Mortality of Canada Pension Plan and Old Age Security Beneficiaries: Implications for Public Pensions
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Foreword

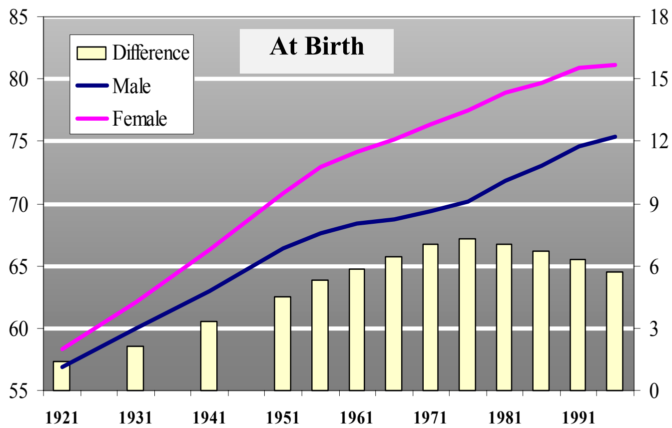
Worldwide, the 20th century brought tremendous gains in life expectancies. In 1900, roughly 75% of the Canadian population died before reaching age 65; today, 70% of the population dies after age 65. Over the last century life expectancy at birth increased by an estimated 27 years with the rate of change diminishing as the century progressed. Most experts agree that the rapid increase in life expectancy of the 20th century will not continue. Future increases in life expectancy will have to take place at older ages as younger ages have already experienced most of the improvement they are likely to see. This study presents an overview of historical and future mortality trends in Canada as well as the results of a mortality study of CPP retirement and survivor beneficiaries.

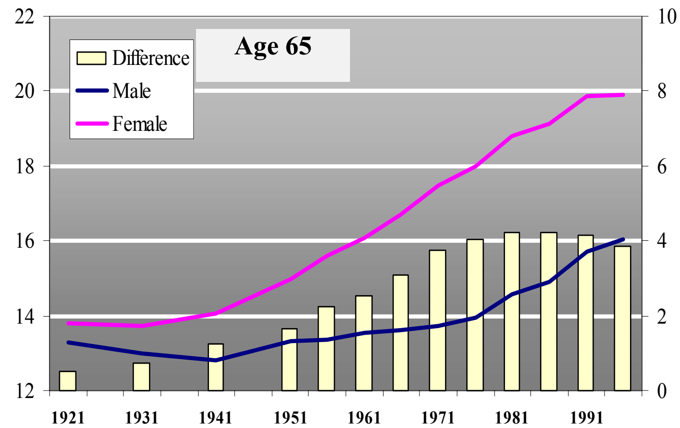
I. Canadian Mortality Trends

Like the rest of the industrialized countries around the world, Canada has seen significant improvements in life expectancy over the last century. Improvements in the standard of living and in working conditions, implementation of good health care programs and tremendous gains in the medical domain have all contributed to an increase in life expectancy.

Chart 1 and Table 1 show the evolution of Canadian life expectancy at birth and at age 65 from 1921 to 1996 using the Life Tables for Canada (LTC), as published by Statistics Canada.

Chart 1 Life Expectancies Since 1921





In the last-century, most of the increases in life expectancy at birth have occurred before 1970. Since the early 1970s life expectancy at birth has increased by 6 years, which is much less than the estimated 21-year increase experienced from 1900 to 1970. Since 1981, male longevity has been catching up to female longevity. Increases in life expectancy at age 65 for males were relatively small over the first 70 years of the 20th century, increasing by about half a year as compared to almost four years for females. Since the early 1970s, male and female life expectancy at age 65 has increased by about two and a half years to 16.0 and 19.9 years for males and females respectively.

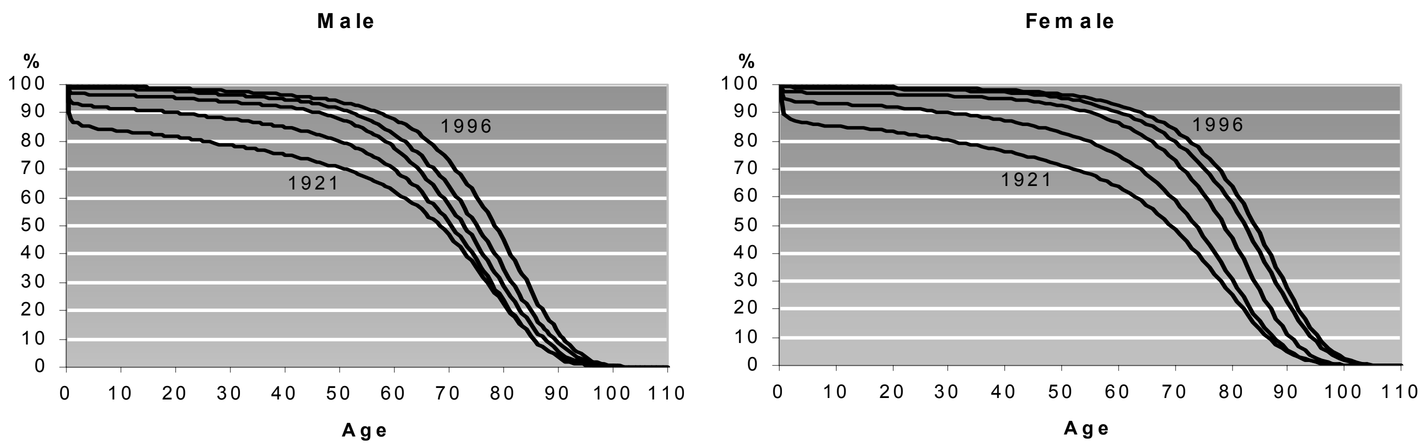
Table 1 Life Expectancies

	Life Expectancy at Birth			Life Expectancy at Age 65		
Year	**Male**	**Female**	**Difference**	**Male**	**Female**	**Difference**
1921	56.9	58.3	1.4	13.3	13.8	0.5
1931	60.0	62.1	2.1	13.0	13.7	0.7
1941	63.0	66.3	3.3	12.8	14.1	1.3
1951	66.4	70.8	4.4	13.3	15.0	1.7
1961	68.4	74.2	5.8	13.5	16.1	2.6
1971	69.4	76.4	7.0	13.7	17.5	3.8
1981	71.9	78.9	7.0	14.6	18.8	4.2
1991	74.6	80.9	6.3	15.7	19.9	4.2
1996	75.4	81.2	5.8	16.0	19.9	3.9

Even though life expectancy increased considerably over the last century, the maximum age to which we can live has not improved much for centuries. Increasing life expectancy through medical discoveries and a better standard of living cannot do much for the fact that with time the human body is continuously aging.

Chart 2 shows the population survival curves (probability for a newborn to survive to a given age) based on the LTC mortality rates for 1921, 1941, 1961, 1981 and 1996. The "squaring" of the survival curve can be explained by the increase in life expectancy while the maximum age to which we can live is assumed to remain constant at 110 years.

