

**TRANSACTIONS OF SOCIETY OF ACTUARIES
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**REPORT OF THE SUBCOMMITTEE ON ANNUITY MORTALITY
COMMITTEE ON EXPECTED EXPERIENCE
OF THE CANADIAN INSTITUTE OF ACTUARIES**

IMPROVEMENT IN ANNUITANT MORTALITY—CANADA

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INTRODUCTION

An analysis of mortality over the last century or more clearly indicates that rates of death have declined dramatically. These improvements have not occurred uniformly during the twentieth century, as can be seen from the table below, which is derived from U.S. population data.¹

Period	Annual Mortality Reduction	
	Males	Females
1900-1936	0.8%	0.9%
1936-1954	1.6	2.5
1954-1968	-0.2	0.8
1968-1982	1.8	2.1
1982-	small	small

Because of these variations, it is difficult to predict the future change in mortality, especially for a particular period of time. Future improvements in mortality will depend upon such factors as medical advances, the presence of environmental pollutants, exercise and nutrition, the misuse of drugs, the incidence of violence, and the prevalence of cigarette smoking. For example, it has been estimated² that the decline in smoking prevalence alone has

¹Social Security Administration: *Actuarial Study No. 105*.

²Thomas W. Reese, FSA, "U.S. Smoking Trends," *Product Development News*, Sept. 1989.

accounted for an average mortality improvement from 1965 to 1987 of about 0.6 percent per annum for males and about 0.2 percent annually for females.

The impact of unexpected events such as AIDS is difficult to predict. AIDS is expected to influence mortality primarily for males in the age range 25 to 45. Based on U.S. population data, it has been estimated³ that the impact of AIDS on average annual mortality improvement over the period 1983–88 has been as follows:

REDUCTION IN AVERAGE ANNUAL MORTALITY IMPROVEMENT
DUE TO AIDS—1983 TO 1988

Ages	Male	Female
15–24	0.5%	0.2%
25–34	2.5	0.8
35–44	2.1	0.6
45–54	0.6	0.0
55–	0.0	0.0

Nevertheless, it is most likely that mortality will continue to improve for the foreseeable future especially for annuitants where the impact of AIDS is expected to be small. The level of improvement is not clear and is open to all kinds of speculation. Assembled below are a variety of sources of information on mortality improvement to assist the actuary in making decisions in this area.

HISTORICAL SCALES

Table 1 shows various scales that have been proposed over the last 40 years. The variety is due, in part, to the fact that they were published at different times and thus reflect the then-current knowledge about longevity. Nevertheless, the more recent scales, Scales G and H, were both recommended in 1983 by two Society of Actuaries committees on annuities. Their difference may be due to subjective thinking rather than to underlying differences between individual and group annuitants. Scales I and J were presented in a recent (1989) paper entitled “The Effects of Mortality on Individual Annuities” by Naftali Teitelbaum (*TSA XL*, Part II, p. 653). These scales assumed mortality improvement greater than previous scales.

Despite the fact there are major differences in the rates of mortality improvement in the various projection scales, the more recent ones all differentiate by sex as well as attained age.

³Tillinghast Update, “Population Mortality—1988 Results.”

TABLE 1
ANNUITY PROJECTION SCALES

Age	A 1949	B 1949	C 1952	D 1971	E	G 1983	H 1983	I 1989	J 1989	P76 1979
Male										
20	2.80	1.25	1.25	0.65	0.65	0.14	0.14	0.29	0.44	0.50
30	2.40	1.25	1.25	0.65	0.65	0.49	0.49	0.68	0.83	0.50
40	2.00	1.25	1.25	0.65	0.65	2.00	2.00	2.30	2.60	0.50
50	1.60	1.25	1.25	0.65	0.65	1.75	1.75	2.00	2.24	0.50
55	1.40	1.23	1.25	0.65		1.60	1.60	1.88	2.20	0.50
60	1.20	1.20	1.20	0.65	0.65	1.50	1.50	1.77	2.02	0.50
63				0.65	0.65	1.50	1.50			0.50
65	1.00	1.10	1.25	0.63		1.50	1.50	1.69	1.81	0.50
68				0.60	0.45	1.45	1.45			0.50
70	0.80	0.95	1.25			1.35	1.35	1.50	1.60	0.50
73				0.50	0.45	1.25	1.25			0.50
75	0.60	0.75	1.00	0.46		1.25	1.25	1.40	1.50	0.50
78				0.40	0.45	1.25	1.25			0.50
80	0.40	0.50	0.67			1.25	1.25	1.40	1.50	0.50
83				0.30	0.45	1.25	1.15			0.50
85	0.20	0.25	0.33	0.26		1.25	0.95	1.40	1.50	0.50
88				0.20	0.45	1.20	0.70			
90	0.00	0.00	0.00			1.10	0.60	1.34	1.50	0.30
92					0.45	1.00	0.50			
95				0.06		1.00	0.26	1.21	1.38	0.10
97				0.02		1.00	0.10			
98				0.00		0.75	0.07			
99						0.50	0.03			
100						0.25	0.00			0.00
Female										
20	2.80	1.25	1.25	1.30		0.50	0.50	0.70	0.80	1.30
30	2.40	1.25	1.25	1.30		1.05	1.05	1.39	1.67	1.30
40	2.00	1.25	1.25	1.30		2.25	2.25	2.59	3.12	1.30
50	1.60	1.25	1.25	1.30		2.00	2.00	2.22	2.35	1.30
55	1.40	1.23	1.25	1.30		1.85	1.85	2.05	2.16	1.30
60	1.20	1.20	1.20	1.30		1.75	1.75	1.92	1.92	1.40
63				1.30		1.75	1.75			
65	1.00	1.10	1.25	1.28		1.75	1.75	1.90	1.86	1.50
68				1.25		1.75	1.75			
70	0.80	0.95	1.25			1.75	1.75	1.96	2.11	1.60
73				1.15		1.70	1.70			
75	0.60	0.75	1.00	1.09		1.60	1.60	1.85	2.25	1.75
78				1.00		1.50	1.50			
80	0.40	0.50	0.67			1.50	1.50	1.75	2.25	1.90
83				0.80		1.50	1.40			
85	0.20	0.25	0.33	0.68		1.50	1.20	1.75	2.19	1.60
88				0.50		1.45	0.90			
90	0.00	0.00	0.00			1.35	0.70	1.57	1.91	1.20
92						1.25	0.50			
95				0.08		1.25	0.35	1.45	1.69	0.80
97				0.00		1.25	0.25			
98						1.00	0.17			
99						0.75	0.08			
100						0.50	0.00			0.40

POPULATION DATA

While population data do not reflect specifically the mortality of annuitants, the data have the advantage of being on large homogenous exposures with mortality results being available at regular intervals on a timely basis. The use of population data for mortality projections of annuitant mortality is examined in greater detail in a 1979 CIA paper by Donald M. Keith entitled "Mortality Projections Based on Population Data." The subcommittee believes that population data are the most reliable source for tracking the historical improvement in rates of mortality, especially in Canada where the amount of data on annuitants is relatively small and not sufficient for mortality trend studies. The following table is derived from Canada Life Tables published by Statistics Canada. Using mortality rates from quinquennial reports, annual rates of mortality improvement can be computed for various periods of time.

AVERAGE ANNUAL RATES OF IMPROVEMENT
OF CANADIAN POPULATION MORTALITY

Ages	1921-31	1931-41	1941-51	1951-61	1961-71	1971-76	1976-81	1981-86
Males								
55-60	0.01%	-0.25%	-0.08%	0.44%	0.51%	0.47%	2.51%	2.19%
60-65	-0.41	-0.48	-0.10	0.25	0.30	0.92	2.15	1.80
65-70	-0.33	-0.28	0.50	0.03	-0.04	0.99	1.53	1.37
70-75	0.24	-0.22	0.69	0.01	0.14	0.63	1.48	0.97
75-80	-0.07	-0.17	0.68	0.45	0.29	0.41	1.08	0.60
80-85	-0.25	-0.17	0.54	0.54	0.38	0.26	1.03	0.38
85-90	-0.02	-0.11	0.19	0.72	0.45	-0.11	0.96	0.02
Females								
55-60	0.04%	1.02%	2.03%	1.98%	1.04%	1.35%	1.64%	1.62%
60-65	-0.16	1.03	1.34	1.92	1.46	1.29	1.55	1.17
65-70	0.49	0.54	1.68	1.52	1.69	1.29	1.58	1.20
70-75	0.54	0.57	1.15	1.67	1.59	1.46	1.82	1.05
75-80	-0.03	0.42	1.05	1.46	1.73	1.66	1.83	0.58
80-85	-0.33	0.34	0.65	1.03	1.63	1.30	1.84	0.74
85-90	0.07	-0.03	0.51	0.59	1.33	0.91	1.66	0.30

A more comprehensive set of statistics (derived from Statistics Canada Life Tables) is provided in Tables 2A (male) and 2B (female). From the mid-1970s to the mid-1980s, mortality improvement was much greater than in previous periods. However, current opinion suggests that these rates of improvement are expected to decrease somewhat in future years (see next section).

