Living to 100 – Myth or Reality

CIA Webcast on Mortality Experience and Projections for Social Security Programs in Canada

by   Assia Billig, Actuary, OCA, OSFI
       Michel Montambeault, Director, OCA, OSFI

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Canada

Presentation

- Actuarial Studies No. 16 and 17
    - Canada Pension Plan Mortality
    - Old Age Security Program Mortality
    - CPP-OAS Mortality Improvement Rates
- Mortality Projections – 27th CPP Actuarial Report
    - Mortality improvement rates
    - Projections results
- Living to 100?

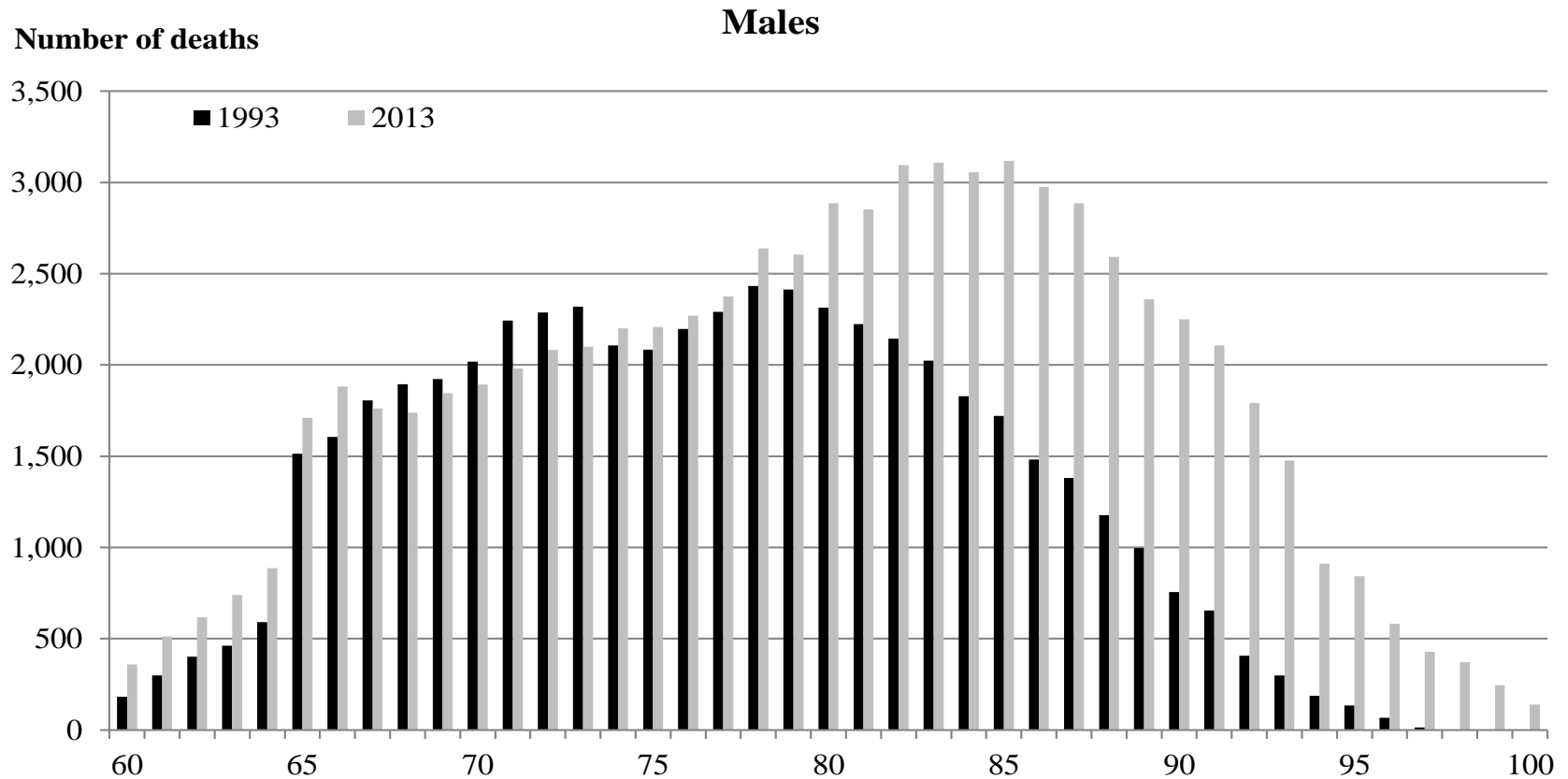OSFI
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CPP Beneficiaries
(Actuarial Study No.16)

- Over the study period 1990-2013, there were 2.4 million retirement deaths and 69.6 million life-years of exposures.

- Each CPP retirement beneficiary was classified by age, sex, and level of pension as a percentage of the maximum.

- Over the study period 1990-2013, there were 872,000 survivor deaths and 19.4 million life-years of exposures.

- Over the study period 1990-2012, there were 206,000 disability deaths and 7.0 million life-years of exposures.
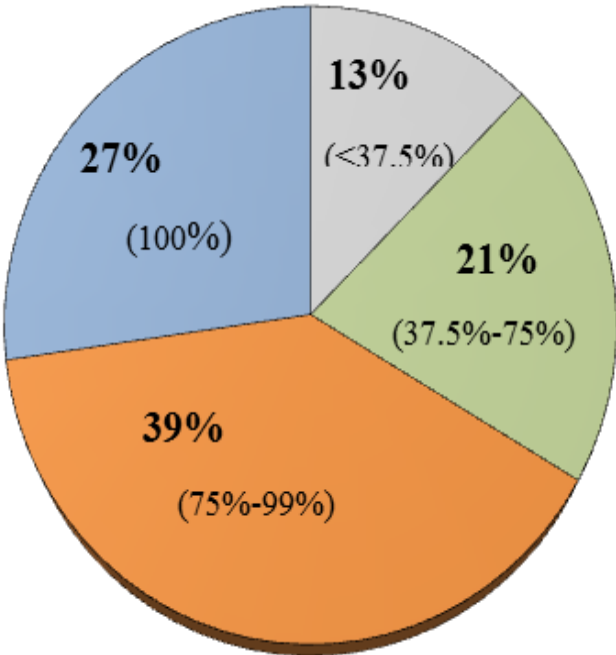
Distribution of Retirement Deaths
(1993 and 2013)

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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Retirement Exposures by Level of Pension
(all ages, 2013)

Males

Females

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Retirement Mortality by Level of Pension
(Males, 2013)

Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015
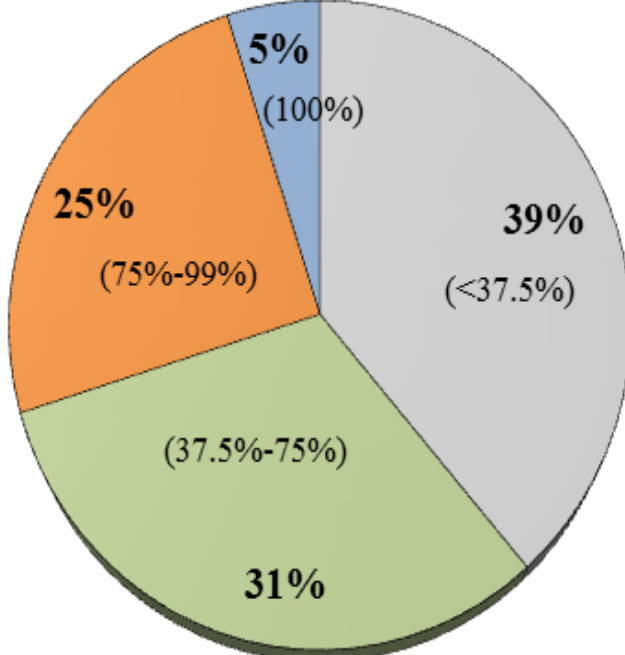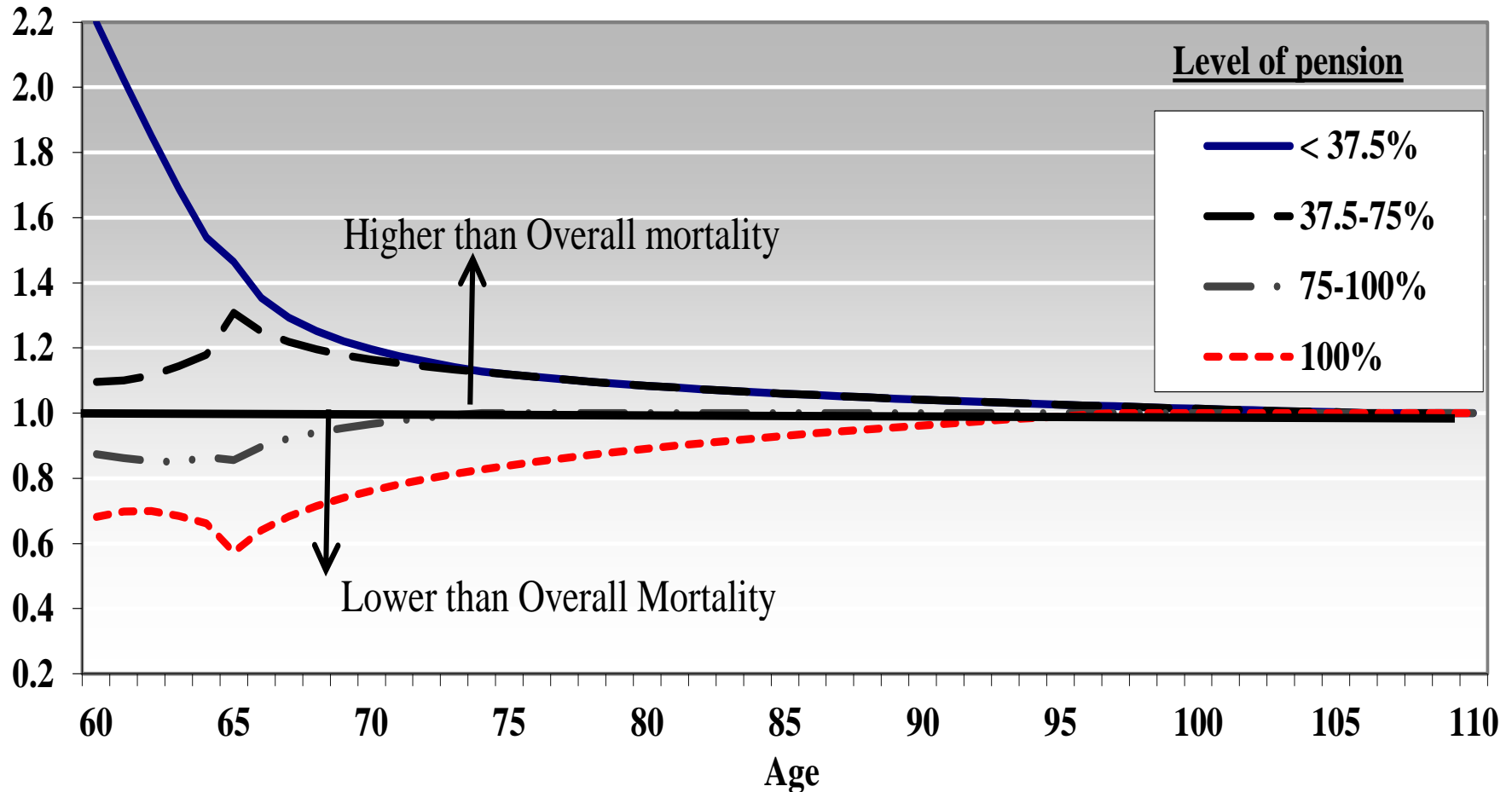
Life Expectancy at 65 by Level of Pension
(2013)

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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Evolution of Life Expectancy at age 65
High vs. Low Retirement Pensions (1990-2013)

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

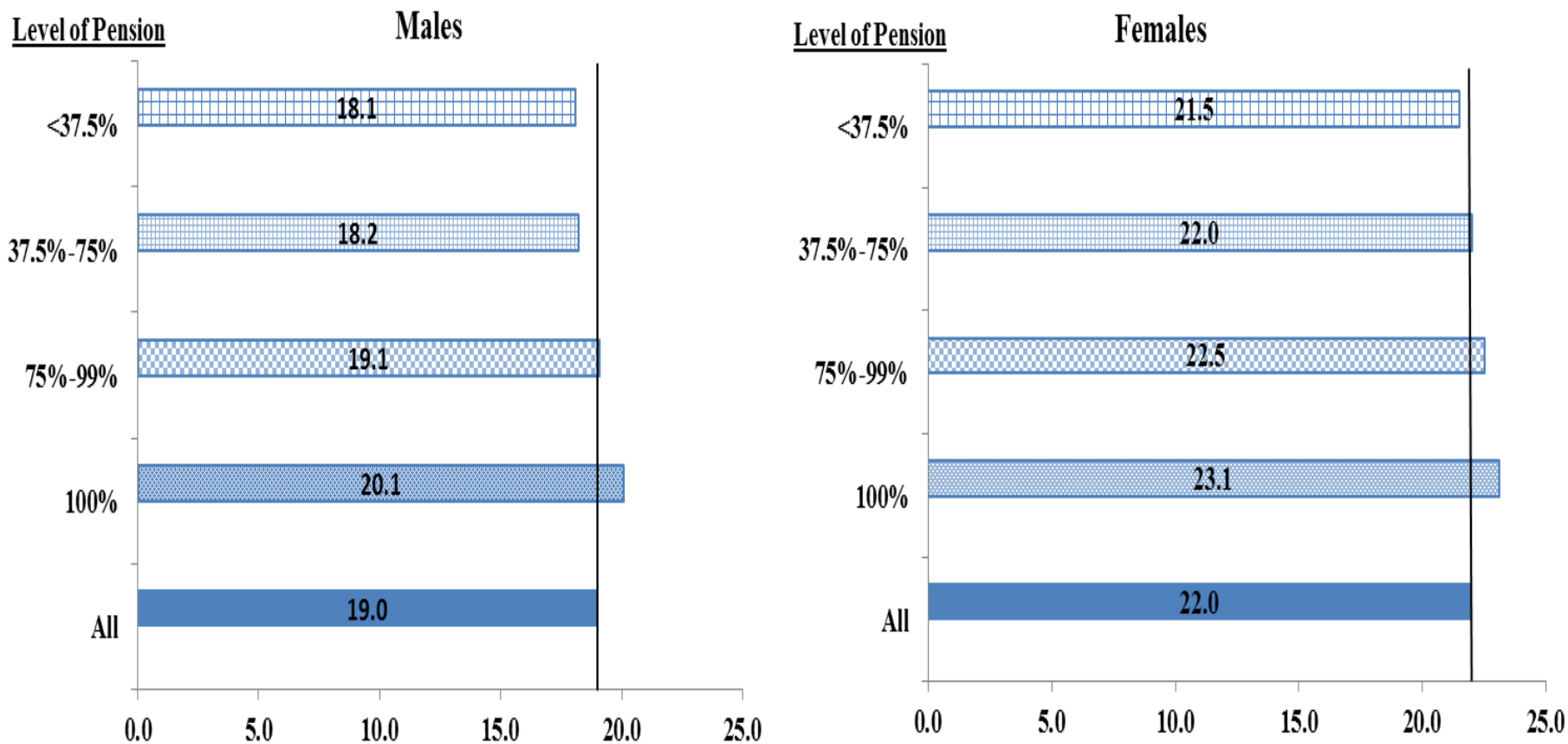**Office of the Chief Actuary   Bureau de l'actuaire en chef**

Distribution of Survivor Deaths
(1993 and 2013)

Number of deaths

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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Ratios of Survivor to Population Mortality
(2011)

Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015
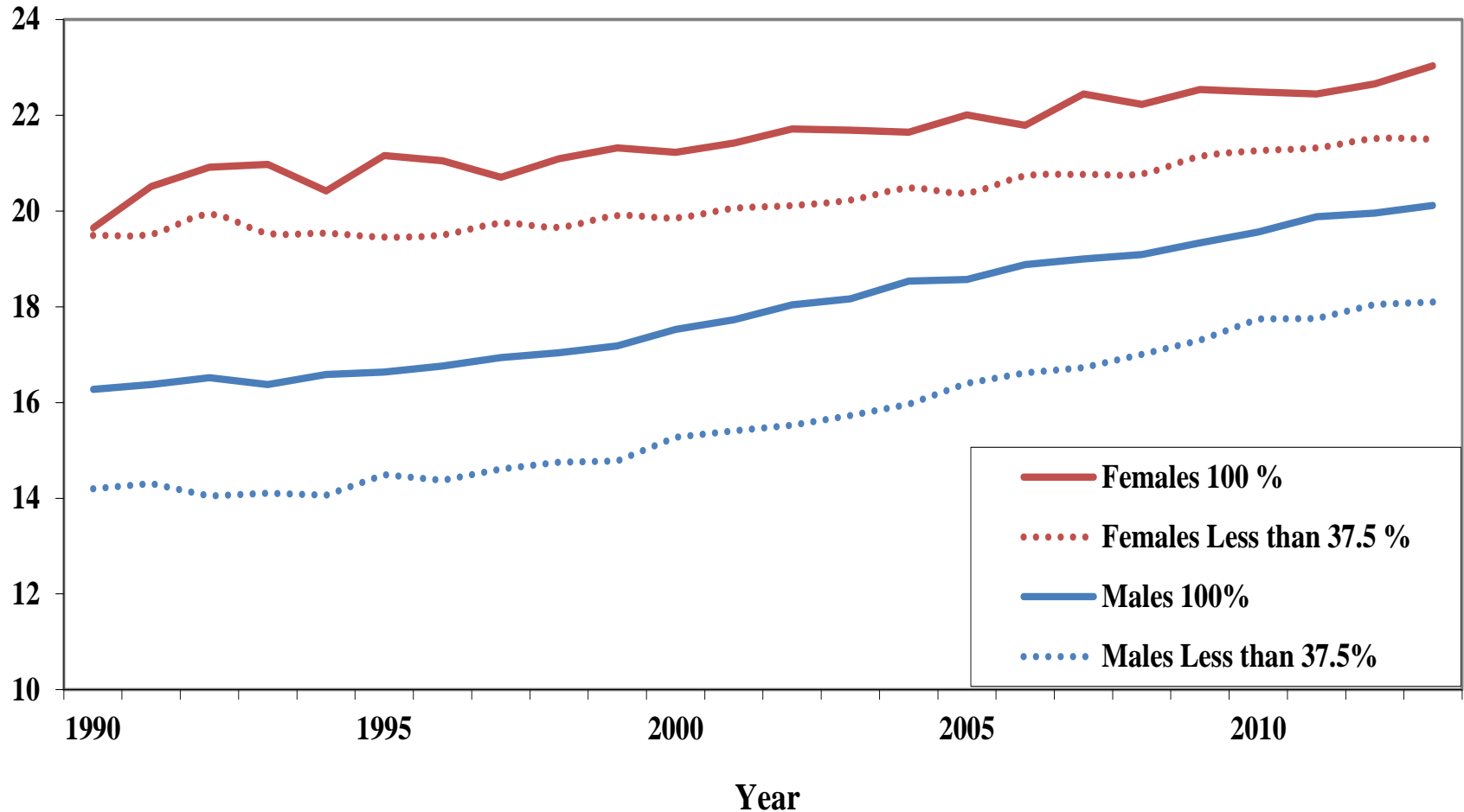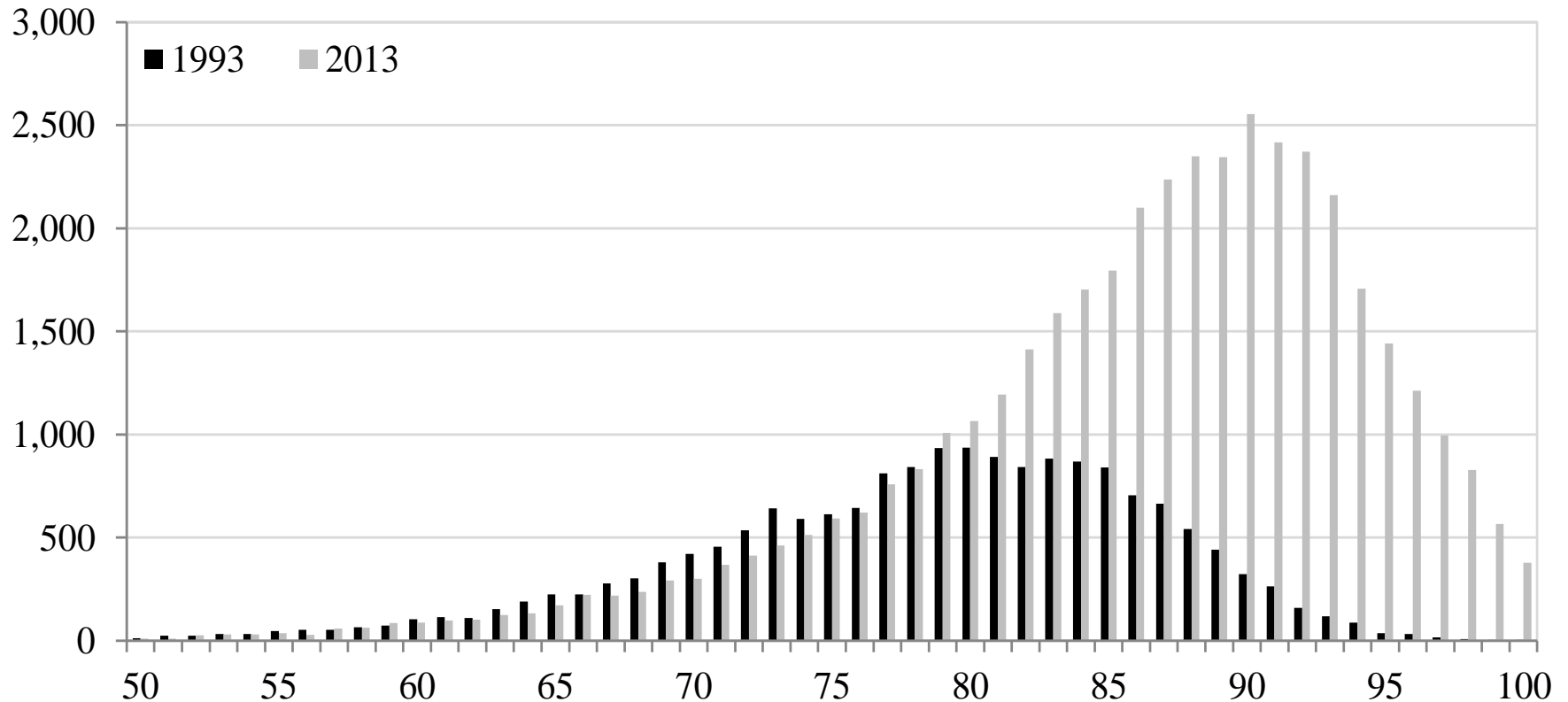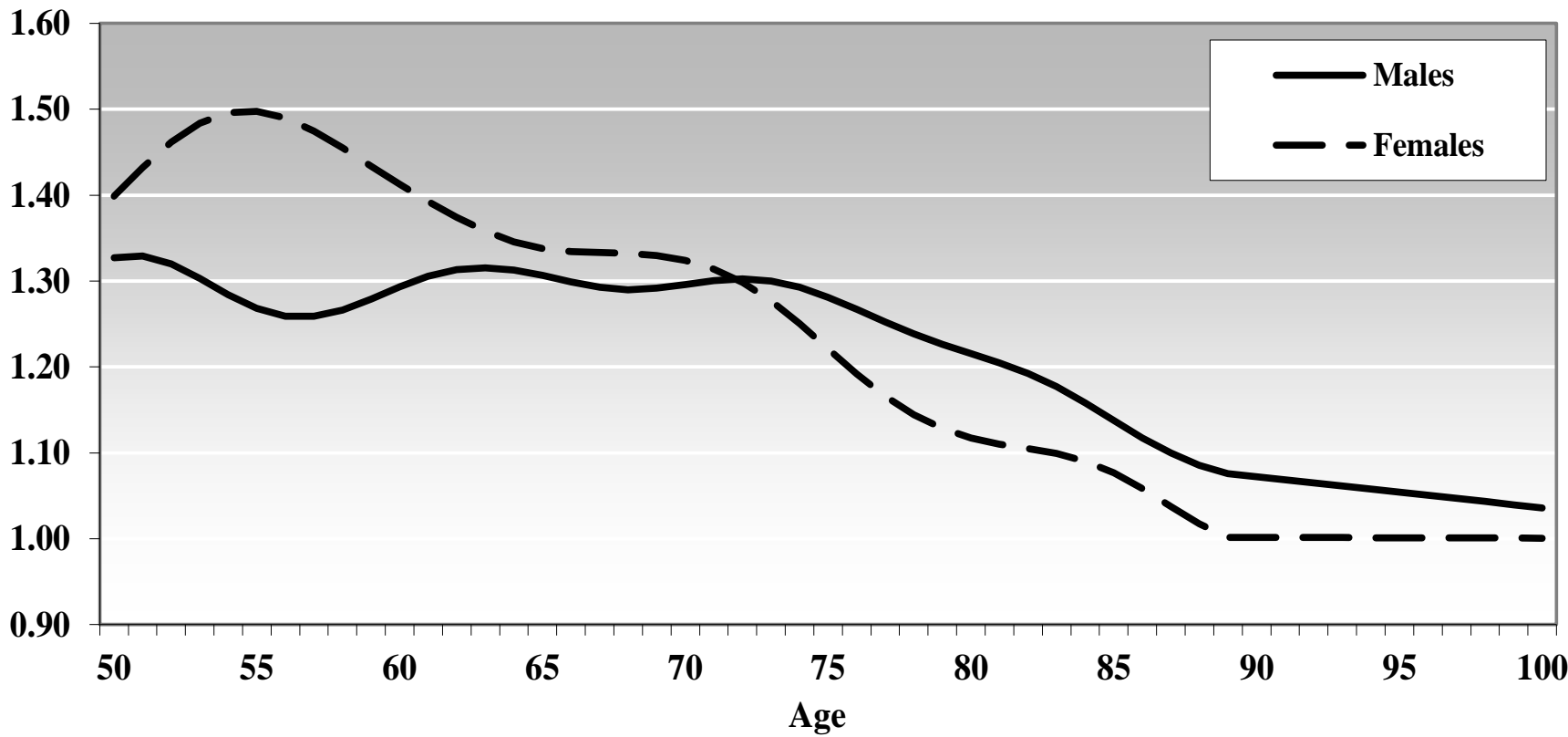
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Distribution of Disability Deaths by Cause
(1991 and 2011)

Male Deaths in 1991

Mental 5%
Other 20%
Injury 3%
Nervous 5%
Circulatory 22%
Neoplasms 36%
Muscular 9%

Male Deaths in 2011

Other 18%
Mental 12%
Injury 4%
Nervous 8%
Neoplasms 39%
Circulatory 11%
Muscular 8%

Female Deaths in 1991

Mental 4%
Injury 1%
Nervous 4%
Circulatory 9%
Other 12%
Muscular 9%
Neoplasms 61%
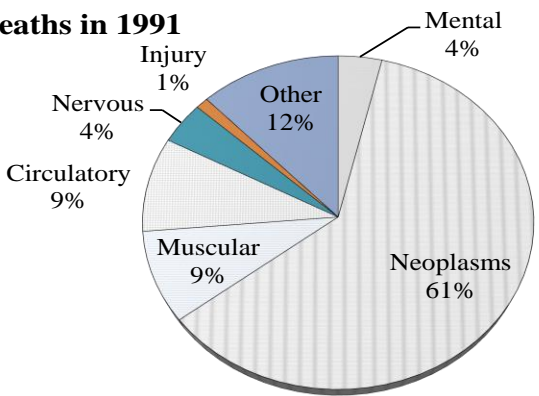
Female Deaths in 2011

Injury 2%
Nervous 7%
Circulatory 5%
Other 13%
Mental 12%
Muscular 9%
Neoplasms 52%

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Distribution of Disability Exposures by Cause
(1991 and 2011)

Male Exposures in 1991
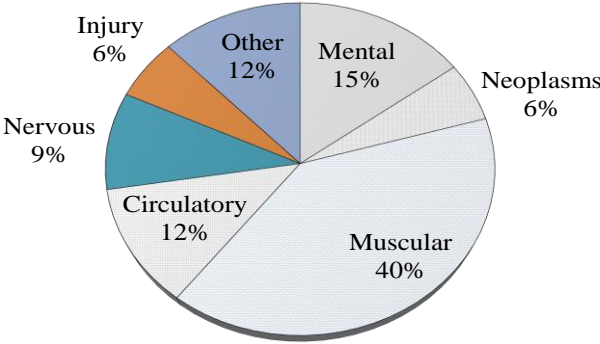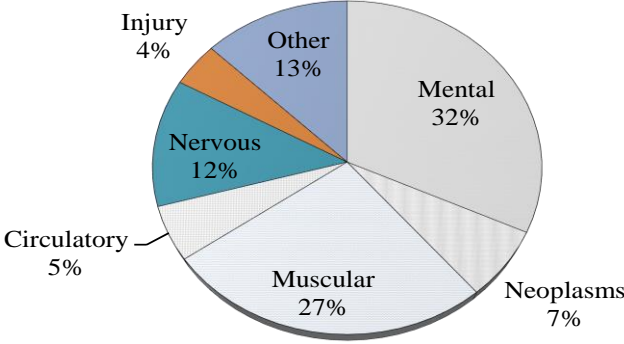
Neoplasms 4%
Other 13%
Mental 11%
Injury 10%
Nervous 8%
Muscular 31%
Circulatory 23%

Male Exposures in 2011

Other 15%
Mental 27%
Injury 9%
Nervous 11%
Neoplasms 6%
Muscular 21%
Circulatory 11%

Female Exposures in 1991

Injury 6%
Other 12%
Mental 15%
Neoplasms 6%
Nervous 9%
Circulatory 12%
Muscular 40%

Female Exposures in 2011

Injury 4%
Other 13%
Mental 32%
Nervous 12%
Circulatory 5%
Muscular 27%
Neoplasms 7%

