THE STANDARD MORTALITY TABLE 2007

Tatsuhiro Yamakawa

Sumitomo Life Insurance Company, Japan

Abstract. This April, the Institute of Actuaries of Japan revised the Standard Mortality Table (SMT), which is used for calculating the standard reserves, in view of the situation that the mortality experience of the Japanese life insurance companies as well as the overall mortality of the Japanese population has been continuously improving, especially for older ages.

In this paper, I would like to present an overview of the SMT revision and construction process for the SMT 2007, and then give some arguments about the SMT.

Key-words: improvement of mortality, revision of the SMT, the SMT 2007

1. Introduction

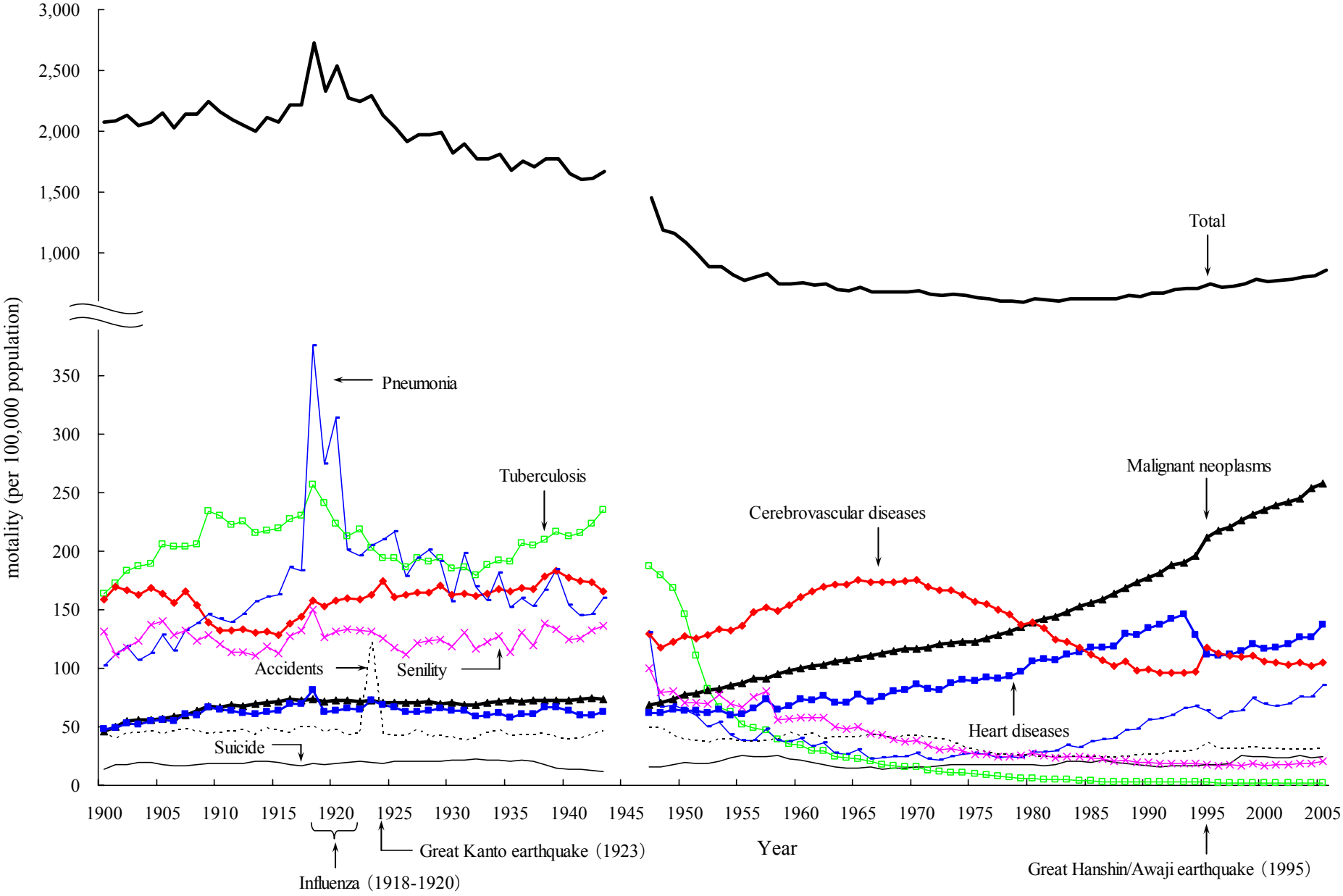
1.1. Trends in Mortality of the Japanese Population (see Fig. 1-2)

First, we would like to look at the trends in the Japanese national population mortality. The mortality was about 1,600 to 2,300 per 100,000 before World War II if we eliminate deaths caused by Influenza and Great Kanto earthquake. The mortality rapidly improved after around 1950, and marked the lowest at 600 per 100,000 in 1979. After around 1980, the mortality shifted and started to increase because of population aging, and it has continued to increase up until 2005.

With regard to causes of death, the main causes were epidemics before World War II, however, since 1958, malignant neoplasm, heart disease and cerebrovascular disease, which are today's adult diseases, have been three leading causes of death.

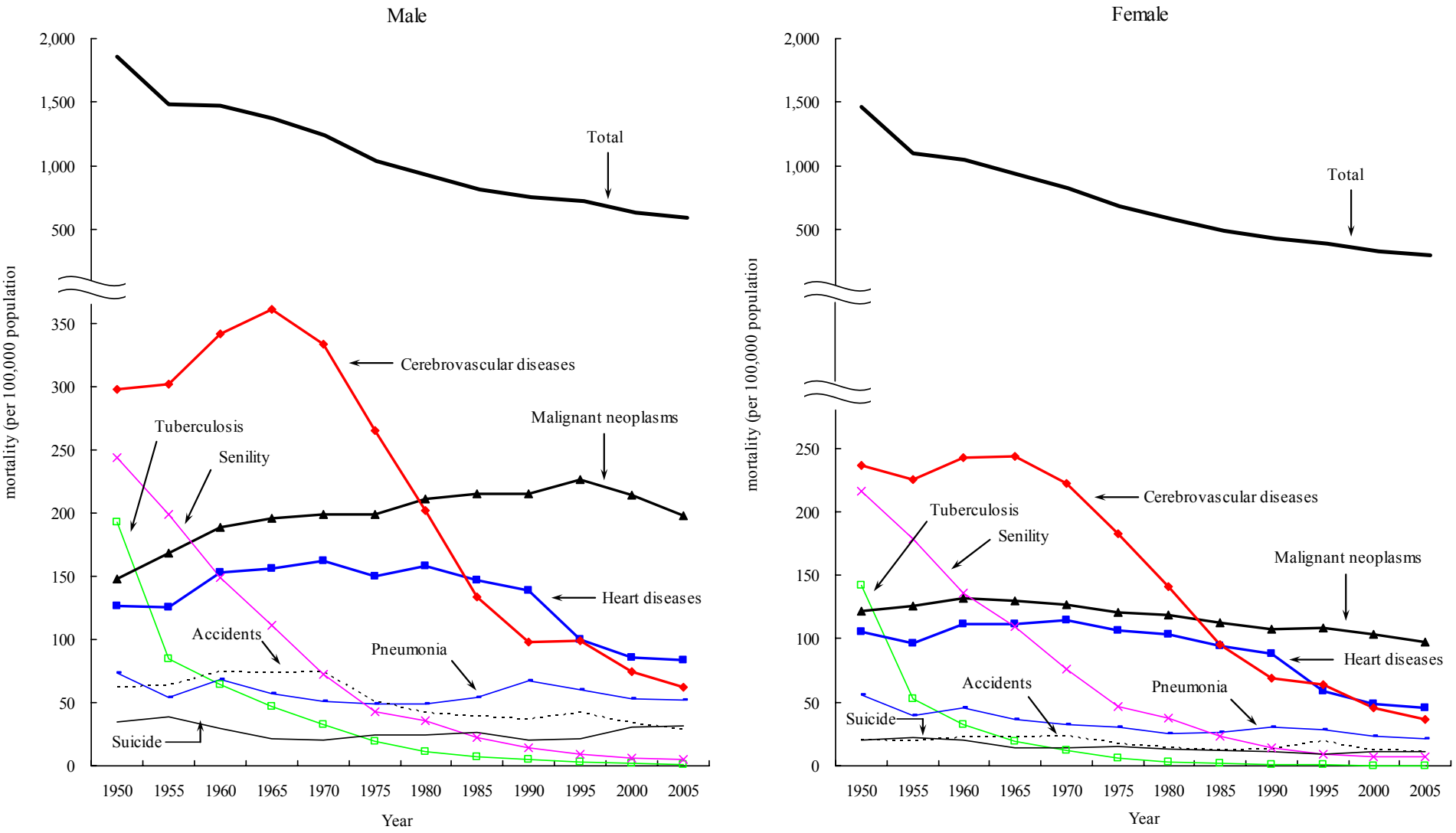
The mortality is influenced by age distribution in each year, and if we see trends of age-adjusted mortality (mortality adjusted for population of each age to remain consistent every year), it has actually been decreasing.

Figure 1. Trends in mortality of the Japanese population by causes of death, 1990-2005



Source: *Current Population Survey* (The Ministry of Health, Labour and Welfare)

Figure 2. Trends in age-adjusted mortality of the Japanese population by causes of death, 1990-2005



Note: Standard population of age-adjusted mortality is model population for 1985.

Source: *Current Population Survey* (The Ministry of Health, Labour and Welfare)

1.2. Population Tables

The Ministry of Health, Labour, and Welfare prepares two series of life tables: the Complete Life Tables and the Abridged Life Tables.

The Complete Life Tables are constructed every five years based on the Annual Vital Statistics and the Population Census, and the latest ones are the 20th Life Tables (2005) published this March.

The Abridged Life Tables are constructed every year based on the Provisional Annual Vital Statistics and the Population Estimates, and the latest ones are the tables for 2006 published this July.

1.3. History of Experience Life Tables before 1996

Experience life tables in Japan had been developed by the Mortality Investigation Committee (MIC) of the Life Insurance Association of Japan (LIAJ). Including the first table after World War II developed in 1969, five tables in total had been published before 1996.

Name of Table	Published in	Observed year
The 1st Experience Table	1969	1960-'63
The 2nd Experience Table	1974	1965-'69
The 3rd Experience Table	1981	1972-'76
The 4th Experience Table	1985	1979-'80
The 5th Experience Table	1990	1984-'85

The MIC has been continuously collecting mortality data from life insurance companies in Japan.

1.4. Introduction of Standard Valuation System

Revision of the Japanese Insurance Business Law in 1996 deregulated pricing of products and consequently made the competition more fierce. On the other hand, the Standard Valuation System was introduced to maintain soundness of insurance companies for the purpose of protecting policyholders.

The standard reserves stipulated in the Japanese Insurance Business Law are net level premium reserves calculated based on the standard calculation bases, which are the standard interest rate and the standard mortality table.

1.5. Development of the Life Insurance Companies Standard Mortality Table 1996

The fist standard mortality table is the Life Insurance Companies Standard Mortality Table 1996 (SMT 1996). It was developed by the Institute of Actuaries of Japan (IAJ), and was validated by the Commissioner of Financial Services Agency. To develop the SMT, the IAJ established the Standard Mortality Advisory Committee (SMAC) and the Standard Mortality Research Subcommittee (SMRS), and the LIAJ provided the mortality experience data to the IAJ. The SMRS is mainly in charge of practical and technical researches, and the SMAC, which member involves university professors specialized in statistics and a medical doctor, works as an advisory body to the Board members of the IAJ.

The SMT 1996 consists of two separate tables developed in order to cover different risk characteristics of death protection products and annuitants.

(1) The SMT 1996 for life coverage
The methodology of the SMT 1996 for life coverage is similar to that of the previous experience life tables developed by the LIAJ. In these tables, selection effect is excluded and risk margins are added to secure sufficient and sound reserves.

As the SMT requires stability and conservativeness, there are some notable differences from the 5th Experience Table as follows:
- In order to secure stability, observed years adopted were lengthened from two to three years.
- In order to secure conservativeness, the truncated period was made longer, i.e., the mortality data for the 1st to 5th year at longest was excluded depending upon gender and age.

(2) The SMT 1996 for annuitants
The SMT 1996 for annuitants was developed by projecting the 15th Complete Tables (1980) as the base table into the future between 2000 to 2059 by age. For this projection, the improvement rates in the past 25 years, from the 10th (1955) through the 15th (1980) Complete Tables, were simply used by gender and age. This anticipated mortality improvement took a rule as the safety margin.

2. Revision of the SMT

2.1. Background

(1) Improvement of mortality experience (see Fig. 3)
Comparing the two crude mortality rates of the SMT 1996 (observed years are 1989-1991) and the SMT 2007 (observed years are 1999-2001) for life coverage, mortality experience has been improving, especially for older ages: While the improvement is slight for late 20s to early 50s, that the improvement rate is 10 to 20% for late 50s and above.