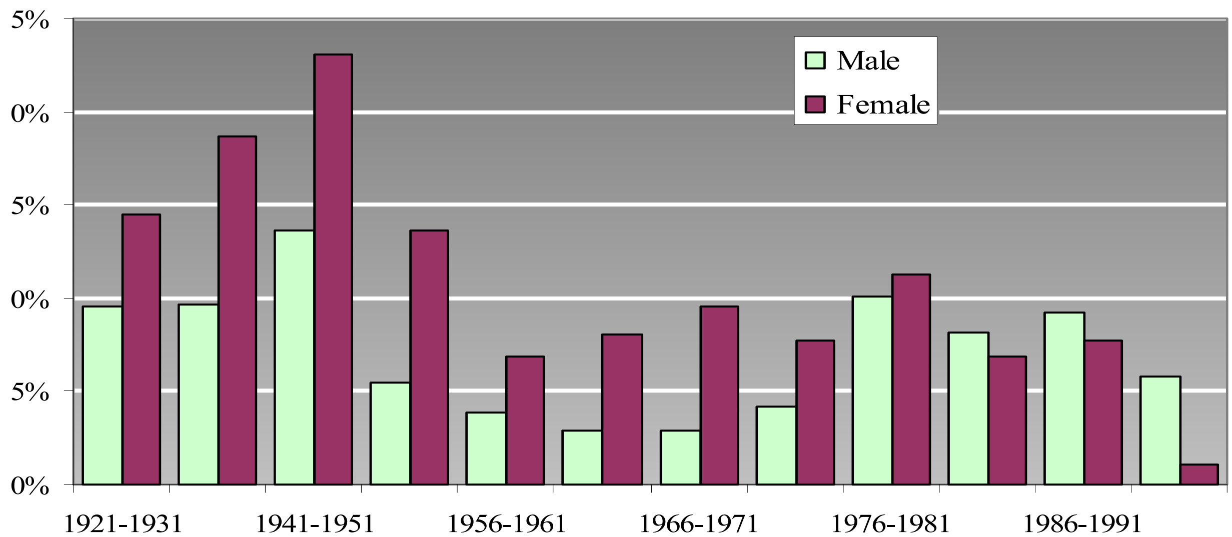
Chart 2 Survival Curves since 1921



Most of the historical mortality improvements have occurred at ages below 90. One consequence of the squaring of the survival curve is that more people are now surviving to older ages. In 1921 a male newborn had a 56% probability of reaching age 65 while a female newborn had a 57% probability; by 1996 those probabilities had risen to 82% and 90%, respectively. Furthermore, in 1921 a cohort of newborns would have lost half of its members by age 69 for males and by age 70 for females. In 1996 the age by which half of the cohort of newborns has died is 79 for males and 85 for females, an increase of 9 and 15 years respectively.

Chart 3 provides an overview of the average annual population-weighted mortality improvement rates in Canada for various subperiods over the 75 years ended in 1996. Average annual mortality improvement rates for males increased over the first 50 years, they then declined to reach a minimum in the first part of the 60s. They then increased again over the next 15 years but started to decline again over the last 20 years. In fact, mortality improvement rates of females are now lower than for males.

Chart 3 Average Annual Population-Weighted Mortality Improvement Rates

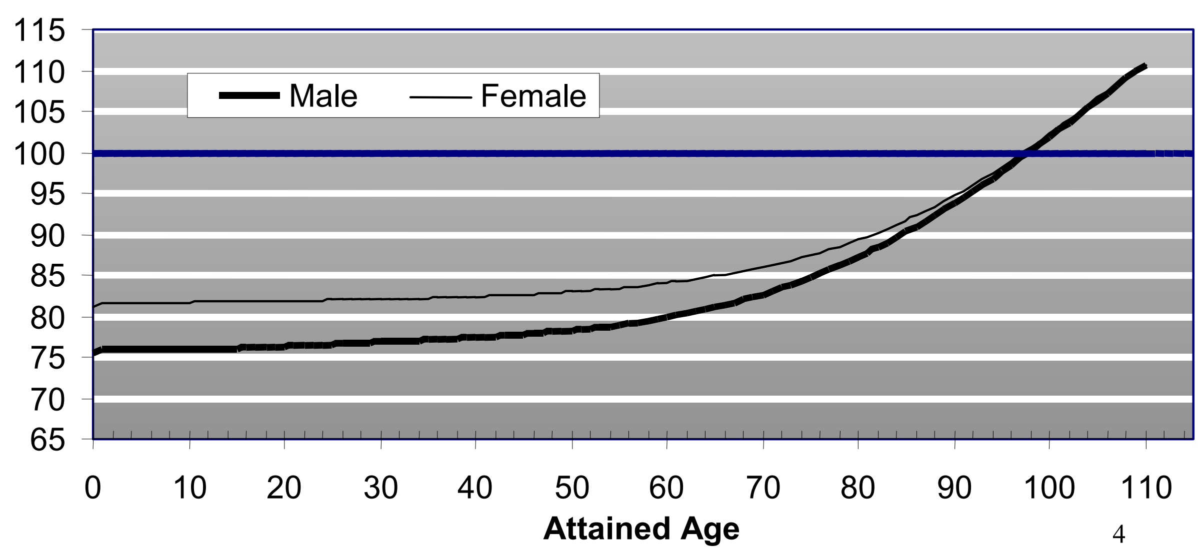


Living to Age 100

The combination of improved mortality, genetic research and advances made in medical science raise a question as to whether a life expectancy of 100 years is possible in the near future. The purpose of this section is to examine the extent to which current mortality rates need to be reduced to obtain a life expectancy at birth of 100 years. We will use simple mathematical models based on the 1995-1997 Life Tables for Canada (LTC) combined with general mortality improvements. A general improvement of, say, 10% means that all of the base mortality rates are reduced by 10%.

The life expectancy for an individual at a given age determines the expected average age at death. Chart 4 below, based on the 1995-1997 LTC, confirms that the average age at death is a non-decreasing function of attained age. It follows that the expected average age at death for a newborn is the lowest of all. From Chart 4 it is interesting to observe that it is only when an individual reaches the age of 98 that the expected average age at death is 100 for both males and females.

Chart 4 Expected Average Age at Death by Attained Age



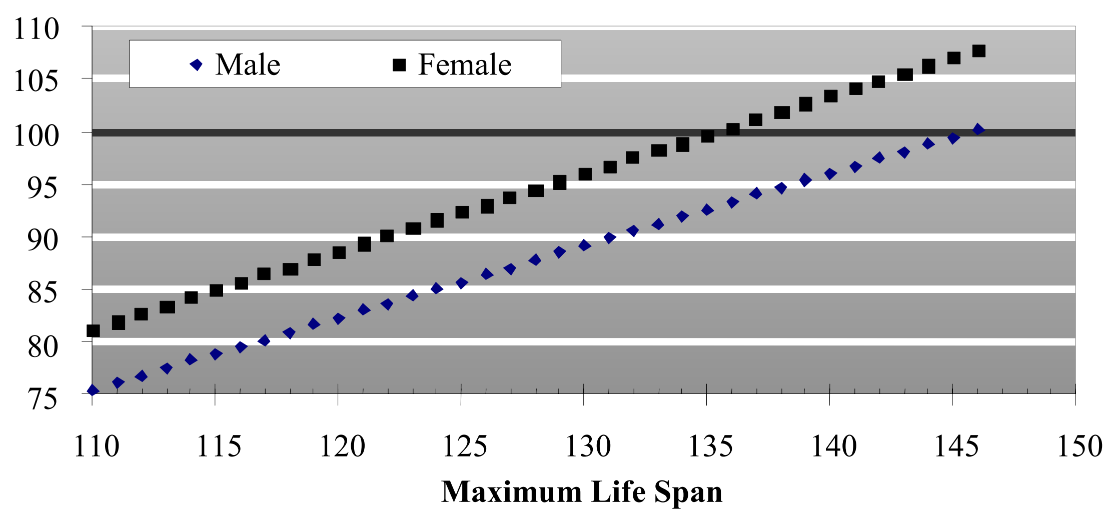
We can now conduct a simple test to see at what age the expected average age at death becomes 100 when we apply a general improvement to the 1995-1997 LTC mortality rates. If there were no mortality from age 0 to any given age, the average age of death for a newborn would then equal the expected average age at death of the given age. As an example, all else being equal, if all mortality rates were zero up to age 98, then the expected average age at death of a newborn would become 100, the same as at age 98.

If we want to have an expected average age at death of 100 for a newborn, the 1995-1997 LTC mortality rates at all ages must decrease by over 90% for males; for females, the corresponding figure is over 85%. The effect is more significant at later ages because the mortality rates are higher. To put these figures in perspective, to achieve a 90% mortality improvement over the next 50 years, we would need an average annual mortality improvement rate of 4.5%. The observed average annual mortality improvement rate in Canada between 1986 and 1996 was about 1.5%. Thus, to achieve 90% mortality improvement would require mortality to improve at three times the current rate, across all ages over the next 50 years, or it would require 150 years of annual mortality improvements equal to the current rate. This test implies that to significantly increase life expectancy at birth, mortality improvements must be significant, especially at later ages.

It makes sense that life expectancy at birth would increase the most if mortality improvement happens at the older ages, as this is where most people die. This suggests measuring the effect of mortality improvement at older ages through an increase in the maximum life span, the ultimate age to which a human being can live. It is worth noting that our mathematical models have so far assumed a maximum life span of 110. Some may consider this unrealistic because significant mortality improvement at older ages should result in an increase in the maximum life span.

