

Original

Senescent Life Expectancy and Medicare

Kazuhiko WAKABAYASHI*

University of Yamanashi, Yamanashi, Japan

Abstract: After 1960, force of death of olds in Japan at the age of 70 years, μ_{70} decreased and their life expectancy at the age of 70 years, e_{70} increased. A comparison was made on the change of e_{70} of olds between 1960 and 1990 referring to olds in other countries and it showed the large improvement of e_{70} in Japan. The value of μ_{70} stopped to decrease at 1990 and the increase of the number of hospital beds also stopped at the same time. These changes were associated with the onset of the decrease of gross domestic capital formation, GDC. The suspended changes of μ_{70} , e_{70} and GDC were started to recover after 1995. The number of hospital beds, however, remained to be the same giving rise to troubles for olds. To lessen these difficulties high-tech medicine was introduced to a larger extent in Japan.

Key words: Force of death, Senescent life expectancy, Hospital beds, Gross domestic capital formation, High-tech medicine

Abbreviations: SL, senescent life expectancy; BL, life expectancy at birth; HE, higher life expectancy; LE, lower life expectancy; GDC, gross domestic capital formation; CT, computer tomography; MRI, Magnetic resonance imaging

INTRODUCTION

Japan experienced several financial crises. The large economic breakdown effected damages to the life of olds. Changes of indicators such as force of death and life expectancies of olds were studied in relation to the economic crisis in this paper. Only two cases were focused since data in the life tables¹⁾ before 1920 were not strictly comparable to those after 1920. In a first instance, after the cease of the long war between 1937 and 1945 abrupt changes of μ_{70} and e_{70} ensued. A law on the welfare of olds was then issued. μ_{70} decreased and e_{70} elevated after 1960. Consequently Japan achieved high life

expectancy in 1990 comparable to those in developed western countries. The costs for welfare charged, however, burdens to Japan²⁾. In a second case, a financial panic at the end of 1989 in Japan initiated big turmoil. The gross domestic capital formation, GDC stopped to increase simultaneously³⁾. The panic caused much troubles for Japanese olds since new hospitals were not build. But GDC started to recover in 1995. To lessen the difficulties in medical performances, efforts were made by introducing high-tech medicine.

Data

Published data from The World Bank, The Life Tables, Historical Statistics of Japan were used. Data available from internet such as pubmed, ssrn (<http://papers.ssrn.com>), ratsw

*1110 Shimokato, Chuo, Yamanashi 409-3808, Japan

Received January 13, 2010

Accepted April 25, 2010

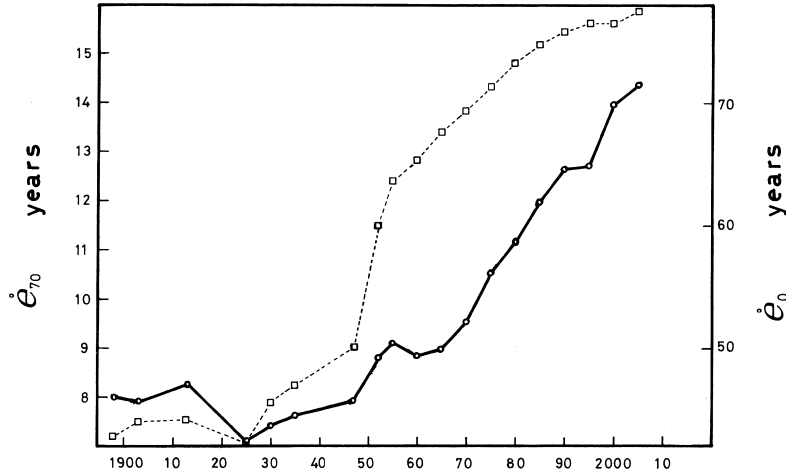


Fig. 1. Senescent life expectancy and life expectancy at birth
A bold line with open circles indicates senescent life expectancy at 70 years, e_{70} . A broken line with squares indicates life expectancy at birth, e_0 .

(<http://www.mortality.org>), <http://www.mhlw.go.jp>, <http://www.cao.go.jp>, <http://www.census.gov>, <http://www.soumu.go.jp> were also referred.

Life expectancy of olds and the force of death

Historical changes of the life of olds in Japan are analyzed by use of μ_{70} and e_{70} . Values of e_x are more frequently used in many reports than the values of μ_x and the value of e_x is also advantageous to compare the olds in Japan with olds in other countries. Thus a curve of the life expectancy of olds at the age of 70 years (e_{70} , solid line) is given in Fig. 1. Values of life expectancies of males are used¹⁾. The values of e_{70} are under 8.82 years until the end of the war time, 1945. They increase after 1947 until 1952, then decrease and start to increase again until 1990 by 3.81 years. The rise almost stops at 1990 and resumes to rise after 1995. These values are termed as SL values (senescent life expectancy).