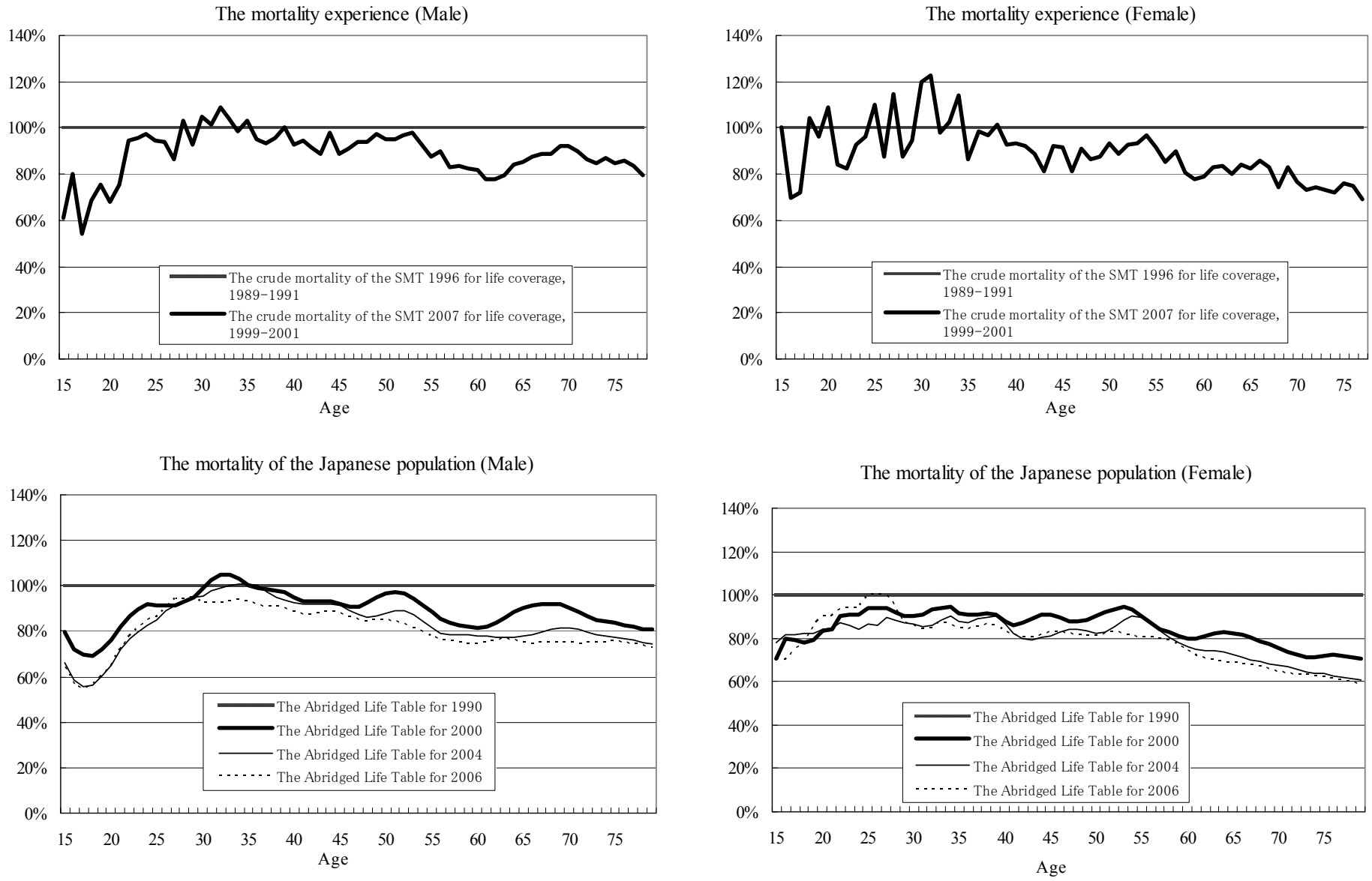
(2) Mortality improvement of the Japanese population (see Fig. 3-4)
Mortality experience of Japanese life insurance companies is based on an observed year, and it is reported after 3 to 4 years from the said year. Therefore we used to analyze the Abridged Life Tables as the preceding index of the mortality experience. We should notice that population tables do not always indicate the same trend as the mortality experience since targets of mortality experience are the people who need life coverage and are medically underwritten instead.

First, from 1990 to 2000, trends in the mortality of the Japanese population show mostly the same trends as in the mortality experience: improvement in mortality is slight for late 20s to early 50s, but that the improvement rate is 10 to 20% for late 50s and above.

Then, from 2000 to 2004, the overall mortality of the Japanese population has continued to improve, especially for older ages.

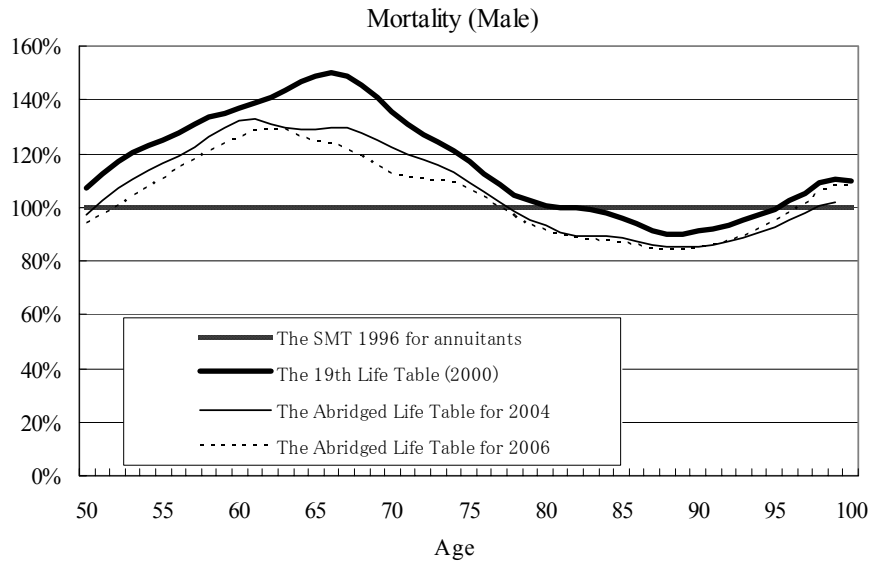
Furthermore, the SMT 1996 for annuitants is lower than the Abridged Life Tables for 2004 in most ages of late 70s and above. Also, the life expectancy of the SMT 1996 for annuitants is lower than that of the Abridged Life Tables for 2004 in many ages.

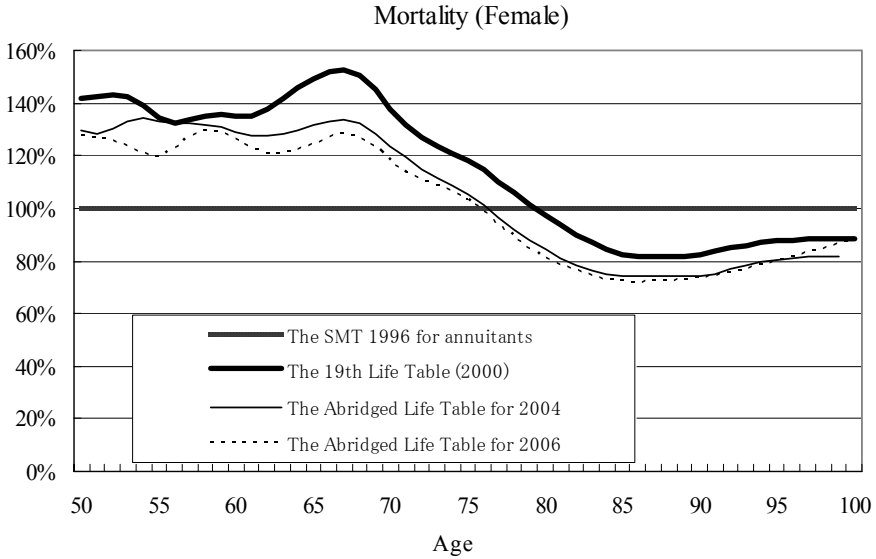
Figure 3. Trends in the mortality experience and the mortality of the Japanese population

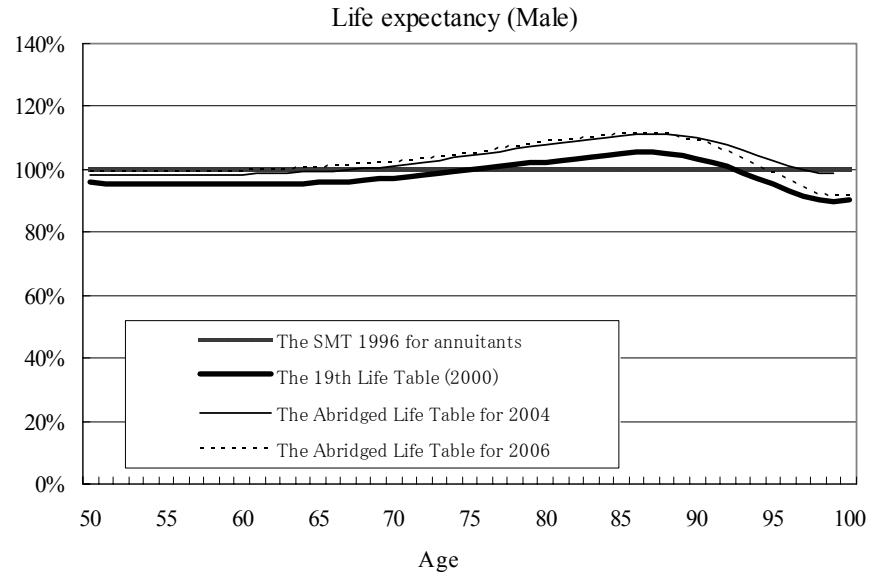


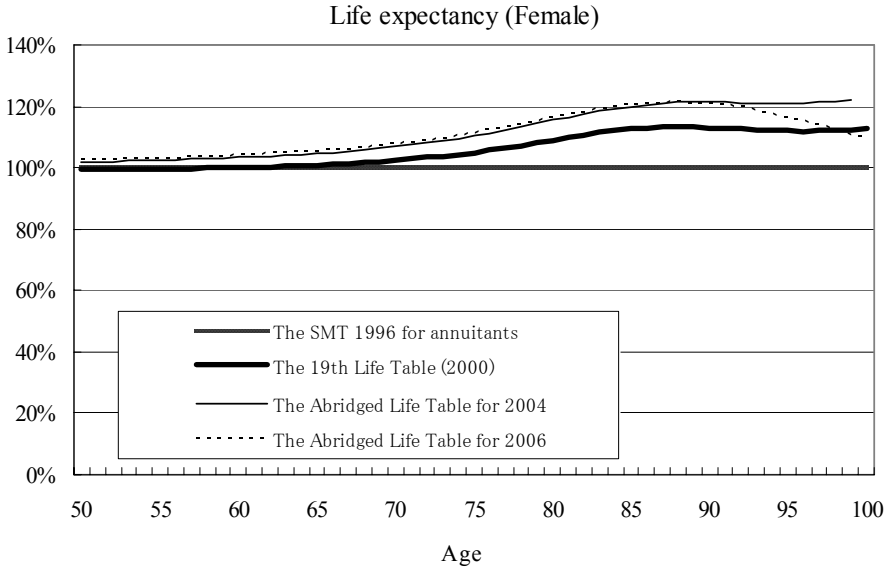
Note: Let the crude mortality of the SMT 1996 equal 100% for the mortality experience,
and let the Abridged Life Table for 1990 equal 100% for the mortality of the Japanese population.

Figure 4. Comparison with the SMT 1996 for annuitants and the Population tables









Note: Let the SMT 1996 for annuitants equal 100%.

2.2. Revision of the SMT for Life Coverage and Annuitants

As we have seen above, since the SMT 1996 was developed, the mortality experience of Japanese life insurance companies as well as the mortality of the Japanese population in general has been continuously improving, especially for older ages. Also, due to the improved longevity of Japanese people, conservativeness of the SMT 1996 for annuitants started to show a sign of its insufficiency.

On the other hand, there is a certain degree of uncertainty of future mortality improvement due to possible outbreak of infectious diseases such as SARS and avian influenza. Also, global warming might negatively affect human health.

Having said that, considering the trends in mortality of the Japanese population, the mortality experience is expected to continuously improve for a short and middle term. In view of these situations, it was settled to revise both tables for life coverage and annuitants.

2.3. Development of the New SMT for Third-Sector Products

Reflecting the impact of the aging society and social security change, third-sector products have become significantly popular in Japan.

Insurance companies used to apply the SMT 1996 for life coverage to calculation of the standard valuation reserves for third-sector products. However, the FSA required in "the Comprehensive Guideline for the Supervision of Insurance Companies" that insurance companies use the mortality which takes into account the characteristics of insureds group and a longevity risk as the calculation basis of reserves for third-sector products since third-sector products have different risk characteristics from death products.

The risk characteristics of third-sector products summarized by the IAJ is shown below.

		Risk characteristics for death	
		Risk becomes larger as mortality increases	Risk becomes larger as mortality decreases
Difference of participation and continuation needs	Coverage for decline in health condition	For life coverage	For third-sector products
	Coverage for maintenance of health condition	-	For annuitants

This shows it is appropriate to apply a mortality table which meets the following conditions to third-sector products:
- The insureds have the same needs as for life coverage
- The direction of risk is opposite to that for life coverage

Therefore the IAJ decided to introduce a different SMT to apply to third-sector products.

3. Construction Process for the SMT 2007

3.1. The SMT 2007 for Life Coverage

For life coverage, construction process and methodology of the SMT 2007 are almost identical to those for the SMT 1996.

(1) Basic data
Basically, the following mortality experience data of standard issues provided by 32 life insurance companies in Japan are used to determine the crude mortality rates:
- Medically underwritten
- Policy year, not longer than 30 years
- Observed year: 1999-2001, combined to secure stability
- Truncated period: at most 1st-5th policy years excluded by gender and age to secure conservativeness.

The details are as follows:

	Male	Female
Observed years	1999-2001 combined except followings: - 1996-2001 combined for ages 15 and younger - 1991-2001 combined for age 0	1999-2001 combined except followings: - 1996-2001 combined for ages 19 and younger - 1991-2001 combined for age 0
Excluded policy years	1st ages 1-9 1st-2nd ages 10-29 1st-3rd ages 30-34 1st-4th ages 35-39 1st-5th ages 40- (Only 1st year is used for age 0)	1st ages 1-9 1st-2nd ages 10-24 1st-3rd ages 25-29 1st-4th ages 30-34 1st-5th ages 35- (Only 1st year is used for age 0)
Policy year	Not longer than 30 years	
Risk classification	Medical except the followings: - Medical and non-medical combined for ages 15 and younger (Non-medical for ages 4 and younger)	Medical except the followings: - Medical and non-medical combined for ages 19 and younger (Non-medical for ages 4 and younger)
Final age	79	79
Total number of policies	62.49 million	37.48 million
Total number of deaths	335 thousand	93 thousand

(2) Modification for younger ages
The crude mortality rates for younger ages (male: 7 and younger, female: 12 and younger) calculated using basic data turned out to be too low, and they are considered to be anomalies due to the data. Therefore, for those ages, the average of mortality rates of the Abridged Life Tables 2002-2004 is used instead of the crude mortality rates.

(3) Development of margins
The basic data of the crude mortality rates are enormous, however, for provision against “fluctuation of mortality in each year”, ”differences in the mortality level at various companies”, and “aggravation concern of future mortality”, risk margins are added. Since the number of deaths is well-modeled by the binomial distribution, the margins are developed as follows:

$$q_x^{(1)} = q_x^{(0)} + \min\left(2\sigma_x, 0.3q_x^{(0)}\right)$$

$q_x^{(0)}$: the crude mortality rate, $\sigma_x = \sqrt{\dfrac{q_x^{(0)}(1-q_x^{(0)})}{n_x}}$

$n_x = 4{,}000{,}000 \times f\left(x_i;\ \mu_i, \sigma_i^2\right)$ (i =1: Male, 2: Female)

where μ_i , σ_i : respectively mean and standard deviation of the age distribution of the number of policies observed in 2001.

