

***Factors Contributing to the Improvement
and Predominance of the Longevity
of the Japanese Population***

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I. Introduction

Prior to 1945, the life expectancy of Japanese males and females was less than 50 years. However, after registering a rapid increase following the end of World War II, it had, by the late 1970s, caught up with the level then prevailing among the world's industrially developed countries. And, in the 1980s, Japanese life expectancy went on to outstrip that of the developed Western countries to become the world's longest ever (Fig. 1). Although the expectation of life at birth for Japanese males and females has subsequently continued to rise, that in many of the world's other developed countries has remained in a state of stagnation. According to the latest (1992) official life tables prepared by the Japanese Ministry of Health and Welfare, life expectancy at birth for Japanese males and females is 76.09 years and 82.22 years, respectively.

This paper aims at analyzing the relationship between the increase in life expectancy and the mortality changes by age and selected causes of death and at discussing the factors relevant to them in the light of medicosocial developments. Also, a comparative analysis is conducted of Japanese and selected European life expectancies and main causes of death with an eye to examine the elements that had contributed to the Japanese preponderance in life expectancy at birth around the year when it surged ahead of the European level as well as in recent years for which data are available.

II. Data and Method

A. Life expectancy data:

- (1) Complete life tables prepared by the Japanese Ministry of Health and Welfare for every 5 years from 1955 through 1990 (the 10th to 17th Complete Life Tables);
- (2) The 1950 Complete Life Table prepared by Haruo Misushima et al. IGAKU KENKYU, Vol. 26, No. 11, 1956;
- (3) Abridged life tables for each year from 1950 to 1990, prepared by the Japanese Ministry of Health and Welfare; and
- (4) Life expectancies of selected developed countries, taken from the Demographic Year Book prepared by the United Nations.

B. Mortality data:

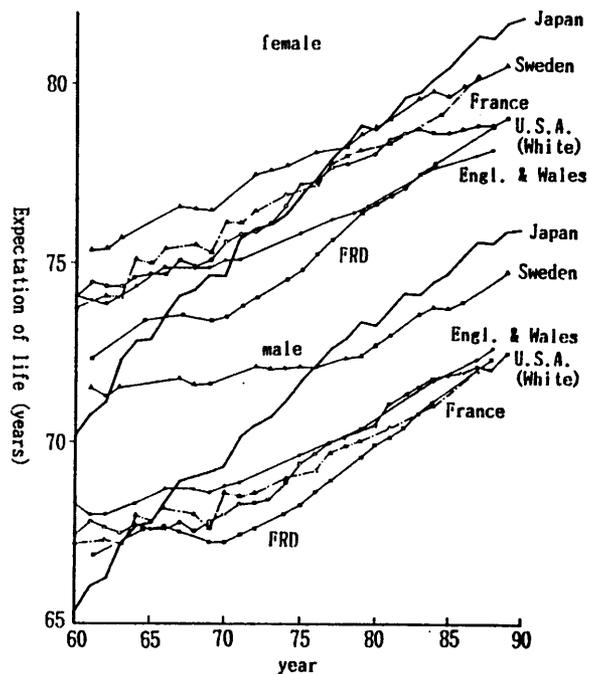
- (1) Mortality data tape of Information Service on World Health Statistics prepared by the World Health Organization; and
- (2) Vital Statistics Annual Report, Japan, prepared by the Japanese Ministry of Health and Welfare.

C. Method:

- (1) Since the collecting of life tables officially published by the government of each given country is extremely difficult, we have elected to reconstruct--for our study of selected European countries--the life tables for selected years from the e_x^o published in the Demographic Year Book. As regards the method of reconstruction employed by us, see Appendix; and
- (2) The method of decomposition developed by Pollard (1980) was used to calculate the contribution of mortality changes by age and selected causes of death to changes in life expectancy.

III. Results

Fig. 1. Expectation of life at birth for selected countries, males and females, 1960-1990



Source: Various years of United Nations, Demographic Yearbook

Although contributions by age groups and selected causes of death were originally analyzed in terms of 5-year age groups and 5-year periods, the results are given in broad age groups and 10-year intervals, as shown in Table 1. The results presented in this report are mainly those given for males, since the general trends noticed for males similarly applied to females.

1. Contributions of mortality changes by age groups and causes of death to the gains in Japanese life expectancy at birth.

The contribution of mortality changes to the gains in life expectancy by age groups among males is shown in Table 1, and that by selected causes of death in Table 2. During the eight years (1947 to 1955) following the end of World War II, Japanese expectation of life at birth in-

Table 1. Contributions of various age groups to the changes in life expectancy at birth for males in Japan 1950~1990

Age	(years)				
	1950-55	1955-65	1965-75	1975-85	1985-90
Changes in %	6.12	4.14	3.99	3.05	1.14
0	1.27	1.45	0.73	0.39	0.08
1~4	1.17	0.69	0.16	0.11	0.01
5~14	0.29	0.30	0.14	0.09	0.03
15~34	1.50	0.84	0.38	0.24	0.09
35~49	0.82	0.43	0.32	0.38	0.19
50~64	0.57	0.41	0.98	0.46	0.19
65~79	0.39	0.12	1.07	1.11	0.45
80+	0.11	-0.10	0.21	0.27	0.11

Table 2. Contributions of selected causes of death to the changes in life expectancy at birth for males in Japan 1950~1990