Values of e_0 are depicted in Fig. 1, which increase at a faster rate than that of e_{70} between 1947 and 1952. The values of the life expectan-

cy at birth, e_0 (dotted line) are denoted as BL values (life expectancy at birth). These curves shows the different rates of the increase, reflecting the age of members involved in two populations, on which e_0 and e_{70} are based. A curve for e_{25} resembled to that of e_0 . The change of the increase of e_{70} in 1990 is more remarkable than that of e_0 . A curve of the survivors at 70 years also shows a change at 1990 (not shown). The values of e_{70} shows the changes of olds more clearly than e_0 . The change in this period is not associated with the large economic change and discussed later. The study is focused on the period between 1990 and 1995 with respect to olds exposed to the drastic economic changes.

Figure 2 indicates the historical change of the values for force of death μ_{70} . Values of males are used. They continue to decrease from 1947 (μ_{70} , 0.07504) to 1990 (μ_{70} , 0.02030). After a small decrease between 1936 (0.07657) and 1947 (0.07504), the values continued to decrease until 1990 as given in Fig. 2 with an exception of a period between 1955 and 1960.

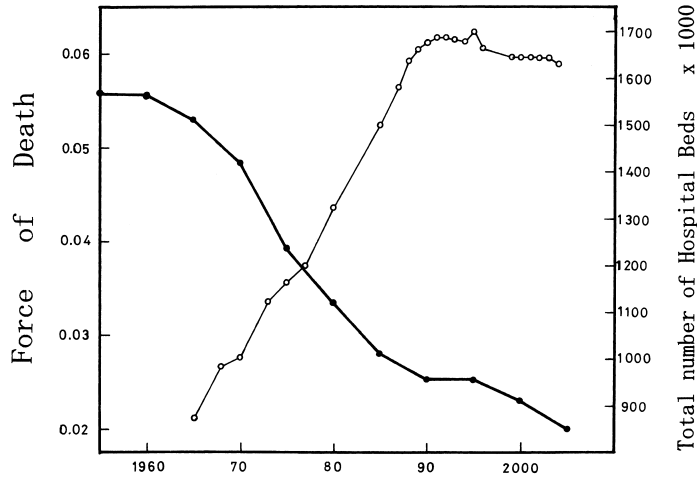


Fig. 2. Force of death and the total number of hospital beds
 A bold line with closed circles indicates the force of death μ_{70} given in The Life Table¹⁾. A left vertical line is scaled with the values of μ_{70} . A thin line with open circles indicates the total number of beds in hospitals. The number of beds in Shinryo-sho is not included. The total number of hospital beds is indicated in a right vertical line.

In order to show the association of the decrease of μ_{70} with the number of beds⁴⁾, their curves between 1960 and 1990 are depicted. The period in which force of death, μ_{70} decreased coincides with the period of improved medical performance by the increase of hospital beds. The increase of the number of hospital beds continued up to 1991 and then stopped. The financial panic in Japan in 1989 was so large that the additional introduction of hospital beds became hard. The loss of the decrease was not effected by the big earthquake in western Japan (The Great Hanshin-Awaji Earthquake in 1991). The change of values from 0.02524 to 0.02534 after the correction shows that the absence of the decrease is not related to the catastrophe. A loss of decrease in μ_{70} and the change in \dot{e}_{70} between 1955 and 1960 are discussed later.

SL values of Japan and its metamorphosis

The SL values of \dot{e}_{70} of Japanese population

between 1960 and 1990 are again plotted with filled rhombi in Fig. 3A. The increase of these values are significant after 1970 and the values are higher than those of other countries, such as India and Bangladesh¹⁾. Values of males are used in Fig. 3A and 3B. The SL values of Japan reached to 12.66 years in 1990 and were equivalent to the values of United States (12.3 years in 1991) and Canada (12.46 years for 1990-1992)¹⁾. Years of the population census and their intervals are not uniform among various countries and only countries are selected, which carried out the population census at least four times during this period with adequate intervals, except China. SL values of countries in Fig. 3A except Japan differs from those of countries in Fig. 3B. Countries in Fig. 3A lacked steady increase in SL values. Their SL values are from 8 to 9 years in 1960 and are from 9 to 9.6 years in 1990. By contrast United States and Canada have higher SL values both in 1960 and in 1990.