Let us examine what effect an increase in the maximum life span has on the life expectancy at birth. Chart 5 presents this information for both males and females. It shows that if we keep the shape of the mortality curve similar to the 1995-1997 LTC using an age mapping, males would need a maximum life span of 146 years to have a life expectancy at birth of 100 years; the comparable figure for females is 135 years.

Chart 5 Life Expectancy at Birth as a Function of Maximum Life Span



Finally, Charts 6 and 7 compare the survival curves for each gender for the two mortality improvement models that result in a life expectancy at birth of 100 years. Chart 6 compares the general mortality improvement of 90% for male ages 0 to 109 with the increase in maximum life span to age 146. The same is done in Chart 7 but for females, for whom the corresponding figures are 85% and age 135.

Chart 6 Comparison of Survival Curves for Males

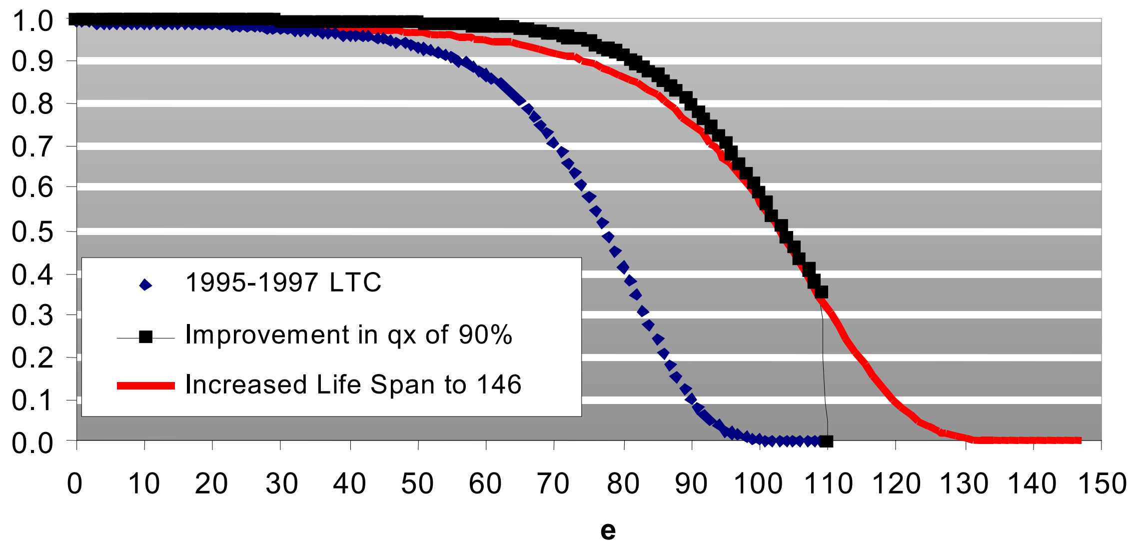
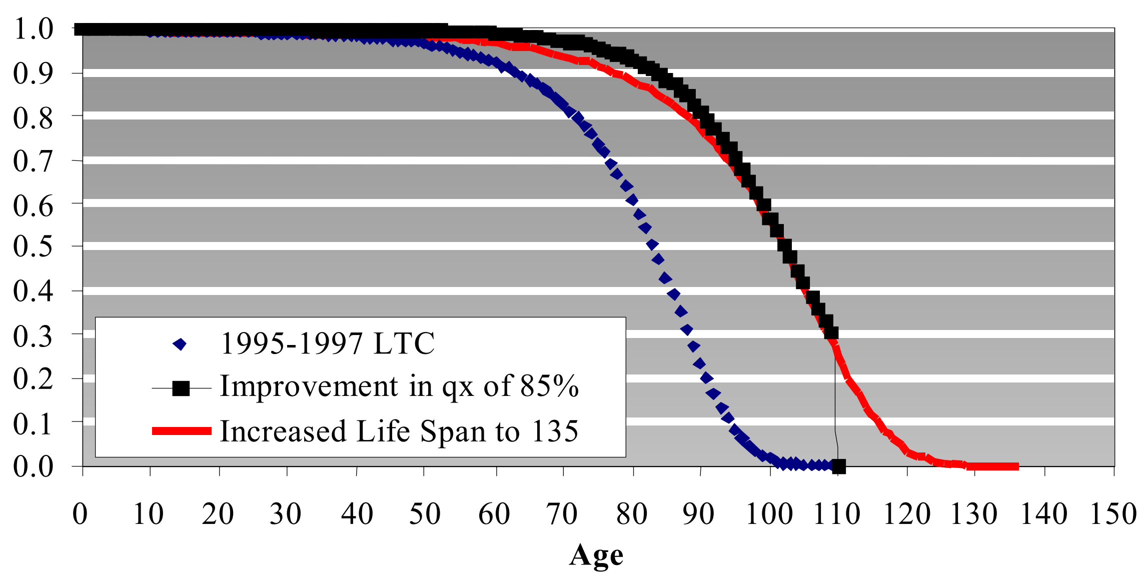


Chart 7 Comparison of Survival Curves for Females



To attain a life expectancy at birth of 100 needs two ingredients:

- Annual mortality improvements much higher than in the past, and
- A significant increase in the maximum life span.

II. Mortality Projections

One of the principal components of the Eighteenth CPP Actuarial Report (AR18) is the population projection, which is used to determine the contributors, beneficiaries and total expenditures in each future year. To obtain the projected population, assumptions on migration, fertility and mortality rates must be made. To project mortality rates, our methodology requires the use of mortality improvement factors.

The methodology used to project mortality rates for AR18 is based on an approach that uses two sets of mortality improvement rates. The first sets defines the initial annual mortality improvement rates based on the most recent mortality experience, and is used to improve mortality rates for the first projection year. The second set is based on a study by cause of death and corresponds to the ultimate annual mortality improvement rates for years 2020 and thereafter. Intermediate annual improvement rates between the initial year and 2020 are determined by linear interpolation.

Table 2 shows the annual mortality improvement rates assumed for 1997 in AR18, based on the Canadian experience over the ten years ended 1997. Beyond 2020, annual mortality improvement rates in AR18 were determined from the latest United States Social Security Administration (SSA) mortality study upon which the 2000 Annual Report of the Board of Trustees as adjusted to reflect Canadian mortality experience. The SSA study was used because of its exhaustive research on mortality improvement rates by cause of death and by age group. Because causes of death in North America should continue to be similar in the future, it is reasonable to assume that the SSA rates should apply to Canadian mortality. However, to recognize historical differences between the two countries, the SSA rates were further adjusted. Historically, death rates for the two countries have shown similar patterns.

Table 2 Assumed Mortality Improvement Rates in AR18

	1987-1996 Average		Assumed for 1997		Assumed for 2021 +	
Age Group	Male	Female	Male	Female	Male	Female
	(%)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
40-44	0.04	0.89	0.50	1.00	0.65	0.50
45-49	1.92	1.47	1.50	1.50	0.60	0.50
50-54	2.35	1.96	2.25	1.50	0.60	0.50
55-59	2.71	1.16	2.50	1.50	0.60	0.50
60-64	2.67	1.40	2.50	1.25	0.60	0.50
65-69	2.03	0.95	2.25	1.25	0.60	0.50
70-74	1.82	1.07	1.75	1.00	0.60	0.50
75-79	1.45	0.87	1.25	0.75	0.60	0.50
80-84	0.79	0.56	0.75	0.50	0.55	0.50
85-89	0.19	-0.08	0.25	0.00	0.55	0.50

As can be seen from the charts 8 and 9, the current differences in life expectancies at birth and age 65 between the two countries decrease over the projection period. By 2075 the difference is less than a year for each sex, both at birth and at age 65. These life expectancies are based on the mortality rates for that year (i.e. no subsequent mortality improvements).