TABLE 2A
ANNUAL RATE OF MORTALITY IMPROVEMENT
CANADIAN POPULATION—MALE

Age	5-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5	1.13%	1.08%	1.93%	5.98%	7.63%	7.20%	4.85%	5.24%	2.73%	2.55%	3.45%	5.47%	4.00%
5-10	5.75	0.63	2.34	4.35	3.67	5.56	5.61	2.91	1.08	1.73	3.07	5.99	5.84
10-15	2.00	3.50	1.43	2.91	3.77	4.84	4.92	2.27	0.88	0.95	3.62	2.13	4.56
15-20	3.22	0.19	3.53	1.40	3.05	3.94	1.49	1.47	-1.40	-2.80	-0.72	3.25	3.81
20-25	2.73	-0.41	4.61	0.17	4.65	1.93	1.42	0.74	-2.19	-0.07	-0.14	3.34	2.54
25-30	2.98	-0.23	3.10	2.51	4.11	3.14	1.40	1.92	-0.79	0.97	-0.14	1.42	1.74
30-35	2.23	-1.05	1.39	3.46	4.14	1.92	2.05	2.68	-0.36	-0.35	1.15	2.93	-0.44
35-40	1.98	-0.97	1.44	2.41	3.10	3.40	2.29	0.06	0.74	0.15	0.36	3.65	2.20
40-45	1.52	-0.90	1.25	0.71	2.30	1.87	2.48	0.90	-1.08	-0.20	1.51	3.72	2.47
45-50	1.74	-1.44	0.05	0.46	0.69	1.07	1.68	0.28	0.23	0.28	0.46	3.44	3.39
50-55	1.24	-2.72	0.72	-0.74	1.13	-0.60	1.14	0.61	-0.41	0.67	0.86	2.90	2.82
55-60	1.46	-1.46	0.20	-0.70	0.73	-0.90	0.69	0.19	0.09	0.92	0.47	2.51	2.19
60-65	0.60	-1.43	-1.71	0.74	0.23	-0.44	0.06	0.44	-0.11	0.70	0.92	2.15	1.80
65-70	0.16	-0.82	0.08	-0.63	0.11	0.89	-0.37	0.43	-0.38	0.30	0.99	1.53	1.37
70-75	1.07	-0.59	-0.27	-0.17	1.04	0.33	0.29	-0.27	0.38	-0.10	0.63	1.48	0.97
75-80	0.37	-0.52	0.21	-0.55	1.07	0.28	0.36	0.54	0.06	0.51	0.41	1.08	0.60
80-85	0.47	-0.99	-0.74	0.39	1.23	-0.15	0.26	0.83	0.31	0.46	0.26	1.03	0.38
85-90	0.01	-0.05	-0.06	-0.16	0.61	-0.22	0.99	0.45	0.03	0.87	-0.11	0.96	0.02
Age	10-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5		1.11%	1.51%	3.98%	6.81%	7.41%	6.03%	5.05%	3.99%	2.64%	3.00%	4.47%	4.74%
5-10		3.22	1.49	3.35	4.01	4.62	5.58	4.27	2.00	1.40	2.40	4.54	5.91
10-15		2.75	2.47	2.18	3.34	4.31	4.88	3.60	1.58	0.92	2.29	2.88	3.55
15-20		1.72	1.87	2.47	2.23	3.50	2.72	1.48	0.05	-2.10	-1.75	1.28	3.53
20-25		1.17	2.13	2.42	2.43	3.30	1.67	1.08	-0.71	-1.12	-0.10	1.62	2.95
25-30		1.39	1.45	2.80	3.31	3.63	2.27	1.66	0.58	0.09	0.42	0.64	1.58
30-35		0.61	0.18	2.43	3.80	3.04	1.98	2.36	1.17	-0.36	0.40	2.04	1.26
35-40		0.52	0.24	1.93	2.76	3.25	2.85	1.18	0.40	0.45	0.26	2.02	2.93
40-45		0.32	0.18	0.98	1.51	2.09	2.18	1.69	-0.08	-0.64	0.66	2.62	3.10
45-50		0.16	-0.69	0.25	0.57	0.88	1.37	0.98	0.25	0.25	0.37	1.96	3.41
50-55		-0.72	-0.98	-0.01	0.20	0.27	0.27	0.87	0.10	0.14	0.77	1.89	2.86
55-60		0.01	-0.62	-0.25	0.02	-0.08	-0.10	0.44	0.14	0.51	0.70	1.49	2.35
60-65		-0.41	-1.57	-0.48	0.49	-0.10	-0.19	0.25	0.17	0.30	0.81	1.53	1.97
65-70		-0.33	-0.37	-0.28	-0.26	0.50	0.27	0.03	0.02	-0.04	0.65	1.26	1.45
70-75		0.24	-0.43	-0.22	0.44	0.69	0.31	0.01	0.06	0.14	0.26	1.06	1.23
75-80		-0.07	-0.16	-0.17	0.26	0.68	0.32	0.45	0.30	0.29	0.46	0.75	0.84
80-85		-0.25	-0.86	-0.17	0.81	0.54	0.05	0.54	0.57	0.38	0.36	0.64	0.70
85-90		-0.02	-0.05	-0.11	0.22	0.19	0.39	0.72	0.24	0.45	0.38	0.43	0.49

TABLE 2A—Continued

Age	15-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5			1.38%	3.02%	5.21%	6.94%	6.57%	5.77%	4.28%	3.52%	2.91%	3.83%	4.31%
5-10			2.93	2.45	3.46	4.53	4.95	4.70	3.22	1.91	1.96	3.61	4.97
10-15			2.31	2.62	2.71	3.84	4.51	4.02	2.70	1.37	1.82	2.24	3.44
15-20			2.33	1.72	2.66	2.80	2.83	2.30	0.53	-0.89	-1.64	-0.06	2.13
20-25			2.33	1.48	3.17	2.27	2.67	1.36	0.00	-0.50	-0.79	1.06	1.93
25-30			1.96	1.80	3.24	3.26	2.89	2.16	0.85	0.71	0.02	0.75	1.01
30-35			0.87	1.29	3.00	3.18	2.71	2.22	1.46	0.66	0.15	1.25	1.22
35-40			0.83	0.97	2.32	2.97	2.93	1.93	1.03	0.32	0.42	1.40	2.08
40-45			0.63	0.36	1.42	1.63	2.22	1.75	0.78	-0.12	0.08	1.69	2.57
45-50			0.12	-0.31	0.40	0.74	1.15	1.01	0.73	0.26	0.32	1.40	2.44
50-55			-0.24	-0.90	0.37	-0.07	0.56	0.38	0.45	0.29	0.38	1.49	2.20
55-60			0.08	-0.65	0.08	-0.29	0.18	0.00	0.32	0.40	0.50	1.30	1.73
60-65			-0.84	-0.80	-0.24	0.18	-0.05	0.02	0.13	0.34	0.50	1.26	1.62
65-70			-0.19	-0.46	-0.15	0.13	0.21	0.32	-0.11	0.12	0.30	0.94	1.30
70-75			0.07	-0.34	0.20	0.40	0.55	0.12	0.14	0.01	0.30	0.67	1.03
75-80			0.02	-0.29	0.24	0.27	0.57	0.39	0.32	0.37	0.33	0.67	0.70
80-85			-0.41	-0.44	0.30	0.49	0.45	0.31	0.47	0.53	0.34	0.58	0.56
85-90			-0.03	-0.09	0.13	0.08	0.46	0.41	0.49	0.45	0.27	0.58	0.29
Age	20-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5				2.55%	4.19%	5.71%	6.42%	6.24%	5.02%	3.85%	3.50%	3.56%	3.88%
5-10				3.29	2.76	3.99	4.80	4.44	3.81	2.85	2.20	2.98	4.17
10-15				2.46	2.91	3.25	4.11	3.96	3.24	2.27	1.94	1.90	2.82
15-20				2.09	2.05	2.98	2.47	2.49	1.39	-0.29	-0.85	-0.39	0.92
20-25				1.80	2.28	2.86	2.05	2.19	0.49	-0.02	-0.41	0.26	1.43
25-30				2.10	2.39	3.22	2.79	2.65	1.43	0.88	0.50	0.37	1.00
30-35				1.52	2.01	2.73	2.90	2.70	1.58	1.01	0.79	0.85	0.83
35-40				1.23	1.51	2.59	2.80	2.22	1.63	0.81	0.33	1.24	1.60
40-45				0.65	0.85	1.53	1.84	1.89	1.05	0.53	0.29	1.00	1.89
45-50				0.21	-0.06	0.56	0.97	0.93	0.82	0.62	0.31	1.11	1.90
50-55				-0.36	-0.39	0.13	0.24	0.57	0.19	0.50	0.44	1.02	1.82
55-60				-0.12	-0.30	-0.16	-0.04	0.18	0.02	0.47	0.42	1.00	1.53
60-65				-0.44	-0.54	-0.29	0.15	0.08	-0.01	0.27	0.49	0.92	1.39
65-70				-0.30	-0.32	0.11	0.00	0.27	0.14	-0.01	0.33	0.61	1.05
70-75				0.01	0.00	0.24	0.37	0.35	0.19	0.08	0.16	0.60	0.75
75-80				-0.12	0.05	0.25	0.29	0.56	0.31	0.37	0.38	0.52	0.65
80-85				-0.21	-0.02	0.19	0.44	0.54	0.31	0.46	0.46	0.51	0.53
85-90				-0.06	0.08	0.04	0.30	0.46	0.31	0.58	0.31	0.44	0.44