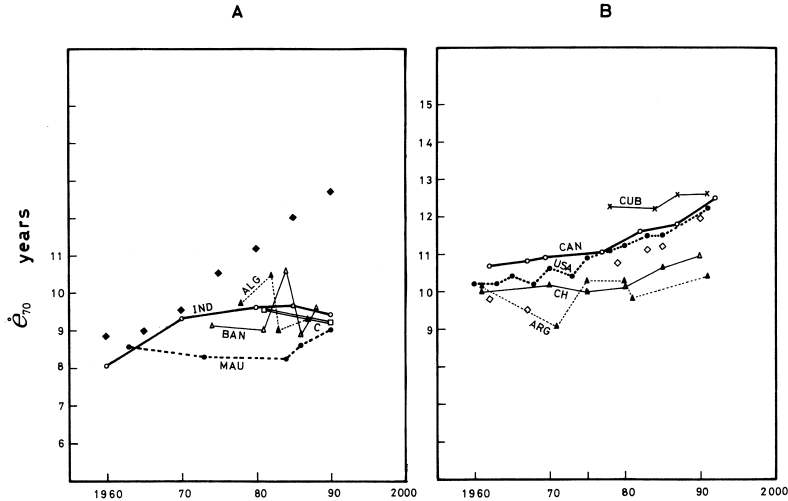


Fig. 3. Countries of two types

A. Countries with smaller SL values. The vertical line at left is scaled with years of SL values. ALG indicates Algeria with a dotted line and filled triangles (\blacktriangle — \blacktriangle); IND indicates India with a bold line and open circles (\circ — \circ); BAN indicates Bangladesh with a thin line with open triangles (\triangle — \triangle); MAU indicates Mauritius with a dotted line with closed circles (\bullet — \bullet); C indicates China with double lines with open squares (\square — \square). Filled rhombi without a line (\blacklozenge) indicate SL values of Japan. All values are life expectancy e_{70} .

B. Countries with larger SL values. The vertical line at left is scaled with years of SL values. CUB indicates Cuba with a thin line and crosses (\times — \times); CAN indicates Canada with a bold line with open circles (\circ — \circ); USA denotes U.S.A. with a dotted line with closed circles (\bullet — \bullet); CH indicates Chile with a thin line with filled triangles (\blacktriangle — \blacktriangle). ARG indicates Argentina with a dotted line with filled triangles (\blacktriangle — \blacktriangle). Open rhombi without a line (\diamond) indicate SL values of Australia.

The scale at the left is the same as in Figure 3A.

The former countries are termed LE type (lower life expectancy) and the latter countries are termed HE type in this paper. European countries have SL values close to United States and they are not depicted in these figures. Due to technical differences in preparing statistical data, not all countries are subjected to this study. However many countries in Asia and in Africa showed similarities to LE type, whereas European and North American countries belong to HE type. Chile and Argentina do not show significant increase of SL values within this period, but their SL values are 10.0 years for

Chile in 1960-1961 and 10.18 years for Argentina in 1959-1961. They are hence depicted in Fig. 3 B. Japan had SL values of 8.85 years in 1960 and is depicted in Fig. 3A. But its increase of SL values in 30 years is remarkable. Its SL values in 1990 is equivalent to that of HE type countries. Japan can be termed moving type. Such case is rare but Australia is close to this case, which is depicted in Fig. 3B.

There are ditches between countries of these two types with regard to the social welfare. Higher infant mortality, lower number of beds and low personal income are observed in LE

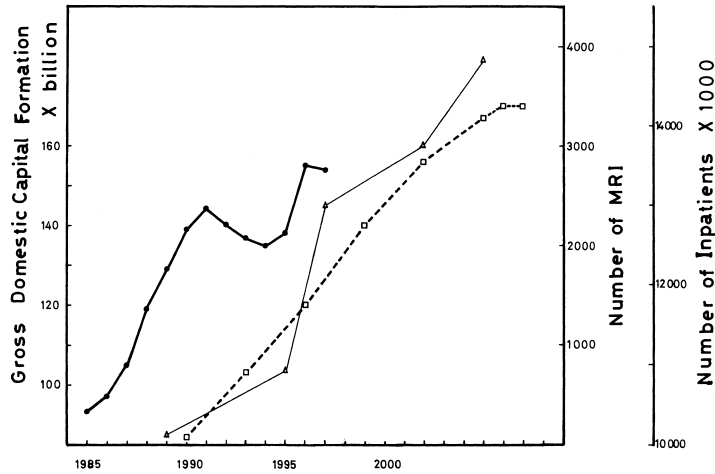


Fig. 4. Change of GDC, a number of MRI equipments and a total number of inpatients

A bold line with closed circles indicates gross domestic capital formation in Japan. Its scale is indicated in a left vertical line and its unit is a billion Yen. A thin line with open triangles indicates number of MRI equipments in use, which is scaled in a right vertical line. A dotted line with open circles indicates a total number of inpatients in Japan. It is scaled in a utmost right vertical line.

countries⁵⁾. Japan had higher infant death rate (124 per 1000 live birth) in 1930. But it decreased to 2.8 per 1000 births in 2004³⁾. The data in combination with the larger number of hospital beds given in Fig. 4 documents the metamorphosis of Japan after the hard war ceased.