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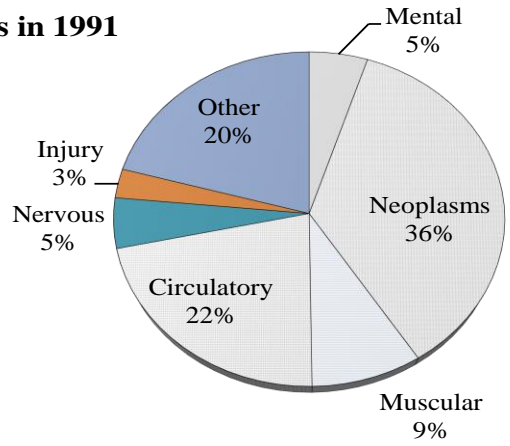# Comparison of Disability and Population Mortality (2011)
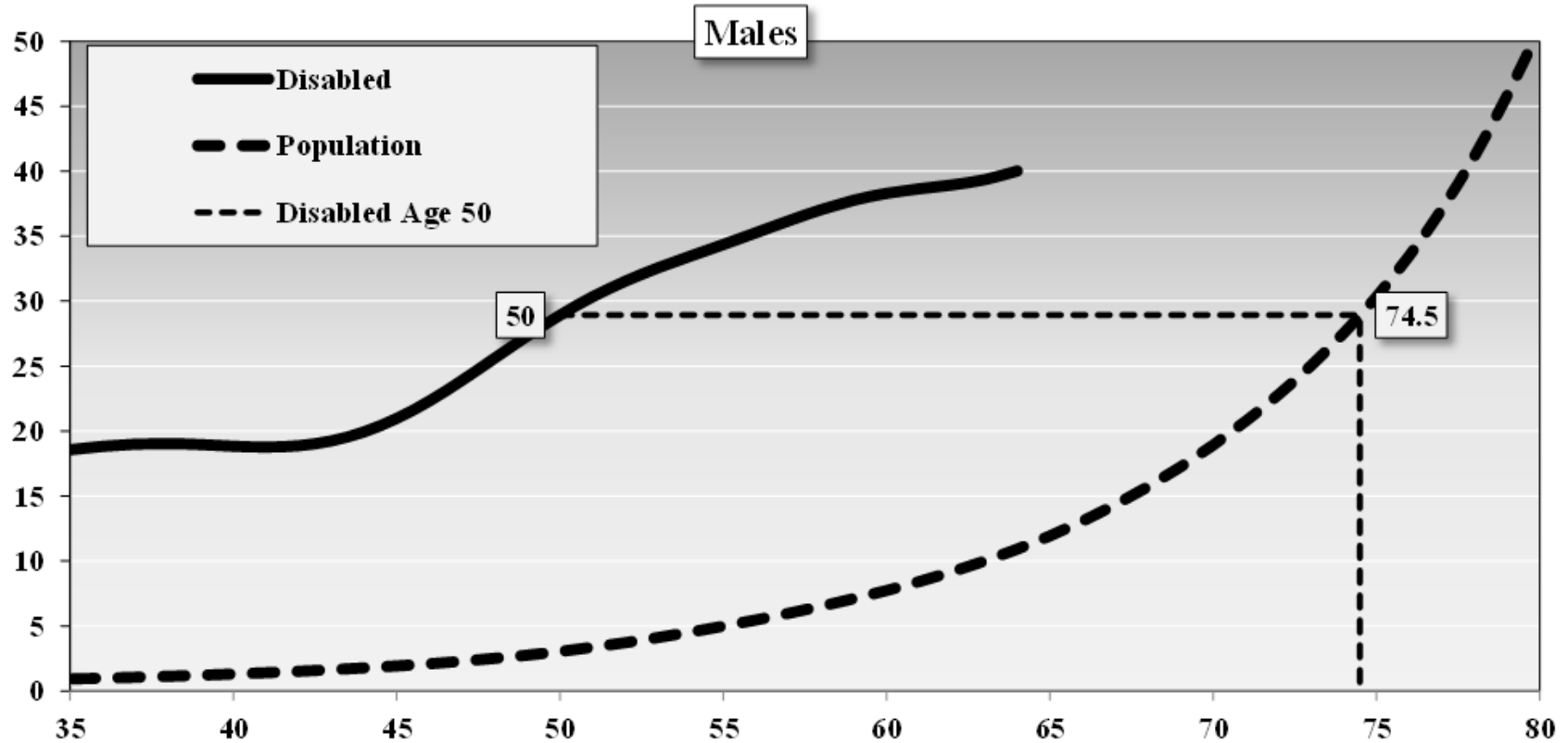
Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015
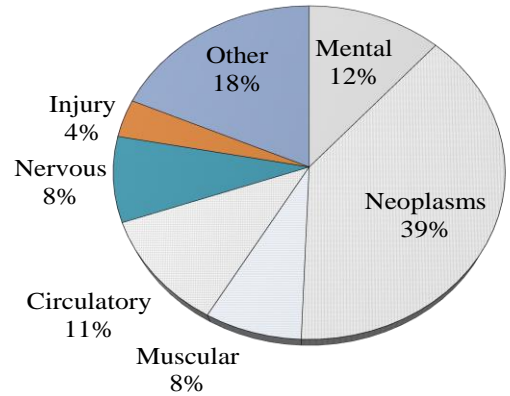
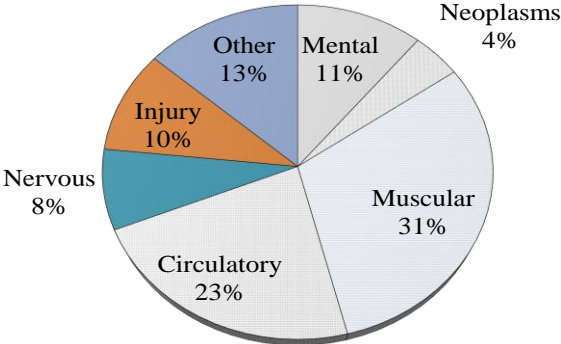# *Probability of 50-Year Old Disabled Reaching Age 65 (males, 2011)*
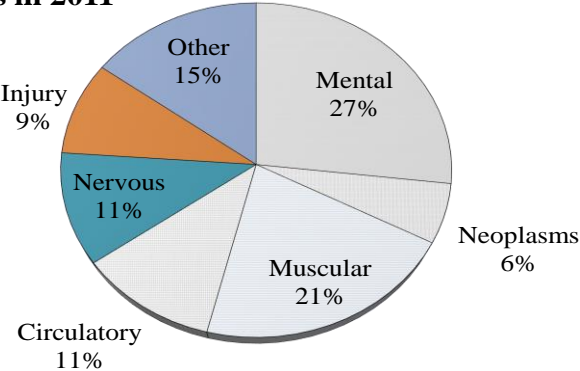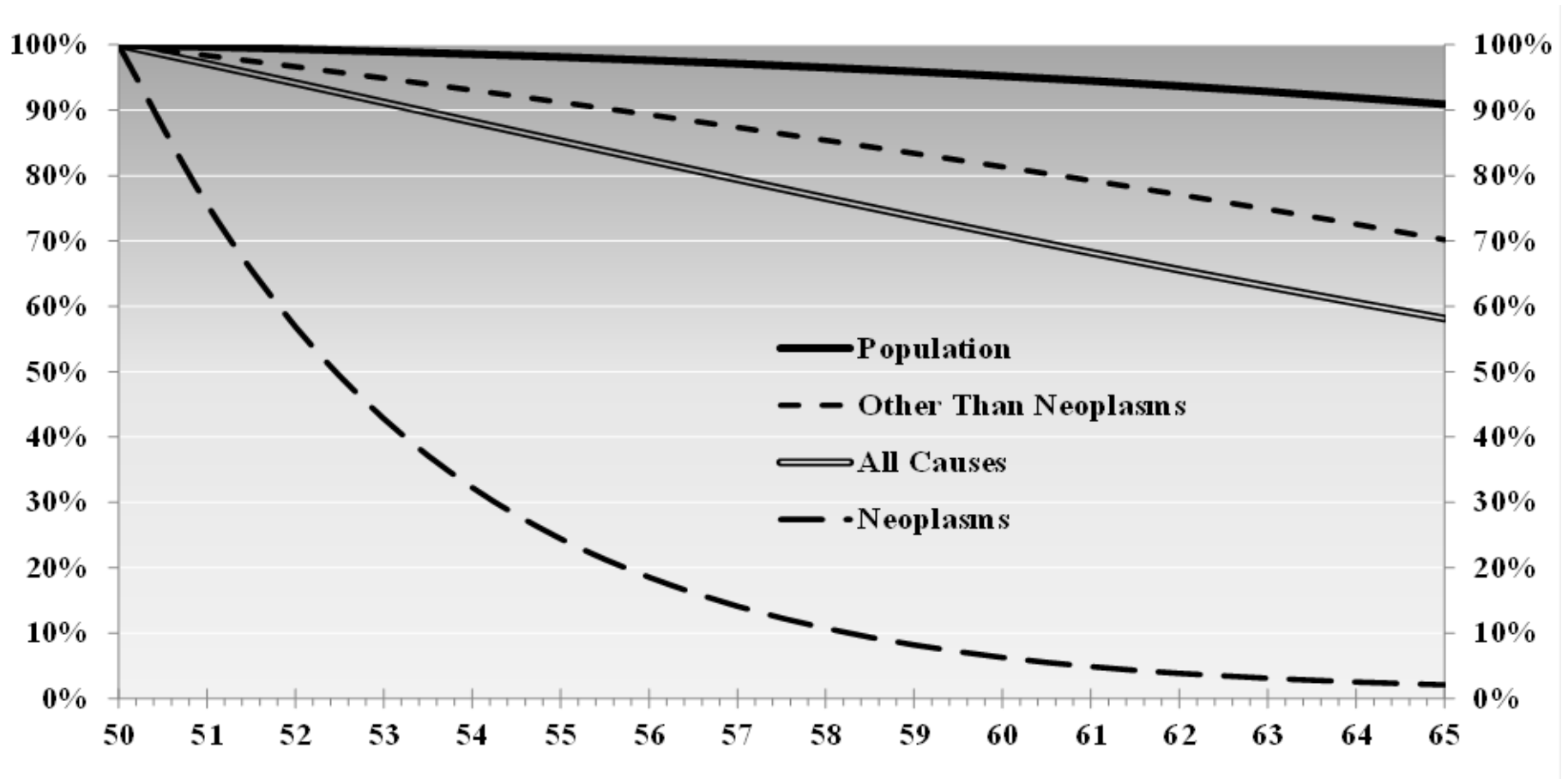

Source: Office of the Chief Actuary, Actuarial Study No. 16: Canada Pension Plan Retirement, Survivor and Disability Beneficiaries Mortality Study, June 2015

OAS Beneficiaries
(Actuarial Study No.17)

- The longer experience period from 1999 to 2013 of this study, relative to its two predecessors provides for the analysis of changes in trends of mortality within the experience period.

- This study accounts for over 64 million life-years of exposure and about 2,753,000 deaths.

- Beneficiaries were classified by type of benefit, marital status and place of birth.

Evolution of OAS Life Expectancy Age 65 (1999-2013)
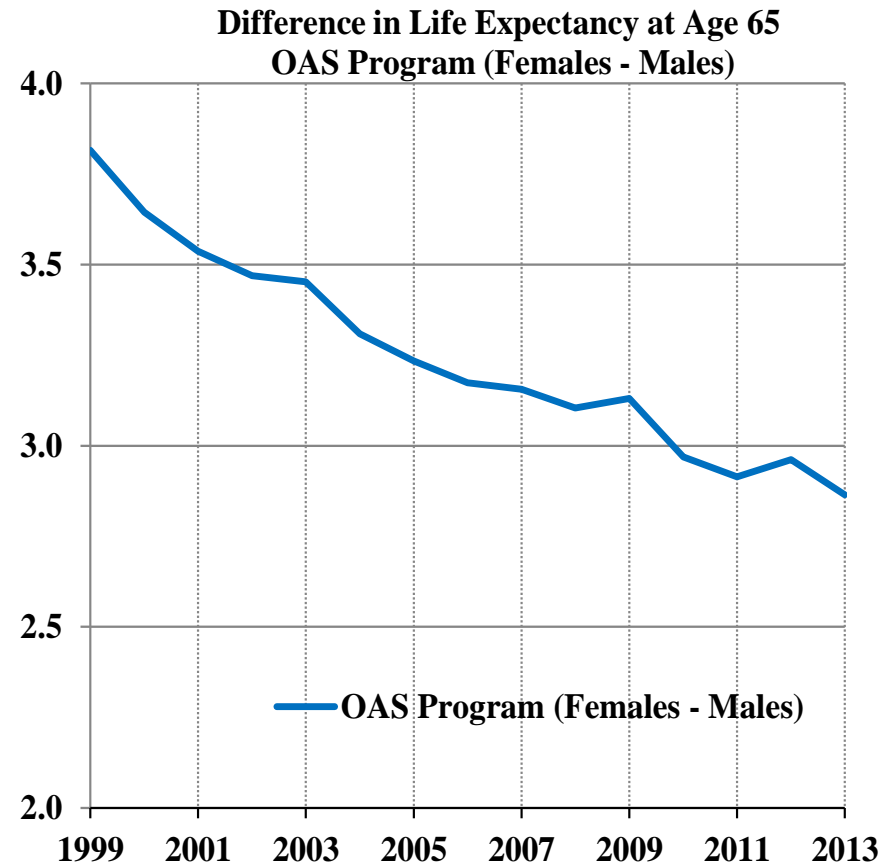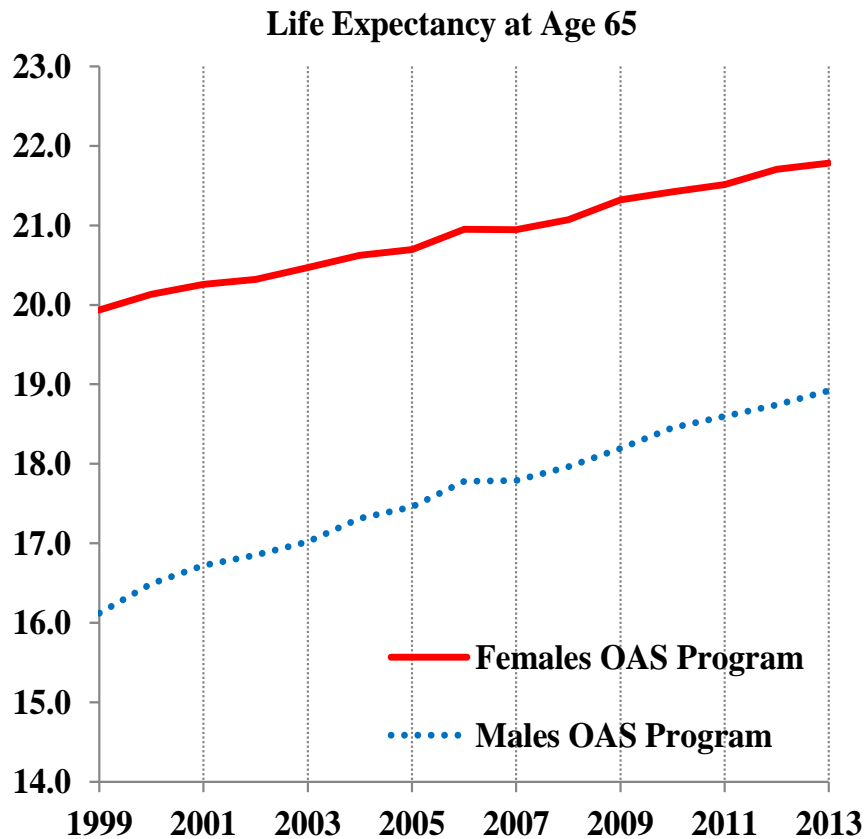
Source: Office of the Chief Actuary, Actuarial Study No. 17: Old Age Security Program Mortality Experience , June 2016

OAS Mortality by Type of Benefit (2013)
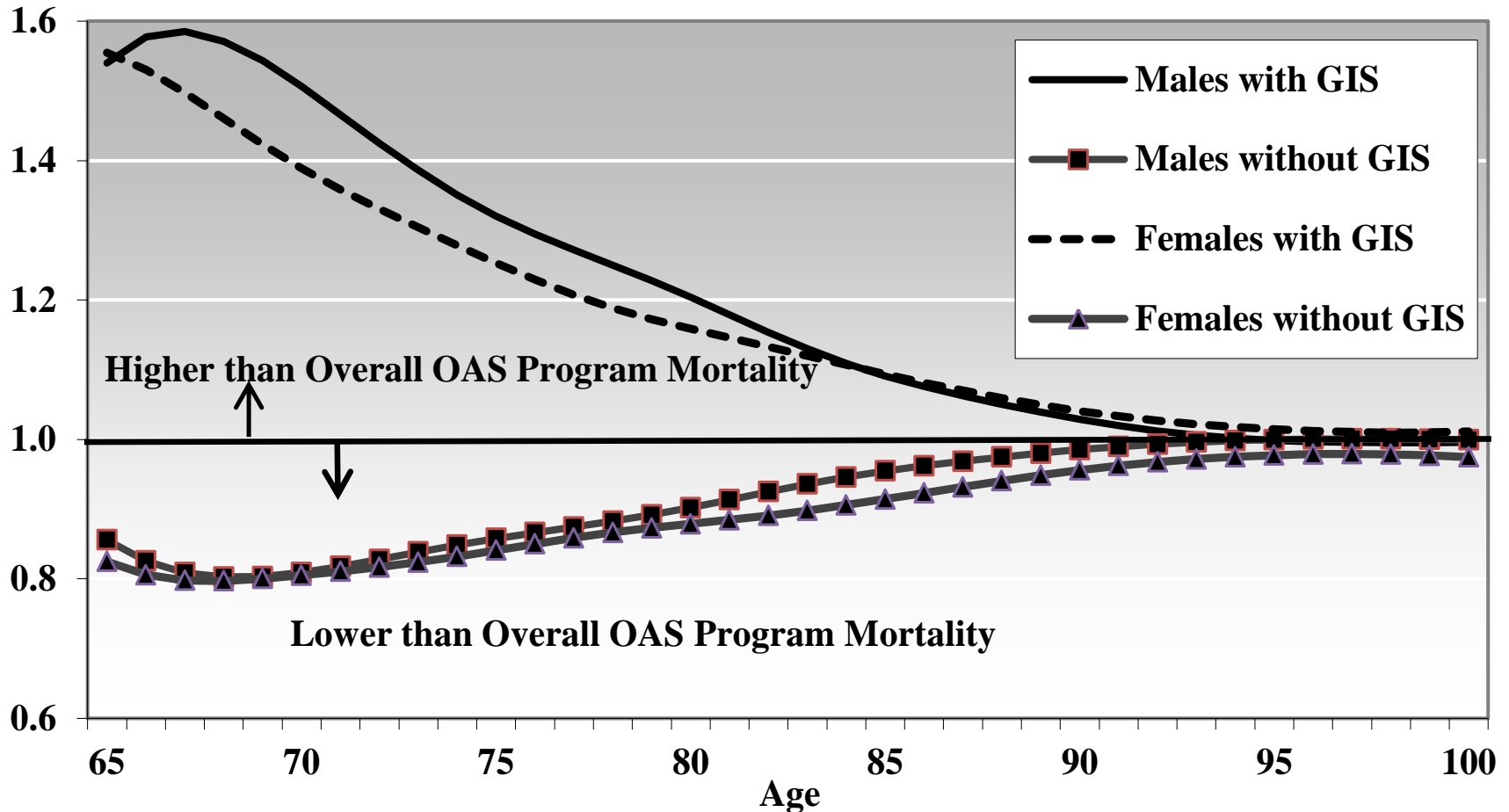
Source: Office of the Chief Actuary, Actuarial Study No. 17: Old Age Security Program Mortality Experience , June 2016

Evolution of OAS Life Expectancies at Age 65 by Type of Benefit (1999-2013)

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

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OAS Mortality by Marital Status (2013)