TABLE 2A—Continued

Age	25-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5					3.59%	4.80%	5.54%	6.19%	5.55%	4.53%	3.77%	3.90%	3.65%
5-10					3.36	3.32	4.31	4.42	3.78	3.40	2.89	2.97	3.56
10-15					2.73	3.30	3.58	3.75	3.35	2.79	2.54	1.97	2.44
15-20					2.29	2.43	2.69	2.27	1.73	0.57	-0.38	-0.02	0.46
20-25					2.37	2.21	2.57	1.79	1.33	0.38	-0.04	0.35	0.72
25-30					2.50	2.54	2.86	2.62	1.97	1.34	0.68	0.68	0.64
30-35					2.05	1.99	2.60	2.85	2.10	1.19	1.04	1.22	0.59
35-40					1.60	1.89	2.53	2.26	1.93	1.34	0.72	1.00	1.43
40-45					0.98	1.05	1.72	1.65	1.30	0.80	0.73	0.98	1.30
45-50					0.30	0.17	0.79	0.84	0.79	0.71	0.59	0.95	1.57
50-55					-0.06	-0.43	0.33	0.31	0.38	0.28	0.58	0.93	1.38
55-60					0.05	-0.42	0.01	0.00	0.16	0.20	0.47	0.84	1.24
60-65					-0.31	-0.52	-0.22	0.21	0.04	0.13	0.40	0.82	1.10
65-70					-0.22	-0.07	0.02	0.09	0.14	0.18	0.19	0.58	0.76
70-75					0.22	0.07	0.25	0.25	0.36	0.13	0.19	0.43	0.67
75-80					0.12	0.10	0.27	0.34	0.46	0.35	0.37	0.52	0.53
80-85					0.08	-0.05	0.20	0.51	0.50	0.34	0.42	0.58	0.49
85-90					0.07	0.02	0.23	0.33	0.37	0.42	0.45	0.44	0.36
Age	30-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5						4.20%	4.81%	5.49%	5.62%	5.05%	4.35%	4.06%	3.92%
5-10						3.73	3.71	4.08	3.87	3.44	3.34	3.41	3.45
10-15						3.08	3.57	3.37	3.28	2.95	2.93	2.47	2.41
15-20						2.56	2.27	2.48	1.67	0.99	0.35	0.23	0.63
20-25						2.30	2.08	2.27	1.14	1.10	0.29	0.53	0.72
25-30						2.61	2.35	2.70	2.06	1.80	1.09	0.80	0.86
30-35						2.03	2.00	2.61	2.32	1.69	1.19	1.36	0.94
35-40						1.91	1.96	2.12	2.01	1.63	1.18	1.22	1.20
40-45						1.13	1.29	1.59	1.20	1.05	0.92	1.23	1.23
45-50						0.43	0.42	0.70	0.73	0.71	0.67	1.07	1.36
50-55						-0.15	-0.17	0.38	0.19	0.43	0.38	0.97	1.25
55-60						-0.10	-0.24	0.04	0.02	0.29	0.25	0.82	1.07
60-65						-0.33	-0.42	-0.11	0.16	0.15	0.26	0.70	0.99
65-70						-0.03	-0.12	0.09	0.01	0.16	0.31	0.42	0.71
70-75						0.24	0.11	0.16	0.27	0.28	0.21	0.41	0.52
75-80						0.14	0.14	0.32	0.29	0.47	0.36	0.49	0.53
80-85						0.04	0.00	0.31	0.48	0.49	0.33	0.52	0.54
85-90						0.02	0.19	0.27	0.28	0.45	0.34	0.53	0.37

TABLE 2A—Continued

Age	35-Year Periods Ending							Age	50-Year Periods Ending			
	1956	1961	1966	1971	1976	1981	1986		1971	1976	1981	1986
1-5	4.29%	4.87%	5.10%	5.19%	4.83%	4.51%	4.05%	1-5	4.06%	4.29%	4.72%	4.93%
5-10	4.00	3.59	3.66	3.57	3.39	3.72	3.76	5-10	3.38	3.11	3.64	3.99
10-15	3.35	3.39	3.02	2.95	3.05	2.81	2.77	10-15	2.76	2.92	2.78	3.10
15-20	2.41	2.16	1.94	1.04	0.74	0.77	0.75	15-20	1.43	1.04	1.34	1.37
20-25	2.17	1.89	1.64	0.97	0.92	0.73	0.82	20-25	1.38	1.09	1.47	1.26
25-30	2.44	2.29	2.21	1.90	1.53	1.14	0.94	25-30	1.92	1.61	1.77	1.64
30-35	2.03	2.10	2.19	1.95	1.61	1.44	1.10	30-35	1.62	1.52	1.91	1.73
35-40	1.96	1.69	1.93	1.74	1.45	1.53	1.36	35-40	1.47	1.31	1.77	1.85
40-45	1.32	1.24	1.21	1.00	1.12	1.33	1.41	40-45	0.89	0.89	1.35	1.48
45-50	0.61	0.40	0.64	0.67	0.67	1.07	1.40	45-50	0.51	0.38	0.87	1.20
50-55	0.03	-0.06	0.27	0.26	0.49	0.75	1.23	50-55	0.11	0.07	0.63	0.85
55-60	0.01	-0.17	0.05	0.15	0.31	0.57	1.01	55-60	0.13	0.03	0.42	0.62
60-65	-0.27	-0.30	-0.11	0.23	0.26	0.54	0.85	60-65	-0.09	-0.06	0.30	0.65
65-70	-0.08	-0.04	0.02	0.05	0.28	0.49	0.55	65-70	-0.02	0.06	0.30	0.43
70-75	0.25	0.05	0.19	0.22	0.33	0.39	0.49	70-75	0.17	0.13	0.34	0.46
75-80	0.18	0.20	0.28	0.32	0.46	0.46	0.51	75-80	0.23	0.24	0.40	0.44
80-85	0.07	0.12	0.31	0.48	0.46	0.43	0.50	80-85	0.21	0.19	0.39	0.50
85-90	0.16	0.22	0.23	0.37	0.37	0.42	0.46	85-90	0.25	0.24	0.34	0.34