	(years)				
	1950-55	1955-65	1965-75	1975-85	1985-90
Changes in ‰	6.12	4.14	3.99	3.05	1.14
1. Gastro-enteritis	0.88	0.41	0.17	0.05	0.00
2. Tuberculosis	2.20	0.82	0.37	0.16	0.03
3. Pneumonia & bronchitis	0.72	0.46	0.27	-0.12	0.07
4. Malignant neoplasms	-0.12	-0.15	0.08	-0.06	-0.01
5. Heart diseases	0.13	0.02	0.11	0.05	0.12
6. Hypertensive diseases	0.02	-0.07	0.10	0.15	0.05
7. Cerebrovascular diseases	-0.37	-0.17	0.98	1.34	0.47
8. Stomach & duodenal ulcer	0.23	0.18	0.11	0.09	0.02
9. Diabetes melitus	0.01	-0.03	-0.02	0.04	0.02
10. Chronic hepatitis & cirrhosis of the liver	-0.02	-0.03	-0.08	0.07	0.07
11. Nephritis & nephrosis	0.17	0.16	0.13	-0.01	0.01
12. Senility	0.15	0.26	0.24	0.12	0.07
13. Accident	0.02	-0.04	0.52	0.32	0.07
14. Suicide	-0.15	0.37	-0.07	-0.04	0.17
15. Others	2.24	1.94	1.07	0.88	-0.02

creased tremendously: by 13.54 years for males and 13.73 years for females. This rapid increase in life expectancy was the outcome of the implementation of vigorous public health programs aimed at controlling infectious diseases and the pervading use of antibiotics and chemotherapeutic drugs in medical practice. The major contributing factors were the decreases in infant and childhood mortalities (2.44 years for those aged

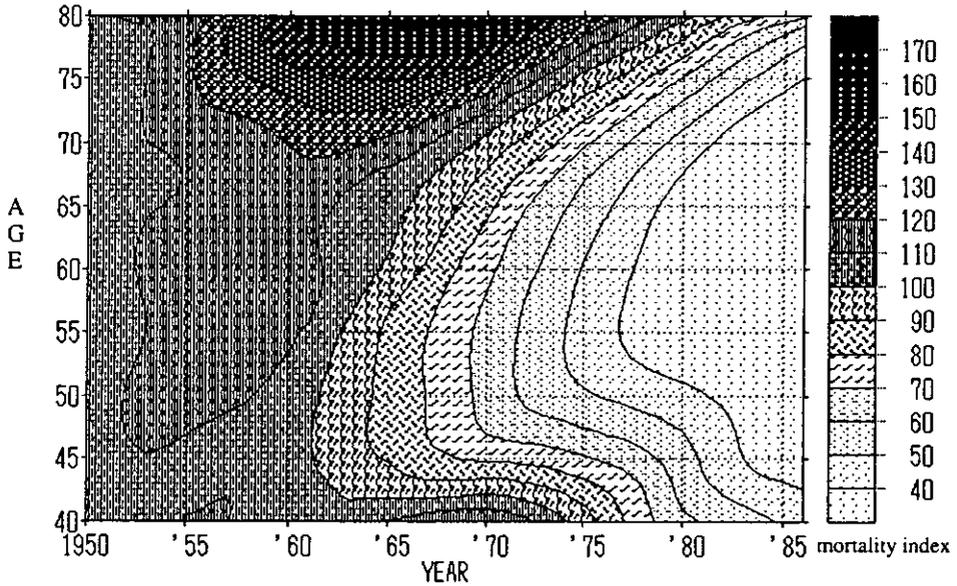
0 to 4) and in the mortality of the young (1.50 years for those aged 15 to 34). As can be seen from the results shown in Table 2, the decrease in mortality due to infectious diseases, particularly tuberculosis, contributed the most.

The 1955-1965 period witnessed an uninterrupted increase--albeit at a decelerated rate--in Japan's life expectancy (4.14 years for males and 5.09 years for females) and it gradually caught up with the Western levels. Trends similar to those observed prior to 1955 were noticed in respect to contribution by age groups and causes of death, although contribution due to changes both in childhood mortality (those aged 1-4) and mortality among the young (those aged 15-34) began decreasing in the latter half of the period. It seemed that successful control of infectious diseases brought their mortalities to the low level of curbing further reduction. On the other hand, contributions due to mortality changes in the middle-aged bracket gradually increased during this period. Against these changes, the sharp post-1950 increase in mortality among the elderly due to cerebrovascular diseases (CVD) produced noticeably negative contribution by the nation's older age group (see negative contribution of CVD in Table 2).

In the next period (1965-1975), Japanese life expectancy continued to increase, although again at a somewhat slowed-down pace, registering an increase of 3.99 years for males and 3.94 years for females. Contribution attributable to changes in infant mortality, childhood mortality and mortality among the young clearly decreased, while that due to changes in mortality among the middle to older ages increased gradually. The years of contribution recorded among males were 0.98 for those aged 50-64, and 1.07 for those in the 60-79 bracket. This corresponded to 24 percent and 27 percent of gains in life expectancy at birth, respectively, for the former and latter age groups. The increase in contribution by both these older age groups resulted chiefly from the decrease in CVD mortality, which began to decrease around 1965. The changes in age-specific CVD mortality are as shown in Fig. 2. The contour map (Shigematsu, et al., 1992) clearly indicates that the decrease in CVD mortality started from the

middle-aged group and gradually spread over to the older ages. It seemed to be brought by the special control program to reduce CVD deaths--a program put into operation since the beginning of the 1960s with a special focus on preventing premature deaths among those in their 50s.

Fig. 2 Mortality trends of cerebrovascular diseases for males shown in contour map of the mortality index (1950:100)



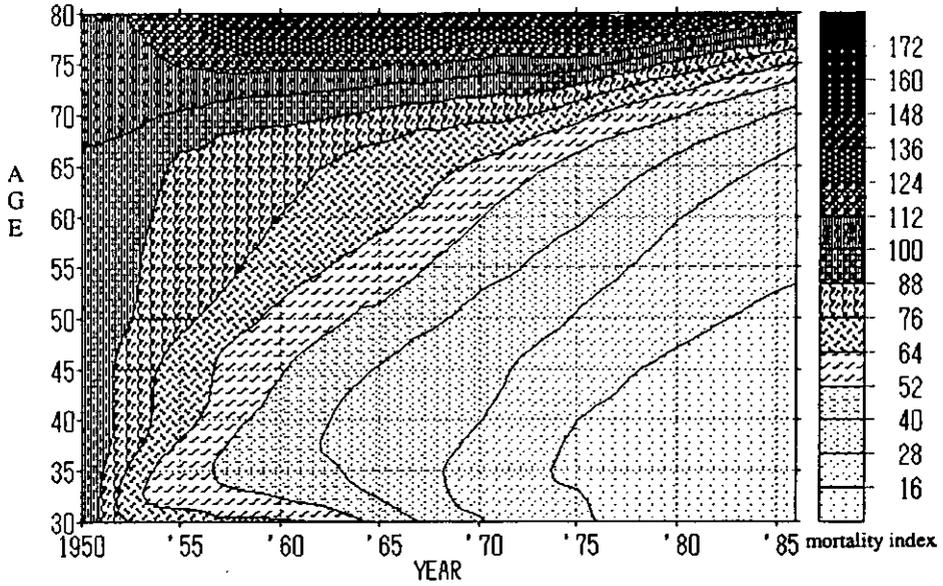
Source: Shigematsu T. et al. (1992)