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

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Evolution of OAS Life Expectancies at Age 65 by Marital Status (2001-2013)
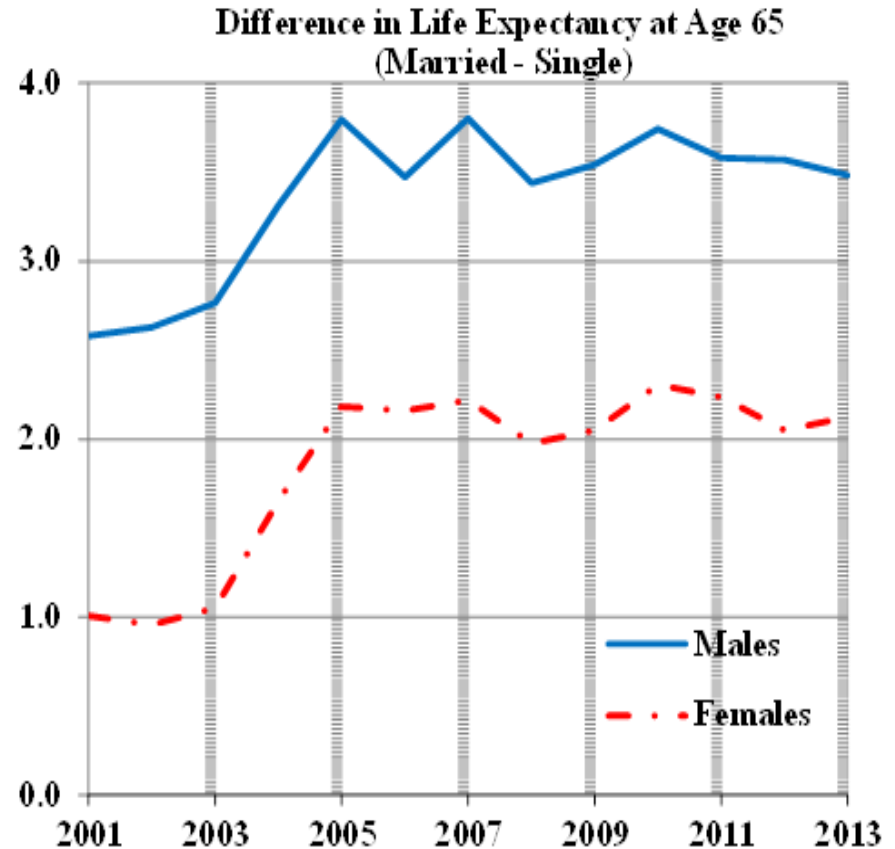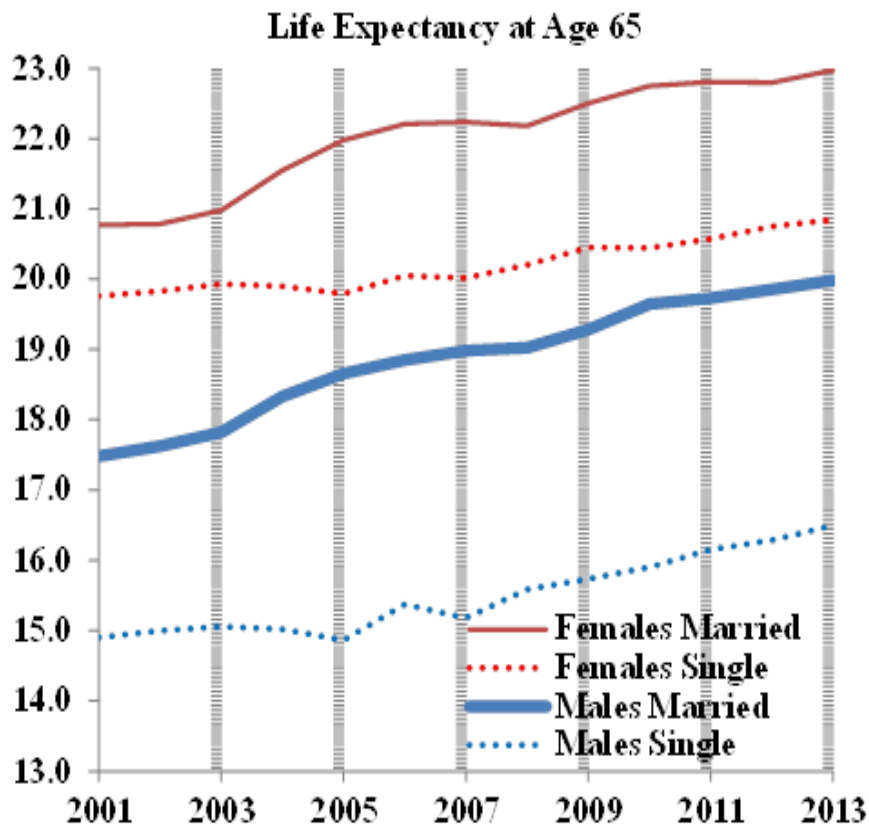
Results for years 2001 to 2004 by marital status should be interpreted with caution due to data limitation on marital status for those years.

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

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Summary OAS Life Expectancy at Age 65 (2013)
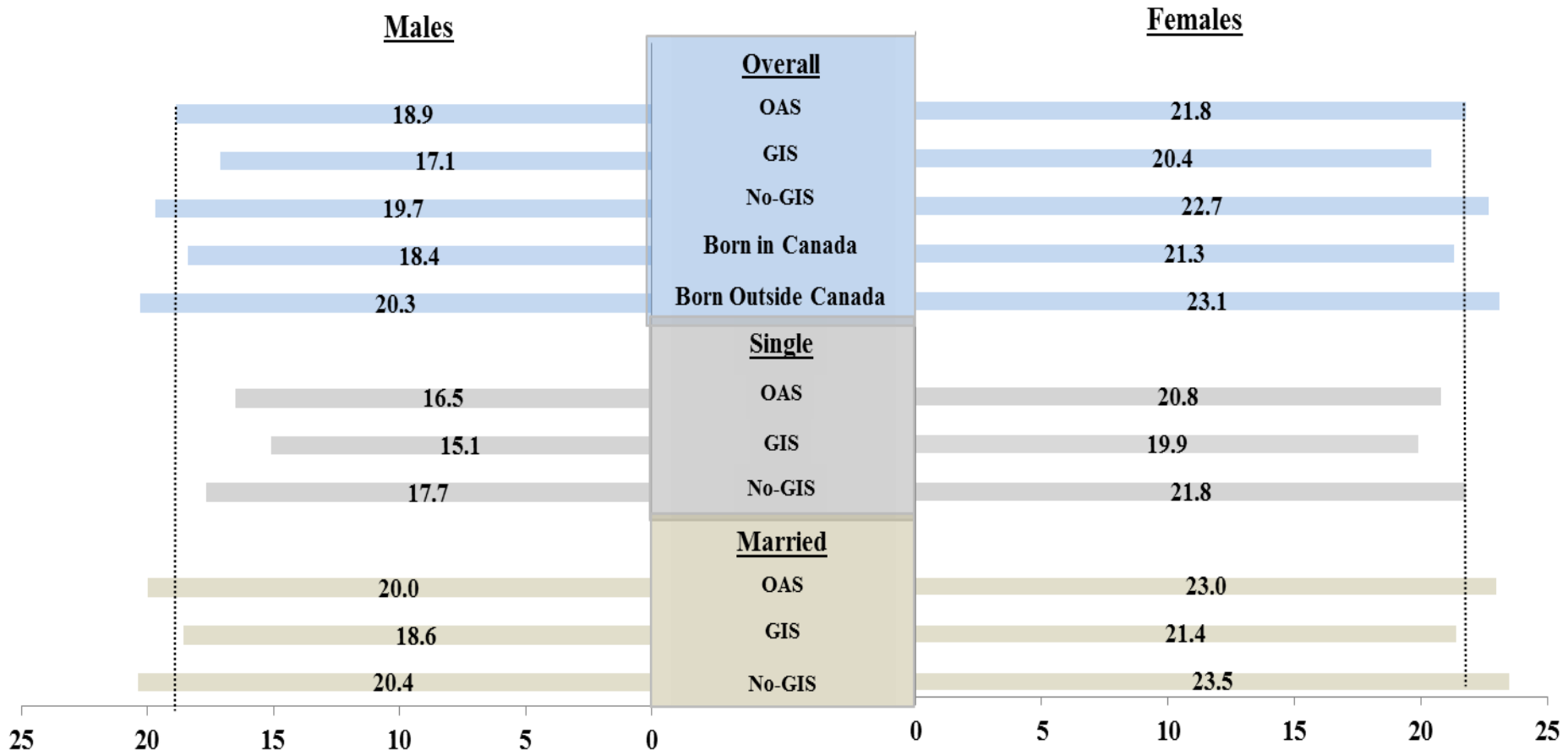
	Males		Females
Overall			
OAS	18.9		21.8
GIS	17.1		20.4
No-GIS	19.7		22.7
Born in Canada	18.4		21.3
Born Outside Canada	20.3		23.1
Single			
OAS	16.5		20.8
GIS	15.1		19.9
No-GIS	17.7		21.8
Married			
OAS	20.0		23.0
GIS	18.6		21.4
No-GIS	20.4		23.5

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

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CPP-OAS Average Annual Mortality Improvement Rates (males)

Source: Office of the Chief Actuary calculations.
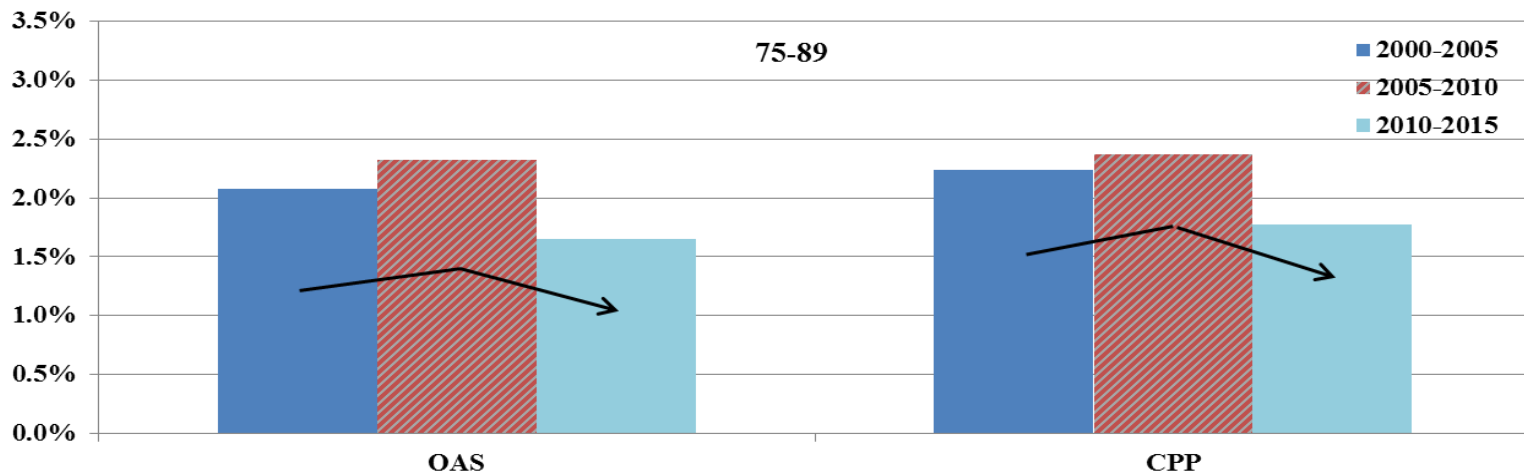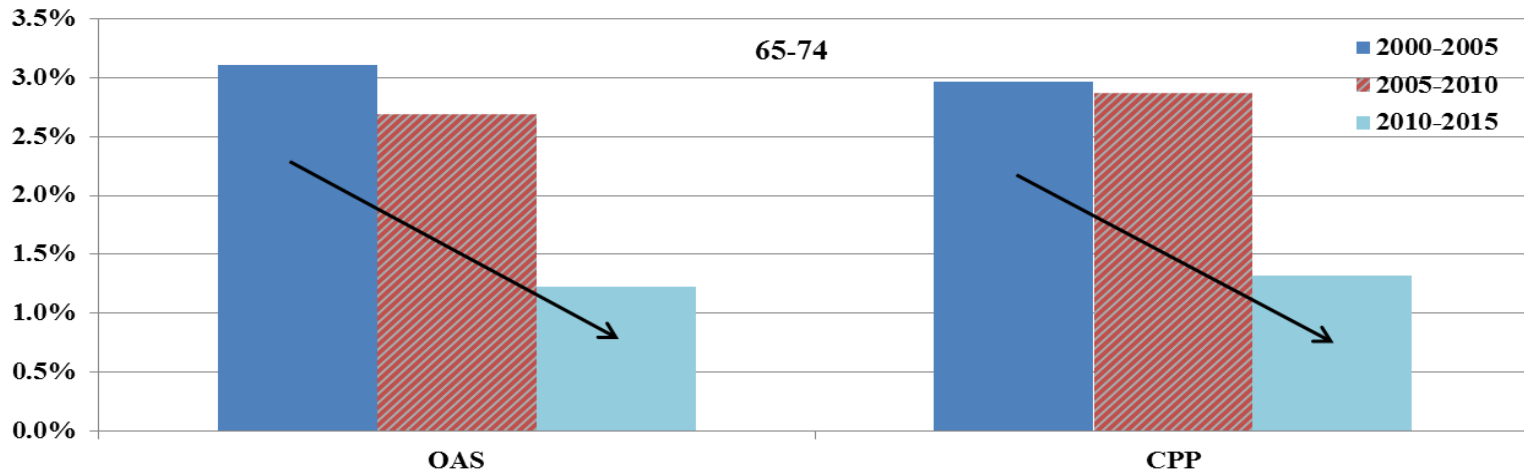
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Life Expectancy at Birth and at Age 65
(by calendar year)
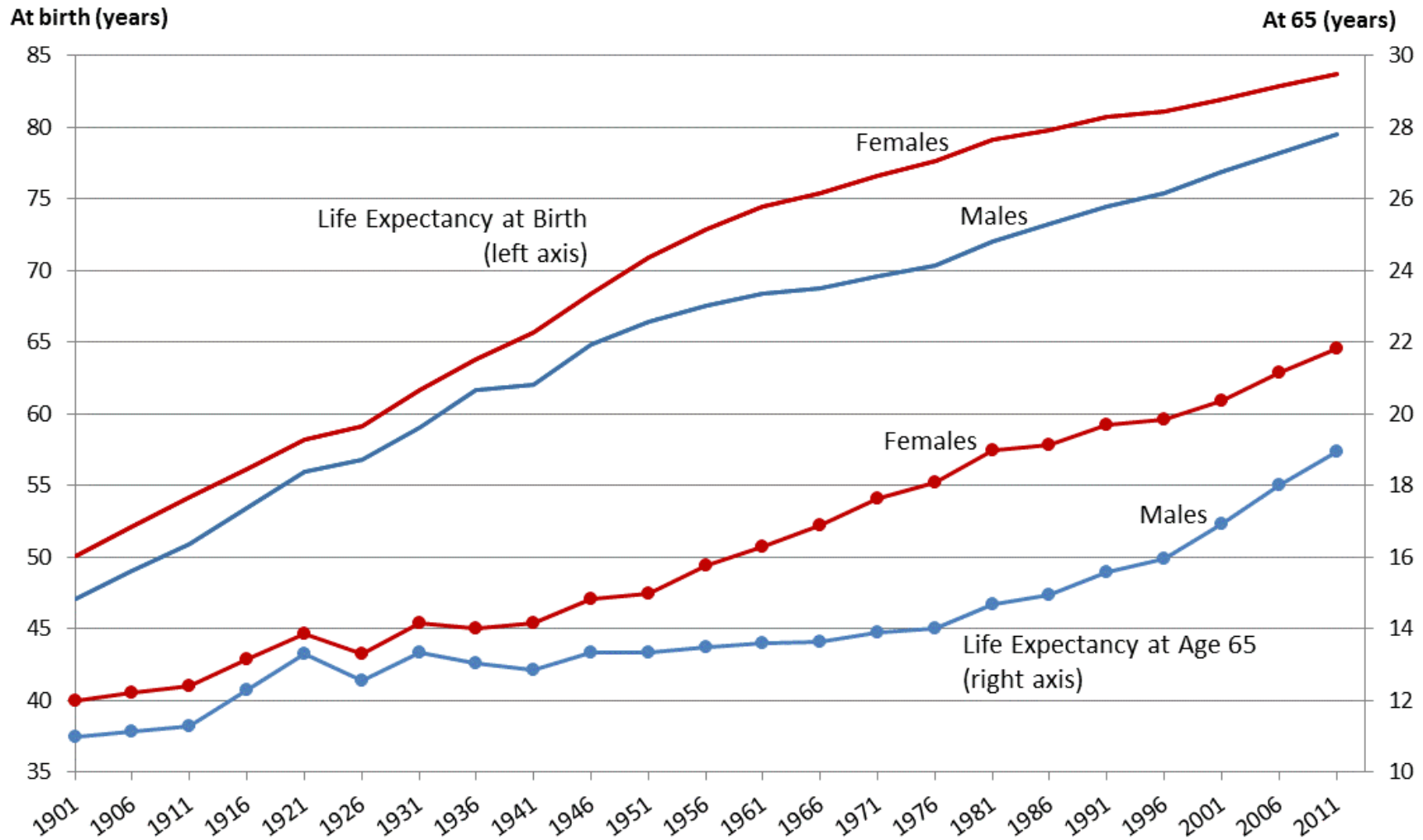
Source : Canadian human Mortality Database, University of Montreal

