Living to 100 - Would Canada Pension Plan be Sustainable?

Presentation to the Canadian Association of Pension Supervisory Authorities

Jean-Claude Ménard, Chief Actuary, OCA, OSFI

2 October 2018
Presentation Outline

• Historical life expectancies
• Mortality improvement rates (MIR)
• Longevity drivers
• Can we live to 100?
• Evolution of mortality projections for the Canada Pension Plan and Canada Public Service
Life Expectancy at Birth and at Age 65 (by calendar year)

Source: Canadian human Mortality Database, University of Montreal
Contribution to increase in life expectancy at birth has gradually shifted to people over age 65

<table>
<thead>
<tr>
<th></th>
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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>
</tr>
<tr>
<td>Mortality (1-44)</td>
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<td>0.8</td>
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</tr>
<tr>
<td>Older adult mortality (45-64)</td>
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<td>0.4</td>
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<td>1.2</td>
</tr>
<tr>
<td>Elderly mortality (65+)</td>
<td>0.0</td>
<td>0.4</td>
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<td>2.9</td>
</tr>
<tr>
<td><strong>Total Change in Life Expectancy</strong></td>
<td><strong>7.4</strong></td>
<td><strong>3.2</strong></td>
<td><strong>4.8</strong></td>
<td><strong>5.1</strong></td>
</tr>
<tr>
<td><strong>% attributable to 65+</strong></td>
<td>0%</td>
<td>12%</td>
<td>28%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Source: Canadian Human Mortality Database, University of Montreal and Office of the Chief Actuary calculations
Contribution to increase in life expectancy at birth has gradually shifted to people over age 65

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<td>38%</td>
<td>45%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Source: Canadian Human Mortality Database, University of Montreal and Office of the Chief Actuary calculations
Improvements in mortality related to heart diseases have been significant over the last 15 years.

Source: Data from Statistics Canada, Health Division and OCA Calculations Standardized Using 2001 Canadian Population
Males Mortality Improvement Rates based on HMD 15-year Average

Deterioration due to AIDS

Deterioration due to Accidents

Cohort Effect
Slowdown in mortality improvements in recent years: a blip or a new trend?

Source: OAS Mortality Fact Sheet – September 2018. OCA
Slowdown in mortality improvements in recent years: a blip or a new trend?

Source: OAS Mortality Fact Sheets. OCA; CPP27
Slowdown in mortality improvements was also observed in UK and USA over the last few years.
Many other countries saw a slowdown in mortality improvements since 2011