In the third period (1975-1985), the trend of increase in Japanese life expectancy showed an indication of further deceleration but had kept definite increase (3.05 years for males and 3.59 years for females) against a slowdown in many of the European countries. Thus, the expectation of life in Japan for both sexes outstripped that of the other developed countries one after another to reach, by 1985, the longest longevity

in the world. Contribution in terms of age groups and causes of death during this period largely shifted from the younger to the older age groups and from infectious diseases to diseases of the elderly. Among males, the largest contribution was made by the older age group (1.11 years for those aged 65-79), mainly as a consequence of the decrease in CVD mortality--i.e., 1.38 years, in terms of years of contribution, and 43 percent, in terms of gains in life expectancy at birth.

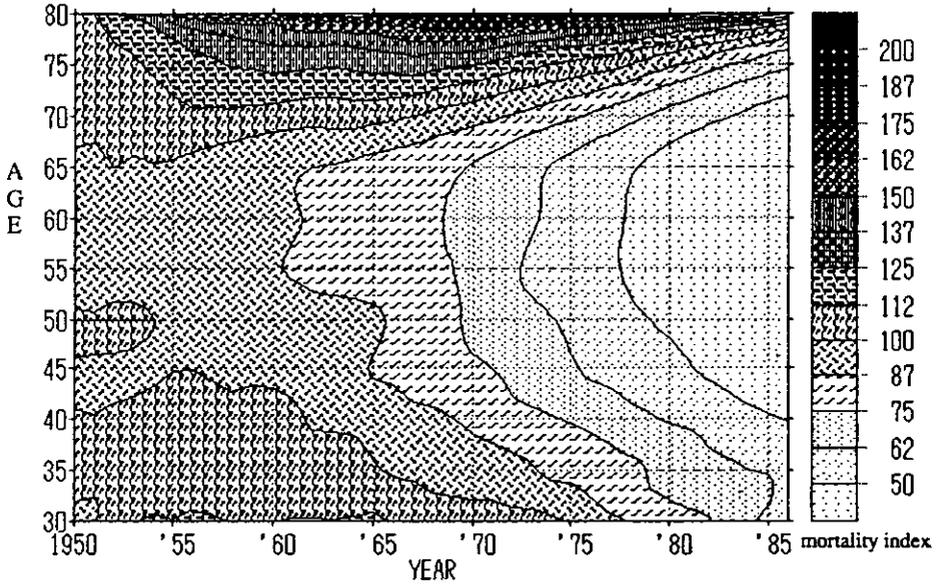
After 1985, Japanese gains in longevity--while continuing to show definite signs of a slowdown--kept on increasing steadily. Contributions to the increase in life expectancy further shifted to the older age groups: about 39 percent of the gains in the expectation of life at birth was produced by males in the 65-79 age group, and 11 percent by those in the 80-and-above age bracket. The largest contributions were accounted for by CVD, 41 percent, and heart diseases and hypertension, which together accounted for 15 percent. Malignant neoplasms contributed negatively in males but recorded a 10-percent positive contribution in females thanks to a definite decrease in mortality caused by stomach and uterine cancers. The decreases in mortality due to these two types of cancer from the year 1950 to 1985 are shown in Figures 3 and 4. The contour map of mortality indices of uterine cancer (Fig. 3) indicates a rapid decrease from 1950 starting with age 30s and spreading over to the older ages. Mortality due to uterine cancer has diminished to one-fifths of the 1950 level. Also, since the 1950s, there has been a clear decrease in female mortality caused by stomach cancer, starting with age 50s and spreading to both the younger and older ages. Female mortality due to stomach cancer today is less than one-half of the 1950 level for women aged 40-70. This decrease in female mortality would seem to be attributable largely to the changes in Japanese life-style as a result of improvements in the standard of living and partly to the intensive mass screening of those two cancers since the early 1950s.

Fig. 3 Mortality trends of uterine cancer for females shown in contour map of the mortality index (1950:100)



Source: Shigematsu T. et al. (1992)

Fig. 4 Mortality trends of stomach cancer for females shown in contour map of the mortality index (1950:100)



Source: Shigematsu T. et al. (1992)

2. Comparisons between Japan and selected European countries around the year when Japan's life expectancy surpassed their's.

In Japan mortalities of various ages and causes of death had decreased tremendously since 1947 and age- and cause-compositions of mortality have largely changed. As a result, Japanese life expectancy increased dramatically in the 1960s and 1970s, as mentioned above, and kept on increasing even after it reached the longest longevity in the world. On the other hand, European countries experienced such mortality transitions in the first half of this century and most of them showed a slow-down in longevity improvement in recent decades. Life expectancy for Japanese males surpassed that for German (Federal Republic of Germany) males in 1964, that of their English counterparts in 1967, that of Danish

Table 3. Contributions of various age groups to the changes of life expectancy at birth in Japan and Sweden in the periods of 1973-78 and 1978-83, males

age group	(years)			
	Sweden		Japan	
	1973-78	1978-83	1973-78	1978-83
Total contribution	0.28	1.14	2.12	1.17
0	0.14	0.12	0.24	0.19
1~4	0.03	0.02	0.09	0.06
5~14	0.01	0.06	0.07	0.04
15~34	-0.01	0.19	0.25	0.07
35~49	0.00	0.21	0.22	0.15
50~64	-0.02	0.22	0.45	0.13
65~79	0.11	0.30	0.65	0.49
80+	0.03	0.03	0.14	0.05

males in 1975, and that of their Swedish counterparts in 1978. We made a comparative analysis of contributions by different age and cause groups for each of the aforementioned four European countries. The comparison was made by covering two 5-year periods--one immediately preceding, and the other immediately following, the year Japan's life expectancy surpassed that of each respective country. The results are given only in summary, and one table (which has to do with Swedish males) is given as an example (see Table 3).