Chart 8 Life Expectancy at Birth (AR18 and SSA)

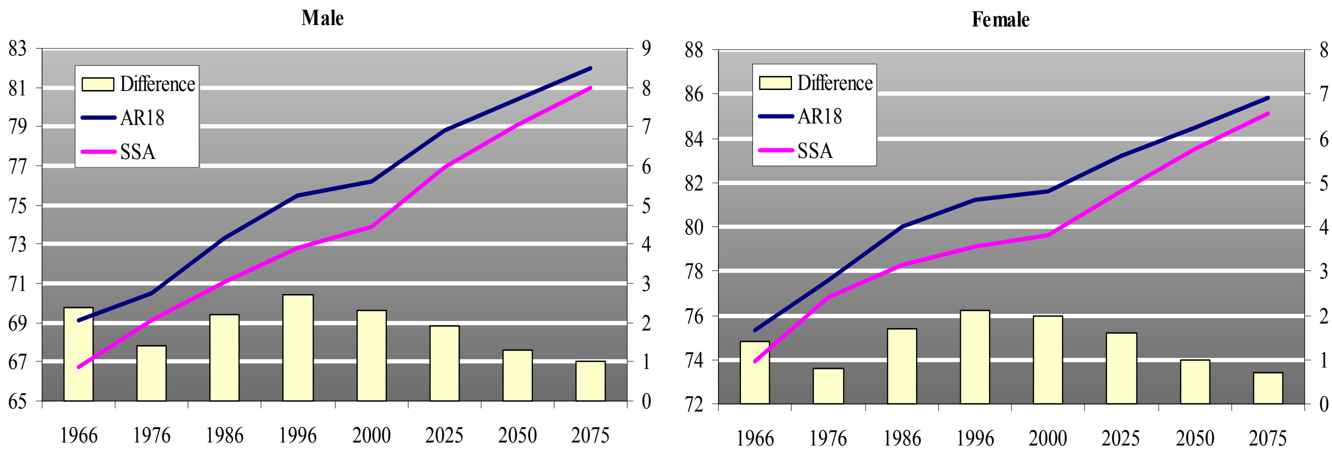
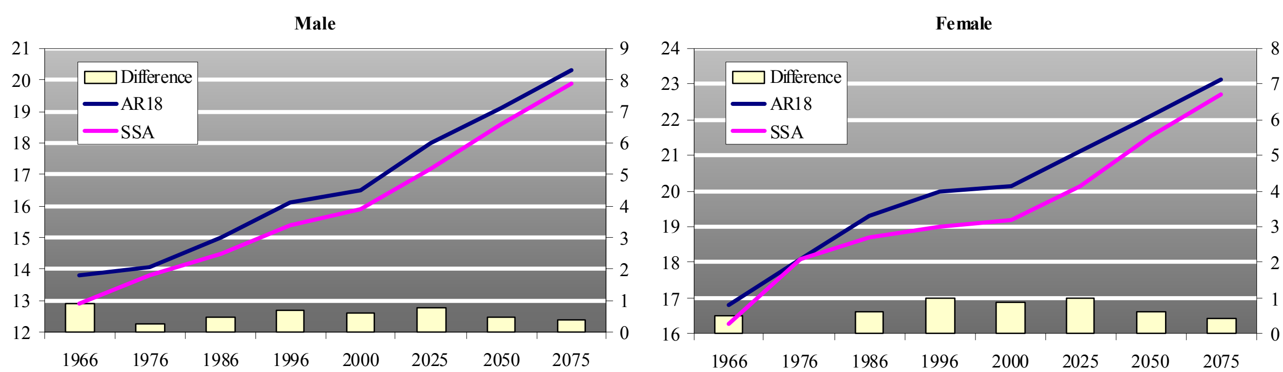


Chart 9 Life Expectancy at Age 65 (AR18 and SSA)



Impact of Mortality Improvement on Canada Pension Plan

In the context of the CPP, what are the consequences of contributors and beneficiaries living longer? The answer is of primary importance for the future financial health of the Plan.

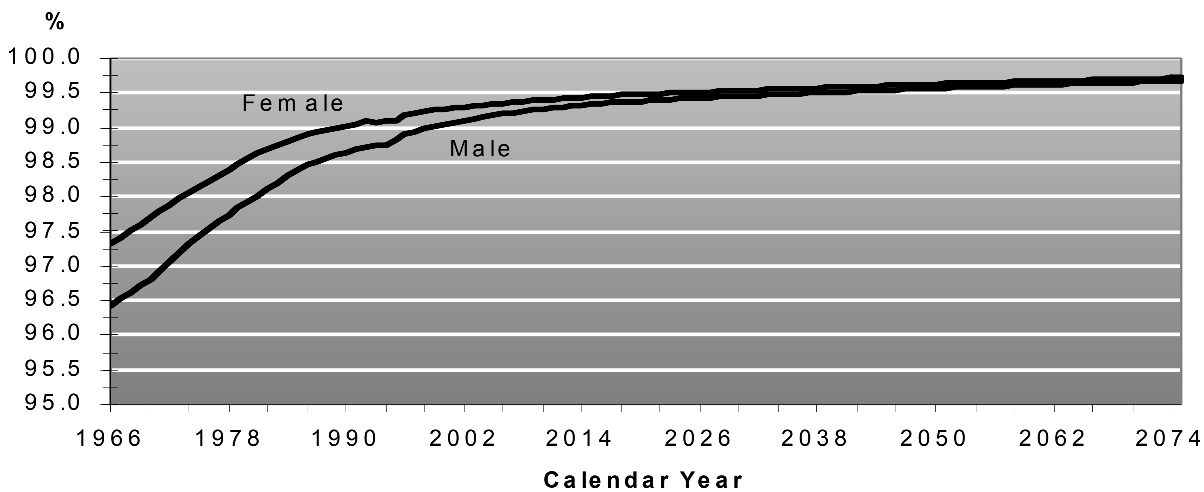
Surviving to Age 18

CPP contributory service begins at age 18 and ends at the age of retirement benefit uptake. The retirement benefit is then paid until death.

One of the important elements of the Plan is the number of contributors, which forms the basis for the financing of the Plan together with investment income. The future number of contributors relies on both fertility and immigration. With respect to fertility a newborn must reach age 18 to become a contributor. By looking at past statistics and using the mortality projections of the Eighteenth CPP Actuarial Report, the evolution of the probability of becoming a contributor (i.e. surviving from birth to age 18) can be traced. Chart 10 shows that probability by sex and calendar year. The probability of a newborn reaching age 18 has increased significantly over the past 40 years and is projected to continue increasing but at a much lower rate.

The gender gap in the probability of reaching age 18 is assumed to continue to narrow. The difference of 0.93% in 1966 narrowed to only 0.22% by 2000 and is projected to virtually disappear by 2075, at which time nearly all newborns (99.68% of boys and 99.72% of girls) should reach age 18. These statistics show that great progress was made in the 20th century in reducing childhood mortality in Canada.

Chart 10 Probability of Surviving from Birth to Age 18



Surviving from Age 18 to Age 65

CPP contributory service begins at age 18, from which time contributions on employment earnings become revenue to the CPP. Chart 11 shows the probability of surviving from age 18 to the normal retirement age of 65. The probability of surviving the contributory period has increased over time for men (from 72.1% in 1966 to 84.1% in 2000) and is projected to reach 90.8% by 2075. The increases have been only half as large for women, (from 84.5% in 1966 to 90.4% in 2000), with 93.8% projected for 2075. The gender gap in the probability of surviving from age 18 to age 65 was a substantial 12.4% in 1966 but is expected to narrow to only 3.0% by 2075.