### Period life expectancy at age 65: Months gained per year elapsed

<table>
<thead>
<tr>
<th>Country</th>
<th>Last Year</th>
<th>Male 2001-11</th>
<th>Male 2011+</th>
<th>Female 2001-11</th>
<th>Female 2011+</th>
<th>Difference M</th>
<th>Difference F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>2016</td>
<td>2.3</td>
<td>1.6</td>
<td>1.6</td>
<td>1.0</td>
<td>-0.7</td>
<td>-0.6</td>
</tr>
<tr>
<td>Austria</td>
<td>2016</td>
<td>2.0</td>
<td>0.9</td>
<td>1.8</td>
<td>0.8</td>
<td>-1.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>Belgium</td>
<td>2015</td>
<td>2.3</td>
<td>1.5</td>
<td>1.7</td>
<td>0.8</td>
<td>-0.8</td>
<td>-0.9</td>
</tr>
<tr>
<td>Canada</td>
<td>2013/15</td>
<td>2.2</td>
<td>1.6</td>
<td>1.8</td>
<td>0.8</td>
<td>-0.6</td>
<td>-1.0</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2016</td>
<td>2.1</td>
<td>2.0</td>
<td>2.3</td>
<td>2.4</td>
<td>-0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Denmark</td>
<td>2015</td>
<td>2.3</td>
<td>2.3</td>
<td>2.0</td>
<td>2.1</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Finland</td>
<td>2016</td>
<td>2.2</td>
<td>1.5</td>
<td>2.2</td>
<td>0.8</td>
<td>-0.7</td>
<td>-1.4</td>
</tr>
<tr>
<td>France</td>
<td>2015</td>
<td>2.4</td>
<td>1.3</td>
<td>2.0</td>
<td>0.6</td>
<td>-1.2</td>
<td>-1.4</td>
</tr>
<tr>
<td>Germany</td>
<td>2015</td>
<td>2.0</td>
<td>0.7</td>
<td>1.5</td>
<td>0.4</td>
<td>-1.3</td>
<td>-1.1</td>
</tr>
<tr>
<td>Italy</td>
<td>2014</td>
<td>2.1</td>
<td>2.4</td>
<td>1.6</td>
<td>2.0</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Japan</td>
<td>2016</td>
<td>1.3</td>
<td>2.1</td>
<td>1.4</td>
<td>1.9</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2014</td>
<td>3.0</td>
<td>2.2</td>
<td>2.1</td>
<td>1.3</td>
<td>-0.8</td>
<td>-0.9</td>
</tr>
<tr>
<td>Norway</td>
<td>2016</td>
<td>2.2</td>
<td>2.4</td>
<td>1.6</td>
<td>1.3</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Poland</td>
<td>2016</td>
<td>1.6</td>
<td>1.6</td>
<td>2.2</td>
<td>1.7</td>
<td>0.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>Portugal</td>
<td>2015</td>
<td>2.4</td>
<td>1.4</td>
<td>2.4</td>
<td>1.2</td>
<td>-1.0</td>
<td>-1.1</td>
</tr>
<tr>
<td>Spain</td>
<td>2016</td>
<td>2.3</td>
<td>1.1</td>
<td>2.2</td>
<td>1.4</td>
<td>-1.1</td>
<td>-0.9</td>
</tr>
<tr>
<td>Sweden</td>
<td>2016</td>
<td>1.9</td>
<td>1.6</td>
<td>1.4</td>
<td>1.0</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td>UK</td>
<td>2016</td>
<td>2.8</td>
<td>0.8</td>
<td>2.3</td>
<td>0.3</td>
<td>-2.0</td>
<td>-1.9</td>
</tr>
<tr>
<td>USA</td>
<td>2015</td>
<td>2.2</td>
<td>0.7</td>
<td>1.8</td>
<td>0.8</td>
<td>-1.5</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

Source: B. Ridsdale, Recent developments in longevity, internationally
Bio-medical technology and behavioural changes are identified as the major forces shaping future mortality.

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)

Life expectancy is impacted by level of income, but trends differ

Life expectancy at age 50 for men by income quintile

USA: Increasing gap

Canada: Stable gap

After age 85, Canada along with Japan and France have the lowest mortality rates

Source: Canadian human Mortality Database, University of Montreal
Mortality Rates by Cause

Source: World Health Organization
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 lower than US female mortality rates.
Elderly mortality have decreased over the last 80 years, more so over the last 10 years.

### Ages 85-89

**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>Diseases of the Heart</td>
<td>21.7</td>
<td>28.2</td>
<td>0.77</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>19.3</td>
<td>16.0</td>
<td>1.21</td>
</tr>
<tr>
<td>Cerebrovascular</td>
<td>6.7</td>
<td>6.9</td>
<td>0.97</td>
</tr>
<tr>
<td>Lower Respiratory</td>
<td>4.9</td>
<td>6.2</td>
<td>0.79</td>
</tr>
<tr>
<td>Alzheimer’s</td>
<td>4.1</td>
<td>6.3</td>
<td>0.65</td>
</tr>
</tbody>
</table>

All rates are standardized using 2015 Canadian population.