Sweden: Analysis was done for the two 5-year periods of 1973-78 and 1978-83. In 1973, five years before Japanese life expectancy surpassed that of Sweden's, expectation of life at birth for Japanese males was 1.42 years less than that of their Swedish counterparts, but in 1983, five years after Japan's life expectancy surpassed Sweden's, it exceeded that of their Swedish counterparts by 0.58 years. As Table 3 shows, gains in life expectancy at birth in Sweden was only 0.29 years, but after 1978 Sweden resumed an increasing trend and recorded nearly the same increase as that in Japan.

The contributions by all Swedish age groups were smaller in comparison to Japan's in the 1973-78 period, but the 1978-83 period witnessed a larger contribution by Swedish males aged 15-64, while a Japanese preponderance was observed for males under 5, and 65 and above. Thus, the gains in life expectancy in 1978-83 were nearly the same in both countries.

Our analysis of contribution by selected causes of death to gains in life expectancy shows that the contribution of every death cause in Sweden during the 1973-78 period was small when compared to Japan--a fact reflecting a stagnation in the improvement of Swedish longevity. By contrast, the largest contribution to the 2.12 years of gain in Japanese life expectancy at birth in the same period was attributable to the decrease in deaths due to CVD (0.65 years), followed by the drop in deaths caused by accidents (0.43 years). In the 1978-83 period, the largest difference between the two countries was observed in respect to CVD: 0.68

years or 58 percent of the gains in Japanese life expectancy, compared to 0.12 years or 11 percent of the gains in Swedish life expectancy. The increase in Swedish longevity in this period was produced mainly by reductions in mortality due to malignant neoplasms and heart diseases (47 percent), while those two causes recorded negative contribution in Japan.

Federal Republic of Germany (FRG): Comparisons were made for the 5-year periods before and after 1964, the year when Japanese life expectancy moved beyond that of the FRG. In both periods, the 35-and-over age groups in Germany had negative contributions while in Japan all age groups--except the oldest ages in the 1959-64 period--contributed positively. The contribution of all the causes in the FRG during the 1964-69 period was either trivial or negative, especially among the aged. These findings indicated stagnations in mortality improvement among Germany's adult populations. The biggest difference was noticed in regard to heart diseases: -0.23 years (in 1959-64) and -0.37 years (in 1964-69) in Germany, compared to Japan's +0.09 years and -0.06 years, respectively, for the two periods.

England and Wales: The two 5-year periods before and after 1967 were taken for comparison. Contribution by all age groups, except that by English males in the 35-49 age bracket (which showed a negative contribution of -0.033 years in the 1967-71 period), was positive in both countries, although the years of contribution in England were much smaller than in Japan. Contribution by English males aged 5-49 was particularly trivial during 1962-67, thus indicating a slowdown in English mortality improvement during that period. During 1967-71, stagnation in mortality improvement prevailed among all English age groups: their total contribution to English life expectancy at birth in this period amounted to only 0.20 years, compared to Japan's 1.14 years. In contribution by causes of death, Japanese preponderance was noticed in respect to CVD and tuberculosis.

Denmark: The periods studied were the five years prior to and following 1975. Large differences in contribution were observed between Japanese and Danish males aged 15-79 and in respect to CVD and tuberculosis. Especially outstanding is the fact that Danish males, in the 1975-80 period, recorded no gain in life expectancy and showed negative contribution in all age groups above age 15 and relatively large negative contribution in respect to malignant neoplasms and suicide.

3. Factors related to the Japanese preponderance in life expectancy at birth in recent years.

In conducting a comparative study of the factors contributive to Japanese preponderance in the expectation of life at birth, we picked 1986, the year when data were available for all of the four European countries under study. The results are as given in Figures 5 and 6. In both figures, positive contribution indicates Japanese preponderance--and negative contribution denotes Japanese inferiority--in life expectancy at birth vis-a-vis each of the 4 European countries.

In general, the Japanese are enjoying the lowest mortality in all age groups, and the contributions to the differences in longevity (between Japan and each of the four European countries) by the various Japanese age groups are all positive, except for childhood, age one to four. As Fig. 5 shows, an especially large difference--that is, Japanese preponderance--is attributable to the low mortality of Japan's older ages, age 50-64 and 65-79. From the viewpoint of causes of death, the largest contribution is noticed in differences in mortalities due to heart diseases. The second largest contribution is accounted for by other causes (Oth), that is, miscellaneous causes other than the nine specifically listed in Fig. 6. On the other hand, moderately negative contribution is recorded for CVD due to its higher mortality in Japan, although the rate of Japanese mortality due to this cause has been rapidly decreasing since the 1970s. Other causes indicating Japanese inferiority in contributions

Fig.5. Contributions by various age groups to the total difference in life expectancy at birth for selected countries in males, 1986 (Japan minus each country)