Age	40-Year Periods Ending							Age	60-Year Periods Ending			
	1956	1961	1966	1971	1976	1981	1986		1971	1976	1981	1986
1-5		4.41%	4.61%	4.79%	4.97%	4.91%	4.45%	1-5			4.13%	4.36%
5-10		3.87	3.28	3.42	3.51	3.72	3.99	5-10			3.57	3.58
10-15		3.21	3.08	2.76	3.03	2.93	3.03	10-15			2.78	2.99
15-20		2.29	1.72	1.36	0.83	1.06	1.16	15-20			1.41	1.46
20-25		1.99	1.39	1.43	0.83	1.23	0.96	20-25			1.42	1.40
25-30		2.37	1.91	2.05	1.65	1.52	1.21	25-30			1.71	1.61
30-35		2.11	1.79	1.88	1.85	1.78	1.20	30-35			1.69	1.47
35-40		1.72	1.57	1.71	1.57	1.73	1.62	35-40			1.56	1.58
40-45		1.27	0.95	1.03	1.07	1.45	1.47	40-45			1.18	1.26
45-50		0.57	0.38	0.59	0.64	1.02	1.36	45-50			0.75	0.89
50-55		0.11	-0.10	0.32	0.34	0.79	1.01	50-55			0.41	0.54
55-60		0.03	-0.14	0.16	0.19	0.59	0.78	55-60			0.36	0.42
60-65		-0.18	-0.27	-0.01	0.32	0.50	0.69	60-65			0.18	0.29
65-70		-0.02	-0.09	0.05	0.17	0.44	0.60	65-70			0.19	0.29
70-75		0.18	0.09	0.16	0.27	0.48	0.47	70-75			0.32	0.31
75-80		0.22	0.18	0.31	0.34	0.54	0.48	75-80			0.32	0.34
80-85		0.17	0.15	0.33	0.45	0.53	0.42	80-85			0.28	0.27
85-90		0.20	0.20	0.31	0.31	0.45	0.37	85-90			0.28	0.28

TABLE 2B
ANNUAL RATE OF MORTALITY IMPROVEMENT
CANADIAN POPULATION—FEMALE

Age	5-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5	0.72%	1.64%	2.17%	6.32%	7.79%	7.74%	4.85%	5.48%	3.69%	1.74%	3.87%	5.99%	2.68%
5-10	6.25	1.91	0.61	5.96	4.77	6.96	7.09	3.16	-0.37	2.37	2.93	5.27	5.03
10-15	2.98	1.60	3.60	4.90	4.84	7.00	5.53	5.68	-0.87	-0.01	3.12	3.28	3.83
15-20	1.44	1.13	4.25	5.03	2.86	9.36	6.96	1.77	-0.38	-2.29	1.38	2.95	1.57
20-25	1.44	1.11	3.62	5.83	3.70	10.26	7.96	2.08	0.67	-0.22	0.87	3.02	2.66
25-30	2.73	-1.25	3.69	4.85	6.17	9.12	5.52	3.75	1.49	-0.08	2.91	0.67	3.95
30-35	3.00	-0.97	2.01	5.76	4.77	7.69	6.31	3.16	-0.10	-0.22	3.06	3.70	1.62
35-40	2.63	0.20	1.39	4.86	4.75	5.25	6.26	1.55	1.05	-0.28	2.32	3.11	4.05
40-45	2.28	-0.56	2.00	2.85	3.73	3.03	4.85	2.33	0.30	-0.14	2.38	2.52	2.44
45-50	2.19	-0.71	1.19	2.10	2.20	2.43	3.63	2.26	0.60	1.19	0.20	3.51	1.68
50-55	3.28	-1.70	0.55	1.85	1.88	2.60	2.72	1.52	0.61	0.92	1.96	1.46	1.46
55-60	2.49	-2.46	1.32	0.71	2.21	1.84	1.93	2.03	0.98	1.10	1.35	1.64	1.62
60-65	1.16	-1.50	-0.09	2.13	1.18	1.51	1.76	2.09	1.33	1.60	1.29	1.55	1.17
65-70	1.47	-0.50	0.56	0.53	1.65	1.71	1.73	1.30	1.78	1.59	1.29	1.58	1.20
70-75	2.18	-1.12	-0.13	1.27	0.92	1.37	2.06	1.29	1.85	1.34	1.46	1.82	1.05
75-80	0.70	-0.76	0.76	0.09	1.52	0.58	1.09	1.83	1.58	1.88	1.66	1.83	0.58
80-85	0.06	-0.73	-0.31	0.97	0.83	0.47	0.91	1.16	1.25	2.01	1.30	1.84	0.74
85-90	-0.55	0.69	0.05	-0.11	0.42	0.59	0.80	0.38	0.98	1.67	0.91	1.66	0.30
Age	10-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5		1.18%	1.90%	4.26%	7.06%	7.77%	6.31%	5.16%	4.59%	2.72%	2.81%	4.93%	4.35%
5-10		4.11	1.26	3.32	5.37	5.87	7.02	5.14	1.41	1.01	2.65	4.11	5.15
10-15		2.29	2.61	4.26	4.87	5.92	6.27	5.60	2.46	-0.44	1.57	3.20	3.56
15-20		1.29	2.70	4.64	3.95	6.17	8.17	4.40	0.70	-1.33	-0.44	2.17	2.26
20-25		1.28	2.37	4.73	4.77	7.04	9.12	5.06	1.38	0.23	0.33	1.95	2.84
25-30		0.76	1.25	4.27	5.51	7.66	7.34	4.64	2.63	0.71	1.43	1.79	2.32
30-35		1.03	0.53	3.91	5.27	6.24	7.00	4.75	1.54	-0.16	1.43	3.38	2.67
35-40		1.43	0.80	3.14	4.80	5.00	5.75	3.93	1.30	0.39	1.03	2.71	3.58
40-45		0.87	0.73	2.43	3.29	3.38	3.95	3.60	1.32	0.08	1.13	2.45	2.48
45-50		0.75	0.24	1.65	2.15	2.32	3.03	2.94	1.43	0.89	0.69	1.87	2.60
50-55		0.82	-0.57	1.21	1.87	2.24	2.66	2.12	1.06	0.76	1.44	1.71	1.46
55-60		0.04	-0.55	1.02	1.46	2.03	1.88	1.98	1.51	1.04	1.23	1.49	1.63
60-65		-0.16	-0.79	1.03	1.66	1.34	1.64	1.92	1.71	1.46	1.45	1.42	1.36
65-70		0.49	0.03	0.54	1.09	1.68	1.72	1.52	1.54	1.69	1.44	1.43	1.39
70-75		0.54	-0.63	0.57	1.09	1.15	1.72	1.67	1.57	1.59	1.40	1.64	1.44
75-80		-0.03	0.00	0.42	0.81	1.05	0.84	1.46	1.70	1.73	1.77	1.75	1.21
80-85		-0.33	-0.52	0.34	0.90	0.65	0.69	1.03	1.20	1.63	1.66	1.57	1.29
85-90		0.07	0.37	-0.03	0.16	0.51	0.70	0.59	0.68	1.33	1.29	1.28	0.98