Canada: Office of the Chief Actuary, 27th CPP Actuarial Report and Statistics Canada catalogue 84-215-x
For ages 90 and over, heart diseases remain the main cause of deaths

### Ages 90+

#### 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>Diseases of the Heart</td>
<td>49.4</td>
<td>62.1</td>
<td>0.80</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>23.5</td>
<td>17.6</td>
<td>1.34</td>
</tr>
<tr>
<td>Cerebrovascular</td>
<td>14.4</td>
<td>13.6</td>
<td>1.06</td>
</tr>
<tr>
<td>Alzheimer’s</td>
<td>9.9</td>
<td>14.8</td>
<td>0.67</td>
</tr>
<tr>
<td>Influenza and pneumonia</td>
<td>8.7</td>
<td>6.5</td>
<td>1.34</td>
</tr>
</tbody>
</table>

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)

Survival Curves for a Life Expectancy of 100 (Males)

\[ e_0 = 80 \quad \text{and} \quad e_0 = 100 \]
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 86% for males (82% 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.
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
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

CPP27 Projections
Evolution of CPP mortality projections over 15 years
Males

Average Age at Death for those Aged 65 - Male Canada
(with future mortality improvements)

No future improvements: the average expected age at death of a male aged 65 in 2015 is 84.7
Evolution of CPP mortality projections over 15 years - Females

**Average Age at Death for those Aged 65 - Female Canada**
(with future mortality improvements)

No future improvements: the average expected age at death of a female aged 65 in 2015 is 87.3
The number of people aged 90 and over increases dramatically

Source for projections: 27th CPP Actuarial Report
Public Service of Canada Mortality Assumptions

Projected Cohort Life Expectancy at age 65 as at 31 March 2017 of Retirement Pensioners (PSSA) (in number of years)

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 31, 2014 Report</td>
<td>21.8</td>
<td>24.0</td>
</tr>
<tr>
<td>Slowdown in mortality improvements</td>
<td>-0.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>Introduction of salary-weighted mortality</td>
<td>+0.4</td>
<td>+0.2</td>
</tr>
<tr>
<td>March 31, 2017 Report</td>
<td>21.9</td>
<td>23.7</td>
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For the first time over the last 20 years, PSSA mortality experience analysis showed that mortality did not improve in the intervaluation period (2014-2017).
So, what is the impact of living longer on the CPP?

Mortality Assumptions of the 27th CPP Report

Life expectancy at age 65 in 2016 (with future improvements)
- M: 21.3 years
- F: 23.7 years

Life expectancy at age 65 in 2050 (with future improvements)
- M: 23.3 years
- F: 25.6 years

Sensitivity Tests on Life Expectancy

+2.5 years
- M: 25.8 years
- F: 28.1 years
+0.3%

-2.5 years
- M: 20.8 years
- F: 23.1 years
-0.3%
Conclusion

- Retirement is expensive and will become even more expensive in the future with improved longevity.
- Projected mortality rates are highly uncertain, especially for people older than age 90.
- It is a professional duty of the actuary to examine all available information in order to develop best-estimate mortality assumptions.
Living to 100 - Would Canada Pension Plan be Sustainable?

Thank you

Questions?

October 2, 2018
Living to 100 - Would Canada Pension Plan be Sustainable?

Appendix

October 2, 2018
Life expectancy is impacted by level of income

Difference of life expectancy at age 65 (2013)

Benchmark
M: 19.0
F: 22.0

BENCHMARK
Overall
CPP Retirement Beneficiaries
Life Expectancy

Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015
Life expectancy is impacted by level of income and marital status

Source: Office of the Chief Actuary, Actuarial Study No. 17: Old Age Security Program Mortality Experience, June 2016
Females Mortality Improvement Rates based on HMD 15-year Average

Significant Improvements in mothers’ health
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. Data for Japan are from National Institute of Population and Social Security Research (Sept. 2013).
International Comparisons - Females

Projected period life expectancy at age 65 - 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).
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.

### Ages 1-14

<table>
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<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>

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

Ages 15-54

Death Rate per 1,000
Top 5 Causes        Canada 2012 | U.S. 2012 | Ratio Can/US
Neoplasms           0.351        | 0.388      | 0.90
Accidents            0.193        | 0.374      | 0.52
Suicides             0.136        | 0.158      | 0.86
Diseases of the Heart 0.134      | 0.300      | 0.45
Cerebrovascular      0.025        | 0.049      | 0.51
Homicides (7th in Can) 0.019     | 0.080      | 0.24

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


Offi. All rates are standardized using 2015 Canadian population.
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