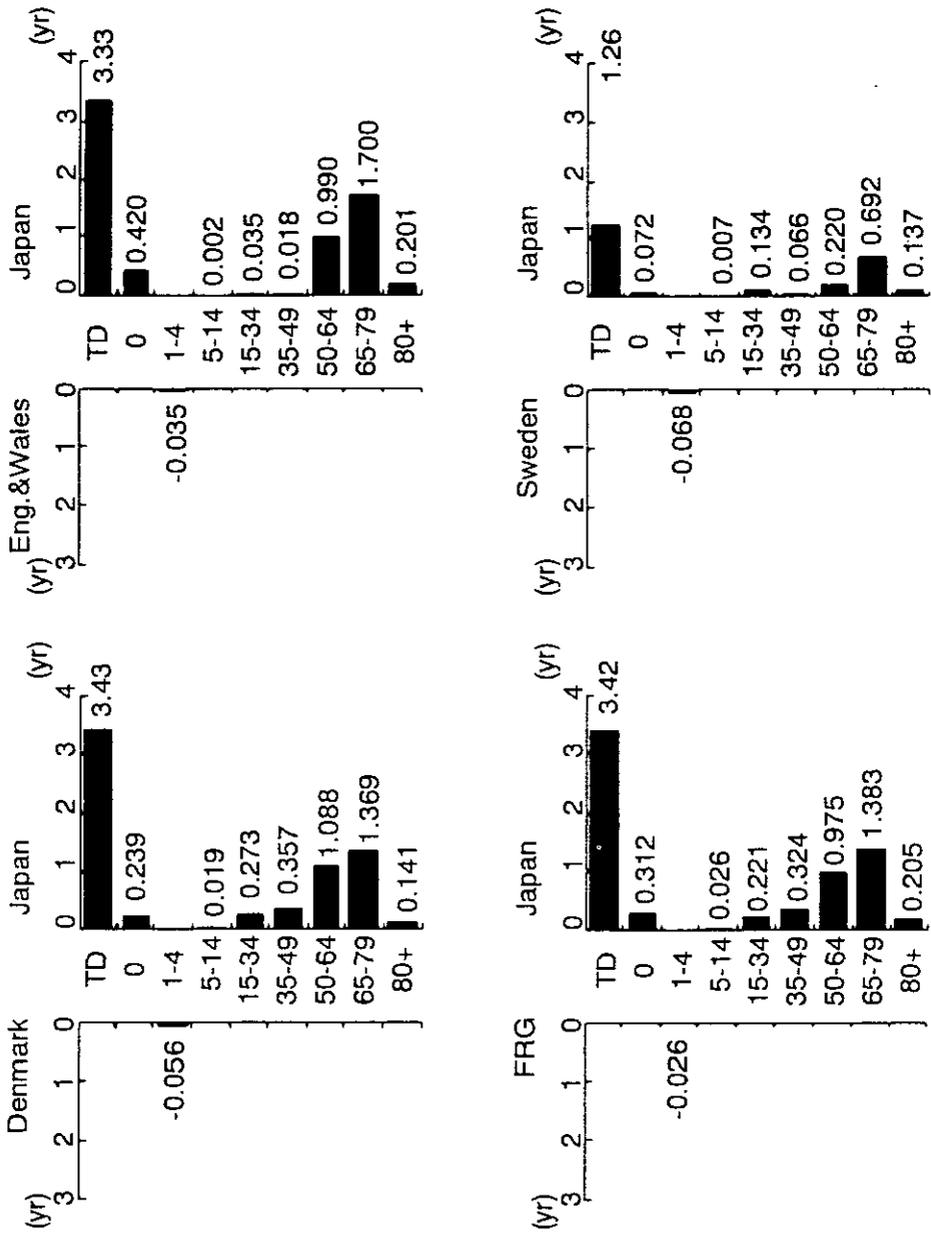
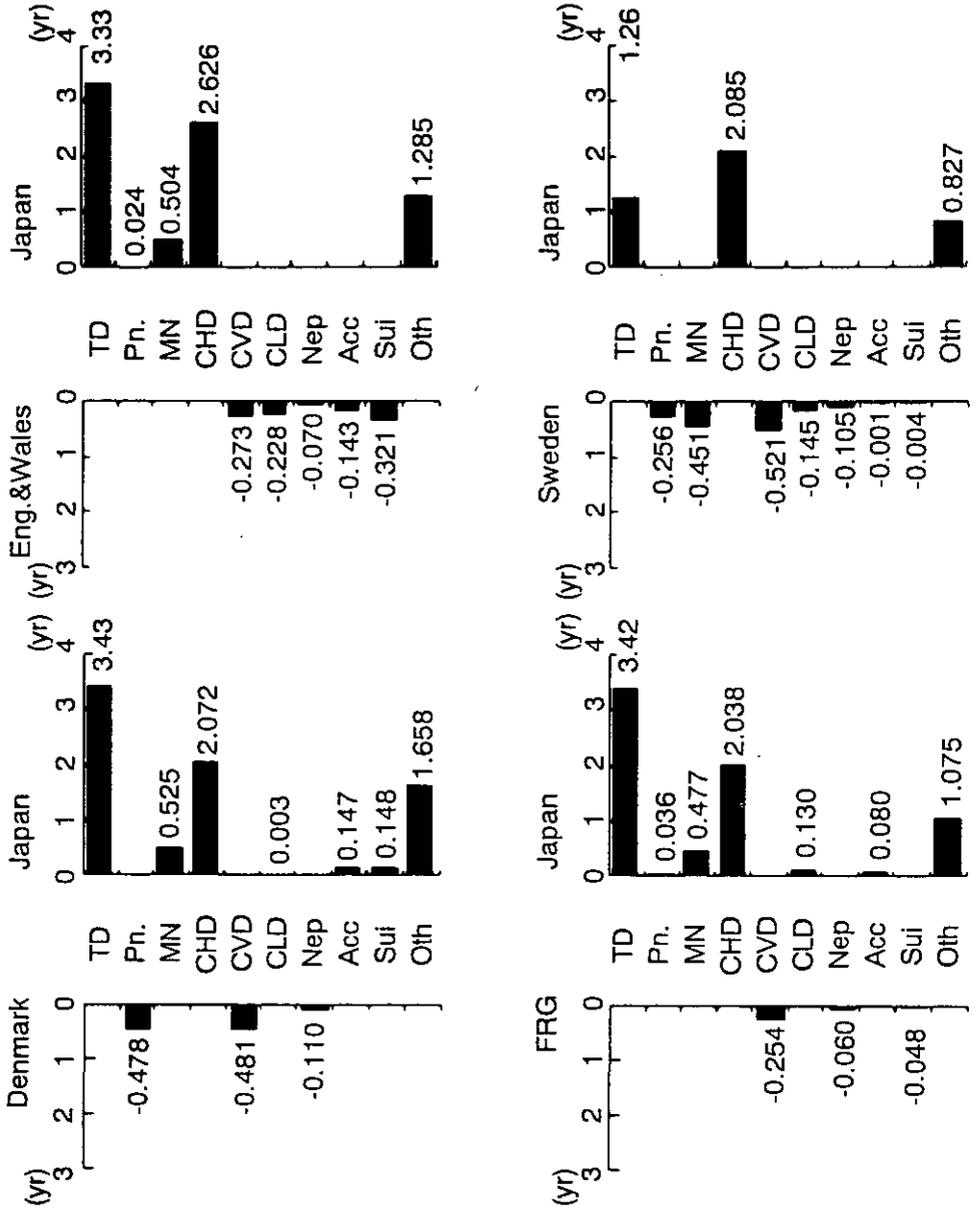


Fig. 6. Contributions of selected causes of death to the total difference in life expectancy at birth for selected countries in males, 1986 (Japan minus each country)



vis-a-vis some of the European countries are: pneumonia & bronchitis and nephritis & nephrosis against Sweden and Denmark, and malignant neoplasms against Sweden.

