these emigrants is estimated to be small. Both the health insurance registries and Statistics Canada staff continue to monitor the data, looking for these issues and finding explanations and mitigation strategies for them. Small differences by age (in the younger age groups) can also be attributed to the different age-at-reference dates between the two data sources. The underestimate found by the Alberta ministry could be attributed to the different methods used by AHCIP (2006 census data was compared) and Statistics Canada Demography Division (conducting the provincial-specific CCDSS denominator adjustment).

Conclusion

Our results illustrate the importance of making an informed choice when selecting estimates of population for research, as the selection can have an effect on the calculation of rates. We found that even after adjusting the CCDSS denominator for deaths and interprovincial migration, the CCDSS denominator was greater than the Statistics Canada estimate.

These findings allow researchers to compare the major reasons for the differences between the CCDSS denominator and Statistics Canada’s estimate of population in order to select the most appropriate denominator for their projects and measuring disease frequency.

It is our opinion that the CCDSS denominator best represents the population at risk for events identified using health administrative data. The CCDSS denominator should be used to measure disease

**TABLE 5**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>CCDSS denominator*</th>
<th>Statistics Canada’s estimates of population†</th>
<th>Percent difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>7.2</td>
<td>7.5</td>
<td>−4.0</td>
</tr>
<tr>
<td>Incidence</td>
<td>6.4 per 1000</td>
<td>6.6 per 1000</td>
<td>−3.0</td>
</tr>
<tr>
<td>Mortality</td>
<td>669.2 per 100 000</td>
<td>690.9 per 100 000</td>
<td>−3.1</td>
</tr>
</tbody>
</table>

Notes: This study was made possible through collaboration between PHAC and the respective provincial governments of Alberta, British Columbia, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, and territorial governments of Yukon, Northwest Territories, and Nunavut. The opinions, results and conclusions reported in this paper are those of the authors. No endorsement by British Columbia, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Yukon, Northwest Territories, Nunavut is intended or should be inferred.

* CCDSS counts were randomly rounded.

† CCDSS denominator data were contributed by provinces and territories, as of November 2015 (v2014).

‡ Statistics Canada’s estimates of population were postcensal (2006 Census).
frequency, as it comprises those with valid health insurance over a period. When Statistics Canada’s estimates of population were used as the denominator, the exposed population was underestimated, as the census was taken at a point in time; however, people who were deceased or away at that time were included in the period prevalence numerator. Although the magnitude of the differences in diabetes rates between the two sources was small, these findings could have a slight implication on the interpretation and conclusions drawn from previous studies that have estimated prevalence, incidence and mortality using Statistics Canada’s estimates of population as population denominator estimates.

Acknowledgements

We wish to thank the members of the CCDSS Scientific and Technical Committee. This study was made possible through the collaboration of PHAC and the provincial governments of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador and the territorial governments of Yukon, Northwest Territories and Nunavut. The opinions, results and conclusions drawn from previous studies that have estimated prevalence, incidence and mortality using Statistics Canada’s estimates of population as population denominator estimates.

References


35. Hwang SW. Homelessness and health. CMAJ. 2001;164(2);229-33.
Prevalence and monetary costs of dementia in Canada (2016)\(^1\): a report by the Alzheimer Society of Canada

Alzheimer Society of Canada

**Background**

Dementia prevalence estimates vary among population-based studies, depending on the definitions of dementia, methodologies and data sources and types of costs they use. A common approach is needed to avoid confusion and increase public and stakeholder confidence in the estimates.

Since 1994, five major studies have yielded widely differing estimates of dementia prevalence and monetary costs of dementia in Canada:

- Canadian Study of Health and Aging, 1994\(^2\)
- Alzheimer Society of Canada. Rising Tide: The Impact of Dementia on Canadian Society, 2010\(^1\)
- Mental Health Commission of Canada: Making the Case for Investing in Mental Health in Canada, 2011\(^4\)
- Economic Burden of Illness in Canada, 2014\(^5\)
- National Population Health Study of Neurological Conditions, 2014\(^6\)

These studies variously estimated the prevalence of dementia for the year 2011 as low as 340 170 and as high as 747 000. The main reason for this difference was that mild cognitive impairment (MCI) was not consistently included in the projections. The estimated monetary costs of dementia for the same year also varied, from $910 million to $33 billion. This discrepancy is largely due to three factors: (1) the lack of agreed-upon methods for estimating financial costs; (2) the unavailability of prevalence estimates for the various stages of dementia (mild, moderate and severe), which directly affect the amount of money spent; and (3) the absence of tools to measure direct, indirect and intangible costs more accurately.

Given the increasing challenges of dementia in Canada and around the globe, reconciling these differences is critical for developing standards to generate reliable information for public consumption and to shape public policy and service development.

**Methods**

In May 2015, following a review of these and other studies, the Alzheimer Society of Canada convened a panel of Canadian and international epidemiologists, health economists and policy analysts, as well as representatives from provincial Alzheimer Societies. Our goal was to provide advice on how best to estimate current and future prevalence and monetary costs of dementia in Canada. *Prevalence and Monetary Costs of Dementia in Canada (2016)*\(^1\) is the result of this collaborative work.

**Panel findings**

**Prevalence estimates**

There was consensus among panel members that the Canadian Study of Health and Aging (1994)\(^2\) remains the best and most reliable population data source to use for building present and future prevalence estimates.

