Mortality Projections for Social Security Programs in Canada

2017 Living to 100 Symposium, General Session IV

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Annie St-Jacques, Actuary, OCA, OSFI

January 5th, 2017
Presentation Outline

• Historical Trends in Canadian Mortality
• Recent Slowdown in MIR and Projections
• Canada and US Mortality Rates
• Can We Live Beyond 100?
• Sustainability of the Canada Pension Plan
Life Expectancy at Birth and at Age 65 (by calendar year)

Source: Canadian human Mortality Database, University of Montreal

Office of the Chief Actuary   Bureau de l’actuaire en chef
### Contribution to increase in life expectancy at birth has gradually shifted to people over age 65

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Infant mortality (&lt;1)</td>
<td>4.1</td>
<td>1.6</td>
<td>0.9</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Mortality (1-44)</td>
<td>3.3</td>
<td>0.8</td>
<td>1.0</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Older adult mortality (45-64)</td>
<td>0.0</td>
<td>0.4</td>
<td>1.6</td>
<td>1.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Elderly mortality (65+)</td>
<td>0.0</td>
<td>0.4</td>
<td>1.3</td>
<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total Change in Life Expectancy</strong></td>
<td>7.4</td>
<td>3.2</td>
<td>4.8</td>
<td>5.1</td>
<td>3.2</td>
</tr>
<tr>
<td>% attributable to 65+</td>
<td>0%</td>
<td>12%</td>
<td>28%</td>
<td>58%</td>
<td>69%</td>
</tr>
</tbody>
</table>

Source: Canadian Human Mortality Database, University of Montreal and Office of the Chief Actuary calculations
Projections: 27th CPP Actuarial Report

Office of the Chief Actuary    Bureau de l’actuaire en chef
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<td>4.1</td>
<td>3.0</td>
<td>2.3</td>
</tr>
<tr>
<td>% attributable to 65+</td>
<td>7%</td>
<td>38%</td>
<td>45%</td>
<td>65%</td>
<td>76%</td>
</tr>
</tbody>
</table>

**Source:** Canadian Human Mortality Database, University of Montreal and Office of the Chief Actuary calculations

**Projections:** 27th CPP Actuarial Report
Life expectancy is impacted by level of income and marital status

Difference of life expectancy at age 65 (2013)

Benchmark
M: 18.9
F: 21.8

Source: Office of the Chief Actuary, Actuarial Study No. 17: Old Age Security Program Mortality Experience, June 2016

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Improvements in mortality related to heart diseases have been significant over the last 15 years.

Source: Data from Statistics Canada, Canadian Vital Statistics and OCA Calculations Standardized Using 2011 Canadian Population
CPP-OAS Average Annual Mortality Improvement Rates (males)

Source: Office of the Chief Actuary calculations.

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The ultimate mortality improvement rates are sometimes based on historical averages

### Average Historical MIR (%) 1921-2011, Canada

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Male</th>
<th>Female</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-74</td>
<td>0.8</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>75-84</td>
<td>0.7</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>85-94</td>
<td>0.5</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>95-99</td>
<td>0.2</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>65+</td>
<td>0.7</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>85+</td>
<td>0.4</td>
<td>0.7</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Estimates of MIRs for ages 65+ for 2012-2014 incorporate OAS experience

CPP27 Assumed Annual Mortality Improvement Rates for Canada (65-74)

<table>
<thead>
<tr>
<th>Average MIR</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last 90 years</td>
<td>0.8%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Last 50 years</td>
<td>1.7%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Average MIR for MALES
- 2012-2014 Avg.: 2.9%
- 2015-2031 Avg.: 1.6%

Average MIR for FEMALES
- 2012-2014 Avg.: 1.9%
- 2015-2031 Avg.: 1.3%

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Males Mortality Improvement Rates
15-year Average

Females Mortality Improvement Rates
15-year Average

Significant Improvements in mothers’ health

For ages 65 to 74, 7 deaths per 1,000 are from cancer, while only 3 deaths per 1,000 are from heart diseases.
Male mortality rates for ages 75 to 84 for Canada are projected to become similar to US female mortality rates.