Chart 11 Probability of Surviving from Age 18 to Age 65

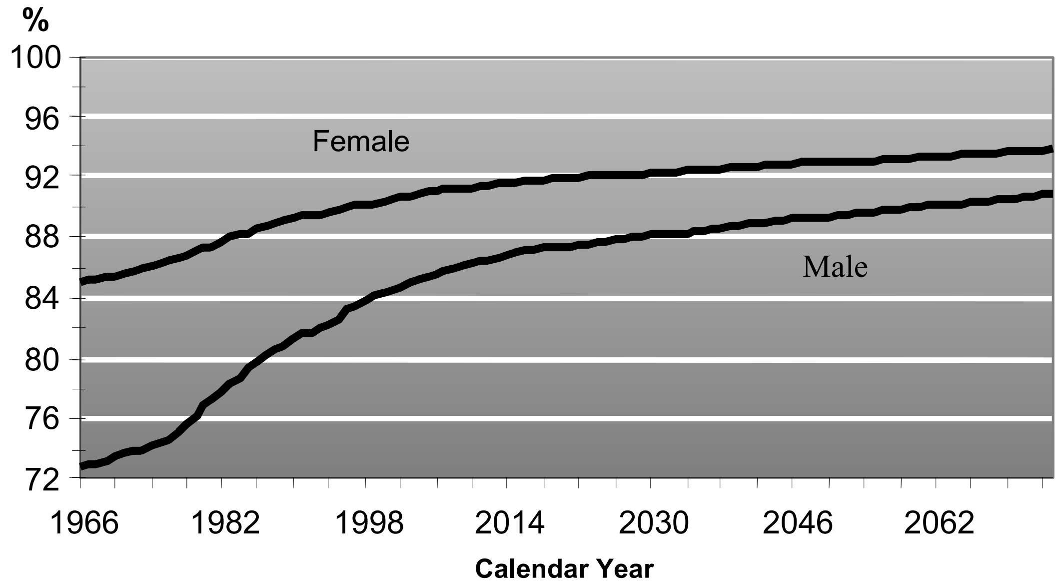
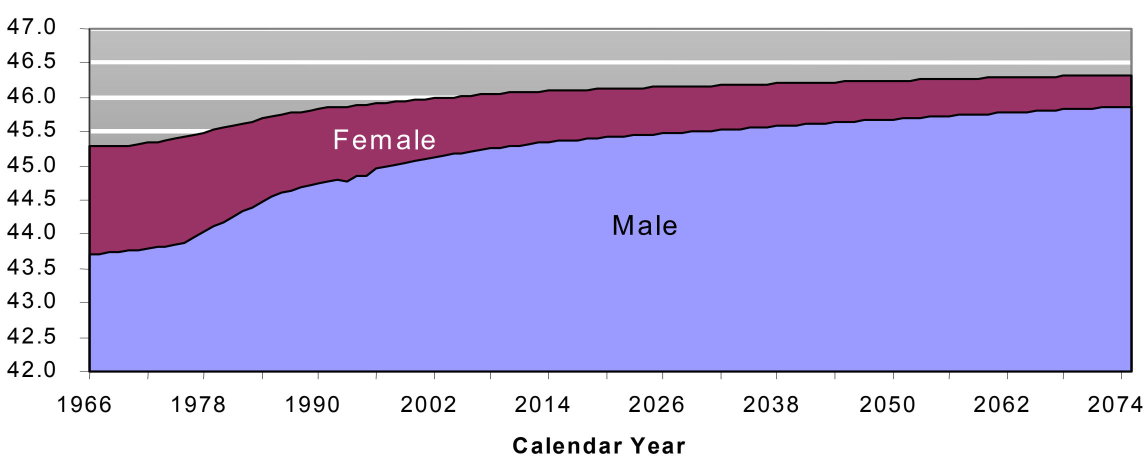


Chart 12 shows the average number of years a person is expected to live between the ages of 18 and 65. In 1966 a male was expected to live an average of 43.7 years out of a possible 47 years. In this case the maximum possible revenue gain for the plan was 3.3 more years of contributions.

Chart 12 Average Number of Years Lived Between the Ages 18 and 65

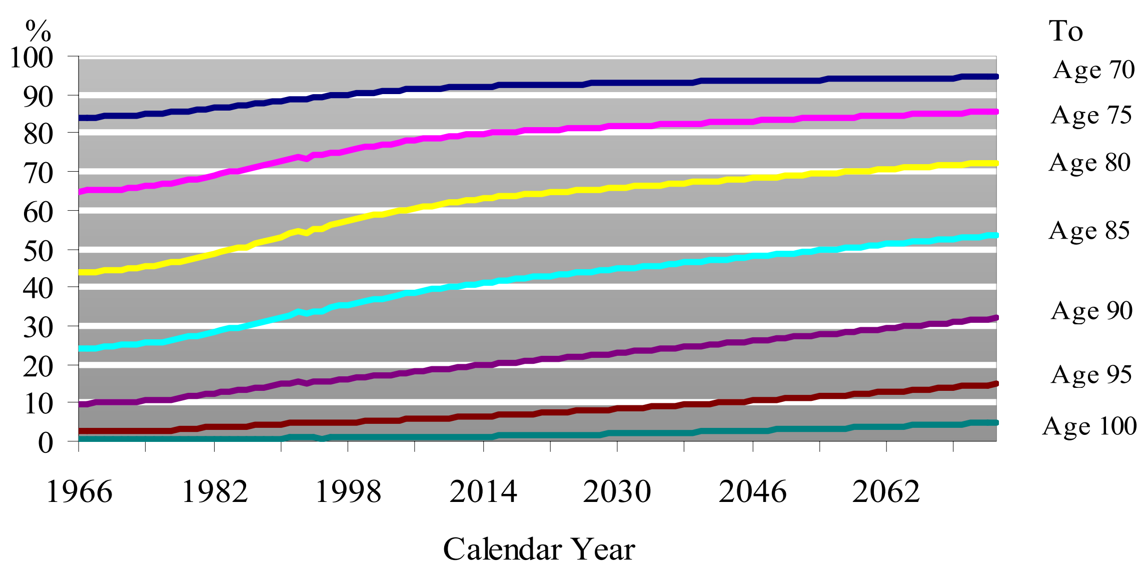


By way of comparison, a female was expected to live 45.2 years for a maximum possible gain of 1.8 years. In 2075 the average number of years lived between age 18 and age 65 is expected to be 45.9 years for males and 46.3 years for females. The gender gap in this statistic is therefore expected to narrow from 1.5 years in 1966 to 0.4 years in 2075. This situation is generally profitable for the CPP because as the life expectancy between ages 18 and 65 increases, so does the average number of years a person will contribute. However this effect is partly offset by more individuals reaching the normal retirement age and becoming beneficiaries.

Surviving After Age 65

Upon attaining the normal retirement age of 65[1], a CPP contributor becomes eligible for a retirement benefit. Since retirement benefits represent a large portion of total CPP benefits, it is not surprising that the number of years the retirement benefits will be paid has a great impact on the Plan financial status. As an example a sensitivity test done under the Eighteenth CPP Actuarial Report shows that doubling the assumed mortality improvements (adding around 1.5 to 2 years to the life expectancy at age 65) would increase the contributory rate by as much as 2% (contribution rate of 10.0% versus only 9.8% under AR18). Chart 13 and 14 show the probability of receiving a CPP retirement benefit up to selected ages from 70 to 100.

Chart 13 Probability of Surviving from Age 65 to Specified Age for Male



1 For simplicity we ignore the reduced benefit available from age 60 onward.

Chart 14 Probability of Surviving from Age 65 to Specified Age for Female

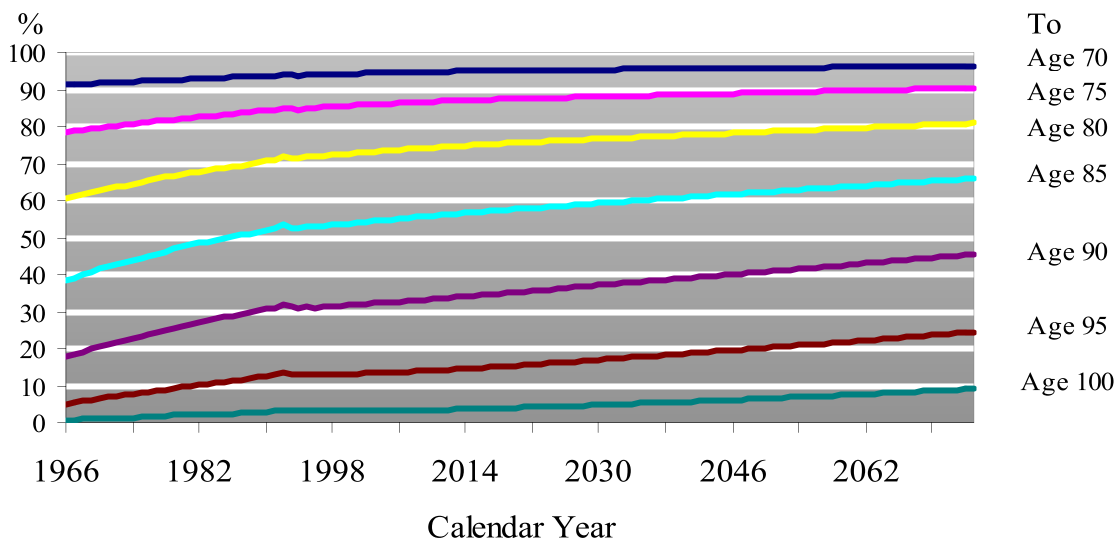


Table 3 presents the probability distribution by sex for the length of the retirement pension payment period for a 65-year-old person. It also shows that the average length of time beneficiaries receive their benefits has substantially increased since the inception of the plan in 1966. In 1966 male beneficiaries were most likely to receive a retirement benefit for 10 to 15 years and females for 15 to 20 years. In the future males will most likely receive retirement benefits for approximately 20 years while females will most likely receive benefits for 20 to 25 years. The difference by gender is assumed to decrease slightly in the future. On average, in 1966 male beneficiaries received 13.9 years of payment, which was 3.1 years less than females (17.0 years). In 2075 the difference between males and females is reduced to 2.8 years, with 20.4 years for males and 23.2 years for females.