TABLE 2B—Continued

Age	15-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5			1.51%	3.40%	5.45%	7.29%	6.80%	6.03%	4.67%	3.65%	3.10%	3.88%	4.19%
5-10			2.95	2.85	3.81	5.90	6.28	5.75	3.34	1.73	1.66	3.53	4.42
10-15			2.73	3.38	4.45	5.59	5.79	6.07	3.49	1.64	0.76	2.14	3.41
15-20			2.28	3.48	4.05	5.79	6.43	6.09	2.83	-0.29	-0.42	0.70	1.97
20-25			2.06	3.54	4.39	6.64	7.35	6.83	3.62	0.85	0.44	1.23	2.19
25-30			1.74	2.46	4.91	6.73	6.95	6.16	3.60	1.74	1.45	1.18	2.52
30-35			1.36	2.31	4.20	6.08	6.26	5.74	3.16	0.96	0.92	2.20	2.80
35-40			1.41	2.17	3.68	4.95	5.42	4.37	2.98	0.78	1.04	1.72	3.16
40-45			1.25	1.44	2.86	3.21	3.87	3.41	2.51	0.84	0.86	1.59	2.45
45-50			0.90	0.87	1.83	2.25	2.76	2.77	2.17	1.35	0.66	1.64	1.80
50-55			0.73	0.25	1.43	2.11	2.40	2.28	1.62	1.02	1.16	1.45	1.62
55-60			0.47	-0.13	1.42	1.59	1.99	1.93	1.65	1.37	1.15	1.36	1.53
60-65			-0.14	0.19	1.08	1.61	1.48	1.79	1.73	1.67	1.41	1.48	1.34
65-70			0.52	0.20	0.91	1.30	1.70	1.58	1.61	1.56	1.55	1.49	1.35
70-75			0.32	0.01	0.69	1.19	1.45	1.57	1.73	1.49	1.55	1.54	1.44
75-80			0.24	0.03	0.79	0.73	1.07	1.17	1.50	1.76	1.71	1.79	1.36
80-85			-0.32	-0.02	0.50	0.76	0.73	0.85	1.11	1.48	1.52	1.72	1.29
85-90			0.06	0.21	0.12	0.30	0.61	0.59	0.72	1.01	1.19	1.41	0.96
Age	20-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5				2.74%	4.51%	6.03%	6.68%	6.47%	5.45%	3.95%	3.70%	3.83%	3.58%
5-10				3.71	3.34	4.61	6.20	5.51	4.26	3.10	2.03	2.57	3.91
10-15				3.28	3.75	5.09	5.57	5.76	4.38	2.63	2.01	1.40	2.57
15-20				2.98	3.33	5.41	6.09	5.29	4.51	1.58	0.13	0.43	0.92
20-25				3.02	3.58	5.89	6.97	6.06	5.32	2.67	0.85	1.09	1.59
25-30				2.53	3.40	5.98	6.43	6.16	5.01	2.70	2.03	1.25	1.88
30-35				2.48	2.93	5.08	6.14	5.50	4.31	2.32	1.49	1.63	2.05
35-40				2.29	2.82	4.07	5.28	4.47	3.55	2.18	1.16	1.56	2.31
40-45				1.65	2.02	2.91	3.62	3.49	2.64	1.86	1.23	1.27	1.81
45-50				1.20	1.20	1.98	2.59	2.63	2.23	1.93	1.06	1.38	1.65
50-55				1.01	0.66	1.72	2.26	2.18	1.87	1.45	1.25	1.24	1.45
55-60				0.53	0.46	1.52	1.67	2.00	1.70	1.51	1.37	1.27	1.43
60-65				0.43	0.44	1.19	1.65	1.64	1.67	1.69	1.58	1.44	1.40
65-70				0.52	0.56	1.12	1.41	1.60	1.63	1.60	1.49	1.56	1.41
70-75				0.56	0.24	0.86	1.41	1.41	1.64	1.63	1.48	1.62	1.42
75-80				0.20	0.41	0.74	0.82	1.26	1.27	1.60	1.74	1.74	1.49
80-85				0.00	0.19	0.49	0.79	0.84	0.95	1.33	1.43	1.60	1.48
85-90				0.02	0.26	0.24	0.43	0.55	0.69	0.96	0.99	1.31	1.14

TABLE 2B—Continued

Age	25-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5					3.77%	5.17%	5.80%	6.44%	5.92%	4.72%	3.93%	4.16%	3.60%
5-10					3.93	4.07	5.11	5.60	4.36	3.88	3.07	2.69	3.07
10-15					3.59	4.41	5.18	5.59	4.47	3.52	2.73	2.27	1.89
15-20					2.96	4.57	5.72	5.24	4.18	3.19	1.54	0.70	0.66
20-25					3.15	4.95	6.31	6.01	5.00	4.24	2.32	1.29	1.41
25-30					3.27	4.58	5.89	5.90	5.24	4.02	2.74	1.76	1.80
30-35					2.94	3.90	5.33	5.55	4.40	3.42	2.47	1.94	1.62
35-40					2.78	3.31	4.52	4.55	3.79	2.80	2.20	1.56	2.06
40-45					2.07	2.22	3.30	3.36	2.86	2.09	1.96	1.49	1.51
45-50					1.40	1.45	2.31	2.53	2.23	2.03	1.58	1.56	1.44
50-55					1.19	1.05	1.92	2.12	1.87	1.68	1.55	1.29	1.28
55-60					0.87	0.74	1.60	1.75	1.80	1.58	1.48	1.42	1.34
60-65					0.58	0.65	1.30	1.73	1.57	1.66	1.61	1.57	1.39
65-70					0.75	0.80	1.24	1.39	1.64	1.62	1.54	1.51	1.49
70-75					0.63	0.47	1.10	1.38	1.50	1.58	1.60	1.55	1.50
75-80					0.47	0.44	0.81	1.03	1.32	1.39	1.61	1.76	1.51
80-85					0.17	0.25	0.58	0.87	0.92	1.16	1.33	1.51	1.43
85-90					0.10	0.33	0.35	0.42	0.64	0.89	0.95	1.12	1.11
Age	30-Year Periods Ending												
	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
1-5						4.44%	5.12%	5.74%	5.99%	5.24%	4.58%	4.28%	3.92%
5-10						4.44	4.58	4.78	4.63	4.03	3.73	3.44	3.08
10-15						4.17	4.59	5.26	4.54	3.74	3.45	2.89	2.53
15-20						4.05	4.97	5.07	4.32	3.13	2.89	1.78	0.85
20-25						4.38	5.46	5.62	5.14	4.15	3.69	2.43	1.52
25-30						4.27	4.73	5.53	5.18	4.38	3.83	2.40	2.13
30-35						3.75	4.31	4.97	4.63	3.65	3.36	2.68	1.88
35-40						3.20	3.81	4.03	3.97	3.13	2.72	2.36	1.98
40-45						2.23	2.67	3.14	2.86	2.37	2.14	2.05	1.64
45-50						1.57	1.82	2.30	2.21	2.06	1.72	1.91	1.58
50-55						1.42	1.33	1.86	1.87	1.71	1.72	1.53	1.32
55-60						1.03	0.94	1.68	1.62	1.68	1.54	1.51	1.45
60-65						0.74	0.84	1.43	1.67	1.58	1.60	1.60	1.51
65-70						0.91	0.95	1.25	1.45	1.63	1.57	1.55	1.46
70-75						0.75	0.73	1.13	1.46	1.47	1.56	1.63	1.47
75-80						0.49	0.55	0.98	1.12	1.42	1.44	1.65	1.56
80-85						0.22	0.36	0.67	0.93	1.11	1.18	1.41	1.39
85-90						0.18	0.41	0.36	0.51	0.81	0.89	1.07	0.99

TABLE 2B—Continued

Age	35-Year Periods Ending							Age	50-Year Periods Ending			
	1956	1961	1966	1971	1976	1981	1986		1971	1976	1981	1986
1-5	4.50%	5.17%	5.45%	5.39%	5.04%	4.78%	4.05%	1-5	4.25%	4.55%	4.98%	5.03%
5-10	4.82	4.38	4.07	4.31	3.88	3.95	3.67	5-10	3.91	3.57	3.91	4.34
10-15	4.36	4.75	4.41	3.91	3.65	3.43	2.96	10-15	3.56	3.57	3.74	3.76
15-20	4.47	4.52	4.31	3.41	2.88	2.90	1.75	15-20	3.07	3.06	3.24	2.98
20-25	4.90	4.99	4.92	4.39	3.69	3.59	2.47	20-25	3.70	3.64	3.83	3.74
25-30	4.45	4.59	4.97	4.45	4.17	3.39	2.62	25-30	3.64	3.66	3.84	3.87
30-35	4.12	4.14	4.26	3.95	3.56	3.41	2.53	30-35	3.18	3.19	3.65	3.61
35-40	3.64	3.49	3.61	3.38	3.01	2.77	2.60	35-40	2.79	2.76	3.05	3.31
40-45	2.61	2.62	2.74	2.44	2.37	2.19	2.11	40-45	2.08	2.09	2.40	2.44
45-50	1.87	1.88	2.06	2.06	1.79	1.98	1.87	45-50	1.71	1.52	1.94	1.99
50-55	1.61	1.36	1.68	1.73	1.75	1.69	1.52	50-55	1.43	1.30	1.61	1.70
55-60	1.16	1.10	1.58	1.55	1.64	1.55	1.52	55-60	1.23	1.11	1.51	1.54
60-65	0.88	1.02	1.42	1.66	1.54	1.59	1.54	60-65	1.12	1.14	1.44	1.56
65-70	1.03	1.00	1.33	1.47	1.58	1.57	1.50	65-70	1.19	1.17	1.37	1.44
70-75	0.94	0.81	1.23	1.44	1.47	1.55	1.55	70-75	1.11	1.03	1.32	1.44
75-80	0.57	0.73	1.07	1.23	1.45	1.50	1.49	75-80	0.93	1.03	1.28	1.27
80-85	0.32	0.47	0.76	1.09	1.13	1.28	1.32	80-85	0.67	0.79	1.05	1.15
85-90	0.27	0.41	0.45	0.68	0.82	1.00	0.96	85-90	0.50	0.64	0.74	0.76