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Contribution to increase in life expectancy at birth has gradually shifted to people over age 65

Change attributable to (in years)	Males			
	1931-1951	1951-1971	1971-1991	1991-2011
Infant mortality (<1)	**4.1**	**1.6**	0.9	0.1
Mortality (1-44)	3.3	0.8	1.0	0.8
Older adult mortality (45-64)	0.0	0.4	**1.6**	1.2
Elderly mortality (65+)	0.0	0.4	1.3	**2.9**
Total Change in Life Expectancy	7.4	3.2	4.8	5.1
% attributable to 65+	*0%*	*12%*	*28%*	*58%*

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

Mortality Rate by Cause
Males 65+

per 1,000

Annual MIR (Until 2012)	Malignant Neoplasms	Diseases of Heart
Last 30 Years	0.8%	3.6%
Last 20 Years	1.3%	4.4%
Last 10 Years	1.7%	4.6%
Last 5 Years	1.8%	4.2%

Diseases of Heart
Malignant Neoplasms
Cerebrovascular Diseases
Chronic Lower Respiratory Diseases
Accidents (unintentional injuries)

1979 1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012
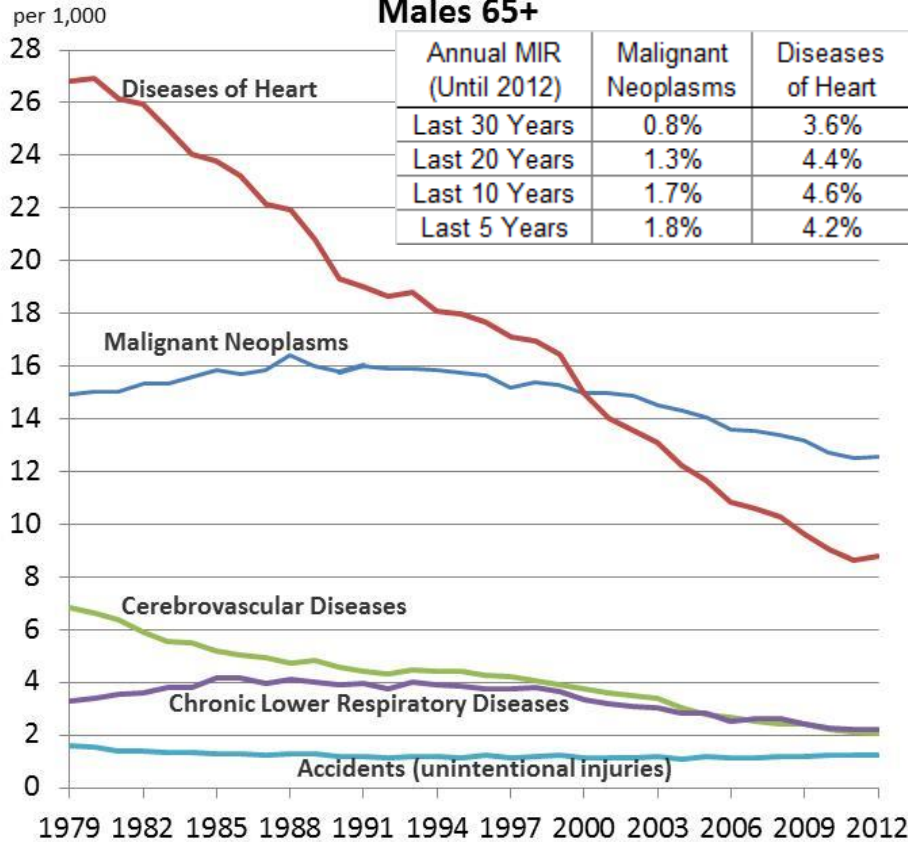
Mortality Rate by Cause
Females 65+

per 1,000

Annual MIR (Until 2012)	Malignant Neoplasms	Diseases of Heart
Last 30 Years	-0.1%	3.2%
Last 20 Years	0.3%	4.0%
Last 10 Years	0.8%	4.4%
Last 5 Years	0.8%	4.3%

Diseases of Heart
Malignant Neoplasms
Cerebrovascular Diseases
Chronic Lower Respiratory Diseases
Accidents (unintentional injuries)

1979 1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012
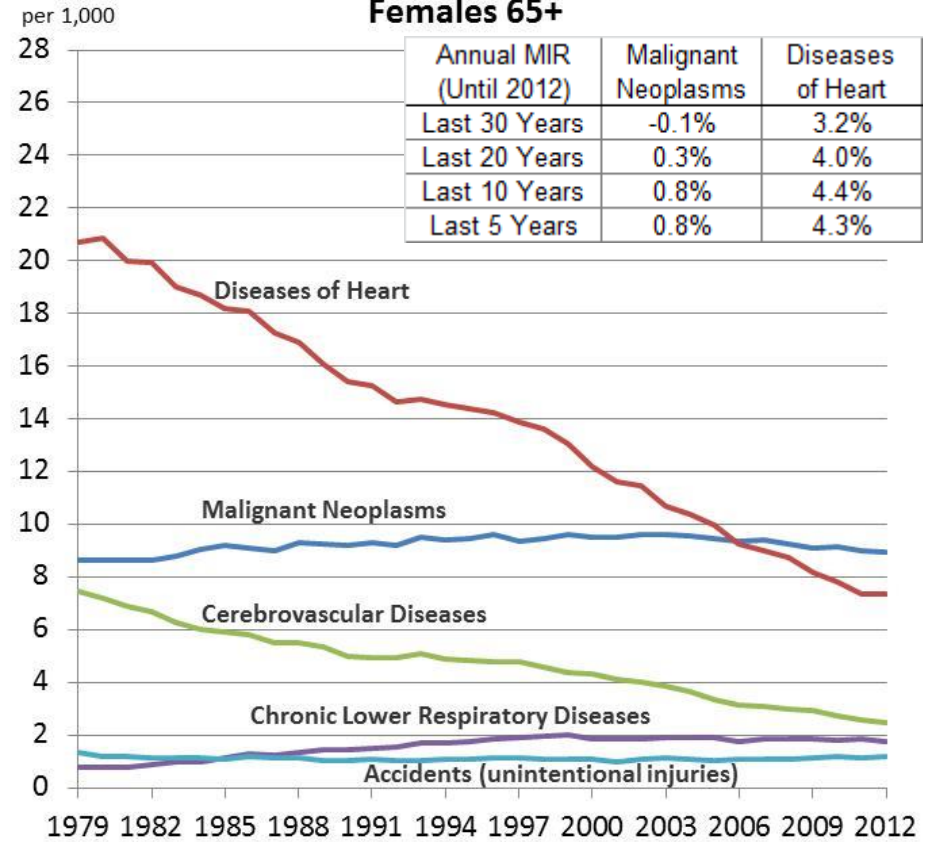
Source: Data from Statistics Canada, Canadian Vital Statistics and OCA Calculations
Standardized Using 2011 Canadian Population

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

Number of deaths per 1,000 (2011, both sexes)

Legend: Canada, Japan, France, Spain, Australia, UK, Switzerland, Sweden

Categories: 65 to 74, 75 to 84, 85 to 89, 90 to 94, 95 to 99

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Mortality Rates by Cause

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

Legend: Canada, Japan, France, Spain, Australia, United Kingdom, Switzerland, Sweden, Italy

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Source : World Health Organization

Males Mortality Improvement Rates based on HMD 15-year Average

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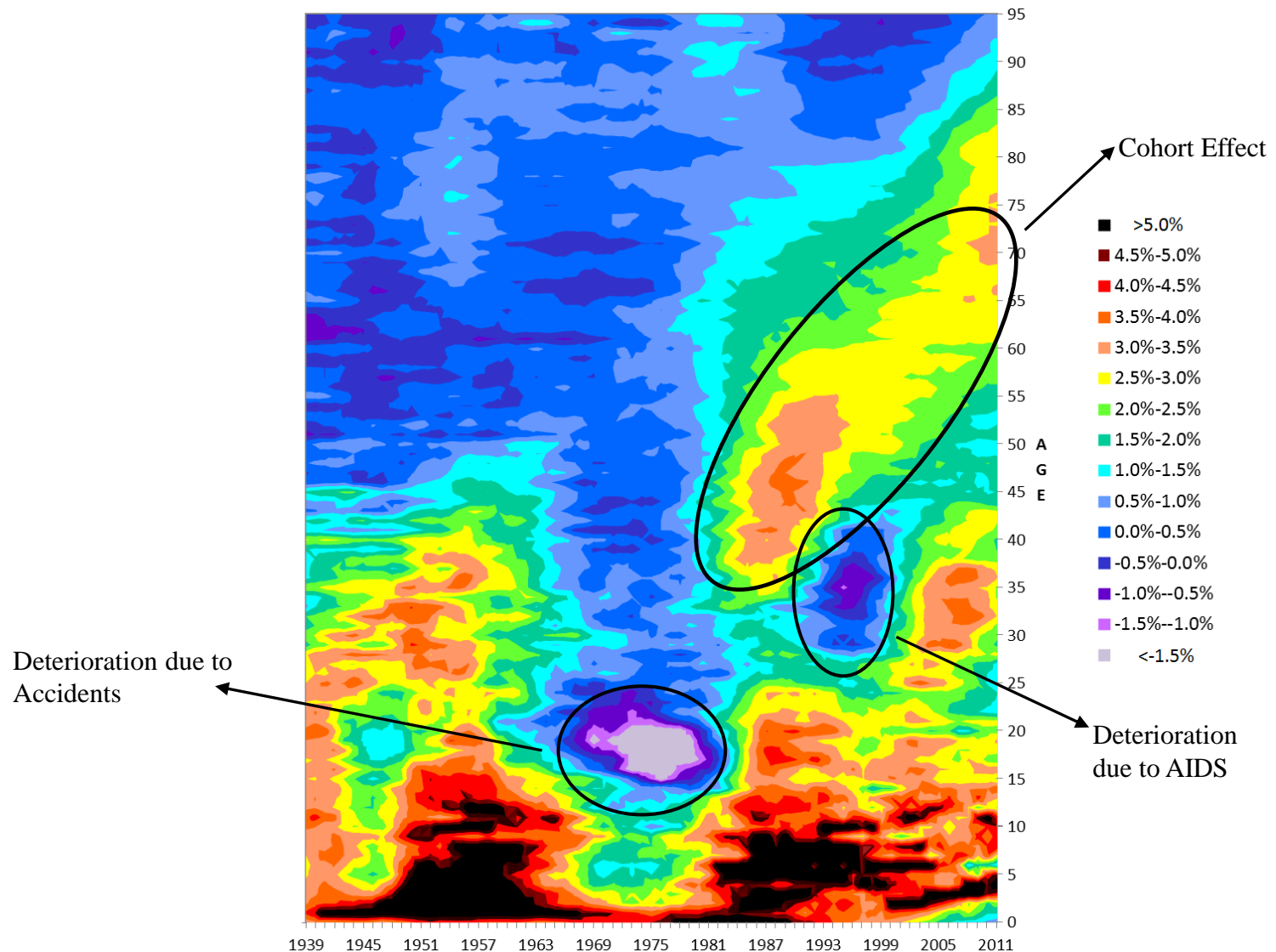
Males and Female Mortality Improvement Rates 10-year Average

(Based on HMD Qx until 2011, blend of HMD and Adjusted OAS Qx from 2012 to 2014)
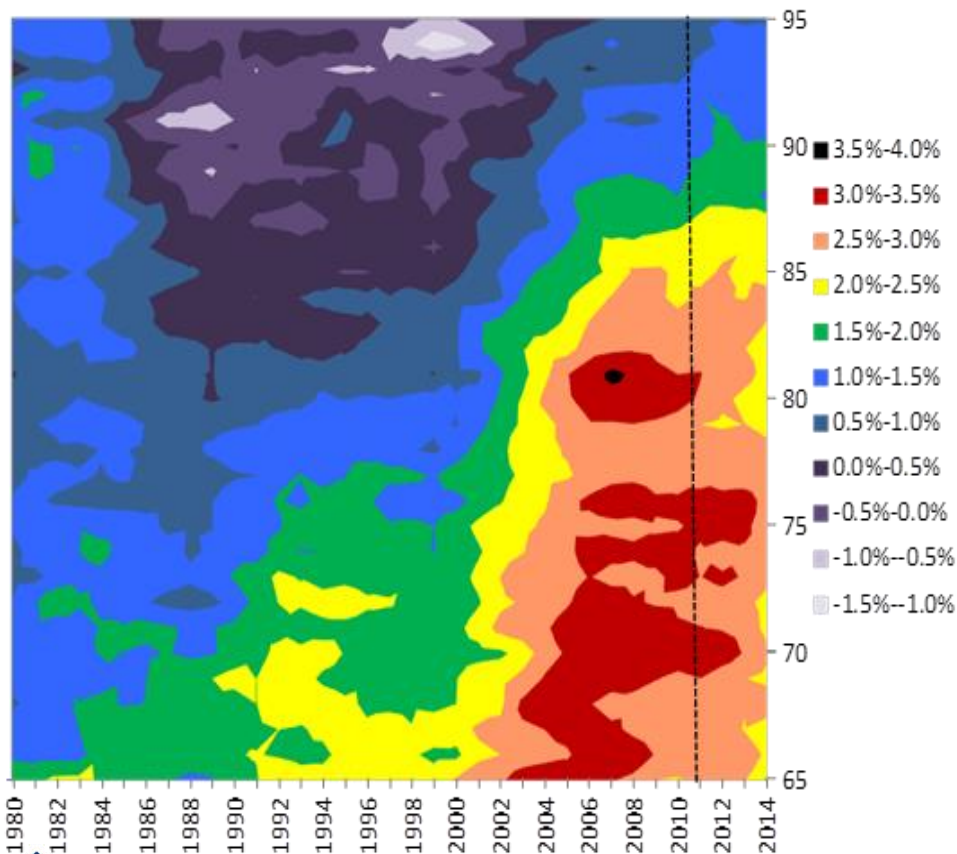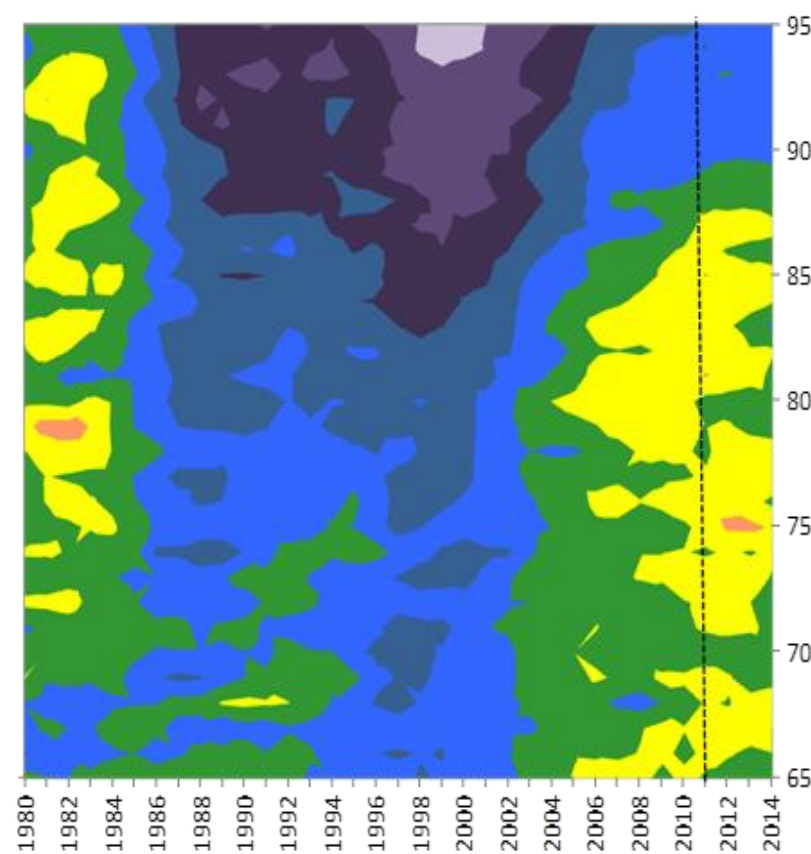
Slowdown in mortality improvements in recent years: a blip or a new trend?