Table 3 Length of Retirement Benefit Payment Period

	Calendar Year Mortality							
Male Age 65	**1966**	**1975**	**1985**	**1995**	**2005**	**2025**	**2050**	**2075**
Payment Period in Years	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
0-5	15.9	14.9	12.9	10.6	8.8	7.3	6.3	5.5
5-10	19.1	18.6	16.9	15.1	13.4	11.6	10.2	8.9
10-15	21.3	20.8	20.2	19.0	17.7	16.2	14.7	13.2
15-20	19.9	20.0	20.4	21.4	21.9	21.3	20.2	18.8
20-25	14.2	15.1	16.4	18.5	20.5	21.7	21.8	21.6
25-30	7.1	7.8	9.4	10.7	12.2	14.2	15.8	17.1
30-35	2.2	2.3	3.2	3.9	4.6	6.1	8.0	10.0
More than 35 years	0.4	0.3	0.6	0.8	1.0	1.7	3.0	4.9
Expectancy at 65 (Avg. number of years)	13.9	14.3	15.2	16.2	17.1	18.2	19.3	20.4
Female Age 65	**1966**	**1975**	**1985**	**1995**	**2005**	**2025**	**2050**	**2075**
Payment Period in Years	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
0-5	8.8	7.8	6.8	6.1	5.5	4.8	4.2	3.7
5-10	12.8	11.3	10.0	9.0	8.3	7.5	6.7	5.9
10-15	18.1	16.0	14.4	13.2	12.7	11.7	10.5	9.5
15-20	22.1	20.5	19.0	18.7	18.7	17.7	16.3	15.0
20-25	20.5	21.2	21.3	21.7	22.3	22.3	21.5	20.5
25-30	12.6	15.4	17.4	18.4	19.0	19.9	20.6	20.9
30-35	4.3	6.5	8.6	9.9	10.3	11.8	13.7	15.4
More than 35 years	0.7	1.4	2.4	3.0	3.2	4.4	6.5	9.1
Expectancy at 65 (Avg. number of years)	17.0	18.2	19.3	20.0	20.4	21.2	22.2	23.2

III. CPP Retirement Beneficiary Mortality

A person aged 60 or over with contributory earnings in at least one past calendar year becomes eligible for a retirement pension upon application. An applicant for a retirement pension that becomes payable before the age of 65 must have wholly or substantially ceased to be engaged in paid employment or self-employment. A person ceases to contribute to the CPP once a retirement pension becomes payable or, in any event, after attaining age 70.

While one could assume that the mortality of CPP beneficiaries should be close to the mortality of the general population, there are some interesting trends and results peculiar to CPP beneficiaries. This section presents the results of our study on the mortality of retirement beneficiaries by level of pension. The study included 761,000 deaths and 21,493,200 life-years of exposure covering the nine-year period from January 1992 to December 2000. Note that in this section the term "general population" will be used to refer to the population of Canada less Québec, as this is the population covered by the CPP.

Methodology

The mortality rate for a given age last birthday in any given calendar year (CY) is the probability that a person at that age on 1 January dies by 31 December. Mortality rates (q_{age}) are calculated for each calendar year by attained age, sex and level of pension by simply dividing the relevant number of deaths (d_{age}) by the corresponding total exposures (E_{age}).

$$q_{age}^{CY} = \frac{d_{age}^{CY}}{E_{age}^{CY}}$$

The mortality rates of CPP retirement beneficiaries determined in such a manner are then compared to the general population mortality rates (based on the 1995-1997 LTC). Since CPP retirement beneficiaries represent a large portion of the general population, the observed mortality rates should be comparable to the general population mortality rates. However, to make the comparison, we need to put the data on the same basis, i.e. mortality rates centered in 1996. For this purpose the CPP retirement beneficiary mortality level considered to apply to 1996 was obtained by using an exponential regression to remove the random year-to-year fluctuations over the experience period 1992-2000. This was done for each age, sex and level of pension, including all levels of pension combined.

The first step in the calculation of experience mortality rates is to count the number of deaths (d_{age}) by calendar year and age for each of the four levels of pensions.

The second step in the calculation of the retirement beneficiary mortality rates is to calculate mortality exposures (E_{age}) by calendar year and attained age last birthdays for each of the four levels of pension. The approach used was seriatim (i.e. each individual separately) approach as opposed to grouped. Exposures are interpreted as the number of persons exposed to the risk of death during the period examined. The methodology used for the calculation of exposures is based on the Balducci convention whereby a person contributes exposure in respect of the portion of the year remaining at the time of death. The exposures including Balducci add-ons, are then tabulated for each of the cells established for the tabulation of the deaths. The exposures for 1996 only are presented in Tables 4 and 5.

Table 4 Level of Pension of Male CPP Retirement Beneficiaries (1996)

	Level of Pension as Percentage of Maximum			
Age Group	**0-25%**	**25-50%**	**50-75%**	**75-100%**
60-64	4.5%	7.8%	12.9%	74.7%
65-69	6.5%	7.9%	12.2%	73.4%
70-74	6.7%	7.7%	12.2%	73.5%
75-79	6.3%	7.5%	12.6%	73.6%
80+	7.6%	11.1%	15.9%	65.3%

Table 5 Level of Pension of Female CPP Retirement Beneficiaries (1996)

Age Group	Level of Pension as Percentage of Maximum			
	0-25%	**25-50%**	**50-75%**	**75-100%**
60-64	31.7%	23.6%	17.7%	27.0%
65-69	33.5%	22.1%	18.0%	26.3%
70-74	35.0%	21.7%	17.8%	25.5%
75-79	33.5%	21.3%	18.2%	27.0%
80+	29.5%	22.7%	20.4%	27.3%

Results

For both males and females, retirement beneficiary mortality rates at ages 60 to 64 are significantly lower than for the general population. This is because retirement beneficiaries between the ages of 60 and 64 do not include disability beneficiaries and are thus somewhat healthier than the general population. At age 65 disability beneficiaries automatically become retirement beneficiaries and the mortality ratio rises accordingly.

For males, mortality rates after age 65 are higher than for the general population. This is difficult to explain since male retirement beneficiaries, who comprise 97% of the male population at age 65 and over, are generally thought to have a higher socio-economic status than the remaining 3% of the male population, and should therefore have lower mortality than the general male population. Part of the answer could lie in the census survey data used in constructing the Life Tables for Canada.

As shown in Table 4, males are mostly distributed in the high pension class, i.e. beneficiaries with a retirement pension between 75% and 100% of the maximum. Females are more evenly distributed among all the pension classes (see Table 5).

Table 6 shows the mortality rates by level of pension. The pattern by level of pension is clearly recognizable; the higher the level of pension, the lower the mortality rate. The reason that individuals with high pensions have lower mortality is likely that their socio-economic background and education makes them less exposed to some mortality risks. With universal access to medical care in Canada, lack of medical care can be ruled out as a significant factor.

Table 7 shows the mortality ratios relative to the general population by level of pension. There is a noticeable increase in the mortality ratios at age 65, particularly for the higher pension classes; this is attributable to the automatic conversion of disability beneficiaries to retirement beneficiaries at that age.