IV. Discussion and Summary

Japanese life expectancy increased with remarkably great strides in the 1950s and rapidly caught up with and surpassed the life expectancies of Western countries one after another in the 1960s and 1970s. Even after having attained the world's longest longevity in the early 1980s, expectation of life at birth in Japan has continued to increase. It is of an increasing interest for demographers as to why and to what extent Japanese life expectancy continues to increase against the experiences in the Western countries, where a slowdown or rather a stagnation in the increase of life expectancy has prevailed after the 1970s. We will next discuss this question by reviewing the various medical and social factors which appear to have influenced the increase in life expectancy in Japan.

Tables 4 and 5 present histories of postwar reconstructions and developments in Japan noting the then policies, progresses, status and topics in socioeconomic and health and medical fields seemingly to have had effects on increase in longevity since 1950. Immediately after the end of World War II, the Japanese lived in a state of chaos, economic collapse, industrial destruction and rampaging epidemics of all kinds of infectious diseases. In spite of such unfavorable conditions, Japanese life expectancy increased with unbelievable stride. This probably resulted from the vigorous implementation of public health programs aimed at controlling infectious diseases and from improvements in medical practice in general --in particular, the introduction and rapid pervasion of chemotherapeutic drugs and antibiotics. This was reflected, until 1955, in the large contribution to the gain in life expectancy at birth through reductions in

Table 4. Changes in social and economic situation in Japan, 1950-1990

	1950	1955	1960	1965	1970	1975	1980	1985	1990						
GNP (trillion yen)		8.6	11.0	20.1	30.3	39.6	54.8	82.8	116.7	152.2	208.9	260.3	305.7	356.2	436.9
Income per capita (1,000yen)		59	80	138	262	551	1,079	1,633	2,123						2,550
Business cycle															
Topics	Korean boom	Jinnmu boom	Iwato boom	Olympic boom	Izanagi boom	Dollar shock	Oil shock I	Oil shock II							
	•Korean War Special Procurements	•Economic take-off •Prewar level of living	•Income doubling P. •Tokyo Olympic	•New S-E development •Air Pollution Control Act	•Okinawa return •Island reformation P.	•Comprehensive Economic development P. •Environment Agency	•New S-E development •New S-E development •New S-E development								
Popularity of															
TV			50%	90%											
Color TV					15%	40%	60%	80%	90%						
Refrigerator				50%	80%										

source: GNP and per capita income Annual Report of National Life Statistics, Ed. Supervision National Life Bureau, Economic Planning Agency, Ed. Center for National Life, Finance Ministry Printing Office, Tokyo, 1990.
 Business cycle and Topics Footprints of Japanese Economy, Ed. K. Takeuchi, Survey and Planning Division, Ministry's Secretariat, Ministry of Finance, Japan, 1988, ZAIKEI SHOHO Co. Tokyo.
 Popularity of TV, color TV and Refrigerator Year Book of Japanese Industry 1976-77 and 1981, Jap. Indust. News Paper Co., Tokyo.

infant and childhood mortality and through the decline in infectious diseases. Most of the acute infectious diseases, excluding dysentery, were controlled by 1950.

Next targets in national health were tuberculosis (tbc) control and improvements in maternal and child health. Tbc was the largest killer in the 1940s in Japan, especially among the younger ages, 20-29 years, with high peak in mortality. The activities against tbc were promoted by enforcement of the Tuberculosis Prevention Act in 1951 and particularly the facts to be recorded were the active roles played by health centers. A nationwide network of health centers actively carried out well-organized prevention programs, BCG vaccination, mass screening, registration and supervisory activities of the detected tbc patients. Progress in medical practices, especially the pervading use of anti-tbc drugs such as streptomycin, PAS, INAH and others since 1950 also played an important role. These successful tbc control activities were reflected in the largest contributions of tbc and of the ages 15-34 in extension of longevity in the 1950s.

In improvements in maternal and child health, health centers played an important role in sharply decreasing infant mortality through their efforts to the public education and the betterments of cares for prenatal and postnatal mothers and newborns. The effects were accelerated by the enforcement of the Maternal and Child Health Act in 1965. Together with those activities, the progress in infectious disease controls mentioned above contributed much as well. Rapid declines in infant and childhood mortalities were reflected in large contributions of the ages 0 and 1-4 through 1975 (see Table 1).

In addition to such improvements in medical conditions, the favorable changes that took place in Japan's socioeconomic conditions should not be overlooked--in fact, the latter may even have played a greater role than the former toward increasing Japanese longevity. The start of the Korean War in 1950 generated a heavy demand for allied special procurements which, in turn, greatly stimulated the reconstruction of Ja-

pan's industrial infrastructure and gradually helped nudge its economy toward recovery. The Japanese economy had, by the latter half of the 1950s, lifted off and regained its prewar living standards. Subsequently, a series of economic policies designed to achieve high growth--starting with the Ikeda Cabinet's income-doubling policy--were launched by the successive administrations (see Table 4); and their implementation ushered in an era in which Japan's economy benefitted from a repeated cycle of high-growth economic booms. Finally, in the 1970s, Japan's economy caught up with the level of the West's industrially advanced countries to rank among the world's most developed economies in terms of GNP, per capita income, TV popularity and so forth (again see Table 4). With those rapid economic developments and improvements in social conditions, people's life in Japan underwent vast changes and their living standard reached a level far beyond that of the prewar years.