$f\left(x_i;\ \mu_i, \sigma_i^2\right)$: density function of the normal distribution with mean μ_i and standard deviation σ_i .

(4) Graduation

The Greville's formula is selected for graduation, which have been used for population tables. Considering smoothness and fitness, following 13-term formula of 3-degree is adopted:

$$q_x^{(2)} = c_0 q_x^{(1)} + \sum_{i=1}^{6} c_i \left(q_{x+i}^{(1)} + q_{x-i}^{(1)}\right)$$

$$q_{x-i}^{(1)} = \sum_{j=1}^{6} a_j q_{x-i+j}^{(1)} \quad (if\ \ x-i<0), \quad q_{x+i}^{(1)} = \sum_{j=1}^{6} a_j q_{x+i-j}^{(1)} \quad (if\ \ 79<x+i)$$

where the parameters $c_i\ (i=0,\cdots\cdots n), a_i\ (i=1,\cdots\cdots n)$ are as follows:

i	c_i	a_i
0	0.240058	-
1	0.214337	1.016301
2	0.147356	0.360880
3	0.065492	-0.021625
4	0.000000	-0.160909
5	-0.027864	-0.138330
6	-0.019350	-0.056317

(5) Extrapolation

Since the number of policies in old ages is small, the mortality of those ages (male: age 78 and above, female: ages 70 and above) is extrapolated by using the Gompertz-Makeham's Law, which have been used for population tables:

$$l_x = k \cdot s^x \cdot g^{c^x}$$

where the parameters s , g , c are as follows, calculated in the King-Hardy Method.

	Male	Female
s	0.9947379074632	0.9975911671752
g	0.9999732398272	0.9999976132662
c	1.1290704338183	1.1509609025069

(6) Comparison with the SMT 1996 for life coverage (see Table 1 and Fig. 5-6)

The SMT 2007 for life coverage is lower than the SMT 1996 except for around the age of 30, especially for older ages: about 20% for male and about 25% for female lower at maximum.

Table 1. Comparison with the SMT 2007 and the SMT 1996 for life coverage

Male

Age	The SMT 2007 for life coverage		The SMT 1996 for life coverage
		vs. SMT1996	
	‰	%	‰
0	1.08	98	1.10
1	0.75	99	0.76
2	0.49	98	0.50
3	0.31	94	0.33
4	0.21	88	0.24
5	0.17	77	0.22
6	0.16	73	0.22
7	0.16	76	0.21
8	0.16	84	0.19
9	0.15	88	0.17
10	0.14	93	0.15
11	0.13	93	0.14
12	0.14	93	0.15
13	0.18	82	0.22
14	0.25	74	0.34
15	0.36	69	0.52
16	0.49	67	0.73
17	0.62	66	0.94
18	0.73	67	1.09
19	0.80	70	1.15
20	0.84	74	1.14
21	0.86	80	1.07
22	0.85	86	0.99
23	0.84	91	0.92
24	0.83	94	0.88
25	0.82	95	0.86
26	0.81	95	0.85
27	0.80	94	0.85
28	0.81	96	0.84
29	0.83	99	0.84
30	0.86	102	0.84
31	0.89	105	0.85
32	0.92	105	0.88
33	0.96	104	0.92
34	1.00	102	0.98
35	1.05	100	1.05
36	1.12	99	1.13
37	1.19	98	1.22
38	1.28	96	1.33
39	1.37	95	1.44
40	1.48	95	1.56
41	1.61	94	1.71
42	1.76	94	1.88
43	1.92	92	2.08
44	2.11	92	2.29
45	2.31	92	2.51
46	2.54	93	2.73
47	2.77	94	2.96
48	3.04	95	3.21
49	3.33	96	3.48
50	3.65	96	3.79
51	4.01	97	4.15
52	4.40	96	4.57
53	4.80	95	5.07
54	5.22	93	5.64

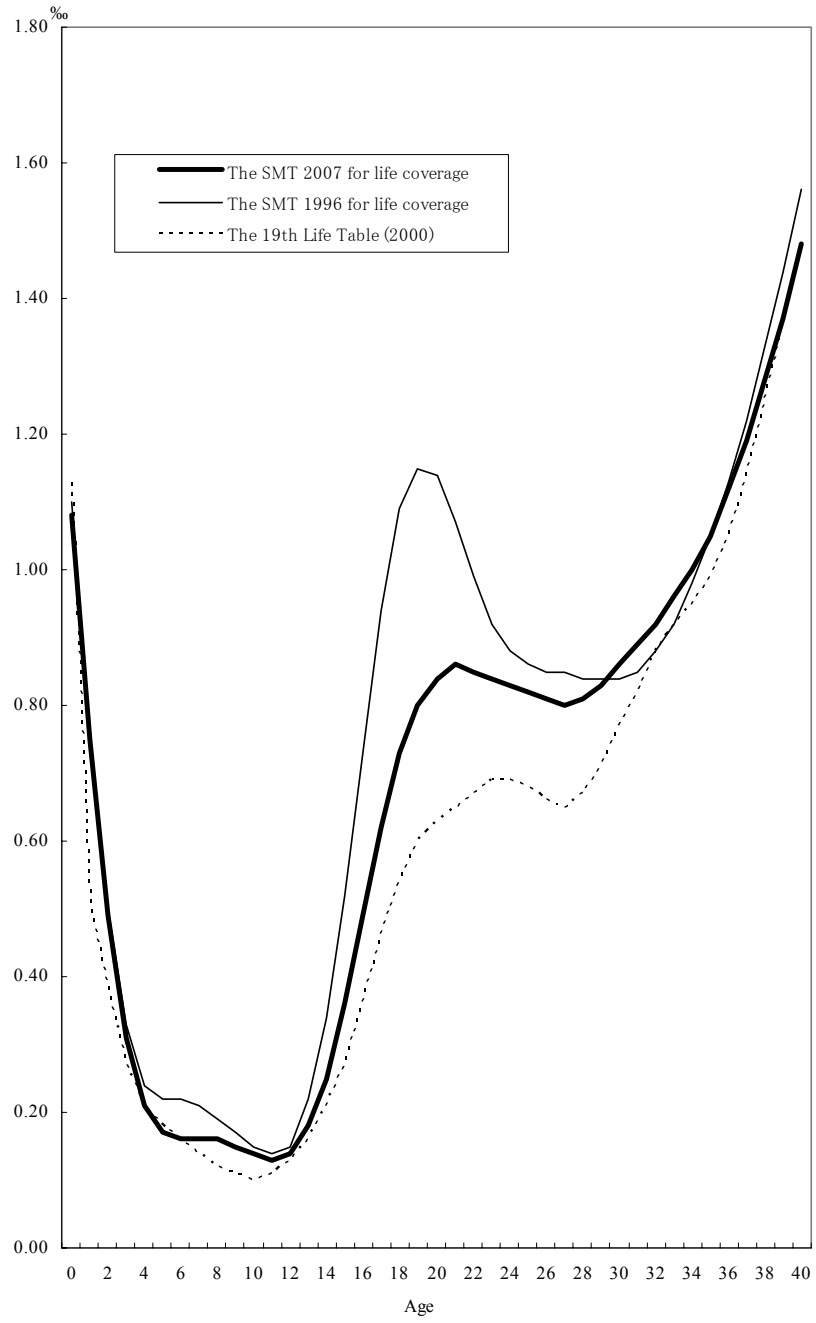
Age	The SMT 2007 for life coverage		The SMT 1996 for life coverage
		vs. SMT1996	
	‰	%	‰
55	5.67	90	6.30
56	6.15	87	7.03
57	6.66	85	7.81
58	7.18	83	8.64
59	7.74	81	9.51
60	8.34	82	10.22
61	9.02	82	11.01
62	9.81	81	12.04
63	10.72	81	13.19
64	11.80	82	14.31
65	13.06	85	15.42
66	14.52	86	16.94
67	16.16	87	18.64
68	17.94	87	20.54
69	19.86	88	22.67
70	21.93	88	25.06
71	24.15	87	27.73
72	26.57	86	30.72
73	29.23	86	34.06
74	32.23	85	37.79
75	35.68	85	41.97
76	39.61	85	46.63
77	44.00	85	51.84
78	48.77	85	57.64
79	54.25	85	64.11
80	60.39	85	71.32
81	67.28	85	79.35
82	75.00	85	88.27
83	83.64	85	98.17
84	93.29	85	109.16
85	104.07	86	121.33
86	116.09	86	134.79
87	129.46	87	149.65
88	144.32	87	166.01
89	160.79	87	184.00
90	179.00	88	203.72
91	199.10	88	225.28
92	221.19	89	248.78
93	245.40	89	274.31
94	271.84	90	301.91
95	300.58	91	331.64
96	331.66	91	363.49
97	365.10	92	397.43
98	400.85	92	433.36
99	438.80	93	471.13
100	478.77	94	510.52
101	520.48	94	551.24
102	563.59	95	592.91
103	607.61	96	635.08
104	652.00	96	677.22
105	696.12	97	718.74
106	739.25	74	1,000.00
107	1,000.00		

Female

Age	The SMT 2007 for life coverage		The SMT 1996 for life coverage
		vs. SMT1996	
	‰	%	‰
0	0.96	102	0.94
1	0.66	96	0.69
2	0.42	88	0.48
3	0.26	84	0.31
4	0.16	80	0.20
5	0.12	86	0.14
6	0.12	92	0.13
7	0.12	92	0.13
8	0.11	85	0.13
9	0.10	83	0.12
10	0.10	91	0.11
11	0.09	90	0.10
12	0.09	90	0.10
13	0.10	77	0.13
14	0.12	71	0.17
15	0.16	76	0.21
16	0.20	80	0.25
17	0.24	83	0.29
18	0.28	90	0.31
19	0.30	94	0.32
20	0.31	94	0.33
21	0.31	94	0.33
22	0.32	94	0.34
23	0.34	94	0.36
24	0.35	95	0.37
25	0.36	95	0.38
26	0.38	97	0.39
27	0.40	100	0.40
28	0.42	100	0.42
29	0.45	102	0.44
30	0.49	107	0.46
31	0.53	108	0.49
32	0.56	106	0.53
33	0.60	105	0.57
34	0.64	102	0.63
35	0.69	100	0.69
36	0.75	99	0.76
37	0.82	99	0.83
38	0.88	98	0.90
39	0.93	96	0.97
40	0.98	93	1.05
41	1.04	91	1.14
42	1.11	90	1.24
43	1.20	90	1.34
44	1.29	88	1.46
45	1.40	89	1.58
46	1.53	91	1.69
47	1.67	91	1.83
48	1.82	91	1.99
49	1.99	93	2.15
50	2.16	93	2.33
51	2.34	93	2.52
52	2.51	93	2.70
53	2.68	93	2.87
54	2.84	93	3.06

Age	The SMT 2007 for life coverage		The SMT 1996 for life coverage
		vs. SMT1996	
	‰	%	‰
55	2.98	91	3.28
56	3.11	88	3.53
57	3.24	86	3.78
58	3.38	83	4.07
59	3.56	81	4.38
60	3.79	81	4.69
61	4.08	81	5.03
62	4.42	82	5.37
63	4.82	82	5.88
64	5.27	82	6.45
65	5.77	81	7.10
66	6.33	81	7.84
67	6.95	80	8.69
68	7.62	79	9.66
69	8.35	78	10.76
70	9.14	76	12.02
71	10.16	76	13.45
72	11.32	75	15.08
73	12.66	75	16.94
74	14.20	75	19.06
75	15.97	74	21.47
76	18.00	74	24.21
77	20.33	74	27.33
78	23.01	75	30.88
79	26.08	75	34.91
80	29.60	75	39.49
81	33.64	75	44.69
82	38.27	76	50.59
83	43.57	76	57.27
84	49.64	77	64.84
85	56.57	77	73.41
86	64.49	78	83.09
87	73.52	78	94.01
88	83.80	79	106.31
89	95.50	79	120.15
90	108.78	80	135.67
91	123.82	81	153.05
92	140.82	82	172.46
93	159.97	82	194.06
94	181.49	83	218.02
95	205.58	84	244.49
96	232.43	85	273.61
97	262.21	86	305.46
98	295.05	87	340.10
99	331.05	88	376.37
100	370.22	89	414.34
101	412.46	91	454.59
102	457.59	92	496.88
103	505.26	93	540.85
104	554.96	95	586.06
105	606.01	96	631.95
106	657.57	97	677.83
107	708.61	98	722.97
108	758.02	99	766.52
109	804.60	80	1,000.00
110	1,000.00		

Figure 5. Comparison with the SMT 2007 and the SMT 1996 for life coverage, and population tables (Male)