For all levels of pension combined, male retirement beneficiaries generally have slightly higher mortality rates than the general population (mortality ratios in the vicinity of 1.025). This is because the excess mortality of males with less than 75% of the maximum pension is only partially offset by the light mortality (ratios generally under 1.000) of those with the highest pensions

For all levels of pension combined, female retirement beneficiaries generally have slightly lower mortality rates than the general population. The mortality ratio of 0.911 at age 65 rises gradually to reach 1.000 by age 109. The overall light mortality is attributable to the light mortality of females with at least 25% of the maximum pension only partially offset by the excess mortality (ratios as high as 1.072) of those with the lowest pensions.

Table 6 CPP Retirement Beneficiary Mortality Rates (by Level of Pension – 1996)
(annual deaths per thousand persons)

	Males						Females					
		Level of Pension as % of Maximum						Level of Pension as % of Maximum				
Age	**General Pop.**	**All**	**0-25%**	**25-50%**	**50-75%**	**75-100%**	**General Pop.**	**All**	**0-25%**	**25-50%**	**50-75%**	**75-100%**
60	10.7	6.5	12.1	9.1	7.8	5.6	6.5	4.1	6.2	3.7	3.2	2.6
65	17.9	18.1	30.7	24.0	21.3	16.1	10.1	9.2	10.4	8.8	8.6	8.4
70	29.0	29.9	39.9	34.8	32.4	27.9	16.1	15.5	17.1	15.1	14.8	14.4
75	46.5	47.8	59.0	53.3	50.3	45.5	26.7	26.1	28.4	25.6	25.2	24.4
80	75.1	77.6	91.0	84.1	80.2	74.6	46.3	45.8	49.6	45.0	44.3	43.0
85	120.7	123.5	139.7	131.3	126.1	119.7	80.9	79.5	85.6	78.3	77.1	74.8
90	183.3	188.4	207.1	197.1	190.4	183.7	137.5	135.5	145.3	133.6	131.7	127.8

Table 7 CPP Retirement Beneficiary Mortality Ratios (by Level of Pension – 1996)

	Males					Females				
	Level of Pension as % of Maximum					Level of Pension as % of Maximum				
Age	**All**	**0-25%**	**25-50%**	**50-75%**	**75-100%**	**All**	**0-25%**	**25-50%**	**50-75%**	**75-100%**
60	0.605	1.128	0.849	0.724	0.526	0.636	0.955	0.569	0.500	0.404
65	1.013	1.719	1.344	1.194	0.899	0.911	1.029	0.868	0.851	0.824
70	1.030	1.376	1.199	1.115	0.963	0.967	1.062	0.939	0.924	0.895
75	1.029	1.269	1.146	1.083	0.979	0.981	1.067	0.959	0.944	0.915
80	1.033	1.211	1.120	1.068	0.993	0.991	1.072	0.973	0.958	0.929
85	1.024	1.158	1.088	1.045	0.992	0.984	1.059	0.968	0.953	0.925
90	1.028	1.130	1.075	1.039	1.002	0.985	1.057	0.972	0.957	0.929

Mortality Improvements and Life Expectancies

Annual mortality improvement rates for retirement beneficiaries were calculated over the period 1987-1996 by age group, sex and level of pension. As a comparison, Table 8 also shows the general population mortality improvement rates for the same period, as well as the ultimate annual improvement rate assumption used in the Eighteenth CPP Actuarial Report, i.e. the rates for 2021 and later.

Over the period 1987 to 1996 the pattern of male retirement beneficiary mortality improvement by age group was the same as for the general population, but the amount of improvement was materially less. The same comments apply to female retirement beneficiaries.

Table 8 CPP Retirement Beneficiary Annual Mortality Improvement Rates

	Male			Female		
Age Group	General Population [1] (1987-96)	CPP Retirement Beneficiaries (1987-96)	18th CPP Actuarial Report (2021+)	General Population [1] (1987-96)	CPP Retirement Beneficiaries (1987-96)	18th CPP Actuarial Report (2021+)
60-64	2.67%	2.04%	0.60%	1.40%	1.09%	0.50%
65-69	2.03	1.67	0.60	0.95	0.73	0.50
70-74	1.82	1.36	0.60	1.07	0.59	0.50
75-79	1.45	1.22	0.55	0.87	0.44	0.50
80-84	0.79	0.54	0.55	0.56	-0.15	0.50
85-89	0.19	-0.27	0.55	-0.08	-1.00	0.50
90+	-	-	0.55	-	-	0.50

[1] Based on Life Tables for Canada.

Tables 9 and 10 show life expectancies without future mortality improvements; based on the CPP retirement beneficiary mortality rates obtained for 1996 and on the comparable general population mortality rates. Male CPP life expectancies do not differ much from the general population life expectancies; they are slightly lower for each level of pension except the 75-100% level. In contrast, CPP females have higher life expectancies than the general population for levels of pension except for the 0-25% level.

From Table 9 we can also observe that males at age 60 with pensions between 75 to 100% of the maximum live about 16% longer (i.e. 2.9 years) than males with pensions between 0 and 25%. By age 65 the difference has narrowed a bit to 15% but at age 90 it is still 10%. For females (Table 10) the difference between the two levels of pension is much lower, being only 6% at age 60. By age 90 the difference increases to about 10%.

Table 9 Male CPP Retirement Beneficiary Life Expectancies[1]

Males	**Level of Pension as % of Maximum**					
Age	**0-25%**	**25-50%**	**50-75%**	**75-100%**	**All**	**95-97 C-QLT**
60	17.71	18.90	19.52	20.61	20.11	20.04
65	14.25	15.13	15.60	16.43	16.03	16.24
70	11.41	12.02	12.37	12.94	12.65	12.84
75	8.81	9.24	9.51	9.91	9.69	9.85
80	6.58	6.89	7.09	7.35	7.19	7.33
85	4.80	5.01	5.16	5.32	5.21	5.31
90	3.45	3.58	3.69	3.78	3.71	3.79

[1] Based on 1996 mortality rates (i.e. no subsequent mortality improvements)

Table 10 Female CPP Retirement Beneficiary Life Expectancies[1]

Females	Level of Pension as % of Maximum					
Age	0-25%	25-50%	50-75%	75-100%	All	95-97 C-QLT
60	23.72	24.68	24.85	25.17	24.50	24.12
65	19.53	20.33	20.45	20.69	20.17	19.98
70	15.65	16.34	16.45	16.67	16.21	16.09
75	12.11	12.70	12.80	12.99	12.59	12.50
80	9.01	9.50	9.58	9.75	9.41	9.34
85	6.46	6.85	6.92	7.06	6.78	6.71
90	4.48	4.78	4.83	4.94	4.73	4.69

[1] Based on 1996 mortality rates (i.e. no subsequent mortality improvements)

IV. CPP Survivor Beneficiary Mortality

The surviving spouse of a contributor is eligible for a survivor benefit if the following three conditions are met as at the date of the contributor's death.

- If the surviving spouse was not legally married to the deceased contributor, they must have cohabited for not less than one year immediately before the death of the contributor.

- The deceased contributor must have made contributions for ten calendar years or, if lesser, one-third of the number of years included wholly or partly in his or her contributory period, but not less than three years.

- The surviving spouse must have dependent children, be disabled or be at least 35 years of age. A surviving spouse with dependent children means a surviving spouse who wholly or substantially maintains a child of the deceased contributor where the child is under age 18, or aged 18 or over but under age 25 and attending school full-time, or aged 18 or over and disabled, having been disabled without interruption since attaining age 18 or the time of the contributor's death, whichever occurred later.

Just as for retirement beneficiary mortality, survivor beneficiary mortality trends diverge somewhat from the general population. This section presents the methodology and results of our study on the mortality of CPP survivor beneficiaries. One of the goals of this study is to develop mortality ratios for CPP survivor beneficiaries relative to the general population. Again the term "general population" will be used to refer to the population of Canada less Québec as this is the population covered by the CPP. The study included 328,000 deaths and 10,773,923 life-years of exposure covering a sixteen-year period from January 1985 to December 2000.