For an example, electric refrigerator was introduced in the late 1950s and pervaded rapidly into Japanese life. By 1965 nearly 100 percent of Japanese homes were equipped with it. This paved the way for the setting up of nationwide networks of cold-chain outlets in the supply of a large variety of foodstuffs--and, consequently, toward revolutionizing Japanese dietary life in general by bringing about a greater consumption of fresh foods and less dependence upon such traditionally preserved sustenances as salted and dried edibles. Together with the postwar practice of providing school lunches (put into effect in compliance with an administrative order issued in 1946 and the School Feeding Law of 1954), both quantitative and qualitative improvements of food supply reformed Japanese dietary life and greatly promoted its nutritional status. As Table 5 shows, protein and fat intakes--particularly animal ones--increased rapidly. By 1975, both intake and balance of nutritions, except salt intake, had risen to a favorable level, and have thereafter maintained that level--that is, a sufficient (nonexcessive) intake of animal proteins and fats, specifically the maintaining of the percentage of fat energy to total energy intake to under 25 percent. Although the postwar process of restituting the nation's nutritional status produced such passing phenomena as the increase in mortality due to CVD and, consequently, its large

negative contribution to the gain in longevity in the 1955-65 period (as mentioned earlier), Japanese mortality has been rapidly decreasing since the late 1960s.

These social developments, economic prosperity and improvements in dietary life not only generally helped to promote the national health and bring about a decline in mortality but also seemed to be the most important factors for the rapid rise in Japanese life expectancy during the decades of the 1960s and 1970s (Mosk, 1986). Together with those socio-economic developments, progress in medical practice and vigorous efforts in public health--both primary and secondary prevention of adult diseases--contributed to further gains in longevity since the 1970s.

After attaining the world's longest longevity in the early 1980s, Japanese life expectancy--although having lost much of its initial momentum--is continuing to increase without any indication of stagnation. The reason for this is not clear but, as was reported by Yanagishita (1988) from the viewpoint of mortality trends by various causes of death, the main factor is the sharp decline in CVD mortality (the largest killer in the 1950s and 1960s) with no increase in ischemic heart diseases since the 1970s. In respect to trends in cancer mortality, moreover, age-adjusted mortality from all sites of cancer has, despite the definite increase in lung and colon cancer mortalities, leveled off among Japanese males and is clearly decreasing among females, thanks to the decrease in mortality from stomach and uterine cancers (the most prevalent sites of cancer in Japan).

As was observed in this study, contributions to the extension of the expectation of life in Japan have been shifted from mortality decrease in the younger ages to the older ages and from that due to infectious diseases to diseases of the aged since the late 1960s. Our comparative study on the Japanese preponderance in longevity revealed that the world's longest life expectancy was achieved by the Japanese population as a result of the definite decrease in mortality among the older ages (those in their 50s and above), together with the low mortality level in all age

groups and the remarkably low mortality from heart diseases, particularly ischemic heart diseases, as well as other miscellaneous death causes in general compared with those in European countries. The largest difference observed in heart disease mortality may be partly due to a racial difference but can also be seen as being mainly the result of a balanced nutrition (as has been mentioned above) and the variety of foods consumed in Japanese dietary life. It is believed to be a particular finding that the family kitchen prepares every type of foods--western, Chinese and other oriental as well as Japanese dishes. Additionally, the large contribution attributable to other miscellaneous causes of death seems to be a reflection of the better levels (on a national average) of medical services in Japan thanks to the efforts of general practitioners and a national health insurance system covering the entire population. Moderately negative contribution is recorded for CVD due to its higher mortality in Japan, but CVD mortality has been rapidly decreasing since the 1970s and is expected to continue to decrease.

In recent years, with the rapid aging of its population, Japan has been carrying out various programs for health promotion and protection to reduce the heavy burdens expected in the 21st century. Enforcement of the Health Act for the Aged in 1983 encouraged nationwide activities in health promotion and protection, both in primary and secondary prevention of adult diseases, and has served to ensure the effectuation of medical services and rehabilitations for the aged. Various programs in health promotion, mass screening, health care and welfare for the aged under the provisions of the above Act are going on--e.g., the Ten-Year Comprehensive Strategy for Health and Welfare of the Aged, the Active 80 Health Plan, the Special Program for the Care of the Demented Aged, the Ten-Year Comprehensive Strategy Against Cancer, and others. Further, medical, health, and welfare services are being reformed with the aim to establish comprehensive services in the fields, such as national and regional programs for health and medical services, national and local programs for health and welfare services, and reformation of community health services.

Together with the progress in medical services and various efforts in health cares and services in recent years, social and economic developments and nutritional improvements appear to support further improvements in mortality. In view of these situations and recent trends in mortality by age and by causes of death in Japan, we can expect further gains in life expectancy at birth (though a gradual slowdown in increase is inevitable) and in the next century Japanese life expectancy will probably reach the level beyond the assumption for e_0° used in population projection by the Institute of Population Problems, 77.87 years for males and 83.85 for females in 2025.

Appendix: Derivation of l_x from $\overset{\circ}{e}_x$ of a life table.

1. For the present study, the values of l_x and $\overset{\circ}{e}_x$ ($x=0,1,2,\dots,85$) of a life table are needed.

The method that can be used to get the values of l_x and $\overset{\circ}{e}_x$ for each x from the values of $\overset{\circ}{e}_x$ ($x=1,2,3,4,5,10,15,\dots,85$) in the "Demographic Year Book" is as shown below:

When $\overset{\circ}{e}_x$ ($x=0,1,5,10,\dots$) are given, the method of deriving other life table functions was studied by Mitra (1974). He fitted the curve

$$\overset{\circ}{e}_x = \exp(ax^2 + bx + c)$$

for $\overset{\circ}{e}_x$ in the age interval (5,80).

In the age interval (0,5), in which the $\overset{\circ}{e}_x$ curve generally assumes the maximum value at some point $x = x_0$ [i.e., maximum point (age), $0 < x_0 < 5$],

$$1/\overset{\circ}{e}_x = m + nx + px^2$$

was fitted.

For almost all of the developed countries in recent years, the maximum point x_0 lies in the interval (0,1). So his method today may not give good results.