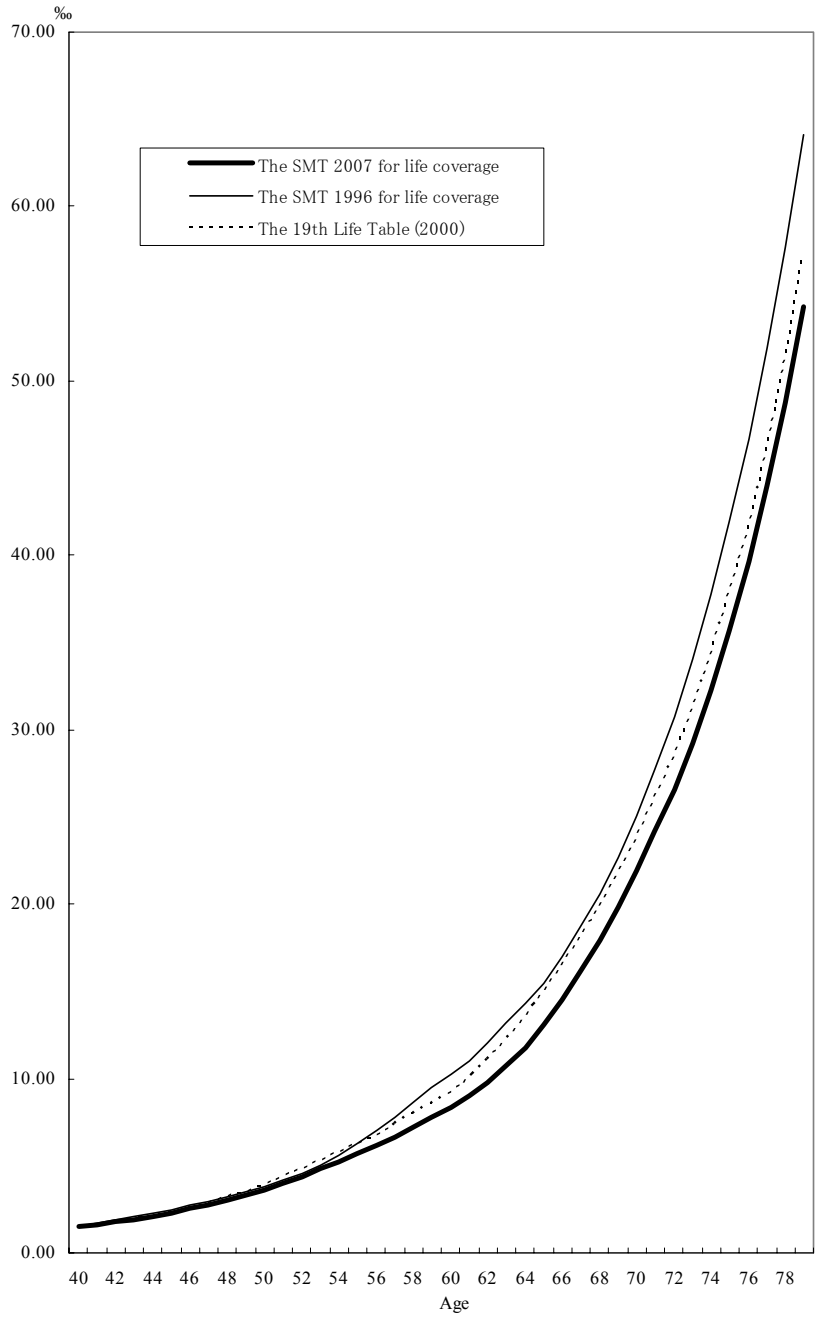
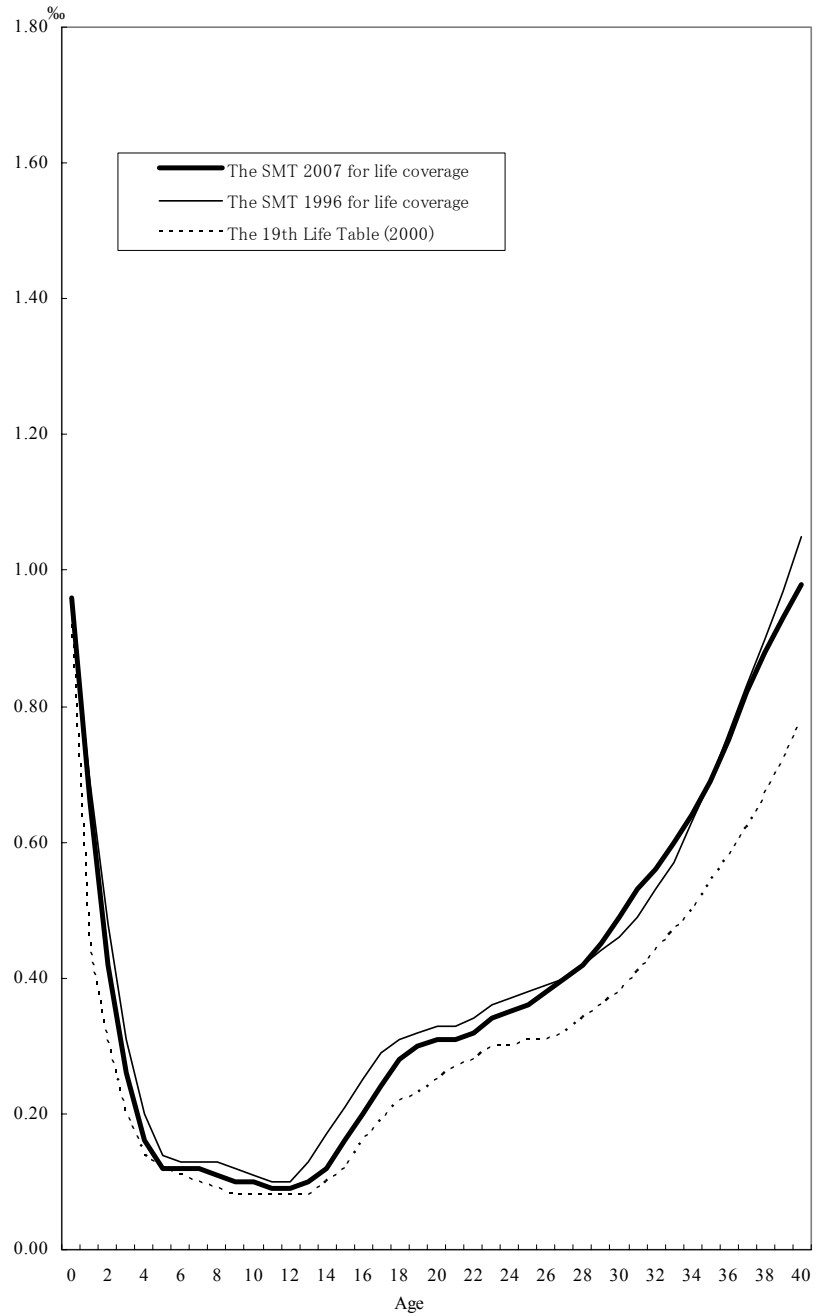
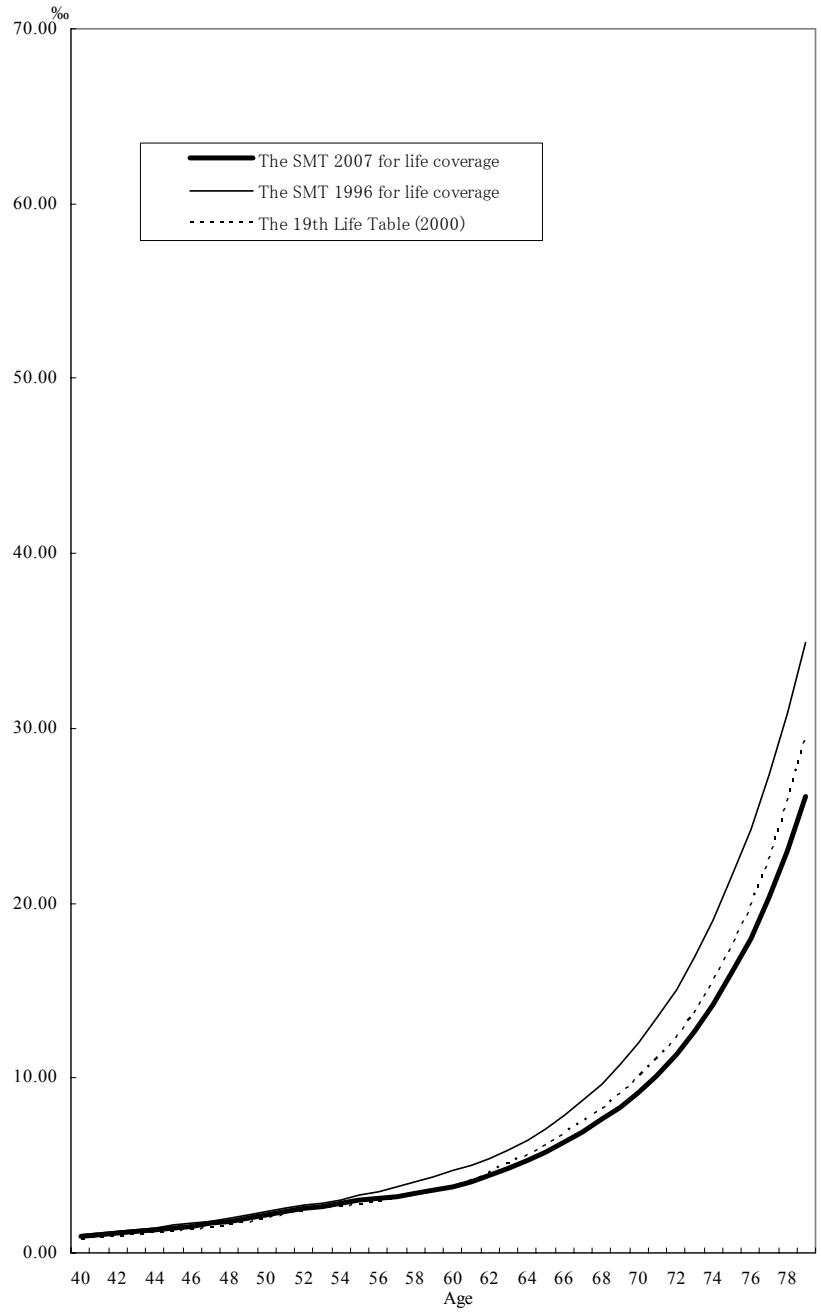


Figure 6. Comparison with the SMT 2007 and the SMT 1996 for life coverage, and population tables (Female)





3.2. The SMT 2007 for Annuitants

For annuitants, construction process and methodology for the SMT 2007 are identical to those for the SMT 1996, except for the followings:
- Estimation of mortality improvement rate
- Adjustment to provide against longevity risk

(1) Basic data
The mortality experience data for annuitants is not large enough to create a mortality table as most of annuity policies chosen by customers are annuities certain in Japan. Therefore, the 19th Complete Table, which is a mortality table for the Japanese population developed based on the Population Census for 2000, was selected as the base table for the SMT.

(2) Determination of future mortality improvement
In Japan, the mortality used to calculate annuity amounts is usually set at its date of issue. And then the SMT is constructed by projecting the base table mortality in the future, and the projection period is set to at least 20 years.

In the case of the SMT 1996, simply, actual mortality improvement rates by gender and age in the past 25 years were used for the projection, that is, it was assumed the Japanese population mortality by gender and age would be improved in the future at the same improvement rate as in the past 25 years. However, this methodology could not catch up with the actual mortality improvement. Thus, causes of death are taken into account as more sophisticated approach.

Future mortality improvement rates by gender and age are calculated using the actual morality improvement from 1980 through 2000 by gender, 5-year age group, and cause of death. The following eight major causes of death were selected:
- Malignant Neoplasm, Heart Disease, Cerebrovascular Disease, Pneumonia, Senility, Accident, Suicide, Others

The following is an example of future mortality improvement rate by cause of death, which is for male, 60-64 age group:

Cause of Death	Improvement Rate
Malignant Neoplasm	0.5%
Heart Disease	1.4%
Cerebrovascular Disease	5.5%
Pneumonia	-1.1% => 0.0%
Senility	10.9%
Accident	1.3%
Suicide	-3.0% => 0.0%
Others	1.8%
Total	1.1%

In this table, the total improvement rate is calculated as follows:

$$r = 1 - \left\{ \frac{\sum_i d_i \times (1 - r_i)^n}{\sum_i d_i} \right\}^{\frac{1}{n}}$$

where d_i, r_i : respectively mortality and its improvement rate from cause i of death
n : projection years (see next (3))

(3) Mortality projection years
It is assumed that all at age x in the SMT 2007 were born in 1960. The mortality rate for age x in the base table (the 19th table, 2000) is projected into the year when the new born in 1960 will reach age x. In case the projection period obtained as above is shorter than 20 years, it is set at 20 years.

The following is an example of projection period by age in the SMT 2007:

Age in the SMT 2007	Age in the year 2000	Projection years
50	2000-1960=40	50-40=10 => 20
60	2000-1960=40	60-40=20
70	2000-1960=40	70-40=30
80	2000-1960=40	80-40=40

(4) Extrapolation toward the older ages and younger ages
a. Extrapolation toward the older ages
The mortality rates of ages 94 and above are extrapolated by the least squares method using a 3-degree polynomial.

Here parameters of the 3-degree polynomial $y = ax^3 + bx^2 + cx + d$, which is the approximation of mortality for age x, are as follows:

	Male	Female
a	0.0020987496	0.0027111850
b	-0.3283838845	-0.4887420372
c	16.1953235050	28.4531680522
d	-228.9231026396	-521.5470400453

b. Extrapolation toward the younger ages
The mortality rates for age 16 and below are set at 60% of the rates in the 19th Table.

(5) Adjustment to provide against longevity risk
In order to make a provision against the uncertainty of the future mortality improvement, a multiple factor of 85% is applied to the mortality rate for each age.

(6) Comparison with the SMT 1996 for annuitants (see Table 2-3 and Fig. 7-8)
The SMT 2007 for annuitants is lower than the SMT 1996: for male about 55% lower at maximum, and for female about 65% lower at maximum, and it is approximately 50-70% and 35-65% of the 19th Complete Tables for 2000 for male and female respectively.

Table 2. Comparison with the SMT 2007 and the SMT 1996 for annuitants, and population tables - Mortality

Male

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
0	0.58		51		1.13
1	0.26		51		0.51
2	0.20		53		0.38
3	0.14		52		0.27
4	0.11		52		0.21
5	0.09		50		0.18
6	0.09		56		0.16
7	0.07		50		0.14
8	0.06		50		0.12
9	0.06		55		0.11
10	0.05		50		0.10
11	0.06		55		0.11
12	0.07		54		0.13
13	0.09		56		0.16
14	0.11		52		0.21
15	0.14		52		0.27
16	0.19	50	53	0.38	0.36
17	0.24	55	52	0.44	0.46
18	0.30	65	56	0.46	0.54
19	0.34	77	57	0.44	0.60
20	0.37	93	59	0.40	0.63
21	0.40	108	62	0.37	0.65
22	0.43	126	64	0.34	0.67
23	0.43	134	62	0.32	0.69
24	0.43	139	62	0.31	0.69
25	0.41	128	60	0.32	0.68
26	0.39	118	59	0.33	0.66
27	0.37	109	57	0.34	0.65
28	0.41	114	61	0.36	0.67
29	0.43	113	61	0.38	0.71
30	0.48	120	62	0.40	0.77
31	0.54	126	66	0.43	0.82
32	0.59	128	67	0.46	0.88
33	0.60	120	65	0.50	0.92
34	0.62	109	65	0.57	0.95
35	0.64	98	65	0.65	0.99
36	0.66	89	63	0.74	1.05
37	0.71	85	62	0.84	1.14
38	0.77	82	62	0.94	1.25
39	0.84	79	62	1.06	1.36
40	0.90	76	61	1.19	1.47
41	0.98	73	62	1.34	1.59
42	1.06	70	61	1.51	1.73
43	1.15	67	61	1.72	1.90
44	1.27	64	60	1.99	2.10
45	1.40	61	60	2.31	2.32
46	1.56	59	60	2.64	2.58
47	1.73	58	60	2.97	2.87
48	1.92	59	60	3.24	3.18
49	2.17	63	62	3.46	3.52
50	2.41	66	61	3.66	3.92
51	2.68	69	62	3.87	4.35
52	2.96	72	62	4.11	4.80
53	3.25	74	62	4.38	5.27
54	3.69	79	64	4.68	5.75
55	4.17	84	67	4.99	6.25
56	4.72	89	70	5.30	6.78
57	5.23	93	71	5.62	7.37
58	5.64	95	71	5.95	7.95
59	5.93	94	69	6.32	8.54