Age	40-Year Periods Ending							Age	60-Year Periods Ending			
	1956	1961	1966	1971	1976	1981	1986		1971	1976	1981	1986
1-5		4.62%	4.98%	5.00%	5.20%	5.16%	4.52%	1-5			4.36%	4.52%
5-10		4.62	3.80	3.86	4.14	4.05	4.08	5-10			3.94	3.84
10-15		4.53	4.06	3.87	3.81	3.61	3.48	10-15			3.50	3.57
15-20		4.14	3.92	3.51	3.16	2.89	2.73	15-20			2.92	2.93
20-25		4.55	4.46	4.30	3.96	3.61	3.48	20-25			3.41	3.51
25-30		4.36	4.21	4.35	4.25	3.74	3.46	25-30			3.34	3.44
30-35		4.00	3.62	3.71	3.84	3.58	3.19	30-35			3.22	3.10
35-40		3.38	3.19	3.13	3.24	3.02	2.93	35-40			2.78	2.90
40-45		2.58	2.33	2.38	2.43	2.39	2.23	40-45			2.14	2.16
45-50		1.92	1.72	1.95	1.83	2.01	1.94	45-50			1.74	1.70
50-55		1.60	1.26	1.59	1.76	1.71	1.66	50-55			1.48	1.33
55-60		1.27	1.08	1.52	1.52	1.64	1.56	55-60			1.27	1.20
60-65		1.04	1.06	1.44	1.61	1.54	1.54	60-65			1.17	1.17
65-70		1.06	1.10	1.36	1.45	1.58	1.52	65-70			1.23	1.20
70-75		0.98	0.94	1.25	1.44	1.51	1.53	70-75			1.19	1.10
75-80		0.73	0.84	1.17	1.28	1.50	1.38	75-80			1.07	1.06
80-85		0.42	0.57	0.91	1.11	1.22	1.21	80-85			0.82	0.87
85-90		0.29	0.48	0.60	0.71	0.93	0.91	85-90			0.63	0.70

Don Keith, in his paper on mortality improvement, concluded that, if the actuary decided to adjust population data when applied to annuitant mortality, the adjustments could be positive or negative, but in no event should they be very large for an indefinite period.

FUTURE PROJECTIONS—SOCIAL SECURITY RESEARCH

The projected costs of social insurance plans in Canada and the United States are affected to a great extent by the future outlook for mortality. Information on mortality improvement is contained in:

(1) *Social Security Administration (United States)*

Population Projections: 1989 Actuarial Study No. 105

Past reduction in mortality has varied greatly by cause of death. Because it is expected that future reduction in mortality rates will also vary greatly by cause of death, the SSA analyzed death rates for the years 1968 through 1986 by age group and sex for ten groups of causes of death. Table 3 shows the average annual percentage reductions in central death rates during 1968–86 (Table 7 in *SSA Actuarial Study No. 105*). Using this guide, the Social Security Administration postulates annual percentage improvements in central death rates by sex and the ten leading causes of death. Three alternatives in ultimate annual percentage reductions in death rates were postulated with Alternative II considered the most likely; see Table 4. Using central death rates by age group, sex and calendar year as published in *SSA Actuarial Study No. 105*, annual percentage reductions in mortality can be computed. Table 5 shows projected mortality according to Alternative II for the period 1990 to 2030 in ten-year steps, and for the period 2030 to 2080.

(2) *Canada Pension Plan*

10th and 11th Statutory Reports

Table 6 shows future assumed mortality rates used in the last two CPP statutory reports. From these data, the annual compound rates of mortality improvement were computed.

The methodology used to project mortality rates is described in the Eleventh Actuarial Report and is summarized as follows:

1. Mortality rates in the 1985–87 Canada Life Tables are assumed to be applicable for 1986.

TABLE 3

AVERAGE ANNUAL PERCENTAGE REDUCTIONS IN CENTRAL DEATH RATES DURING 1968-86 BY AGE GROUP, SEX, AND CAUSE OF DEATH

Age Group	Cause of Death										
	Total*	Heart Disease	Cancer	Vascular Disease	Violence	Respiratory Disease	Infancy	Digestive Disease	Diabetes Mellitus	Cirrhosis (Liver)	Other†
Male											
0	4.55	-3.97	2.65	1.28	5.72	11.75	5.30	6.76	7.70	3.77	-2.99
1-4	3.04	-2.22	3.82	6.65	2.51	8.65	2.10	1.68	7.14	5.42	2.55
5-9	3.65	-0.38	3.87	7.40	3.39	6.99	4.42	4.38	6.23	8.32	3.30
10-14	2.69	0.56	2.76	8.23	2.45	4.96	3.08	5.41	5.63	2.46	2.40
15-19	1.94	0.32	2.83	7.18	1.55	5.94	2.90	6.26	6.03	7.63	3.48
20-24	1.77	0.73	2.84	7.18	1.38	6.11	2.76	6.71	4.58	5.07	3.48
25-29	1.12	1.19	2.09	6.08	0.88	4.77	3.83	5.98	4.17	2.76	1.09
30-34	1.22	2.43	1.60	6.01	1.03	3.72	2.88	4.44	3.28	2.26	0.39
35-39	2.15	3.45	1.71	5.84	1.72	4.66	2.95	3.90	2.54	3.26	1.31
40-44	2.56	3.44	1.16	5.59	2.11	4.76	2.75	3.87	1.97	3.67	1.68
45-49	2.62	3.47	0.65	5.12	2.39	4.47	3.54	3.86	1.84	3.51	1.67
50-54	2.27	3.09	0.01	5.03	2.52	3.65	4.09	3.11	2.08	2.95	1.23
55-59	2.21	3.05	-0.14	5.24	2.94	2.96	3.06	3.15	2.04	2.75	1.08
60-64	2.09	2.90	-0.22	5.22	3.25	2.30	1.70	2.91	2.20	2.51	0.71
65-69	1.59	2.36	-0.71	4.90	2.85	1.03	0.84	2.47	2.22	1.32	-0.04
70-74	1.32	2.06	-0.96	4.66	2.26	0.10	-0.31	1.95	2.17	0.14	-0.93
75-79	1.12	1.82	-1.13	4.43	1.79	-0.75	-0.19	1.41	1.96	-0.13	-1.80
80-84	1.10	1.69	-1.25	4.43	2.03	-1.47	-1.83	0.79	1.90	-0.28	-2.27
85-89	1.12	1.64	-1.43	4.50	2.14	-2.01	-0.10	-0.04	1.88	0.30	-2.43
90-94	1.12	1.49	-1.72	4.48	2.55	-1.77	-2.06	-1.00	0.58	1.02	-2.52
Total	1.60	2.16	-0.64	4.68	1.95	0.32	4.97	1.89	2.04	2.21	-0.66