2. Method

To get the values of ${}_nq_x$ (or ${}_np_x$) from the values of $\overset{\circ}{e}_x$, the following formula was used:

$$\overset{\circ}{e}_x = n \cdot {}_n a_x \cdot {}_n q_x + (n + \overset{\circ}{e}_{x+n}) (1 - {}_n q_x) \quad (1)$$

where ${}_n a_x$ is the fraction of the interval, from the x -th to the

($x+n$)th birthday, lived by those dying in the interval, on the average. (Chiang[1984]).

The formula (1) can be derived by substituting

$${}_nL_x = T_x - T_{x+n}$$

into

$${}_nL_x = n \cdot {}_n a_x \cdot {}_n d_x + n \cdot l_{x+n}$$

and dividing throughout the expression obtained by l_x (Namboodiri et al. [1987])

From (1), we have

$${}_n p_x = 1 - {}_n q_x = (\overset{\circ}{e}_x - n \cdot {}_n a_x) / (\overset{\circ}{e}_{x+n} + n - n \cdot {}_n a_x) \quad (2)$$

According to Chiang (1984), age pattern of mortality in some country hardly varies over time (although death rates do).

So, ${}_n a_x$ may be regarded as constant and used for the construction of life table. But, the value of ${}_n a_x$ slightly varies in respect to specific countries and time. In fact, the values of ${}_n a_x$ for the countries in question extending over a period of about 30 years are needed for our study. Since it's not easy to obtain such values of ${}_n a_x$, we will give the method of getting the l_x values, by reducing the number of ${}_n a_x$ to a minimum.

Now, we begin with obtaining the values of $\overset{\circ}{e}_x$ for each age by spline interpolation. Then, the formula (1) is based for $n=1$.

The value of ${}_1 a_0 = {}_1 a_0$ of the country in question should be calculated from reliable life tables, and let ${}_1 a_x$ for each x be 0.5.

If the values of $\overset{\circ}{e}_x$ are given for ages 0,1,5,10,...,85, the values of $\overset{\circ}{e}_x$ for $x=5,6,7,\dots,85$ are obtained by spline interpolation, and the formula (1) is used with $n=1$ for $x=0$ and $n=4$ for $x=1$.

Therefore, the values of a_0 and ${}_4a_1$ calculated from reliable life tables and ${}_1a_x=0.5$ for $x=5,6,\dots,84$ are used.

We will describe our method again:

1. When the values of $\overset{\circ}{e}_x$ for $x=0,1,2,3,4,5,10,15,\dots,85$ are given, the values of $\overset{\circ}{e}_x$ for each x are obtained by cubic spline interpolation.
2. When the value of a_0 for the country in question for a specified year (say, T_0) is needed, we used the values of l_0 , l_1 , $\overset{\circ}{e}_0$ and $\overset{\circ}{e}_1$ of the life table of the country for the nearest year to T_0 , which was obtained from "World Health Statistics Annual (WHO)", then the value of a_0 can be obtained from the formula

$$a_0 = (L_0 - L_1) / d_0$$

where $L_0 = l_0\overset{\circ}{e}_0 - l_1\overset{\circ}{e}_1$ and $d_0 = l_0 - l_1$.

The value of a_0 obtained above can be used for several years for our study.

From the formula (1) with $n=1$, we have

$$p_0 = 1 - q_0 = (\overset{\circ}{e}_0 - a_0) / (\overset{\circ}{e}_1 + 1 - a_0) \quad (3)$$

for $x=0$,

$$p_x = 1 - q_x = (\overset{\circ}{e}_x - 0.5) / (\overset{\circ}{e}_{x+1} + 0.5) \quad (4)$$

for $1 \leq x < 85$.

All the values of P_x (or q_x) are calculated using (3) and (4), and l_x using (5):

$$l_{x+1} = l_x P_x \quad (x=0,1,2,\dots,84). \quad (5)$$

The values of l_x were computed with a radix of 10,000, because the values of e_x^o are rounded off to two decimals.

This method gives fairly precise results. Two examples are shown, in Tables A and B, where $a_0=0.14$ is used throughout.

Table A. Estimated values \hat{l}_x compared with the values l_x of the 1960, 1970, 1980 and 1990 life tables. ($a_0=0.14$, Japanese Males)

Age	0	1	5	20	40	65	85
The 11-th life table(1960)	l_x	10,000	9667	9564	9425	8971	824
	Estimated \hat{l}_x	10,000	9668	9565	9425	8971	821
The 13-th life table(1970)	l_x	10,000	9852	9805	9705	9372	7207
	Estimated \hat{l}_x	10,000	9852	9806	9705	9371	7210
The 15-th life table(1980)	l_x	10,000	9917	9888	9825	9610	7939
	Estimated \hat{l}_x	10,000	9917	9888	9824	9611	7938
The 17-th life table(1990)	l_x	10,000	9951	9930	9879	9706	8260
	Estimated \hat{l}_x	10,000	9950	9930	9879	9707	8259

Table B. Estimated values \tilde{l}_x compared with the values l_x of the 1960, 1970, 1980 and 1990 life tables. ($a_0=0.14$, Japanese Female)

Age	0	1	5	20	40	65	85
The 11-th life table(1960) l_x	10,000	9726	9639	9545	9215	7521	1711
Estimated \tilde{l}_x	10,000	9725	9639	9544	9215	7524	1712
The 13-th life table(1970) l_x	10,000	9885	9850	9799	9605	8257	2336
Estimated \tilde{l}_x	10,000	9886	9851	9800	9605	8259	2341
The 15-th life table(1980) l_x	10,000	9934	9912	9881	9765	8850	3595
Estimated \tilde{l}_x	10,000	9933	9911	9881	9765	8848	3593
The 17-th life table(1990) l_x	10,000	9958	9943	9919	9829	9132	4874
Estimated \tilde{l}_x	10,000	9957	9942	9918	9829	9131	4869

(Note): Since the information at old ages is not negligible, Makeham's curve was used for the values of l_{70} , l_{75} , l_{80} and l_{85} to get

$$l_x \text{ for } 85 < x \leq 90.$$

Then we have

$$L_x = 0.5 \cdot (l_x + l_{x+1}), \quad T_{x+1} = T_x - L_x \quad (x=85, 86, \dots, 89)$$

and

$$e_x^{\circ} = T_x / l_x \quad (x=85, 86, \dots, 90)$$

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