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
60	6.42	95	70	6.75	9.23
61	6.78	94	67	7.25	10.07
62	7.37	94	67	7.85	11.06
63	8.08	95	66	8.53	12.26
64	8.86	96	65	9.27	13.59
65	9.66	96	64	10.07	14.98
66	10.50	96	64	10.99	16.46
67	11.40	94	63	12.17	18.08
68	12.05	88	61	13.68	19.88
69	13.06	84	60	15.52	21.81
70	14.11	80	59	17.63	23.84
71	15.23	76	58	19.92	26.05
72	15.94	71	56	22.40	28.50
73	17.26	69	55	25.17	31.26
74	18.73	66	54	28.42	34.37
75	20.35	63	54	32.33	37.84
76	22.08	60	53	37.02	41.62
77	24.12	57	52	42.57	46.06
78	26.50	54	52	48.95	51.27
79	29.24	52	51	56.01	57.31
80	33.57	53	52	63.60	64.01
81	37.08	52	52	71.65	71.56
82	40.76	51	51	79.99	79.62
83	44.57	50	51	88.83	88.13
84	50.68	51	52	98.87	96.99
85	54.98	50	52	110.76	106.40
86	59.68	48	51	124.62	116.78
87	64.72	46	51	139.94	128.06
88	70.19	45	50	155.79	140.42
89	76.02	44	49	171.30	153.78
90	83.18	45	49	186.12	170.13
91	94.01	47	51	200.35	184.65
92	100.64	47	50	213.86	199.68
93	107.40	47	50	226.55	215.23
94	114.78	48	50	238.36	231.29
95	123.57	50	50	249.24	247.87
96	132.84	51	50	259.15	264.96
97	142.57	53	50	268.11	282.55
98	152.79	55	51	276.12	300.65
99	163.49	57	51	289.01	319.23
100	174.69	57	52	308.39	338.28
101	186.41	57	52	328.37	357.78
102	198.65	57	53	349.00	377.72
103	211.42	57	53	370.30	398.08
104	224.74	57	54	392.15	418.81
105	238.61	58	54	414.35	439.89
106	253.05	58	55	437.31	461.29
107	268.06	58	56	460.98	482.97
108	283.66	58	56	485.31	504.87
109	299.86	59	57	510.23	526.96
110	316.67	59	58	535.67	549.18
111	334.09	59	58	561.55	571.47
112	352.16	60	59	587.75	593.78
113	370.85	37	37	1,000.00	1,000.00
114	390.20				
115	410.21				
116	430.89				
117	452.26				
118	474.32				
119	497.08				
120	520.57				
121	544.77				
122	1,000.00				

Female

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
0	0.47		51		0.92
1	0.22		50		0.44
2	0.15		50		0.30
3	0.10		50		0.20
4	0.07		50		0.14
5	0.06		50		0.12
6	0.06		55		0.11
7	0.05		50		0.10
8	0.04		44		0.09
9	0.04		50		0.08
10	0.04		50		0.08
11	0.04		50		0.08
12	0.04		50		0.08
13	0.04		50		0.08
14	0.05		50		0.10
15	0.06		50		0.12
16	0.09	100	56	0.09	0.16
17	0.10	100	53	0.10	0.19
18	0.12	120	55	0.10	0.22
19	0.13	130	57	0.10	0.23
20	0.14	140	56	0.10	0.25
21	0.16	160	59	0.10	0.27
22	0.17	170	61	0.10	0.28
23	0.18	180	60	0.10	0.30
24	0.18	180	60	0.10	0.30
25	0.18	150	58	0.12	0.31
26	0.18	138	58	0.13	0.31
27	0.18	129	56	0.14	0.32
28	0.20	143	59	0.14	0.34
29	0.20	133	56	0.15	0.36
30	0.22	138	58	0.16	0.38
31	0.24	133	59	0.18	0.41
32	0.26	130	59	0.20	0.44
33	0.28	127	60	0.22	0.47
34	0.29	121	58	0.24	0.50
35	0.31	115	57	0.27	0.54
36	0.34	113	59	0.30	0.58
37	0.36	109	58	0.33	0.62
38	0.39	105	58	0.37	0.67
39	0.43	105	60	0.41	0.72
40	0.47	102	60	0.46	0.78
41	0.53	102	62	0.52	0.85
42	0.59	102	63	0.58	0.94
43	0.65	100	63	0.65	1.04
44	0.71	97	63	0.73	1.13
45	0.77	94	63	0.82	1.22
46	0.81	89	62	0.91	1.31
47	0.88	88	62	1.00	1.43
48	0.97	87	61	1.11	1.58
49	1.05	85	60	1.24	1.75
50	1.18	86	60	1.38	1.96
51	1.28	85	60	1.51	2.15
52	1.35	83	58	1.63	2.33
53	1.49	85	59	1.76	2.51
54	1.57	82	59	1.91	2.66
55	1.65	79	59	2.08	2.79
56	1.78	80	61	2.22	2.94
57	1.89	81	60	2.34	3.13
58	1.97	80	59	2.47	3.34
59	2.07	79	58	2.63	3.56

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
60	2.18	77	57	2.84	3.83
61	2.26	73	54	3.08	4.16
62	2.39	72	52	3.32	4.58
63	2.58	72	51	3.58	5.07
64	2.81	73	50	3.85	5.62
65	3.01	73	49	4.15	6.18
66	3.24	72	48	4.48	6.80
67	3.39	69	45	4.90	7.48
68	3.66	67	44	5.48	8.25
69	3.81	61	42	6.26	9.07
70	4.10	57	41	7.24	9.99
71	4.29	51	39	8.39	11.06
72	4.50	46	37	9.68	12.28
73	5.06	46	37	11.11	13.71
74	5.53	43	36	12.76	15.39
75	6.32	43	36	14.75	17.40
76	7.26	42	37	17.25	19.74
77	8.08	40	36	20.41	22.49
78	9.39	39	36	24.32	25.73
79	10.94	38	37	29.03	29.44
80	12.75	37	38	34.58	33.65
81	14.86	36	39	41.00	38.37
82	17.26	36	40	48.35	43.56
83	19.20	34	39	56.73	49.34
84	22.31	34	40	66.24	55.81
85	25.98	34	41	76.69	63.16
86	28.96	33	40	87.66	71.55
87	33.78	34	42	99.28	80.85
88	37.52	34	41	111.93	91.17
89	43.67	35	43	125.75	102.52
90	48.51	35	42	140.47	115.50
91	53.75	35	41	155.54	129.79
92	62.30	37	43	170.53	144.72
93	67.83	37	42	185.55	159.66
94	73.43	37	42	201.12	174.98
95	80.84	37	42	217.48	190.62
96	88.73	38	43	234.45	206.55
97	97.12	39	44	252.04	222.78
98	106.02	39	44	270.23	239.29
99	115.45	40	45	289.01	256.09
100	125.40	41	46	308.39	273.16
101	135.92	41	47	328.37	290.48
102	147.00	42	48	349.00	308.05
103	158.65	43	49	370.30	325.85
104	170.90	44	50	392.15	343.87
105	183.76	44	51	414.35	362.10
106	197.24	45	52	437.31	380.50
107	211.35	46	53	460.98	399.07
108	226.12	47	54	485.31	417.78
109	241.54	47	55	510.23	436.61
110	257.64	48	57	535.67	455.54
111	274.43	49	58	561.55	474.54
112	291.93	50	59	587.75	493.59
113	310.14	50	60	614.17	512.66
114	329.09	33	62	1,000.00	531.72
115	348.78		63		550.75
116	369.23		65		569.70
117	390.45		39		1,000.00
118	412.46				
119	435.27				
120	458.90				
121	483.34				
122	508.64				
123	534.79				
124	561.82				
125	589.72				
126	1,000.00				

Table 3. Comparison with the SMT 2007 and the SMT 1996 for annuitants, and population tables - Survival rate

Male

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
0	999.42		100		998.87
1	999.74		100		999.49
2	999.80		100		999.62
3	999.86		100		999.73
4	999.89		100		999.79
5	999.91		100		999.82
6	999.91		100		999.84
7	999.93		100		999.86
8	999.94		100		999.88
9	999.94		100		999.89
10	999.95		100		999.90
11	999.94		100		999.89
12	999.93		100		999.87
13	999.91		100		999.84
14	999.89		100		999.79
15	999.86		100		999.73
16	999.81	100	100	999.62	999.64
17	999.76	100	100	999.56	999.54
18	999.70	100	100	999.54	999.46
19	999.66	100	100	999.56	999.40
20	999.63	100	100	999.60	999.37
21	999.60	100	100	999.63	999.35
22	999.57	100	100	999.66	999.33
23	999.57	100	100	999.68	999.31
24	999.57	100	100	999.69	999.31
25	999.59	100	100	999.68	999.32
26	999.61	100	100	999.67	999.34
27	999.63	100	100	999.66	999.35
28	999.59	100	100	999.64	999.33
29	999.57	100	100	999.62	999.29
30	999.52	100	100	999.60	999.23
31	999.46	100	100	999.57	999.18
32	999.41	100	100	999.54	999.12
33	999.40	100	100	999.50	999.08
34	999.38	100	100	999.43	999.05
35	999.36	100	100	999.35	999.01
36	999.34	100	100	999.26	998.95
37	999.29	100	100	999.16	998.86
38	999.23	100	100	999.06	998.75
39	999.16	100	100	998.94	998.64
40	999.10	100	100	998.81	998.53
41	999.02	100	100	998.66	998.41
42	998.94	100	100	998.49	998.27
43	998.85	100	100	998.28	998.10
44	998.73	100	100	998.01	997.90
45	998.60	100	100	997.69	997.68
46	998.44	100	100	997.36	997.42
47	998.27	100	100	997.03	997.13
48	998.08	100	100	996.76	996.82
49	997.83	100	100	996.54	996.48
50	997.59	100	100	996.34	996.08
51	997.32	100	100	996.13	995.65
52	997.04	100	100	995.89	995.20
53	996.75	100	100	995.62	994.73
54	996.31	100	100	995.32	994.25
55	995.83	100	100	995.01	993.75
56	995.28	100	100	994.70	993.22
57	994.77	100	100	994.38	992.63
58	994.36	100	100	994.05	992.05
59	994.07	100	100	993.68	991.46

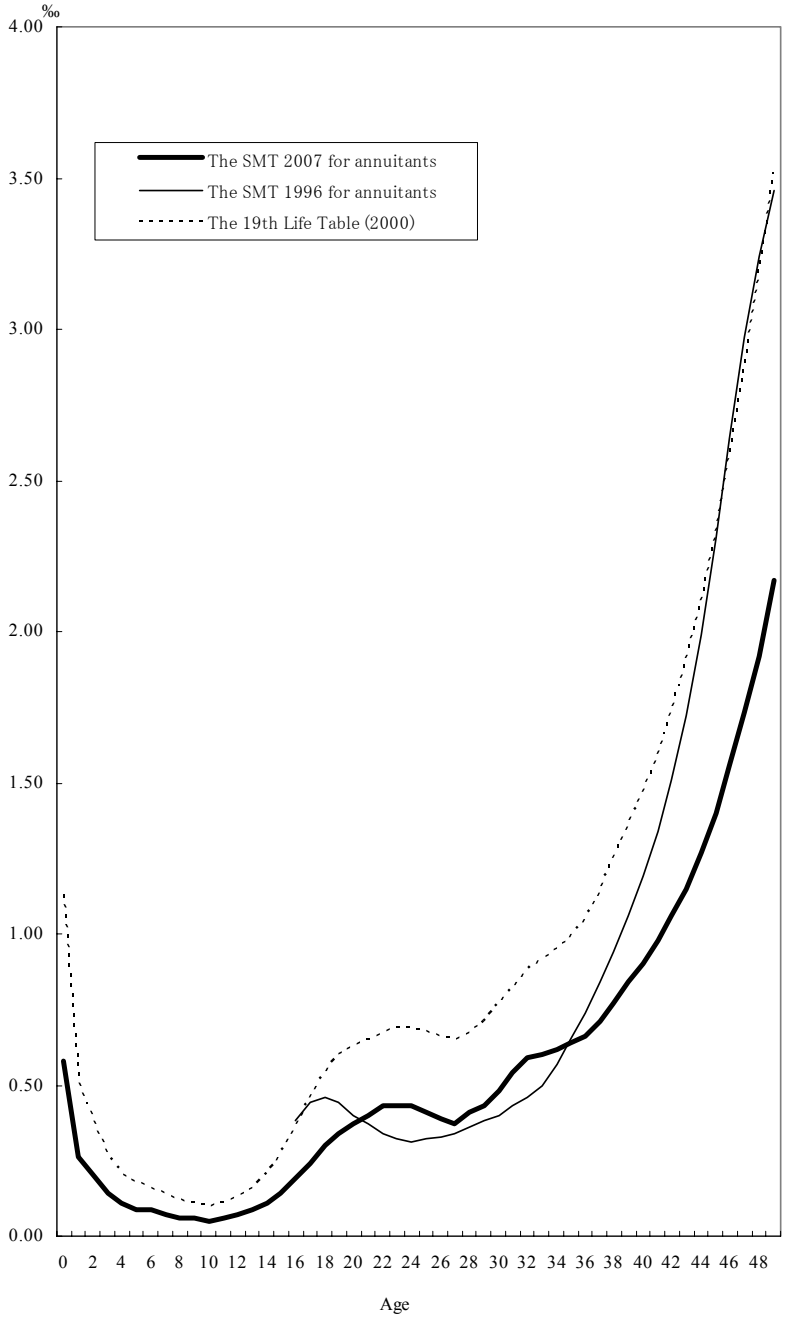
Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
60	993.58	100	100	993.25	990.77
61	993.22	100	100	992.75	989.93
62	992.63	100	100	992.15	988.94
63	991.92	100	100	991.47	987.74
64	991.14	100	100	990.73	986.41
65	990.34	100	101	989.93	985.02
66	989.50	100	101	989.01	983.54
67	988.60	100	101	987.83	981.92
68	987.95	100	101	986.32	980.12
69	986.94	100	101	984.48	978.19
70	985.89	100	101	982.37	976.16
71	984.77	100	101	980.08	973.95
72	984.06	101	101	977.60	971.50
73	982.74	101	101	974.83	968.74
74	981.27	101	102	971.58	965.63
75	979.65	101	102	967.67	962.16
76	977.92	102	102	962.98	958.38
77	975.88	102	102	957.43	953.94
78	973.50	102	103	951.05	948.73
79	970.76	103	103	943.99	942.69
80	966.43	103	103	936.40	935.99
81	962.92	104	104	928.35	928.44
82	959.24	104	104	920.01	920.38
83	955.43	105	105	911.17	911.87
84	949.32	105	105	901.13	903.01
85	945.02	106	106	889.24	893.60
86	940.32	107	106	875.38	883.22
87	935.28	109	107	860.06	871.94
88	929.81	110	108	844.21	859.58
89	923.98	111	109	828.70	846.22
90	916.82	113	110	813.88	829.87
91	905.99	113	111	799.65	815.35
92	899.36	114	112	786.14	800.32
93	892.60	115	114	773.45	784.77
94	885.22	116	115	761.64	768.71
95	876.43	117	117	750.76	752.13
96	867.16	117	118	740.85	735.04
97	857.43	117	120	731.89	717.45
98	847.21	117	121	723.88	699.35
99	836.51	118	123	710.99	680.77
100	825.31	119	125	691.61	661.72
101	813.59	121	127	671.63	642.22
102	801.35	123	129	651.00	622.28
103	788.58	125	131	629.70	601.92
104	775.26	128	133	607.85	581.19
105	761.39	130	136	585.65	560.11
106	746.95	133	139	562.69	538.71
107	731.94	136	142	539.02	517.03
108	716.34	139	145	514.69	495.13
109	700.14	143	148	489.77	473.04
110	683.33	147	152	464.33	450.82
111	665.91	152	155	438.45	428.53
112	647.84	157	159	412.25	406.22
113	629.15				
114	609.80				
115	589.79				
116	569.11				
117	547.74				
118	525.68				
119	502.92				
120	479.43				
121	455.23				