TABLE 3—Continued

Age Group	Cause of Death										
	Total*	Heart Disease	Cancer	Vascular Disease	Violence	Respiratory Disease	Infancy	Digestive Disease	Diabetes Mellitus	Cirrhosis (Liver)	Other†
Female											
0	4.32	-3.42	3.28	1.70	5.46	12.14	4.84	6.81	8.69	4.89	-2.62
1-4	3.30	-2.60	3.98	6.48	2.77	8.45	2.87	0.28	4.44	6.69	3.01
5-9	3.52	-0.34	3.89	5.96	3.12	6.65	4.74	3.62	6.45	9.38	2.96
10-14	2.62	0.36	2.88	6.14	1.79	5.61	2.43	5.92	6.72	9.23	2.79
15-19	1.81	1.21	2.51	7.33	0.77	5.66	3.53	5.77	5.70	11.03	3.22
20-24	1.99	0.98	2.27	7.30	0.73	5.98	3.11	7.57	5.38	6.48	3.34
25-29	2.25	1.77	1.94	6.95	1.01	5.54	3.33	6.40	4.12	3.82	2.97
30-34	2.89	3.39	1.80	7.73	1.76	5.24	3.60	6.27	3.97	4.16	3.03
35-39	3.42	4.12	1.79	7.30	2.57	5.62	2.55	5.44	3.03	5.93	3.77
40-44	3.11	3.41	1.52	6.18	2.79	5.02	3.11	4.72	2.84	5.77	3.39
45-49	2.62	2.90	1.21	5.54	2.89	3.56	4.20	4.03	3.16	5.18	2.45
50-54	1.89	2.50	0.38	5.00	2.98	1.82	2.82	3.02	2.58	3.75	1.79
55-59	1.58	2.56	-0.12	5.00	3.05	0.31	2.78	2.71	2.96	2.90	1.04
60-64	1.16	2.36	-0.89	4.83	3.03	-1.30	1.85	1.93	2.71	1.36	0.08
65-69	0.90	2.11	-1.45	4.67	2.61	-2.75	1.16	1.18	2.91	-0.55	-1.04
70-74	1.35	2.37	-1.20	4.85	2.58	-2.73	-0.75	1.02	3.32	-1.34	-1.57
75-79	1.77	2.43	-0.60	4.92	3.25	-1.87	-1.55	0.73	3.42	-1.54	-2.30
80-84	1.93	2.30	-0.38	4.78	3.91	-0.91	-1.39	0.15	2.91	-1.32	-2.84
85-89	1.78	1.96	-0.32	4.41	4.53	-0.66	-2.08	-0.66	1.83	-0.33	-3.22
90-94	1.43	1.41	-0.80	3.98	5.03	-0.40	-3.14	-1.64	0.12	-0.07	-3.34
Total	1.74	2.17	-0.41	4.70	2.54	-0.17	4.56	1.12	2.85	2.32	-0.84

*Includes AIDS.

†Excludes AIDS.

Note: The average annual percentage reduction is the complement of the exponential of the least-squares line through the logarithms of the central death rates.

Source: SSA Actuarial Study No. 105.

TABLE 4
ASSUMED ULTIMATE ANNUAL PERCENTAGE REDUCTIONS IN DEATH RATES
BY ALTERNATIVE, SEX, AGE GROUP, AND CAUSES

Sex and Age Group	Cause of Death									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Alternative I										
Male										
<15	0.3	0.2	0.7	0.3	0.3	0.8	0.6	0.5	0.3	0.0
15-64	0.6	0.1	0.9	0.2	0.2	0.6	0.4	0.4	0.2	0.0
65+	0.5	0.0	0.8	0.3	0.0	0.4	0.2	0.3	0.1	0.0
Female										
<15	0.3	0.2	0.7	0.3	0.3	0.8	0.6	0.5	0.3	0.0
15-64	0.6	0.1	0.9	0.2	0.2	0.6	0.4	0.4	0.2	0.0
65+	0.5	0.0	0.8	0.3	0.0	0.4	0.2	0.3	0.1	0.0
Alternative II										
Male										
<15	0.6	0.5	1.2	0.6	0.5	1.5	0.8	0.8	0.5	0.2
15-64	1.0	0.3	1.4	0.3	0.3	1.3	0.6	0.7	0.3	0.2
65+	0.8	0.2	1.3	0.4	0.2	1.1	0.4	0.6	0.2	0.2
Female										
<15	0.6	0.5	1.2	0.6	0.5	1.5	0.8	0.8	0.5	0.2
15-64	1.0	0.3	1.4	0.4	0.3	1.3	0.6	0.8	0.4	0.2
65+	0.9	0.2	1.3	0.5	0.2	1.1	0.4	0.6	0.2	0.2
Alternative III										
Male										
<15	0.9	1.3	1.4	0.9	0.6	2.0	1.0	1.0	0.8	0.4
15-64	1.3	1.2	1.8	0.6	0.5	1.8	0.9	0.9	0.6	0.4
65+	1.1	1.1	1.7	0.8	0.4	1.6	0.8	0.9	0.6	0.4
Female										
<15	0.9	1.3	1.4	0.9	0.6	2.0	1.0	1.0	0.8	0.4
15-64	1.3	1.3	1.8	0.8	0.5	1.8	0.9	1.0	0.7	0.4
65+	1.2	1.2	1.7	0.9	0.4	1.6	0.8	0.9	0.6	0.4

Source: SSA Actuarial Study No. 105.

TABLE 5
ANNUAL IMPROVEMENT IN MORTALITY RATES—ALTERNATIVE II
SOCIAL SECURITY ADMINISTRATION ACTUARIAL STUDY NO. 105.

Age Group	Annual Improvement in Mortality from					
	1990 to 2000	2000 to 2010	2010 to 2020	2020 to 2030	1990 to 2030	2030 to 2080
Male						
1-4	1.96%	1.37%	0.60%	0.58%	1.13%	0.53%
5-9	2.69	1.51	0.50	0.53	1.31	0.52
10-14	2.29	1.26	0.56	0.50	1.16	0.53
15-19	1.63	0.86	0.33	0.32	0.79	0.31
20-24	0.88	1.22	0.32	0.30	0.68	0.28
25-29	-1.05	2.04	0.29	0.24	0.39	0.23
30-34	-1.88	2.55	0.31	0.20	0.31	0.20
35-39	-1.89	2.73	0.38	0.21	0.37	0.20
40-44	-0.41	2.22	0.45	0.34	0.65	0.29
45-49	0.56	1.78	0.48	0.41	0.81	0.36
50-54	1.18	1.17	0.52	0.47	0.84	0.44
55-59	1.46	0.93	0.54	0.50	0.86	0.47
60-64	1.46	0.85	0.54	0.52	0.84	0.49
65-69	1.08	0.60	0.44	0.42	0.63	0.39
70-74	0.83	0.50	0.44	0.43	0.55	0.40
75-79	0.63	0.44	0.45	0.44	0.49	0.41
80-84	0.54	0.43	0.47	0.46	0.47	0.42
85-89	0.47	0.41	0.48	0.47	0.46	0.43
90-94	0.46	0.43	0.50	0.49	0.47	0.45
Female						
1-4	1.98%	1.46%	0.59%	0.55%	1.15%	0.53%
5-9	2.41	1.43	0.62	0.56	1.26	0.48
10-14	2.17	1.07	0.54	0.57	1.09	0.52
15-19	1.26	0.76	0.41	0.42	0.71	0.39
20-24	1.33	0.84	0.43	0.40	0.75	0.40
25-29	0.31	1.67	0.38	0.36	0.68	0.33
30-34	-0.58	2.20	0.35	0.29	0.57	0.26
35-39	1.49	1.56	0.44	0.36	0.96	0.34
40-44	2.07	1.27	0.46	0.41	1.06	0.39
45-49	2.05	1.05	0.48	0.45	1.01	0.42
50-54	1.45	0.82	0.48	0.46	0.80	0.43
55-59	1.09	0.61	0.47	0.46	0.66	0.43
60-64	0.64	0.46	0.49	0.47	0.51	0.45
65-69	0.30	0.30	0.41	0.40	0.35	0.37
70-74	0.60	0.39	0.44	0.43	0.47	0.40
75-79	0.97	0.54	0.49	0.48	0.62	0.44
80-84	1.15	0.64	0.55	0.53	0.72	0.49
85-89	1.05	0.66	0.59	0.57	0.72	0.53
90-94	0.79	0.63	0.62	0.61	0.66	0.56