Table 11 shows the CPP survivor mortality rates relative to the rates for the general population. CPP survivor beneficiary mortality is seen to be significantly higher than that of the general population. One reason must be that survivors have mortality similar to single persons that are known to have a higher mortality than the general population. One other reason may be that survivors are deeply affected by the loss of their spouse, especially at the older ages where the survivor may already be in a weakened condition. Also in some cases one could assume that losing part of the primary source of income adds stress to the survivors.

Table 12 shows the life expectancy of survivor beneficiaries without future mortality improvements based on the graduated mortality rates obtained for 1996. For comparison purposes, the table also shows the general population life expectancy at comparable ages. Male CPP survivor beneficiary life expectancies are materially lower (roughly 5% at most ages) than the corresponding figures for the general population; for female survivor beneficiaries, they are slightly lower (generally 1% to 2%) until about age 80, after which they are the same as for the general population.

Table 11 CPP Survivor Beneficiary Mortality Rates and Ratios – 1996

	Mortality Rates (per thousand)				Mortality Ratios for CPP Survivors		
	General Population[1]		CPP Survivors		General Population[1]		Female
Age	Male	Female	Male	Female	Male	Female	Vs. Male
50	4.0	2.5	4.3	3.2	1.09	1.30	0.73
55	6.5	4.1	8.0	5.2	1.22	1.27	0.65
60	10.7	6.5	13.7	7.9	1.28	1.23	0.58
65	17.9	10.1	22.7	12.0	1.27	1.18	0.53
70	29.0	16.1	35.6	18.1	1.23	1.13	0.51
75	46.5	26.7	54.4	28.5	1.17	1.07	0.52
80	75.1	46.3	83.7	47.1	1.11	1.02	0.56
85	120.7	80.9	129.2	80.9	1.07	1.00	0.63
90	183.3	137.5	191.6	137.5	1.05	1.00	0.72

[1]Derived from 1995-1997 Canada and Quebec LTC rates using 1996 population as weights.

Table 12 CPP Survivor Beneficiary Life Expectancies[1] - 1996

	Males		Females	
Age	General Population	CPP	General Population	CPP
50	28.50	26.95	33.01	32.21
55	24.15	22.65	28.47	27.79
60	20.04	18.69	24.12	23.59
65	16.24	15.12	19.98	19.60
70	12.84	11.99	16.09	15.87
75	9.85	9.27	12.50	12.41
80	7.33	6.96	9.34	9.32
85	5.31	5.10	6.71	6.71
90	3.79	3.66	4.69	4.69

[1] Based on 1996 mortality rates (i.e. no subsequent mortality improvements)

V. OAS Beneficiary Mortality

The OAS basic pension is a monthly benefit available, on application, to anyone age 65 or over who meets the residence requirements specified in the *Old Age Security Act*.

To qualify for a basic pension, a person must be 65 years of age or over, and

- must be a Canadian citizen or a legal resident of Canada on the day preceding the approval of his or her application; or
- if the person no longer lives in Canada, must have been a Canadian citizen or a legal resident of Canada on the day preceding the day he or she stopped living in Canada.

A minimum of 10 years of residence in Canada after reaching age 18 is required to receive a basic pension in Canada. To receive the pension outside the country, a person must have lived in Canada for a minimum of 20 years after reaching age 18. An international social security agreement may assist a person to meet the 10- and 20-year requirements.

Historically, mortality at older ages has been difficult to measure accurately. Reliable sources of data have been rare. A good source of data for measuring mortality at ages 80 and over in future will be the administrative database of Old Age Security beneficiaries. The methodology used in the Fifth OAS Actuarial Report as at 31 December 2000 was the same as the one used for the Eighteenth CPP Actuarial Report at the same date.

Table 13 and 14 present the evolution of the number of OAS beneficiaries and their distribution by age group. It can be seen that over the last 15 years the number of OAS beneficiaries age 80 and over increased from 16% in 1985 to almost 19% in 2000 for males. For females the figures are respectively 23% and 27%. By 2050, it is expected to increase to 31% and 38% for males and females respectively.

Table 13 OAS Number of Male Beneficiaries

Age Group	1985	1990	1995	2000	2025	2050
65-69	392,500	465,300	511,200	529,900	1,136,000	1,136,500
70-74	315,600	334,700	415,700	454,100	924,000	1,033,300
75-79	202,800	242,500	267,300	331,700	681,900	847,000
80-84	106,400	132,900	164,900	182,900	383,500	653,900
85-89	45,300	56,200	71,500	88,600	181,200	455,400
90-94	16,700	17,000	22,000	26,900	70,200	202,200
95-99	3,800	4,000	4,100	4,900	18,200	58,600
100+	600	700	600	500	2,700	11,100
ALL	1,083,700	1,253,200	1,457,200	1,619,500	3,397,700	4,397,900

Table 14 OAS Number of Female Beneficiaries

Age Group	1985	1990	1995	2000	2025	2050
65-69	465,200	554,100	565,000	568,200	1,186,000	1,163,200
70-74	396,600	433,700	523,300	533,600	1,007,700	1,084,300
75-79	287,100	346,800	384,300	463,400	805,200	955,000
80-84	182,700	225,600	278,000	308,200	511,000	812,700
85-89	100,600	120,600	152,200	186,300	292,200	657,300
90-94	42,100	49,700	61,600	75,400	144,100	357,700
95-99	10,900	13,600	16,100	19,100	49,600	127,000
100+	1,800	2,300	2,700	2,900	9,800	28,200
ALL	1,486,900	1,746,500	1,983,200	2,157,100	4,005,500	5,185,500

A new database with seriatim data will enable us in the future to do a complete study of the mortality of OAS beneficiaries.

VI. Conclusion

The maximum age to which we can live (maximum life span) has not significantly increased over the years. One reason is that most of the observed mortality improvements have occurred at ages 90 and below. A life expectancy at birth of 100 years is practically impossible in the next half century unless there are dramatic medical and scientific breakthroughs. It would require sustained mortality improvements at a level about three times what has been observed over the last 10 years. Alternatively, assuming a maximum human life span of about 145 years (a 35-year increase if one assumes a current maximum of 110) could result in a life expectancy at birth of 100 years.

Based on the assumptions of the Eighteenth CPP Actuarial Report, life expectancy at birth for Canada is expected to increase from 76.2 years in 2000 to 82.0 in 2075 for males and from 81.6 years to 85.8 years for females. Accordingly, the gap between males and females would narrow from the current 5.4 years to only 3.8 years by 2075.

The probability of a newborn reaching age 18, the starting age for the CPP, is already high and future improvements will only slightly increase that probability. The probability of a contributor age 18 reaching the normal retirement age of 65 is also expected to increase. The probability of a male age 18 reaching age 65 is expected to increase from 84.1% in 2000 to 90.8% by 2075; the corresponding figures for a female are 90.4% and 93.8%, respectively.

CPP beneficiaries are expected to live longer. Life expectancy at age 65 for males is projected to increase from the current 16.7 years to 20.4 years by 2075 and from 20.2 years to 23.2 years for females.

Female retirement beneficiary mortality rates after age 65 are significantly lower than the rates for the general population with the gap being about 11% at age 66 but reducing steadily thereafter and ultimately disappearing. Male retirement beneficiary mortality rates after age 65 are close to the general population rates, being only about 2% higher at age 66. The differential narrows as age increases and ultimately disappears.

By level of retirement pension, female mortality rates are generally lower than for the general population except for the lowest level (i.e. less than 25% of the CPP maximum), where mortality at ages 66 and over is up to 8% higher. By level of retirement pension, male mortality rates are lower than for the general population only at the highest level (i.e. 75-100% of the CPP maximum), and even at that level there are some ages where this does not hold.

Survivor beneficiary mortality rates are significantly higher than the rates for the general population. The excess mortality decreases with age and vanishes by age 83 for females but only at the end of the life table for males.

Major medical advances and improvements in the quality and standard of living in the 20th century increased our life expectancy at birth by almost 30 years. However, a great deal of medical research is still required to increase life expectancy even further. One proof is that mortality improvements have recently shown signs of slowing down. The greater slowdown in mortality improvements for females in recent years has narrowed the gender gap in mortality.

Future mortality improvements are expected to come more slowly and at older ages, as mortality rates at younger ages are already very low. In the context of the Canada Pension Plan, more and more contributors are expected to reach the normal retirement age of 65 and receive a pension. Retirement beneficiaries are also expected to receive their benefit for a longer period.