### Ages 75-84

<table>
<thead>
<tr>
<th>Top 5 Causes</th>
<th>Canada 2012</th>
<th>U.S. 2012</th>
<th>Ratio Can/US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoplasms</td>
<td>13.1</td>
<td>11.6</td>
<td>1.13</td>
</tr>
<tr>
<td>Diseases of the Heart</td>
<td>7.9</td>
<td>11.0</td>
<td>0.72</td>
</tr>
<tr>
<td>Cerebrovascular</td>
<td>2.5</td>
<td>2.7</td>
<td>0.93</td>
</tr>
<tr>
<td>Lower Respiratory</td>
<td>2.4</td>
<td>3.6</td>
<td>0.67</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.2</td>
<td>1.5</td>
<td>0.80</td>
</tr>
</tbody>
</table>

All rates are standardized using 2015 Canadian population.
Elderly mortality has decreased over the last 80 years, more so over the last 10 years

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x
All rates are standardized using 2015 Canadian population.
Three-quarters of Canadian men aged 20 today are expected to live to age 80 (82% of women)

Near half of Canadian men aged 20 today are expected to live to age 90 (58% of women)

8% of Canadian men aged 20 today are expected to live to age 100 (14% of women)

Uncertainty of Results

Life Expectancies at age 65 if MIRs by cause are sustained

Source for MIR by cause of death: Statistics Canada, Office of the Chief Actuary calculations

Source for projections: 27th CPP Actuarial Report

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Uncertainty of Results

Life Expectancies at age 65 if mortality from cancer is wiped out

Source for MIR by cause of death: Statistics Canada, Office of the Chief Actuary calculations
Source for projections: 27th CPP Actuarial Report

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Survival Curves for a Life Expectancy of 100 (Males)

\[ e_0 = 80 \quad \text{and} \quad e_0 = 100 \]

- **CHMD 2011**
- **Increased Life Span to 140**
- **Reduction of Qx at each age by 84%**

Probability of Survival from Age 0 to Attained Age

Age

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To live beyond 100…

- A calendar year life expectancy at birth of 100 in 2011 is achievable if:
  - $Q_x$ at each age are reduced by 84% for males (80% for females).
  - $Q_x$ below age 97 are zero, followed by current $Q_x$ from ages 97 to 120.
  - The maximum life span increases to 140 years for males (132 years for females) and mortality rates are changed accordingly.

✓ If $Q_x$ at each age decrease at the same pace as observed over the past 15 years, a calendar year life expectancy of 100 at birth would be attained after 2200.

✓ If $Q_x$ at each age decrease at twice the pace observed over the past 15 years, a calendar year life expectancy of 100 at birth would be attained in about a century.
So, what is the impact of living longer on the CPP?

<table>
<thead>
<tr>
<th>Cohort Life Expectancy at Age 65 in 2050</th>
<th>Minimum Contribution Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
<td>FEMALES</td>
</tr>
<tr>
<td>Best-Estimate</td>
<td>23.3</td>
</tr>
<tr>
<td>Low Cost Scenario</td>
<td>20.9</td>
</tr>
<tr>
<td>High Cost Scenario</td>
<td>25.8</td>
</tr>
</tbody>
</table>

*If no mortality improvements at all after 2011* 8.99%

Source: 27th CPP Actuarial Report as at 31 December 2015

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Conclusion

- It is projected that 69% of increase in life expectancy at birth for men (76% for women) will come from the reduction of mortality rates past age 65.

- Projected mortality rates are highly uncertain, especially for people older than age 90.

- Despite increased longevity of Canadian population, the CPP is expected to be sustainable over the long term based on the most recent Actuarial Report tabled before Parliament on Sept. 27, 2016.
Mortality Projections for Social Security Programs in Canada

2017 Living to 100 Symposium, General Session IV

Thank you

Questions?

January 5th, 2017
Mortality Projections for Social Security Programs in Canada

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Appendix

January 5th, 2017
Future drivers of mortality are not easy to quantify

“Easy” gains have been somewhat achieved:

– Previous improvement in heart disease mortality will be tough to duplicate

– Favorable effects of decreasing smoking prevalence should continue for awhile but will diminish in 20-30 years.

Other factors: obesity, income inequality, aging, marital status

Future drivers of mortality could be:

**FAVORABLE**

✅ Enhanced medical treatment
✅ Pharmaceuticals
✅ Technology Breakthroughs
✅ Self-driving cars

**UNFAVORABLE**

✅ Pandemics
✅ Increasing drug resistance
✅ Natural and man-made disasters (increasing with future climate change)

The number of people aged 90 and over increases dramatically

Increase from 2010 to 2050
90-99 → 534%  
100+ → 1,105%

Source for projections: 27th CPP Actuarial Report
Life expectancy is impacted by level of income

Difference of life expectancy at age 65 (2013)

Benchmark
M: 19.0
F: 22.0

Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015

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CPP-OAS Average Annual Mortality Improvement Rates (females)