Female

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
0	999.53		100		999.08
1	999.78		100		999.56
2	999.85		100		999.70
3	999.90		100		999.80
4	999.93		100		999.86
5	999.94		100		999.88
6	999.94		100		999.89
7	999.95		100		999.90
8	999.96		100		999.91
9	999.96		100		999.92
10	999.96		100		999.92
11	999.96		100		999.92
12	999.96		100		999.92
13	999.96		100		999.92
14	999.95		100		999.90
15	999.94		100		999.88
16	999.91	100	100	999.91	999.84
17	999.90	100	100	999.90	999.81
18	999.88	100	100	999.90	999.78
19	999.87	100	100	999.90	999.77
20	999.86	100	100	999.90	999.75
21	999.84	100	100	999.90	999.73
22	999.83	100	100	999.90	999.72
23	999.82	100	100	999.90	999.70
24	999.82	100	100	999.90	999.70
25	999.82	100	100	999.88	999.69
26	999.82	100	100	999.87	999.69
27	999.82	100	100	999.86	999.68
28	999.80	100	100	999.86	999.66
29	999.80	100	100	999.85	999.64
30	999.78	100	100	999.84	999.62
31	999.76	100	100	999.82	999.59
32	999.74	100	100	999.80	999.56
33	999.72	100	100	999.78	999.53
34	999.71	100	100	999.76	999.50
35	999.69	100	100	999.73	999.46
36	999.66	100	100	999.70	999.42
37	999.64	100	100	999.67	999.38
38	999.61	100	100	999.63	999.33
39	999.57	100	100	999.59	999.28
40	999.53	100	100	999.54	999.22
41	999.47	100	100	999.48	999.15
42	999.41	100	100	999.42	999.06
43	999.35	100	100	999.35	998.96
44	999.29	100	100	999.27	998.87
45	999.23	100	100	999.18	998.78
46	999.19	100	100	999.09	998.69
47	999.12	100	100	999.00	998.57
48	999.03	100	100	998.89	998.42
49	998.95	100	100	998.76	998.25
50	998.82	100	100	998.62	998.04
51	998.72	100	100	998.49	997.85
52	998.65	100	100	998.37	997.67
53	998.51	100	100	998.24	997.49
54	998.43	100	100	998.09	997.34
55	998.35	100	100	997.92	997.21
56	998.22	100	100	997.78	997.06
57	998.11	100	100	997.66	996.87
58	998.03	100	100	997.53	996.66
59	997.93	100	100	997.37	996.44

Age	The SMT 2007 for annuitants			The SMT 1996 for annuitants	The 19th Life Table
		vs. SMT1996	vs. 19th LT		
	‰	%	%	‰	‰
60	997.82	100	100	997.16	996.17
61	997.74	100	100	996.92	995.84
62	997.61	100	100	996.68	995.42
63	997.42	100	100	996.42	994.93
64	997.19	100	100	996.15	994.38
65	996.99	100	100	995.85	993.82
66	996.76	100	100	995.52	993.20
67	996.61	100	100	995.10	992.52
68	996.34	100	100	994.52	991.75
69	996.19	100	101	993.74	990.93
70	995.90	100	101	992.76	990.01
71	995.71	100	101	991.61	988.94
72	995.50	101	101	990.32	987.72
73	994.94	101	101	988.89	986.29
74	994.47	101	101	987.24	984.61
75	993.68	101	101	985.25	982.60
76	992.74	101	101	982.75	980.26
77	991.92	101	101	979.59	977.51
78	990.61	102	102	975.68	974.27
79	989.06	102	102	970.97	970.56
80	987.25	102	102	965.42	966.35
81	985.14	103	102	959.00	961.63
82	982.74	103	103	951.65	956.44
83	980.80	104	103	943.27	950.66
84	977.69	105	104	933.76	944.19
85	974.02	105	104	923.31	936.84
86	971.04	106	105	912.34	928.45
87	966.22	107	105	900.72	919.15
88	962.48	108	106	888.07	908.83
89	956.33	109	107	874.25	897.48
90	951.49	111	108	859.53	884.50
91	946.25	112	109	844.46	870.21
92	937.70	113	110	829.47	855.28
93	932.17	114	111	814.45	840.34
94	926.57	116	112	798.88	825.02
95	919.16	117	114	782.52	809.38
96	911.27	119	115	765.55	793.45
97	902.88	121	116	747.96	777.22
98	893.98	123	118	729.77	760.71
99	884.55	124	119	710.99	743.91
100	874.60	126	120	691.61	726.84
101	864.08	129	122	671.63	709.52
102	853.00	131	123	651.00	691.95
103	841.35	134	125	629.70	674.15
104	829.10	136	126	607.85	656.13
105	816.24	139	128	585.65	637.90
106	802.76	143	130	562.69	619.50
107	788.65	146	131	539.02	600.93
108	773.88	150	133	514.69	582.22
109	758.46	155	135	489.77	563.39
110	742.36	160	136	464.33	544.46
111	725.57	165	138	438.45	525.46
112	708.07	172	140	412.25	506.41
113	689.86	179	142	385.83	487.34
114	670.91		143		468.28
115	651.22		145		449.25
116	630.77		147		430.30
117	609.55				
118	587.54				
119	564.73				
120	541.10				
121	516.66				
122	491.36				
123	465.21				
124	438.18				
125	410.28				

Table 7. Comparison with the SMT 2007 and the SMT 1996 for annuitants, and population tables - Mortality (Male)



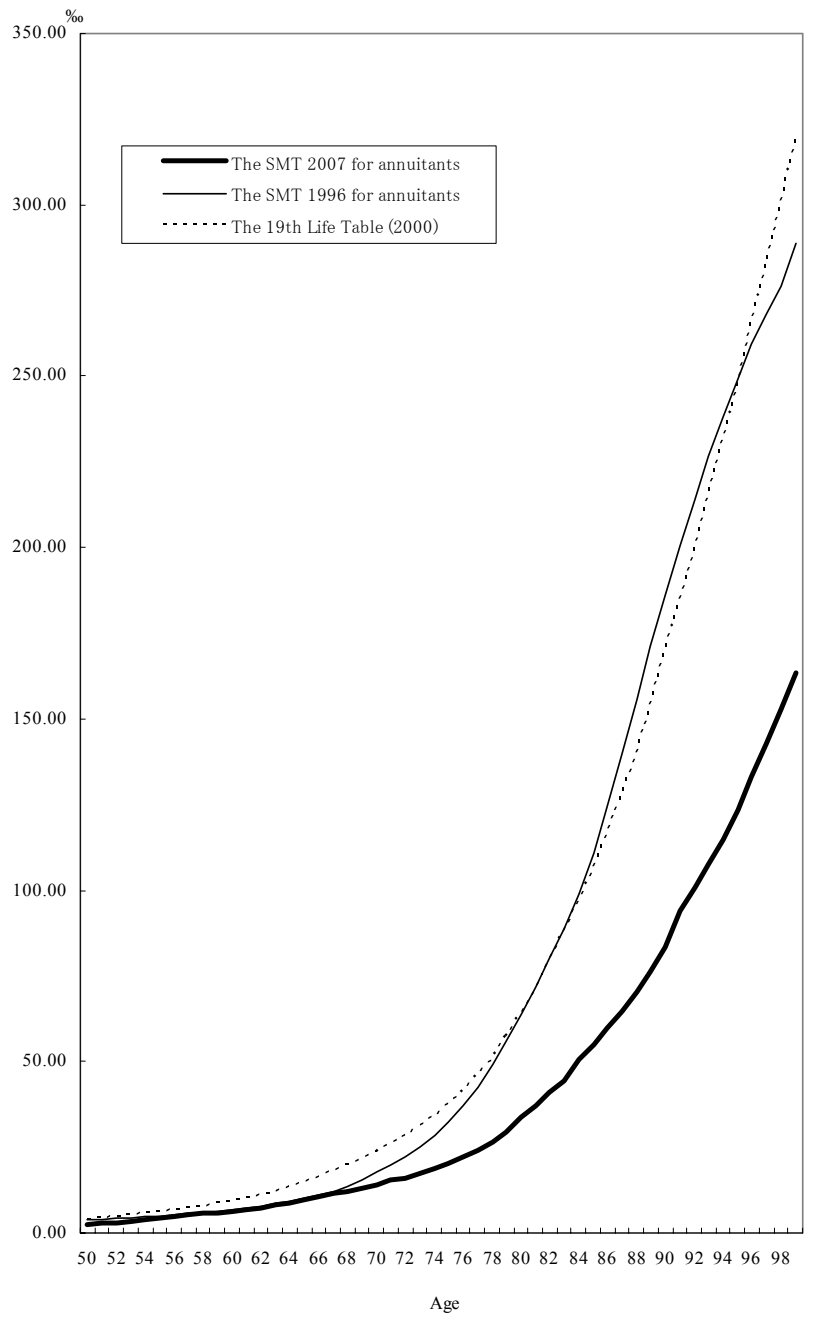
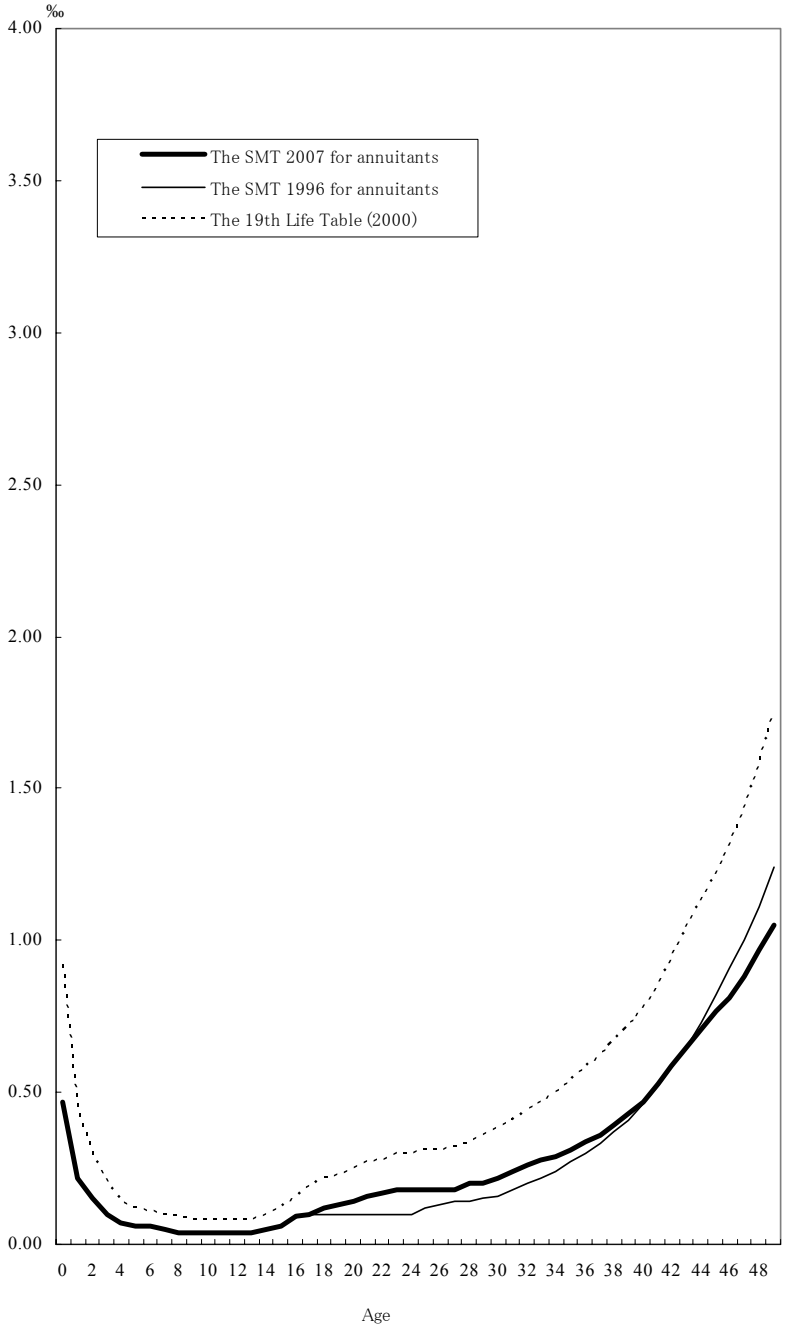
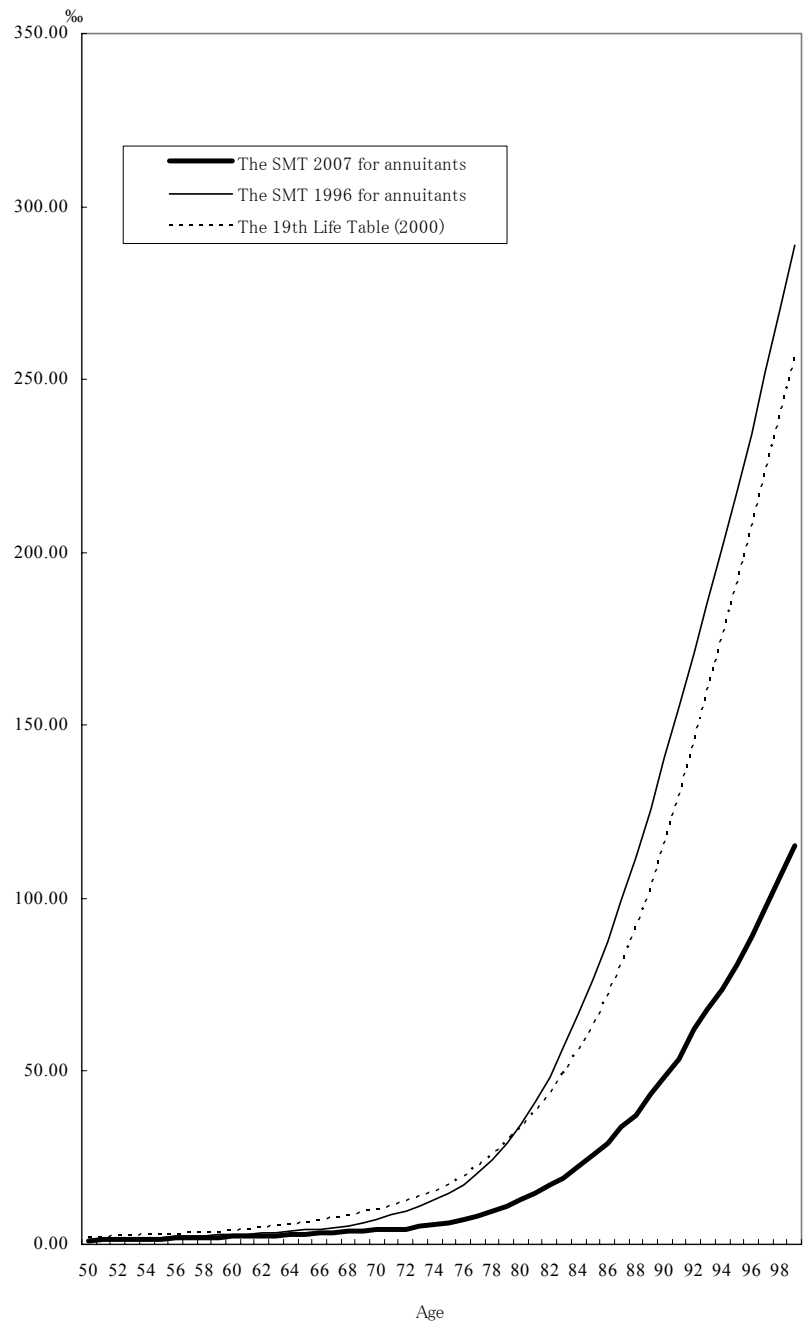