The authors of this study derived the data from questionnaires and interviews conducted with 9008 individuals aged 65 years and older who were living in the community, and 1255 individuals living in long-term care homes. For the individuals who were interviewed, researchers then carried out clinical, neurological and neuropsychological examinations of 2914 people who had low cognitive scores, and a random sample of those with normal scores.

A team made up of a physician, a nurse and a neuropsychologist then assessed whether these individuals should be classified as having probable or definite dementia, and further determined the type of dementia. This method is consistent with the way diagnosis is currently achieved in a clinical setting, using multiple data sources and input from multiple health care professionals. Autopsies are seldom done, despite the fact that they are the most accurate means of diagnosing dementia.

Prevalence estimates drawn from health administrative data are not based on standardized clinical assessment as in the Canadian Study of Health and Aging or in autopsies.

Based on projections using the Canadian Study of Health and Aging (1994)\(^2\) data, as of 2016 there are an estimated 564 000 Canadians living with dementia. By 2031, this number is expected to rise to 937 000, an increase of 66%. Of the current number of Canadians with dementia, more than 65% are women.

**Monetary cost estimates**

When estimating the present and future costs of dementia, three key factors must be taken into account:

1. **perspective**, which focuses on who incurs the cost, e.g. the public health care system only or society as whole, including people with dementia, their caregivers and employers;
2. **scope**, which is concerned with what costs are included, e.g. direct and indirect, informal and intangible costs; and
3. **valuation**, which involves the method of attributing a cost to dementia that would not otherwise exist.
Because the financial impact of dementia goes well beyond the health care system and takes a tremendous toll not only on those living with dementia, but also their families, caregivers and employers, the Panel recommended taking a societal perspective in estimating the economic consequences of the condition. It also recommended that the scope should include direct, indirect, informal and intangible costs, and that these costs should be compared between populations living with dementia and those without the condition.

The Panel concluded that the National Population Health Study of Neurological Conditions (2014) met these requirements and provided the best foundation for projecting the monetary costs of dementia. According to this study, the combined Canadian health care system costs and out-of-pocket caregiver costs amounted to $10.4 billion in 2016. By 2031, this figure is expected to increase to $16.6 billion.

Generally, costs for people with dementia are estimated to be five-and-a-half times greater than for those who do not have the condition. Home care and long-term care are the largest contributors to direct costs. In 2011, family caregivers provided 19.2 million unpaid hours of care. This number is projected to double by 2031.

### Applicability

Accurate and reliable data on dementia are particularly important because Canada’s population is aging, and there is still no cure and pharmacological treatments are helpful only for limited times in the course of the condition for some patients. Evidence from economically developed countries shows that incidences of dementia may be declining because of higher levels of education, greater health awareness and in some cases better control of vascular risk factors.

Public health uses for these data include

- providing benchmarks against which future progress can be measured and evaluated; and
- informing service planning and policy development, such as a national dementia strategy, human resources policies across workplaces, government projections and budgets.

The Public Health Agency of Canada, in collaboration with provincial and territorial ministries of health, has developed the first national case definition that will be used to consistently report the epidemiology of Alzheimer’s disease and other dementias (prevalence, incidence and all-cause mortality) among Canadians aged 65 years and older. Data will be disaggregated by sex, age group, fiscal year and province or territory. Annual reporting of these data is expected to begin in 2017/18.

### Conclusion

Prevalence and Monetary Costs of Dementia in Canada (2016) provides useful and more reliable information about the prevalence of dementia and its economic impact on Canadian society. It serves to help Alzheimer Societies across Canada as well as other like-minded organizations to develop awareness campaigns and other public initiatives, create new programs and services and influence policy development and service planning now and in the future.

To read the full report online, visit http://www.alzheimer.ca/~/media/Files/national/Statistics/PrevalenceandCostsofDementia_EN.pdf

### References


Call for papers: The food environment in Canada

Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice

Special issue on: The Food Environment in Canada

Editors: Robert Geneau (Editor-in-Chief, Public Health Agency of Canada) and Lana Vanderlee (guest editor; Department of Nutritional Sciences, University of Toronto)

Diet is a fundamental component of health, and dietary habits are closely linked with the development of chronic disease and obesity. The food environment in which people make their food choices plays a major role in establishing eating habits and overall diet quality. Broadly defined as the physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence food choices and nutrition status, the food environment can promote or impede healthy diets.

The current food environment in Canada does not consistently support healthy food choices, which is reflected in the overall poor dietary habits of Canadians. Nationally and internationally, greater attention is being paid to how the food environment can be shifted towards one that is conducive to healthier food patterns.

Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice is seeking articles that examine the food environment in Canada. All article types are invited for submission. We are seeking research relating to all aspects of food environment, which may include, but are not limited to, food composition, labelling, promotion and marketing, provision and procurement, retail, prices and trade and investment. In particular, we are seeking articles that

- characterize the current Canadian food environment;
- examine the impact of food environment policies and interventions in the Canadian context; and
- synthesize evidence regarding the state of the food environment in Canada.

Kindly submit articles to Journal_HPCDP-Revue_PSPMC@phac-aspc.gc.ca by October 31, 2016. Submissions should mention this Call for Papers.

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We welcome submissions of manuscripts with practical, authoritative information on infectious diseases that will inform policy, program and practice.