TABLE 6
CANADA PENSION PLAN—ASSUMED RATES OF MORTALITY IMPROVEMENT

Age	Mortality Rates Canada Life Tables		Rates Assumed for 1986 in Report 10	Mortality Rates Assumed for Year 2100		Annual Rates of Mortality Improvement from 1986 to 2100	
	1980-82	1985-87		Report 10	Report 11	Report 10	Report 11
Male							
1	0.81	0.67	0.78	0.53	0.27	0.34%	0.79%
5	0.39	0.30	0.38	0.25	0.12	0.37	0.80
10	0.22	0.18	0.21	0.12	0.08	0.49	0.71
20	1.53	1.30	1.50	1.17	0.64	0.22	0.62
30	1.32	1.30	1.30	1.05	0.83	0.19	0.39
40	2.23	1.97	2.15	1.38	0.95	0.39	0.64
50	6.28	5.32	6.09	4.17	2.50	0.33	0.66
60	16.28	14.68	15.77	10.57	7.75	0.35	0.56
70	39.07	36.73	38.13	27.96	21.21	0.27	0.48
80	89.41	86.65	87.31	64.61	52.59	0.26	0.44
90	187.75	191.97	185.77	136.21	114.49	0.27	0.45
Female							
1	0.66	0.62	0.63	0.40	0.24	0.40%	0.83%
5	0.27	0.22	0.26	0.16	0.07	0.42	1.00
10	0.18	0.14	0.18	0.10	0.05	0.51	0.90
20	0.47	0.42	0.46	0.38	0.20	0.17	0.65
30	0.57	0.51	0.56	0.37	0.26	0.36	0.59
40	1.32	1.12	1.27	0.76	0.53	0.45	0.65
50	3.38	3.12	3.28	2.21	1.68	0.35	0.54
60	8.04	7.51	7.84	5.71	4.23	0.28	0.50
70	19.83	18.67	19.35	14.08	10.23	0.28	0.53
80	54.01	51.73	52.04	33.30	27.19	0.39	0.56
90	143.51	144.15	142.87	92.33	72.61	0.38	0.60

Source: CPP Statutory Reports 10 and 11.

2. To reflect anticipated sustained improvements in life expectancy, these rates were projected to the year 2100 using the following annual rates of decrease:
 - (a) For 1987 to 2010, the annual rates of decrease (varying by age, sex and calendar year) were determined by interpolation between (i) the average reduction in rates experienced in Canada between 1976 and 1986, and (ii) the constant rates of decrease, described in (b) below, in respect of the period 2011 to 2100.
 - (b) For 2011 and later years, the annual rates of decrease (varying by age and sex only, not by calendar year) are those identified as "Alternative II (medium)" in *Actuarial Study No. 102* (Social Security Area Population Projection) prepared by the Office of the Actuary of the U.S. Social Security Administration.
3. To account for AIDS, which was ignored in the above steps, male mortality was increased for the years 1989 to 2018 by the increments estimated by the Canadian Institute of Actuaries' Task Force on AIDS in its November 1988 Report of the Subcommittee on Modeling. A constant level of new infections is assumed to hold from 1984 to 1988 and to decrease gradually from that level to zero in 1999. On the basis of the cumulative number of deaths attributable to AIDS (as reported by the Federal Centre for AIDS), female mortality was also increased but by only 10% of the above increments for males.
4. The following table shows the impact on the expectation of life of using the mortality improvement described.

EXPECTATION OF LIFE (YEARS)				
	1986		2100	
	Male	Female	Male	Female
At Birth	73.0	79.7	80.3	86.9
At Age 65	14.9	19.1	19.3	24.5

IMPACT OF MORTALITY IMPROVEMENT ON ANNUITY VALUES

Table 7 shows the impact on an immediate annuity of \$1,000 per month of using mortality according to the 1983 Basic Table along with improvement according to Scales G and H. Two projection approaches are employed: (1) a generation approach, whereby the mortality rate depends on sex, attained age and the calendar year in which that age is reached, and (2) a static approach using 17 years of mortality improvement from 1983 for all ages.

TABLE 7

IMPACT ON ANNUITY VALUES OF VARIOUS PROJECTION SCALES AND METHODS OF PROJECTION:
 RATIO OF ANNUITY VALUES TO BASE
 (1983 BASIC TABLE WITH NO PROJECTION AT 10.0% INTEREST
 FOR 20 YEARS AND 5.0% THEREAFTER)

Age at Birthday in 1990	Immediate Life Annuity				Immediate Life Annuity with 10 Years Certain			
	Projection				Projection			
	Scale G Generation #1	Scale G Static #2	Scale H Generation #3	Scale H Static #4	Scale G Generation #1	Scale G Static #2	Scale H Generation #3	Scale H Static #4
Male								
60	104.1%	103.7%	103.6%	103.5%	103.5%	102.8%	103.0%	102.6%
65	104.5	104.5	103.9	104.2	103.5	103.0	102.9	102.8
70	104.9	105.6	104.2	105.1	103.3	103.2	102.7	102.8
75	105.5	107.1	104.5	106.2	102.9	103.1	102.0	102.4
Female								
60	103.9%	103.1%	103.3%	102.8%	103.6%	102.6%	102.9%	102.3%
65	104.4	103.9	103.6	103.5	103.7	103.0	103.0	102.6
70	104.8	105.0	103.9	104.4	103.7	103.3	102.9	102.8
75	105.4	106.4	104.2	105.4	103.5	103.5	102.4	102.6

1. Scale G with projection from 1983 using a generation approach.
2. Scale G with projection from 1983 to 2000 (static approach).
3. Scale H with projection from 1983 using a generation approach.
4. Scale H with projection from 1983 to 2000 (static approach).

VIEW OF THE ANNUITY MORTALITY SUBCOMMITTEE

The Annuity Mortality Subcommittee of the CIA Expected Experience Committee makes the following observations and suggestions regarding mortality improvement on individual annuitants:

1. While there is no general agreement as to the level of change, annuitant mortality is expected to continue to improve in the future.
2. The subcommittee feels there are insufficient data from the Canadian Annuitant Mortality study to be able to recommend a particular scale for Canadian annuitants. However, a review of all the evidence available with an emphasis on research based on population data suggests that Scale G rates of mortality improvement are probably conservative at ages over 65 in forecasting mortality improvement over the foreseeable future.
3. The scale of mortality improvement rates chosen by the actuary should vary by sex and attained age. Table 8 compares the rates of mortality improvement from several sources. For example, based on this information, an assumption for mortality improvement over the next 20 years

for males might be 1.25 percent at age 65 decreasing to 0.50 percent at age 90 and over. For female annuitants, a reasonable assumption might be 1.50 percent at age 65 decreasing to 0.75 percent at age 90 and over.

TABLE 8
RATES OF MORTALITY IMPROVEMENT—COMPARISONS

Age	G	H	P76	Canada Life Tables Improvement to 1986 from			SSA Study No. 105 Improvement from		CPP 11th Report Improvement from 1986 to 2100
				1976	1966	1956	1990	1990	
							to 2000	to 2030	
Male									
55	1.60	1.60	0.50	2.35	1.53	1.07	1.46	0.86	0.56
60	1.50	1.50	0.50	1.97	1.39	0.99	1.46	0.84	
65	1.50	1.50	0.50	1.45	1.05	0.71	1.08	0.63	0.48
70	1.35	1.35	0.50	1.23	0.75	0.52	0.83	0.55	
75	1.25	1.25	0.50	0.84	0.65	0.53	0.63	0.49	0.44
80	1.25	1.25	0.50	0.70	0.53	0.54	0.54	0.47	
85	1.25	0.95	0.50	0.49	0.44	0.37	0.47	0.46	0.45
90	1.10	0.60	0.30				0.46	0.47	
95	1.00	0.26	0.10						
100	0.25	0.00	0.00						
Female									
55	1.85	1.85	1.30	1.63	1.43	1.45	1.09	0.66	0.50
60	1.75	1.75	1.40	1.36	1.40	1.51	0.64	0.51	
65	1.75	1.75	1.50	1.39	1.41	1.46	0.30	0.35	0.53
70	1.75	1.75	1.60	1.44	1.42	1.47	0.60	0.47	
75	1.60	1.60	1.75	1.21	1.49	1.56	0.97	0.62	0.56
80	1.50	1.50	1.90	1.29	1.48	1.39	1.15	0.72	
85	1.50	1.20	1.60	0.98	1.14	0.99	1.05	0.72	0.60
90	1.35	0.70	1.20				0.79	0.66	
95	1.25	0.35	0.80						
100	0.50	0.00	0.40						

- The generation approach is preferred for determining mortality rates which include improvement. The use of a static table may be used as an approximation, but such a table should be tested for its continued appropriateness from year to year, and updated where necessary. This is because, compared to a generation table, a static table will tend to release margins more quickly.

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