Source: Office of the Chief Actuary calculations.
International Comparisons - Males

Projected period life expectancy at age 65 - males

Source: 18th International Conference of Social Security Actuaries and Statisticians presentations and reports. Data for Canada are produced by the Office of the Chief Actuary, based on CPP27th preliminary assumptions. Data for Japan are from National Institute of Population and Social Security Research (Sept. 2013).
International Comparisons - Females

Source: 18th International Conference of Social Security Actuaries and Statisticians presentations and reports. Data for Canada are produced by the Office of the Chief Actuary, based on CPP27th preliminary assumptions. Data for Japan are from National Institute of Population and Social Security Research (Sept. 2013).
After age 85, Canada along with Japan and France has the lowest mortality rates
Mortality Rates by Cause

Mortality rates by cause, 75-84, both sexes, 2011

- Canada
- Japan
- France
- Spain
- Australia
- United Kingdom
- Switzerland
- Sweden
- Italy

Source: World Health Organization
Probability of living to a certain age for men/women aged 25 today

Source: 27th CPP Actuarial Report
Probability of living to a certain age for men/women aged 50 today

Source: 27th CPP Actuarial Report
Marital Status has more Impact than Level of Income for Men

Life Expectancy at age 65 is HIGHER for Married with GIS than Single without GIS

Source: Office of the Chief Actuary, Actuarial Study No. 11: Old Age Security Program Mortality Experience, July 2012
Women

Life Expectancy at age 65 is LOWER for Married with GIS than Single without GIS

Source: Office of the Chief Actuary, Actuarial Study No. 11: Old Age Security Program Mortality Experience, July 2012
Probability of living to 90 for Canada, the U.S., the U.K. and Switzerland

Probability of living to 100 for Canada, the U.S., the U.K. and Switzerland

Infant Mortality Rates have decreased significantly over the last 80 years

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x
All rates are standardized using 2015 Canadian population.
For ages 1 to 14, main causes of death are accidents, followed by cancer.

### Table: Death Rate per 1,000

<table>
<thead>
<tr>
<th>Top 5 Causes</th>
<th>Canada 2012</th>
<th>U.S. 2012</th>
<th>Ratio Can/US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents</td>
<td>0.031</td>
<td>0.051</td>
<td>0.61</td>
</tr>
<tr>
<td>Malignant Neoplasms</td>
<td>0.018</td>
<td>0.023</td>
<td>0.78</td>
</tr>
<tr>
<td>Congenital Malformations</td>
<td>0.013</td>
<td>0.013</td>
<td>1.00</td>
</tr>
<tr>
<td>Suicides</td>
<td>0.006</td>
<td>0.015</td>
<td>0.40</td>
</tr>
<tr>
<td>Homicides</td>
<td>0.004</td>
<td>0.011</td>
<td>0.36</td>
</tr>
</tbody>
</table>

### Graph: Ages 1-14

- **Can-Males**
- **Can-Females**
- **US-Males**
- **US-Females**

- **80% Reduction**: 3 deaths per 1,000 (1931)
- **79% Reduction**: 0.6 deaths per 1,000 (1971)
- **42% Reduction**: 0.2 deaths per 1,000 (1991)
- **0.12 deaths per 1,000 (2011)**
- **28% lower than US Qx**
- **0.07 deaths per 1,000 (2051)**

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x

All rates are standardized using 2015 Canadian population.
Canadian mortality rates at ages 15 to 54 are significantly lower than US rates

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x
All rates are standardized using 2015 Canadian population.
Mortality rates for older age groups have decreased over the last 80 years, more so over the last 40 years for males.

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x
All rates are standardized using 2015 Canadian population.
Slowdown in mortality improvements in recent years: a blip or a new trend?

- **UK:**
  “improvements have slowed considerably since then [2011] and mortality in 2015 was at a similar level to that in 2011, 10% above the projected trend.”
  
  *CMI Working Paper No.90*

- **USA:**
  In 2015 and 2016, the Society of Actuaries released an updated mortality improvement scale for pensions MP-2015 and MP-2016

  *Cohort Life Expectancies at age 65*

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<th>Females</th>
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<tbody>
<tr>
<td>MP-2014</td>
<td>21.6</td>
<td>23.8</td>
</tr>
<tr>
<td>MP-2016</td>
<td>20.8</td>
<td>22.8</td>
</tr>
<tr>
<td>Changes</td>
<td>(0.8)</td>
<td>(1.0)</td>
</tr>
</tbody>
</table>