- *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

	Males	**Females**
MP-2014 (in 2014)	21.6	23.8
MP-2016 (in 2016)	20.8	22.8
Changes	(0.8)	(1.0)

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Future drivers of mortality are not easy to quantify

- Future drivers of mortality could be <u>positive</u>
  - Enhanced medical treatment, pharmaceuticals, technology breakthroughs
- as well as <u>negative</u>
  - Obesity, antimicrobial resistance (700,000 per annum globally now; 10m by 2050?), natural and man-made disasters (increasing with future climate change)
- as well as <u>unknown</u>
- "Easy" gains have been somewhat achieved
  - For cardiovascular diseases: improved diagnostics and treatment of risk factors such as high blood pressure and cholesterol
  - Decrease in smoking prevalence: effects should continue for awhile but will diminish in 20-30 years.

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The ultimate mortality improvement rates are sometimes based on historical averages

Average Historical Mortality Improvement Rates
1921-2011, Canada

Age Group	MIR 1921-2011 (%)		
	Male	Female	Both
65-74	0.8	1.5	1.2
75-84	0.7	1.2	1.0
85-94	0.5	0.8	0.7
95-99	0.2	0.4	0.3
65+	0.7	1.1	0.9
85+	0.4	0.7	0.6
85-89	0.5	0.9	0.8
90-94	0.3	0.6	0.5

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Estimates of MIRs for ages 65+ for 2012-2014 incorporate OAS experience

CPP27 Assumed Annual Mortality Improvement Rates for Canada

Age	Males				Females		
	2012-2014*	2015-2031*	2032+		2012-2014*	2015-2031*	2032+
	%	%	%		%	%	%
0	0.7	0.7	0.8		0.4	0.6	0.8
1-14	3.5	1.9	0.8		2.5	1.5	0.8
15-44	2.1	1.2	0.8		1.2	1.0	0.8
45-64	1.9	1.2	0.8		1.2	1.0	0.8
65-74	2.9	1.6	0.8		1.9	1.3	0.8
75-84	2.8	1.6	0.8		2.1	1.3	0.8
85-89	2.0	1.3	0.8		1.7	1.2	0.8
90-94	1.3	0.9	0.5		1.2	0.9	0.5
95+	0.4	0.3	0.2		0.5	0.4	0.2

*The mortality improvement rates shown for 2012-2014 and 2015-2031 represent average rates over these periods.

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For ages 65 to 74, 7 deaths per 1,000 are from cancer, while only 3 deaths per 1,000 are from heart diseases

Ages 65-74

Death Rate per 1,000 Top 5 Causes	Canada 2012	U.S. 2012	Ratio Can/US
Neoplasms	6.6	6.3	1.05
Diseases of the Heart	2.6	3.9	0.67
Lower Respiratory	0.7	1.4	0.50
Cerebrovascular	0.5	0.8	0.63
Diabetes	0.5	0.7	0.71

Legend:
- Can-Males
- Can-Females
- US-Males
- US-Females

22% Reduction

52% Reduction

40% Reduction

40 deaths per 1,000 (1931)

31 deaths per 1,000 (1971)

22 deaths per 1,000 (1991)

15 deaths per 1,000 (2011) 22% lower than US Qx

9 deaths per 1,000 (2051)

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Male mortality rates for ages 75 to 84 for Canada are projected to become similar to US female mortality rates

Ages 75-84

Death Rate per 1,000 Top 5 Causes	Canada 2012	U.S. 2012	Ratio Can/US
Neoplasms	13.1	11.6	1.13
Diseases of the Heart	7.9	11.0	0.72
Cerebrovascular	2.5	2.7	0.93
Lower Respiratory	2.4	3.6	0.67
Diabetes	1.2	1.5	0.80

Legend:
- Can-Males
- Can-Females
- US-Males
- US-Females

22% Reduction   45% Reduction   39% Reduction

| 96 deaths per 1,000 (1931) | 75 deaths per 1,000 (1971) | 61 deaths per 1,000 (1991) | 41 deaths per 1,000 (2011) 17% lower than US Qx | 25 deaths per 1,000 (2051) |

Source: office of the chief Actuary, 27th CPP Actuarial Report and 2015 OASDI Trustees Report
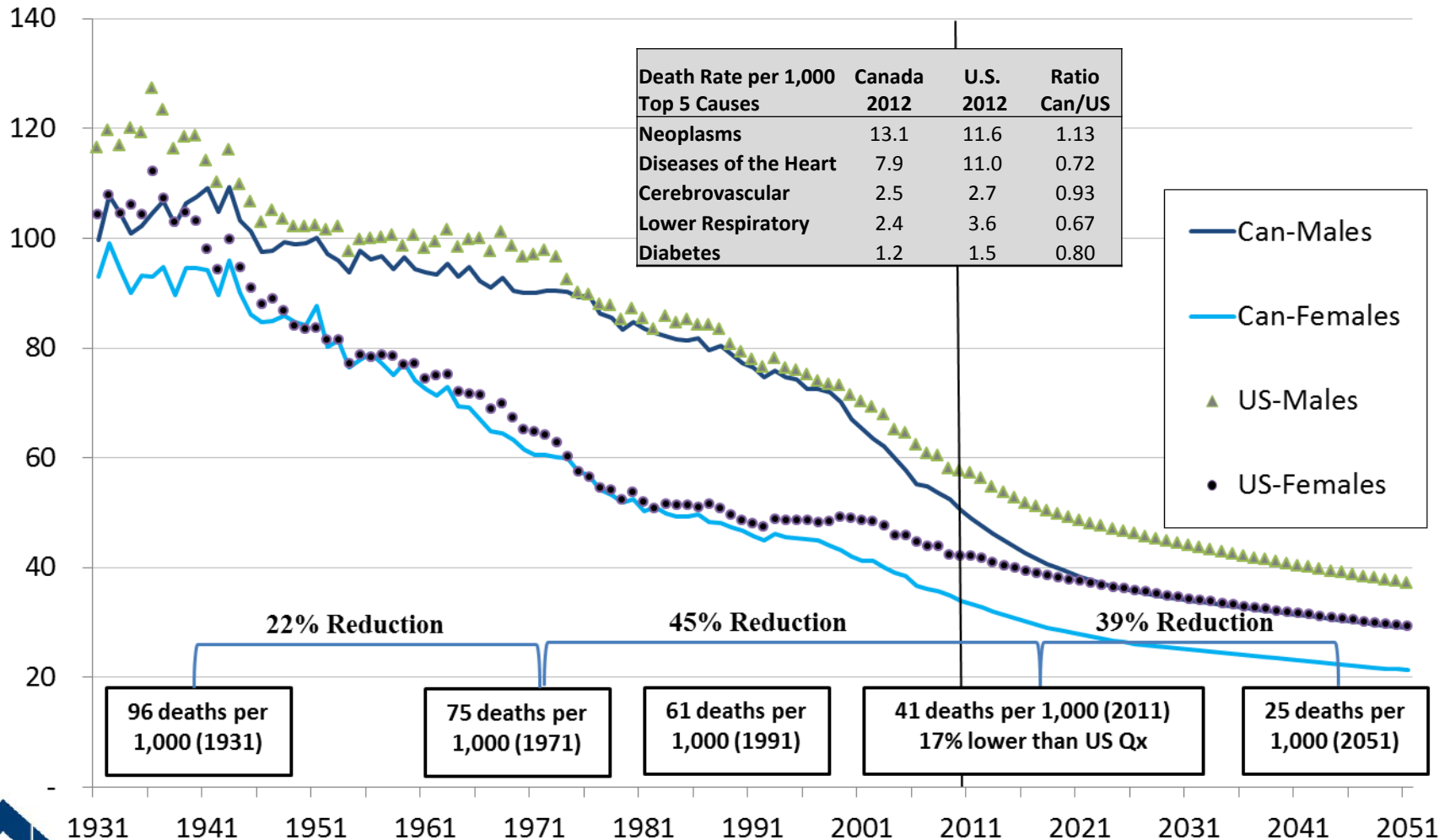
U.S. National Vital Statistics Report, Volume 63 No.9 and Statistics Canada catalogue 84-215-x
Standardized using 2015 Canadian population

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Elderly mortality have decreased over the last 80 years, more so over the last 10 years

Ages 85-89

Death Rate per 1,000 Top 5 Causes	Canada 2012	U.S. 2012	Ratio Can/US
Diseases of the Heart	21.7	28.2	0.77
Neoplasms	19.3	16.0	1.21
Cerebrovascular	6.7	6.9	0.97
Lower Respiratory Dis	4.9	6.2	0.79
Alzheimer's	4.1	6.3	0.65

17% Reduction 34% Reduction 35% Reduction

175 deaths per 1,000 (1931)

146 deaths per 1,000 (1971)

124 deaths per 1,000 (1991)

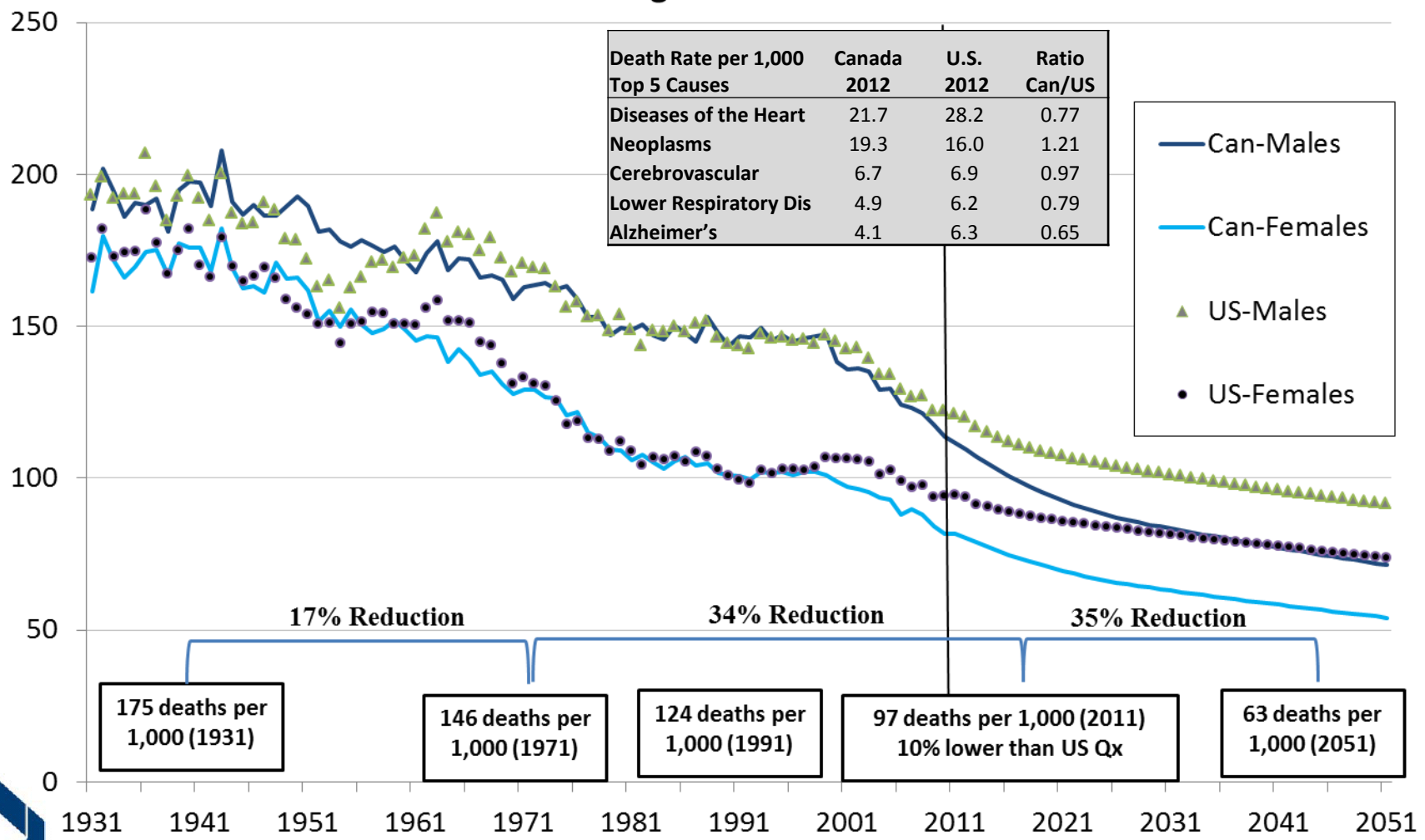97 deaths per 1,000 (2011) 10% lower than US Qx

63 deaths per 1,000 (2051)

U.S. National Vital Statistics Report, Volume 63 No.9 and Statistics Canada catalogue 84-215-x Standardized using 2015 Canadian population

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Projected Life Expectancy at 65
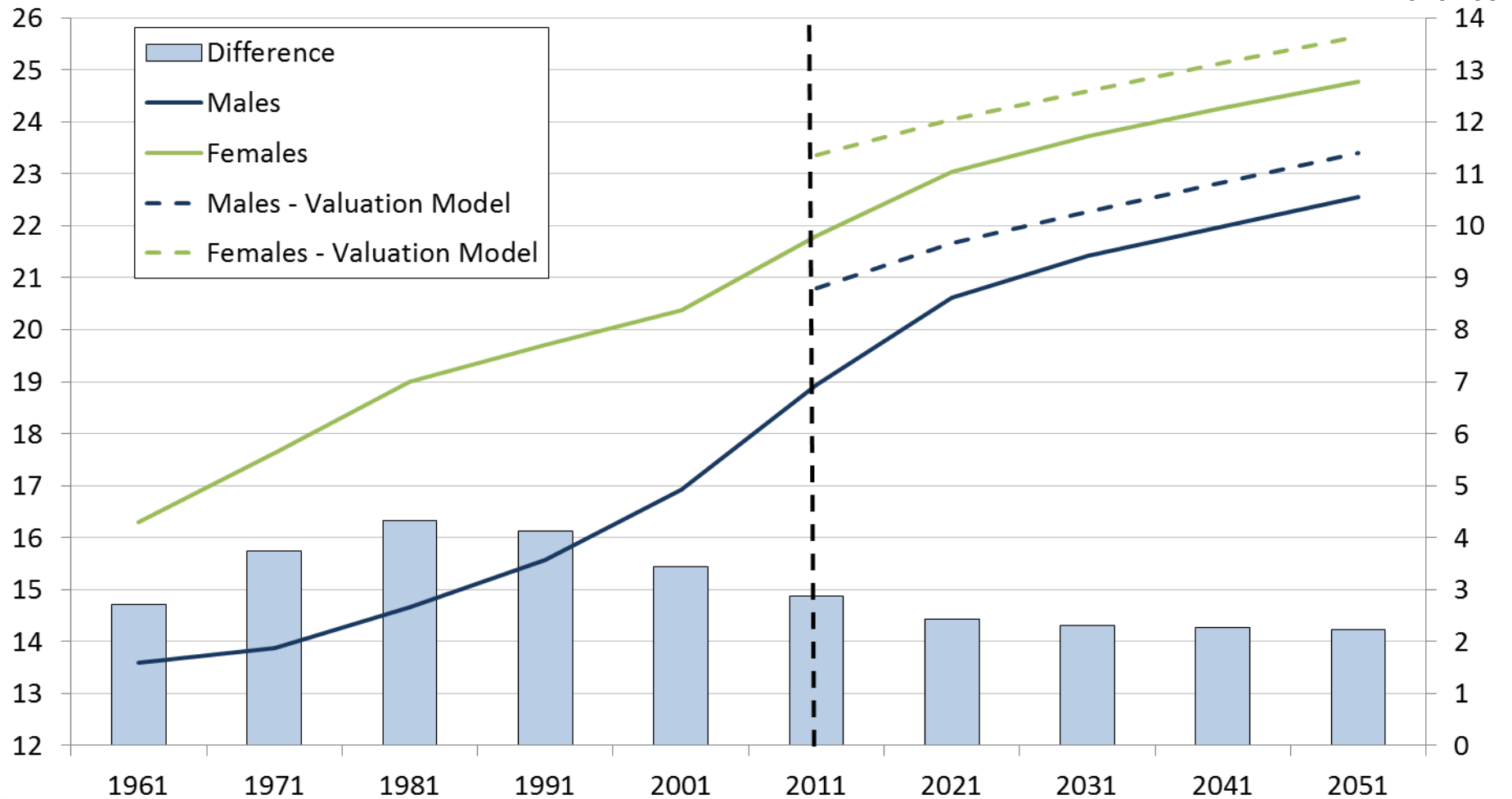
More contributors are expected to reach the retirement age of 65 (93% for someone age 18 in 2015). Retirement beneficiaries are expected to receive their benefits for a longer period.
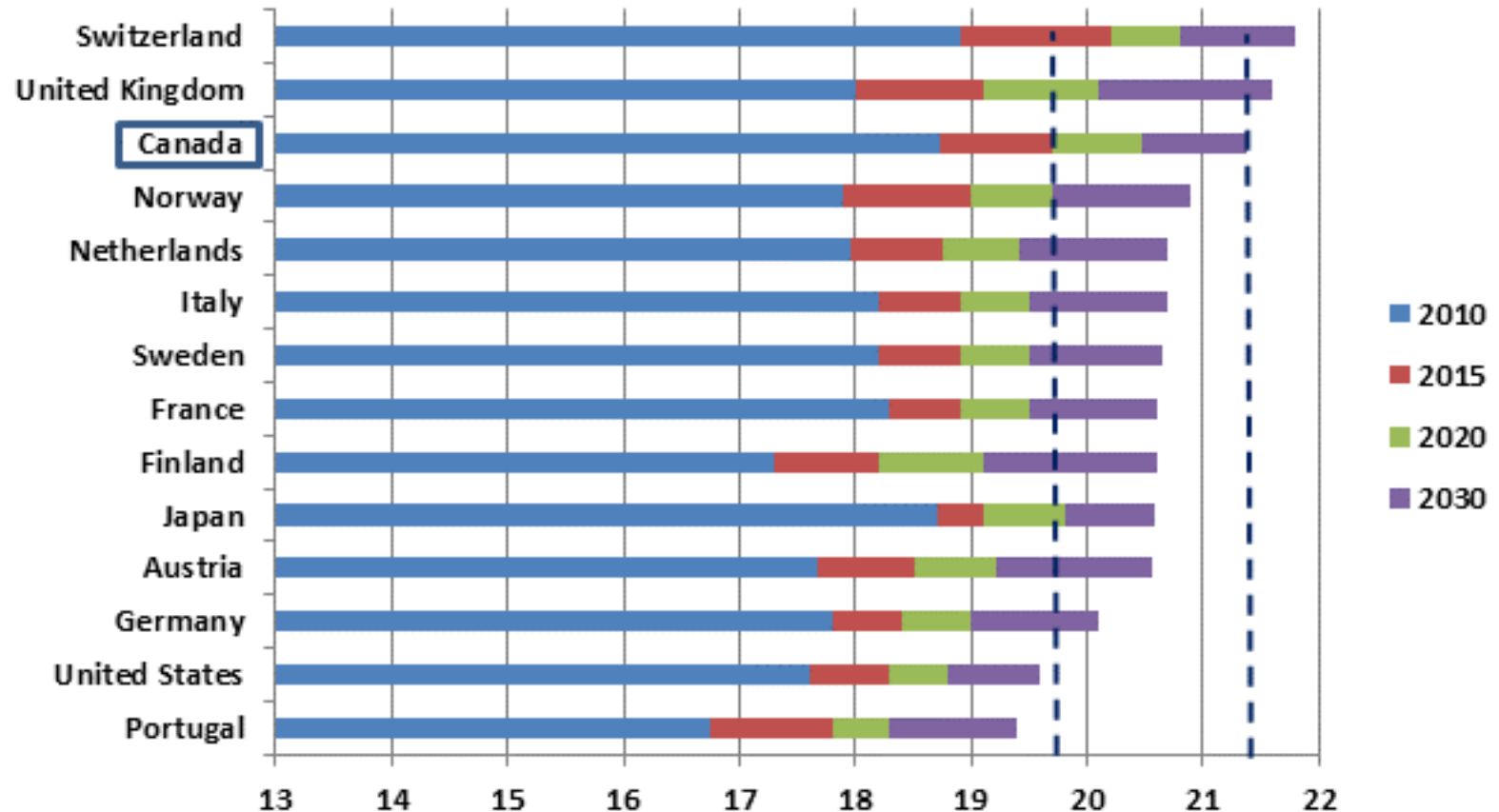
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International Comparisons - Males