Table 8. Comparison with the SMT 2007 and the SMT 1996 for annuitants, and population tables - Mortality (Female)





3.3. The SMT 2007 for Third-Sector Products

The construction process and methodology for the SMT 2007 for third-sector products are identical to those for the SMT 2007 for life coverage, except for the followings:
- Exclusion of selection effect
- Risk margins

(1) Basic data
Since it is appropriate to consider that the insured for third-sector products have the same needs as for life coverage, the same mortality experience data as the SMT 2007 for life coverage are used, except for the following:
- No policy years are truncated from the basic data considering conservativeness.

(2) Modification for younger ages
The crude mortality rates for younger ages are modified in use of the population tables as in the SMT 2007 for life coverage.

(3) Development of margins
The direction of risk for third-sector products is opposite to that for life coverage, therefore risk margins are extracted as follows, while they are added in the SMT 2007 for life coverage:

$$q_x^{(1)} = q_x^{(0)} - \min\left(2\sigma_x, 0.3q_x^{(0)}\right)$$

(4) Graduation
The Greville's 13-term formula of 3-degree is adopted for graduation as in the SMT 2007 for life coverage.

(5) Extrapolation
The mortality of old ages (male: age 78 and above, female: ages 70 and above) is extrapolated by using the Gompertz-Makeham's Law as in the SMT 2007 for life coverage.

(6) Comparison with the SMT 2007 for life coverage (see Table 4 and Fig. 9-10)
The SMT 2007 for third-sector products is about 45-85% and about 40-95% of the SMT 2007 for life coverage for male and for female respectively.

Table 4. Comparison with the SMT 2007 for third-sector products and for life coverage etc.

Male

Age	The SMT 2007 for third-sector products			a. The SMT 2007 for life coverage	b. The SMT 1996 for life coverage
		vs. a	vs. b		
	‰	%	%	‰	‰
0	0.58	54	53	1.08	1.10
1	0.41	55	54	0.75	0.76
2	0.26	53	52	0.49	0.50
3	0.17	55	52	0.31	0.33
4	0.11	52	46	0.21	0.24
5	0.09	53	41	0.17	0.22
6	0.09	56	41	0.16	0.22
7	0.08	50	38	0.16	0.21
8	0.08	50	42	0.16	0.19
9	0.07	47	41	0.15	0.17
10	0.06	43	40	0.14	0.15
11	0.06	46	43	0.13	0.14
12	0.07	50	47	0.14	0.15
13	0.09	50	41	0.18	0.22
14	0.14	56	41	0.25	0.34
15	0.21	58	40	0.36	0.52
16	0.28	57	38	0.49	0.73
17	0.35	56	37	0.62	0.94
18	0.39	53	36	0.73	1.09
19	0.42	53	37	0.80	1.15
20	0.43	51	38	0.84	1.14
21	0.42	49	39	0.86	1.07
22	0.41	48	41	0.85	0.99
23	0.40	48	43	0.84	0.92
24	0.39	47	44	0.83	0.88
25	0.38	46	44	0.82	0.86
26	0.37	46	44	0.81	0.85
27	0.37	46	44	0.80	0.85
28	0.37	46	44	0.81	0.84
29	0.38	46	45	0.83	0.84
30	0.40	47	48	0.86	0.84
31	0.42	47	49	0.89	0.85
32	0.45	49	51	0.92	0.88
33	0.48	50	52	0.96	0.92
34	0.51	51	52	1.00	0.98
35	0.56	53	53	1.05	1.05
36	0.61	54	54	1.12	1.13
37	0.67	56	55	1.19	1.22
38	0.74	58	56	1.28	1.33
39	0.81	59	56	1.37	1.44
40	0.88	59	56	1.48	1.56
41	0.98	61	57	1.61	1.71
42	1.08	61	57	1.76	1.88
43	1.21	63	58	1.92	2.08
44	1.35	64	59	2.11	2.29
45	1.51	65	60	2.31	2.51
46	1.68	66	62	2.54	2.73
47	1.87	68	63	2.77	2.96
48	2.08	68	65	3.04	3.21
49	2.32	70	67	3.33	3.48
50	2.59	71	68	3.65	3.79
51	2.89	72	70	4.01	4.15
52	3.22	73	70	4.40	4.57
53	3.56	74	70	4.80	5.07
54	3.92	75	70	5.22	5.64

Age	The SMT 2007 for third-sector products			a. The SMT 2007 for life coverage	b. The SMT 1996 for life coverage
		vs. a	vs. b		
	‰	%	%	‰	‰
55	4.30	76	68	5.67	6.30
56	4.72	77	67	6.15	7.03
57	5.15	77	66	6.66	7.81
58	5.59	78	65	7.18	8.64
59	6.07	78	64	7.74	9.51
60	6.58	79	64	8.34	10.22
61	7.16	79	65	9.02	11.01
62	7.83	80	65	9.81	12.04
63	8.61	80	65	10.72	13.19
64	9.52	81	67	11.80	14.31
65	10.59	81	69	13.06	15.42
66	11.83	81	70	14.52	16.94
67	13.21	82	71	16.16	18.64
68	14.71	82	72	17.94	20.54
69	16.30	82	72	19.86	22.67
70	17.98	82	72	21.93	25.06
71	19.78	82	71	24.15	27.73
72	21.73	82	71	26.57	30.72
73	23.88	82	70	29.23	34.06
74	26.29	82	70	32.23	37.79
75	29.06	81	69	35.68	41.97
76	32.22	81	69	39.61	46.63
77	35.72	81	69	44.00	51.84
78	39.52	81	69	48.77	57.64
79	43.88	81	68	54.25	64.11
80	48.77	81	68	60.39	71.32
81	54.23	81	68	67.28	79.35
82	60.35	80	68	75.00	88.27
83	67.19	80	68	83.64	98.17
84	74.83	80	69	93.29	109.16
85	83.35	80	69	104.07	121.33
86	92.86	80	69	116.09	134.79
87	103.44	80	69	129.46	149.65
88	115.20	80	69	144.32	166.01
89	128.25	80	70	160.79	184.00
90	142.72	80	70	179.00	203.72
91	158.72	80	70	199.10	225.28
92	176.37	80	71	221.19	248.78
93	195.80	80	71	245.40	274.31
94	217.13	80	72	271.84	301.91
95	240.46	80	73	300.58	331.64
96	265.89	80	73	331.66	363.49
97	293.50	80	74	365.10	397.43
98	323.34	81	75	400.85	433.36
99	355.43	81	75	438.80	471.13
100	389.74	81	76	478.77	510.52
101	426.18	82	77	520.48	551.24
102	464.60	82	78	563.59	592.91
103	504.78	83	79	607.61	635.08
104	546.42	84	81	652.00	677.22
105	589.12	85	82	696.12	718.74
106	632.40	86	63	739.25	1,000.00
107	675.69	68		1,000.00	
108	718.35				
109	1,000.00				

Female

Age	The SMT 2007 for third-sector products			a. The SMT 2007 for life coverage	b. The SMT 1996 for life coverage
		vs. a	vs. b		
	‰	%	%	‰	‰
0	0.51	53	54	0.96	0.94
1	0.36	55	52	0.66	0.69
2	0.23	55	48	0.42	0.48
3	0.14	54	45	0.26	0.31
4	0.09	56	45	0.16	0.20
5	0.07	58	50	0.12	0.14
6	0.07	58	54	0.12	0.13
7	0.06	50	46	0.12	0.13
8	0.06	55	46	0.11	0.13
9	0.06	60	50	0.10	0.12
10	0.06	60	55	0.10	0.11
11	0.05	56	50	0.09	0.10
12	0.05	56	50	0.09	0.10
13	0.06	60	46	0.10	0.13
14	0.07	58	41	0.12	0.17
15	0.08	50	38	0.16	0.21
16	0.10	50	40	0.20	0.25
17	0.11	46	38	0.24	0.29
18	0.12	43	39	0.28	0.31
19	0.13	43	41	0.30	0.32
20	0.13	42	39	0.31	0.33
21	0.14	45	42	0.31	0.33
22	0.14	44	41	0.32	0.34
23	0.15	44	42	0.34	0.36
24	0.16	46	43	0.35	0.37
25	0.17	47	45	0.36	0.38
26	0.17	45	44	0.38	0.39
27	0.18	45	45	0.40	0.40
28	0.19	45	45	0.42	0.42
29	0.20	44	45	0.45	0.44
30	0.22	45	48	0.49	0.46
31	0.23	43	47	0.53	0.49
32	0.25	45	47	0.56	0.53
33	0.27	45	47	0.60	0.57
34	0.29	45	46	0.64	0.63
35	0.31	45	45	0.69	0.69
36	0.35	47	46	0.75	0.76
37	0.39	48	47	0.82	0.83
38	0.42	48	47	0.88	0.90
39	0.46	49	47	0.93	0.97
40	0.50	51	48	0.98	1.05
41	0.55	53	48	1.04	1.14
42	0.60	54	48	1.11	1.24
43	0.67	56	50	1.20	1.34
44	0.74	57	51	1.29	1.46
45	0.82	59	52	1.40	1.58
46	0.91	59	54	1.53	1.69
47	1.00	60	55	1.67	1.83
48	1.11	61	56	1.82	1.99
49	1.22	61	57	1.99	2.15
50	1.35	63	58	2.16	2.33
51	1.48	63	59	2.34	2.52
52	1.61	64	60	2.51	2.70
53	1.74	65	61	2.68	2.87
54	1.86	65	61	2.84	3.06

Age	The SMT 2007 for third-sector products			a. The SMT 2007 for life coverage	b. The SMT 1996 for life coverage
		vs. a	vs. b		
	‰	%	%	‰	‰
55	1.98	66	60	2.98	3.28
56	2.09	67	59	3.11	3.53
57	2.19	68	58	3.24	3.78
58	2.31	68	57	3.38	4.07
59	2.46	69	56	3.56	4.38
60	2.64	70	56	3.79	4.69
61	2.86	70	57	4.08	5.03
62	3.12	71	58	4.42	5.37
63	3.42	71	58	4.82	5.88
64	3.77	72	58	5.27	6.45
65	4.15	72	58	5.77	7.10
66	4.58	72	58	6.33	7.84
67	5.05	73	58	6.95	8.69
68	5.56	73	58	7.62	9.66
69	6.10	73	57	8.35	10.76
70	6.70	73	56	9.14	12.02
71	7.47	74	56	10.16	13.45
72	8.37	74	56	11.32	15.08
73	9.40	74	55	12.66	16.94
74	10.58	75	56	14.20	19.06
75	11.95	75	56	15.97	21.47
76	13.53	75	56	18.00	24.21
77	15.35	76	56	20.33	27.33
78	17.45	76	57	23.01	30.88
79	19.87	76	57	26.08	34.91
80	22.66	77	57	29.60	39.49
81	25.87	77	58	33.64	44.69
82	29.56	77	58	38.27	50.59
83	33.81	78	59	43.57	57.27
84	38.69	78	60	49.64	64.84
85	44.29	78	60	56.57	73.41
86	50.73	79	61	64.49	83.09
87	58.11	79	62	73.52	94.01
88	66.56	79	63	83.80	106.31
89	76.22	80	63	95.50	120.15
90	87.26	80	64	108.78	135.67
91	99.84	81	65	123.82	153.05
92	114.15	81	66	140.82	172.46
93	130.40	82	67	159.97	194.06
94	148.80	82	68	181.49	218.02
95	169.56	82	69	205.58	244.49
96	192.91	83	71	232.43	273.61
97	219.06	84	72	262.21	305.46
98	248.21	84	73	295.05	340.10
99	280.52	85	75	331.05	376.37
100	316.11	85	76	370.22	414.34
101	355.04	86	78	412.46	454.59
102	397.24	87	80	457.59	496.88
103	442.55	88	82	505.26	540.85
104	490.67	88	84	554.96	586.06
105	541.09	89	86	606.01	631.95
106	593.14	90	88	657.57	677.83
107	645.96	91	89	708.61	722.97
108	698.48	92	91	758.02	766.52
109	749.52	93	75	804.60	1,000.00
110	797.81	80		1,000.00	
111	1,000.00				

Figure 9. Comparison with the SMT 2007 for third-sector products and for life coverage, and population tables (Male)

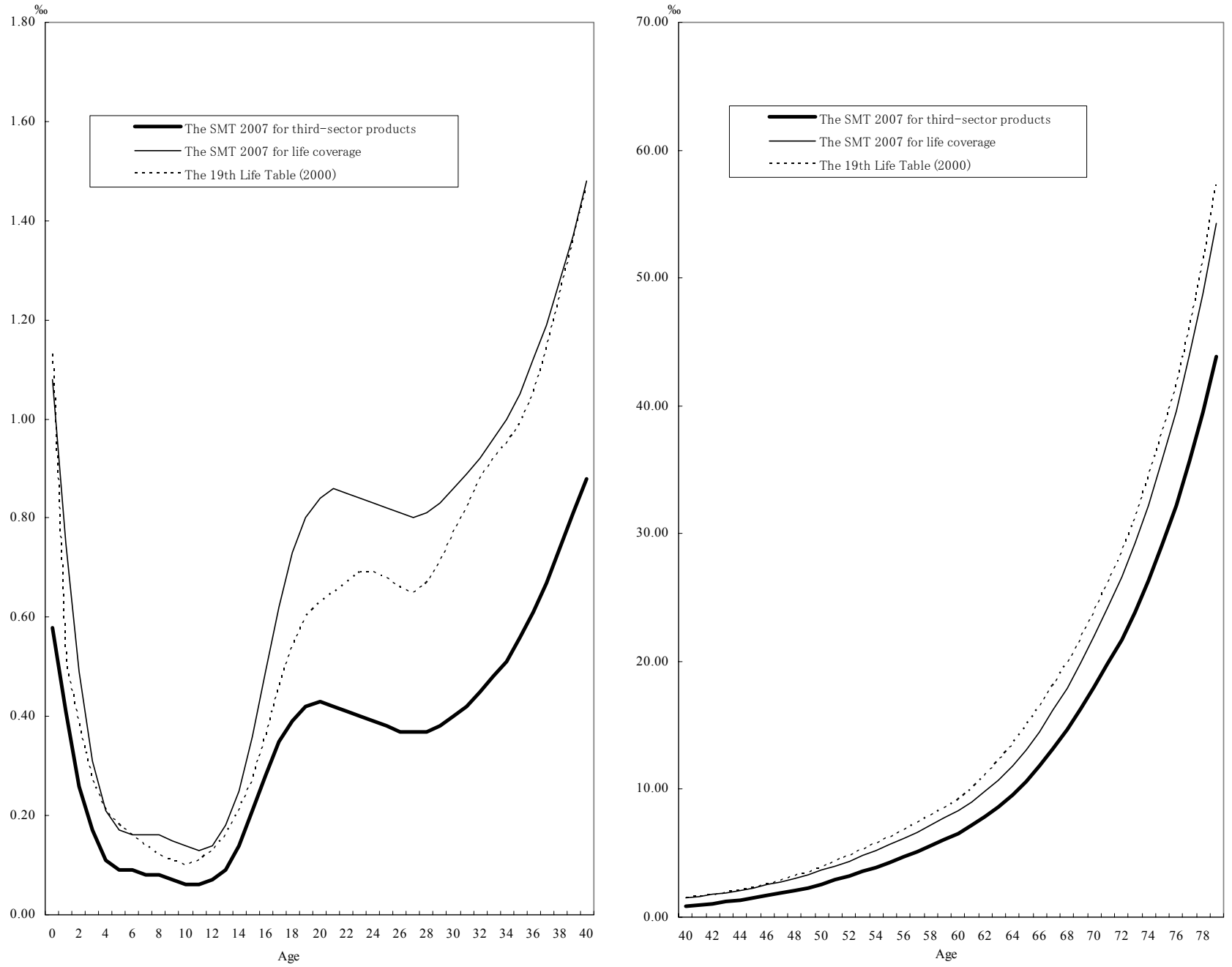
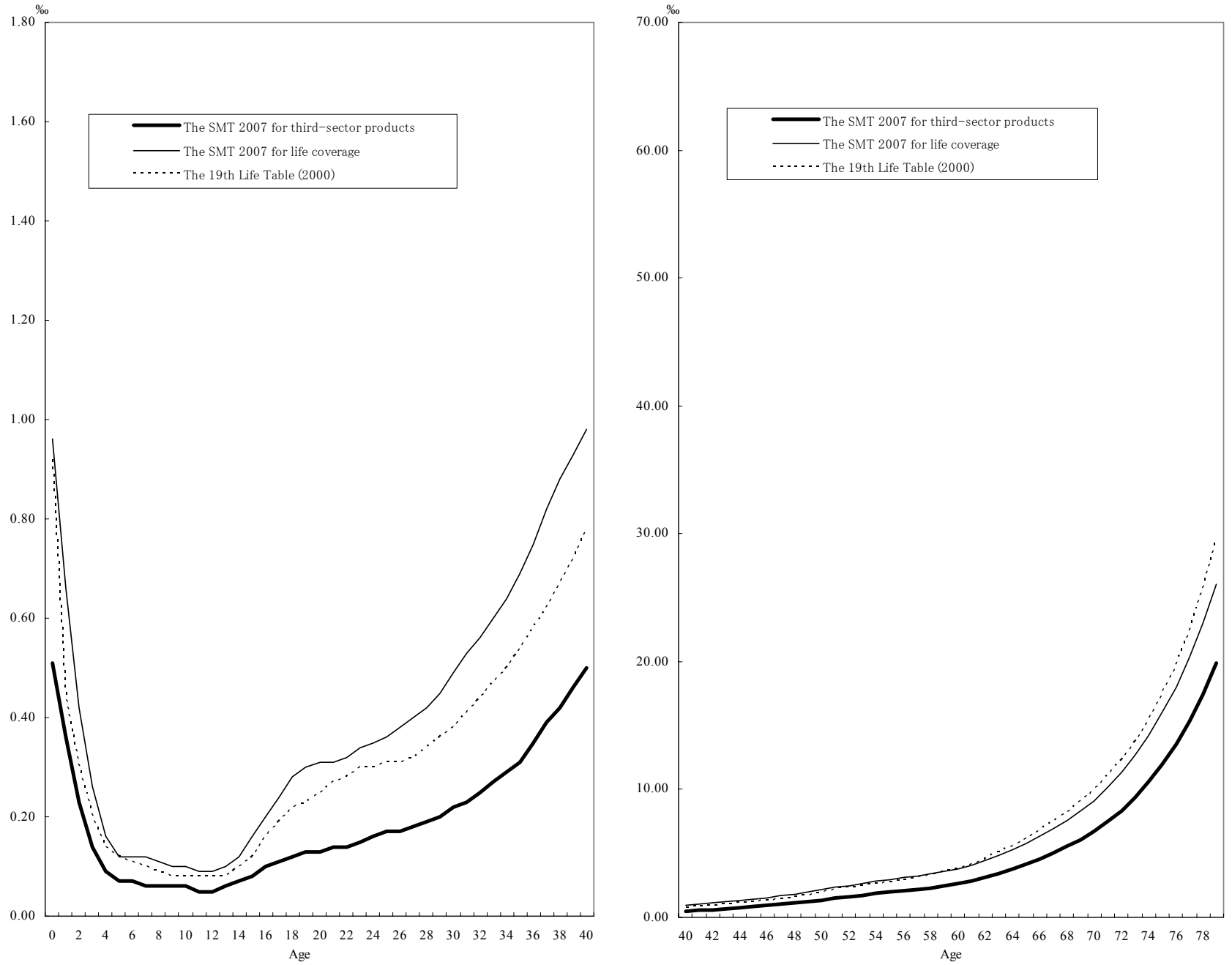


Figure 10. Comparison with the SMT 2007 for third-sector products and for life coverage, and population tables (Female)



4. Arguments about the SMT 2007

Lastly, I would like to give some arguments about the SMT 2007.

4.1. The SMT 2007 for Life Coverage

(1) The future mortality of the current young and middle ages
Mortality improvement of the young and middle ages is lower than that of the other generations for the past 10 years because of the deaths caused by adult diseases, for example. Therefore, the mortality improvement for the older ages may not show the same level as the mortality for the older ages in the future due to the cohort effect when these currently young and middle ages become older.

In view of the above situation, for life coverage, it is debatable whether it is appropriate in terms of soundness to simply apply the mortality improvement of the currently old ages to the SMT.

Specifically, the following can be examples of influential factors of the future mortality, and I think we should continue to monitor the mortality experience from these viewpoints:
- Progress in medical technique (genetic treatment etc.)
- Increase of adult diseases caused by corpulence
- Influence of smoking on the health
- The outbreak and increase of new infectious disease (SARS and avian influenza etc.)
- Rising concern of increase in the mortality by the global warming
- Influence of economy or social environmental change on a trend of suicide

(2) Introduction of select and ultimate tables
The SMT is now excluded the selection effect, that is ultimate table. But since reserves depend on the slope of future expected mortality in general, reserves calculated by using select and ultimate tables might be larger than reserves calculated by using ultimate tables. In this case, there is the point at issue whether select and ultimate mortality tables are more appropriate in terms of soundness. Actually, these tables were adopted in the 2001 CSO Tables. However, this point must be argued with the approach to reserving, and there are some difficulties that it will cause many loads to use these tables.

(3) Methodology of graduation and extrapolation
For graduation and extrapolation, the Greville's formula and the Gompertz-Makeham's Law are adopted respectively, which have been used for population tables by the Ministry of Health, Labour and Welfare. But there is room for argument on the point that the other methods should be weighed. For example, graduation by Whittaker-Henderson method and extrapolation by Logistic model are adopted in some foreign countries.

4.2. The SMT 2007 for Annuitants

(1) Differences among the guarantee types of annuity products
In Japan, conventional annuity product was usually set annuity amounts at its date of issue. However, in this time of low interest rates, such annuity product as variable annuity, which annuity amounts is set at the start of annuitization by using the then calculation basis, is increasing mainly on bank sales. And since this new kind of annuity product is effective in reducing its risk for the life insurance companies, this mechanism recently comes to be adopted by conventional annuity product in some companies.

In such a situation, it is debatable whether there are any problems of calculating annuity amounts and reserves of this new type of annuity product by using the same mortality tables, which are

projected for the same period, as the traditional type. For this argument, there is a way to set the standard mortality at every start of annuitization, but there are some difficulties that it will cause enormous loads to adopt this way. In Japan, the ratio that the lifetime annuity accounts is not yet high and its influence on reserves is slight, therefore overall decision will be necessary.

(2) Selection of projection models
About projection models, there is room for argument on the following point:
- Projection periods are decided only by the representative year of birth (1960).
- The past mortality improvement rates by age are assumed to continue in the future for several decades.

I think we should consider the former problem with the propriety of setting the standard mortality at every start of annuitization, which we have seen above (1). And about the latter, for example, the following projection models are given as well as the traditional model depending on only current age:

- Traditional model

$$\frac{q_{x,t+1}}{q_{x,t}} = \exp\left(-F\left(x\right)\right)$$ with a trend function $F\left(x\right)$ depending on current age x

- Cohort model

$$\frac{q_{x,t+1}}{q_{x,t}} = \exp\left(-G\left(t+1-x\right)\right)$$ with a trend function $G\left(t+1-x\right)$ depending on year of birth

- Synthesis model

$$\frac{q_{x,t+1}}{q_{x,t}} = \exp\left(-F\left(x\right)-G\left(t+1-x\right)\right)$$ stemming from a combination of the two

- Lee-Carter model

$$\ln\left(m_{x,t}\right) = a_x + b_x k_t + \varepsilon_{x,t}$$

These models were weighed in introducing the German mortality tables DAV2004R for annuity products, and the Lee-Carter model has also been used to calculate the population projections for Japan. When we select the model, we should weigh up several models based on the characteristic of Japanese mortality, such as the cohort effect that the mortality of males born in 1926-1935 is comparatively high (in addition, it was shown that the Lee-Carter model can be used even if a cohort effect exists).

(3) Projection of mortality from causes of death
For annuitants, it is controversial whether it is appropriate to take cause of death into account in estimating the mortality improvement. Actually, the difficulty of using the cause specific mortality to project the aggregate mortality is pointed out in some foreign countries as follows: “The aggregate projected mortality improvements arising from cause specific approaches will have a tendency to undershoot historic aggregate improvement rates (because there exist shifts of causes of deaths.)”

In the classic theory of evolution, it is said that there is a limit of life span and there is no way that the average life span increase linearly as before from now on. But in the forefront of the current biodemography, the following assertion seems to become convincing: even if there is a limit of life span eventually, it is not such a low level as 85 years old but more upper age.

After all, I think we should monitor the mortality improvement and investigate it in a long span.

4.3. The SMT 2007 for Third-Sector Products

(1) Collection of mortality experience data
For third-sector products, expected morbidity is more essential than expected mortality, but we would first need to collect and investigate the mortality experience data for this type of products. As each company has various products, we need to work with collecting the mortality experience data which is common throughout the industry.

References

[1] Institute of Actuaries of Japan. *Construction process for the Life Insurance Companies Standard Mortality Table 1996*. March 1996.
[2] Institute of Actuaries of Japan. *Construction process for the Standard Mortality Table 2007*. 228th bulletin separate volume. December 2006.
[3] Pasdika, Ulrich and Spivak, Grigory. "German annuities," *The Actuary*. May 2005.
[4] Pasdika, Ulrich. "Reacting before it is too late - the valuation of annuity business," *Regular meeting*. Institute of Actuaries of Japan. 2005.
[5] National Institute of Population and Social Security Research. *Population Projections for Japan: 2006-2055 (With long-range Population Projections: 2056-2105)*. Health and Welfare Statistics Association. May 2007.
[6] Sunamoto, Naoki. "Cohort Effect Structure in the Lee-Carter Residual Term." 2005.
[7] Continuous Mortality Investigation Mortality sub-committee. "Working Paper 3: Projecting future mortality: A discussion paper." 2004.
[8] Kouno, Shigemi. "The trend of the death rate: How old is the life prolonged to?" *Basic lecture of Population problem*. Health and Welfare Statistics Association. 2000.