Projected period life expectancy at age 65 - males

Legend: 2010, 2015, 2020, 2030

Countries (top to bottom): Switzerland, United Kingdom, Canada, Norway, Netherlands, Italy, Sweden, France, Finland, Japan, Austria, Germany, United States, Portugal

X-axis: 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

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 CPP 27th assumptions.
Data for Japan are from National Institute of Population and Social Security Research (Sept. 2013).

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International Comparisons - Females

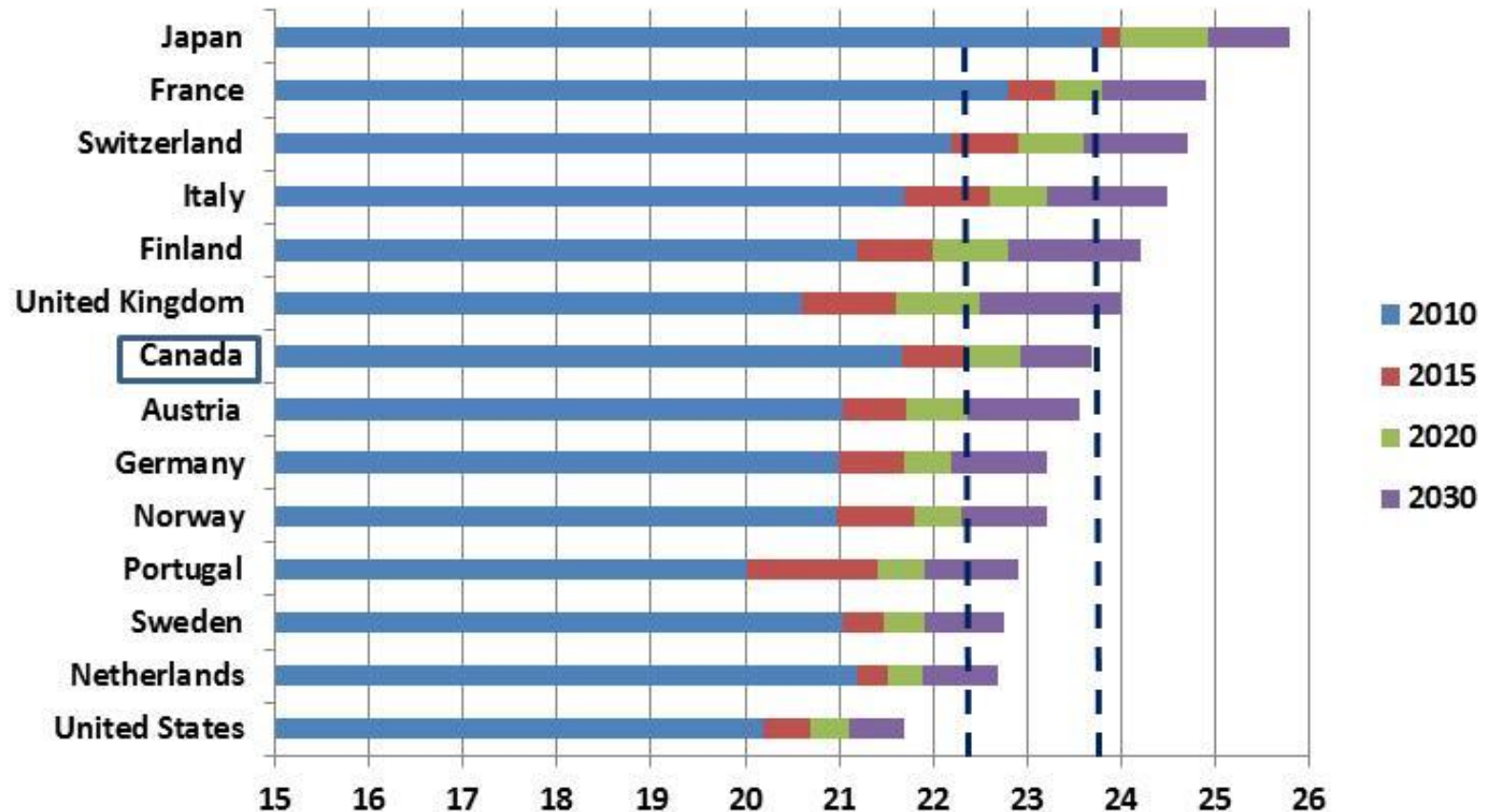Projected period life expectancy at age 65 - females

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 CPP 27th assumptions.
Data for Japan are from National Institute of Population and Social Security Research (Sept. 2013).

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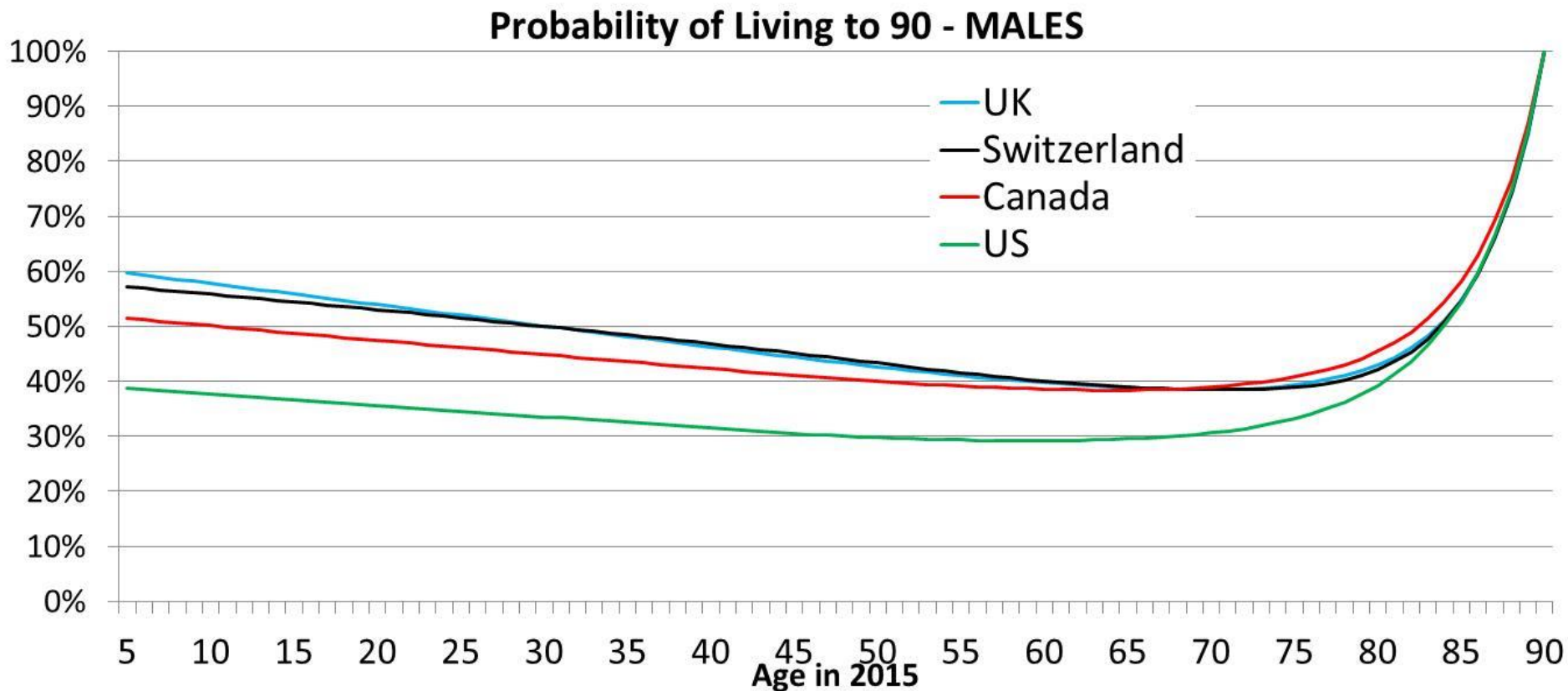# *Three-quarters of Canadian men aged 20 today are expected to live to age 80 (82% of women)*

Probability of Living to 80 - MALES
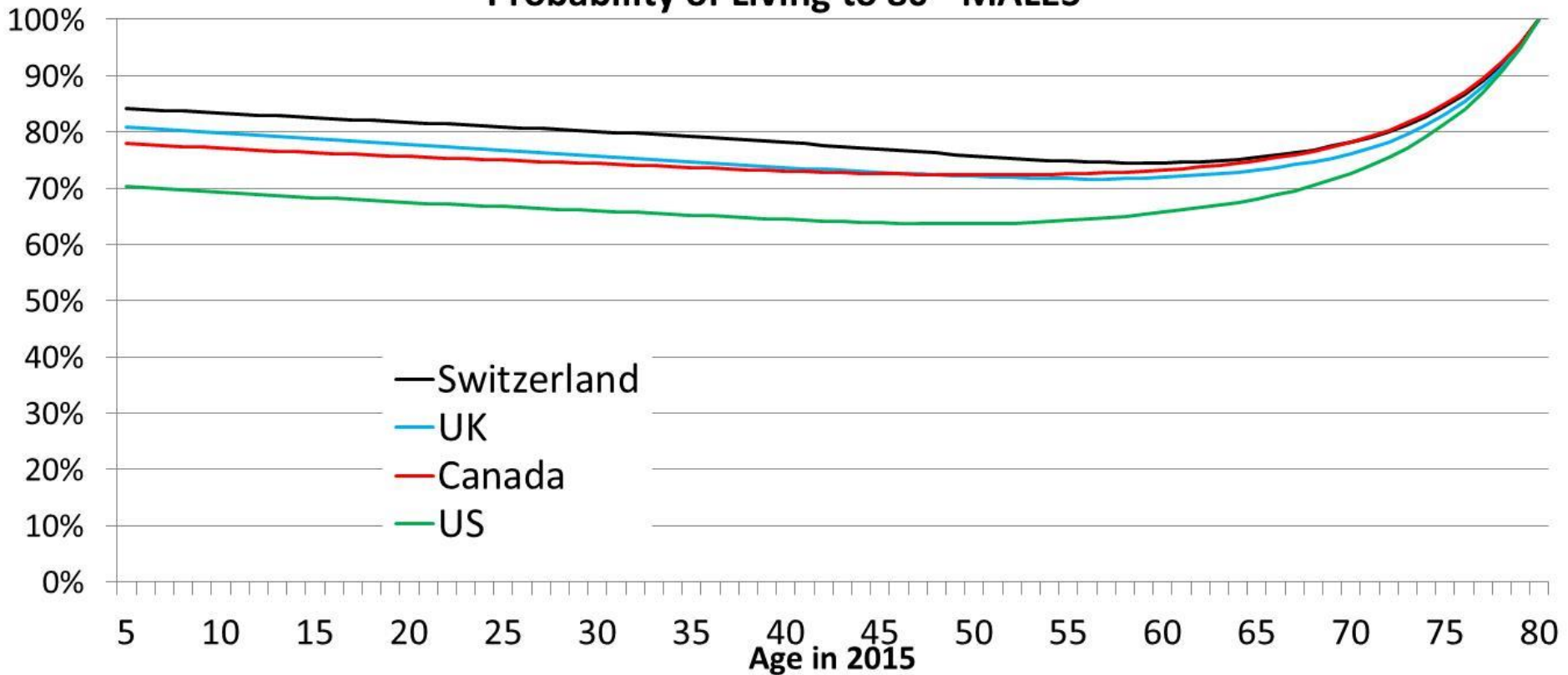
Legend: Switzerland, UK, Canada, US
X-axis: Age in 2015 (5 to 80)
Y-axis: 0% to 100%

Source: UK Office for National Statistics, Confédération Suisse – Office fédéral de la statistique, 27th CPP Actuarial Report, 2015 OASDI Trustees Report

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

Probability of Living to 90 - MALES

Legend: UK, Switzerland, Canada, US

Age in 2015

Source: UK Office for National Statistics, Confédération Suisse – Office fédéral de la statistique, 27th CPP Actuarial Report, 2015 OASDI Trustees Report

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

Probability of Living to 100 - MALES

Legend: UK, Switzerland, Canada, US

Y-axis: 0% to 100%
X-axis: Age in 2015 (5 to 100)

Source: UK Office for National Statistics, Confédération Suisse – Office fédéral de la statistique, 27th CPP Actuarial Report, 2015 OASDI Trustees Report
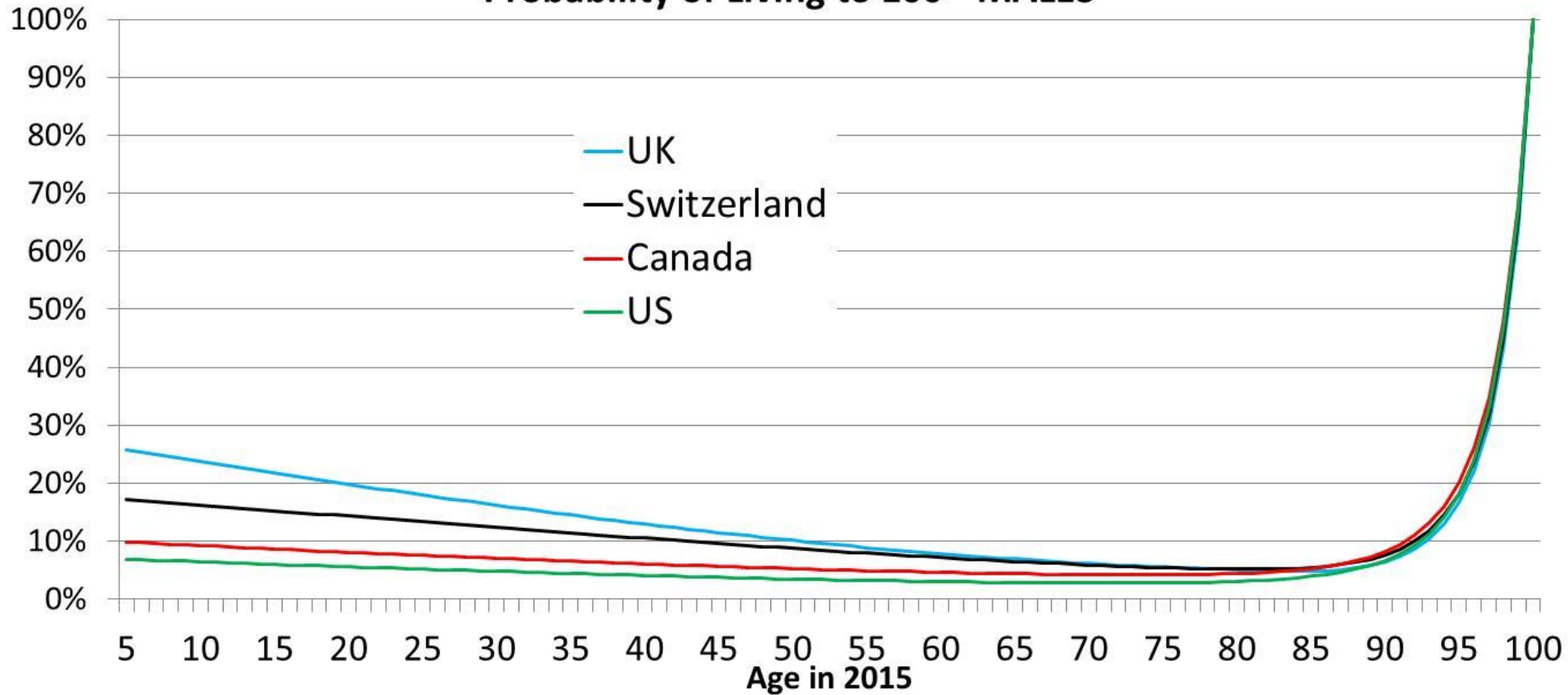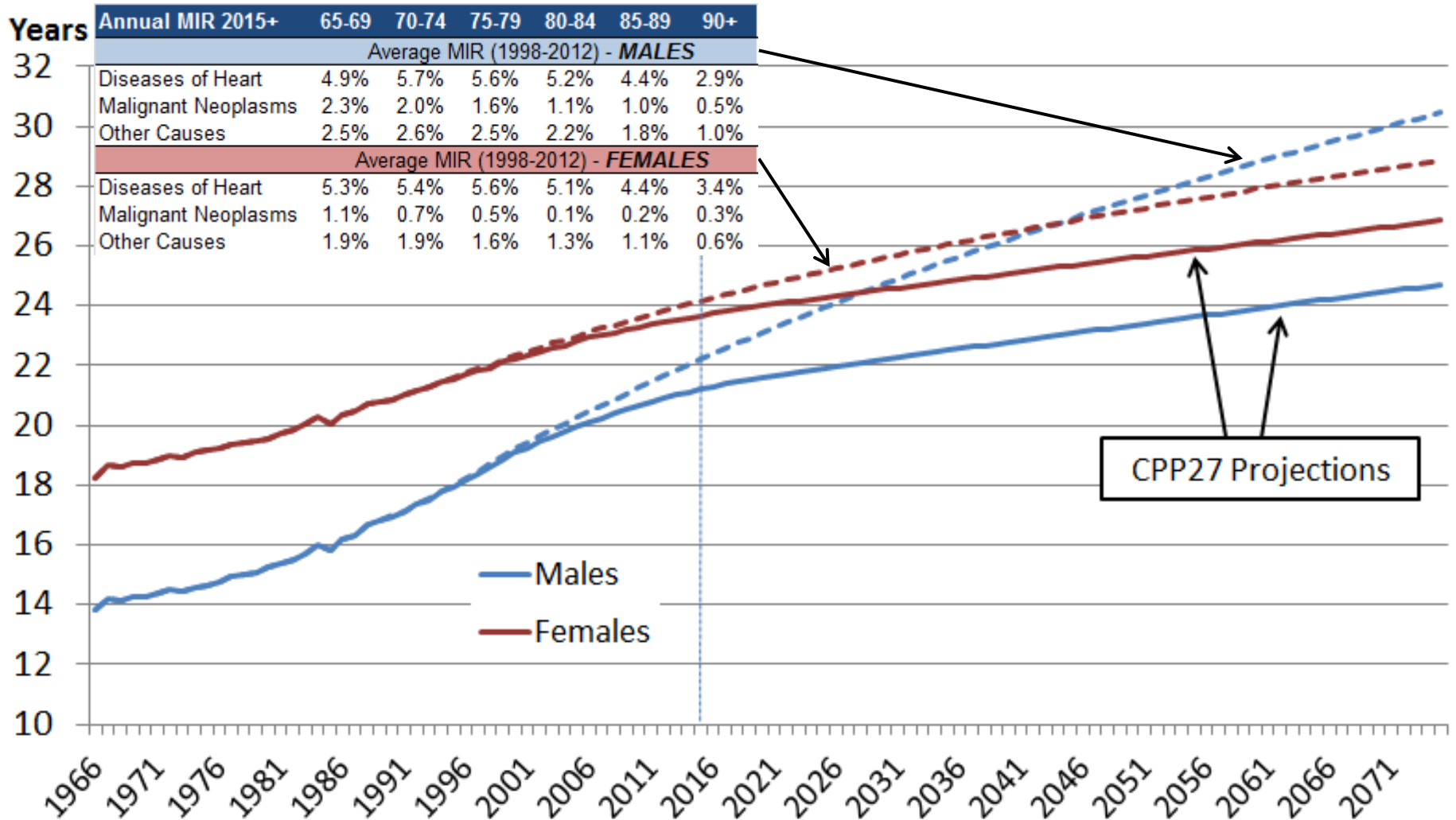
Uncertainty of Results
Life Expectancies at age 65 if MIRs by cause are sustained

Annual MIR 2015+	65-69	70-74	75-79	80-84	85-89	90+
Average MIR (1998-2012) - **MALES**						
Diseases of Heart	4.9%	5.7%	5.6%	5.2%	4.4%	2.9%
Malignant Neoplasms	2.3%	2.0%	1.6%	1.1%	1.0%	0.5%
Other Causes	2.5%	2.6%	2.5%	2.2%	1.8%	1.0%
Average MIR (1998-2012) - **FEMALES**						
Diseases of Heart	5.3%	5.4%	5.6%	5.1%	4.4%	3.4%
Malignant Neoplasms	1.1%	0.7%	0.5%	0.1%	0.2%	0.3%
Other Causes	1.9%	1.9%	1.6%	1.3%	1.1%	0.6%

CPP27 Projections

— Males
— Females

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

Survival Curves for a Life Expectancy of 100 (Males)
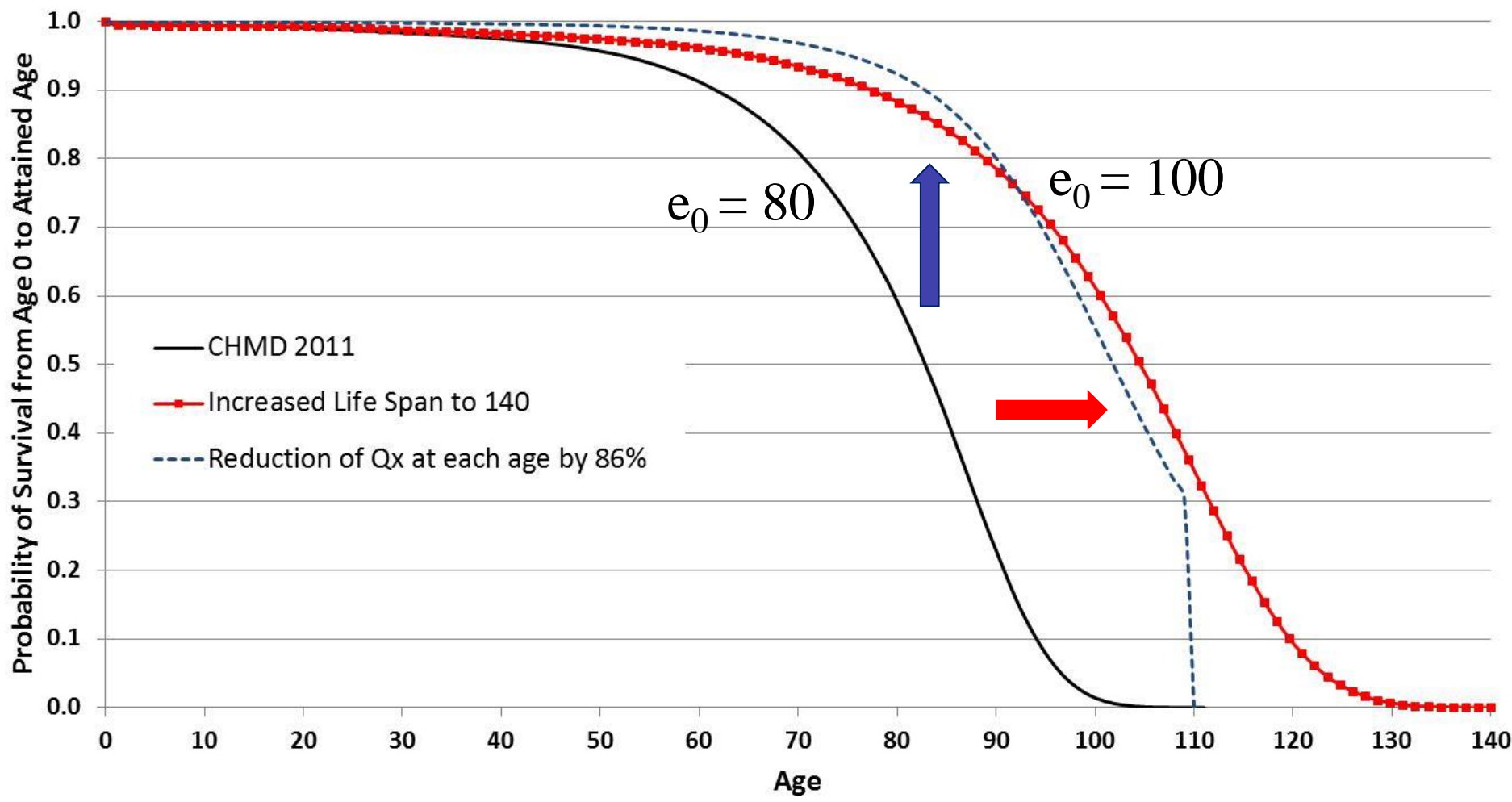
To live beyond 100…

- 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.

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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.
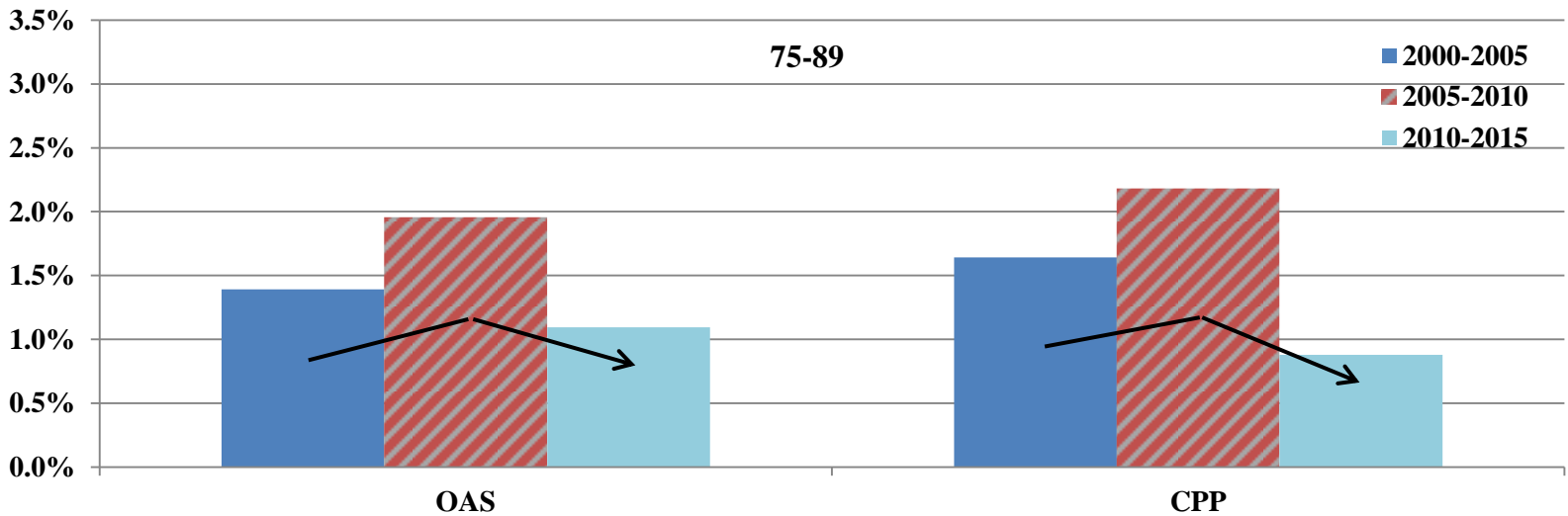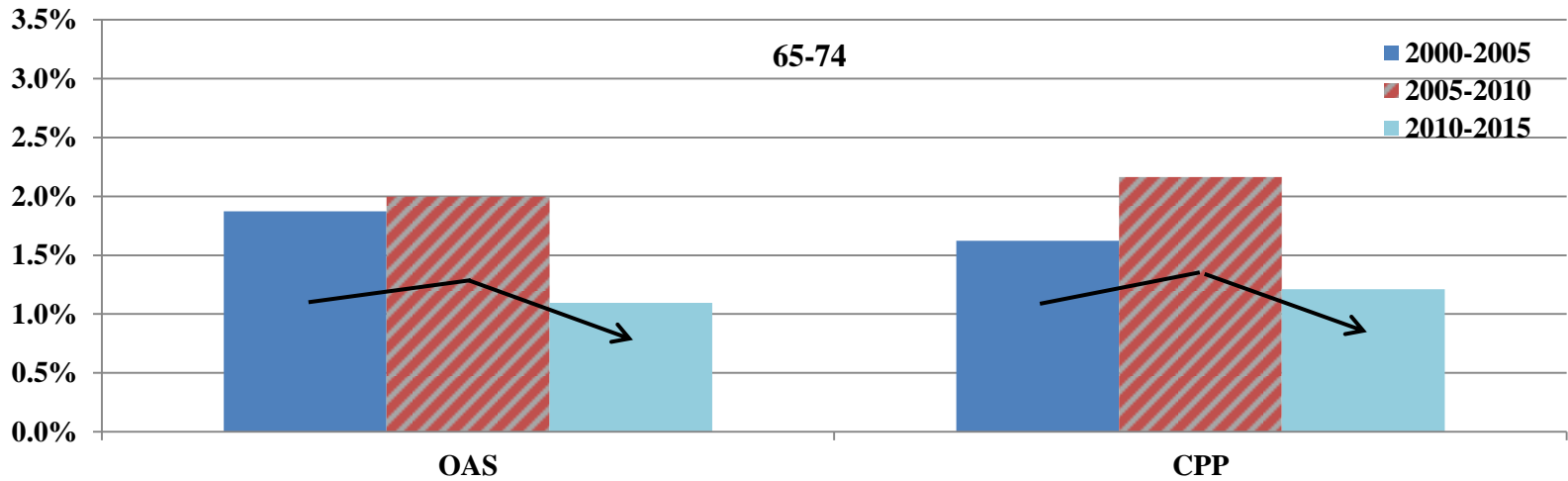
CPP-OAS Average Annual
Mortality Improvement Rates (females)

Source: Office of the Chief Actuary calculations.

Contribution to increase in life expectancy at birth has gradually shifted to people over age 65

Change attributable to (in years)	Females			
	1931-1951	**1951-1971**	**1971-1991**	**1991-2011**
Infant mortality (<1)	3.2	1.4	0.7	0.1
Mortality (1-44)	**4.3**	1.1	0.7	0.3
Older adult mortality (45-64)	1.1	1.0	0.8	0.6
Elderly mortality (65+)	0.6	**2.2**	**1.8**	**1.9**
Total Change in Life Expectancy	9.2	5.8	4.1	3.0
% attributable to 65+	*7%*	*38%*	*45%*	*65%*

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

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