Large SL values without increase of beds

The steady increase of hospital beds are advantageous in promoting the elevation of SL values. The increase is drastically stopped by financial panic. The simultaneous changes in SL values, force of death, as well as death rates after 1990 evidenced the strong effects of economic factors on medical performance in Japan. Change in the general domestic capital formation (GDC) is given in Fig. 4. It shows that the new formation of capitals did not take place until 1995, after which GDC resumed to

increase³⁾. After 1991 the number of hospital beds, however, does not increase and the hospitalization became a small gate, which gave olds much difficulties. Olds needed longer stay in hospitals in Japan than younger people in 1983⁶⁾.

Three diseases, neoplasms, circulatory disorders in brain, heart diseases are the major causes of death in Japan, lowering its SL values. Japanese are westernized for foods after the Second World War and changes were reported in pathological findings of endothelium in arteriosclerosis⁷⁾. Ultrasonic equipments with a high resolution are effective for the early diagnosis of arteriosclerosis. Japan still had capability to introduce expensive high-tech medical equipments after 1995. Increased number of high-tech instruments has been introduced in 1990's in Japan. The number of MRI equipments used in Japan⁸⁾ is given in Fig. 4. Its

increase started at 1997, in agreement with the initiation of the increase of GDC.

The elevation of the life expectancy is accompanied with the reported increase of inpatients which reached 1.4 folds from 1990 to 2007⁹⁾ as shown in Fig. 4. Governmental medicare, such as Ryoyo-Byosho did not meet the everlasting needs of olds. It is worth to point out that the increase in the number of inpatients goes parallel with the increase of MRI equipments. It seems to be true that the medical performance in Japan is partly sustained by the introduction of high-tech medicine. It is worth but too expensive.

DISCUSSION

The decrease of μ_{70} in Fig. 2 continued from 1960 to 1990 in agreement with the increase of \dot{e}_{70} . It is interrupted twice after 1947. In a period between 1955 and 1960 the values of μ_{70} decrease only slightly (from 0.5598 to 0.5571). By contrast, values of \dot{e}_{70} decrease by 0.28 years. In spite of the changes of μ_{70} and \dot{e}_{70} , values of GDC and the number of hospital beds¹⁰⁾ increase during this period. These change differ from the change between 1990 and 1995, in which the changes of μ_{70} and \dot{e}_{70} , is associated with the cease of the increase of GDC. The exceptional decrease of \dot{e}_{70} between 1995 to 1960 may be derived from the inadequate values used as parameters in the calculations of \dot{e}_{70} in 1955. The indicator \dot{e}_x is calculated after complex mathematical procedures. The mathematical formula used in the calculation of \dot{e}_x applies Gompertz law¹¹⁾, which was later amended by Makeham¹²⁾. Recently a notion was made that an attempt to calculate human life expectancy simply by mathematics is doubtful and regarded as alchemy¹³⁾. This method is, however, widely used¹⁴⁾ and useful, if the mathematical proce-

dures involved is properly estimated.

The World Bank declared that the life tables made in underdeveloping countries are not always adequate and the data on the mortality is more reliable⁵⁾. To avoid the possible errors by complex mathematical procedures, values of μ_{70} is chosen as a better indicator to study the olds in Japan in this paper. But the values for life expectancies are frequently in use and values of μ_{70} are not always given by foreign governments. Thus the values for \dot{e}_{70} are plotted in the first figure and the third figure for easier comprehension. It is often oversimplified to discuss the life expectancy of olds referring only to \dot{e}_0 value. The suspension of μ_{70} values is also observed on μ_{65} and μ_{80} . The criticism on the actual methods of mathematical calculations is not the subject of the discussion in this paper. Background mortality is not studied here.

The Japanese government distinguishes usual hospital beds from, the beds in smaller hospitals, Shinryo-sho (clinic). The total number of actual beds is thus much larger than the number given in this paper. Both beds increased in the same way. The installation of additional hospital beds is very effective for welfare in underdeveloped countries. Japan took advantages of the increase of new hospital beds after 1960. The World Bank claims, however that there are differences in the definition of beds among countries⁵⁾. Japan is one of the typical capitalistic countries and its hospital system is similar to those in other developed countries.

The longer stays in hospitals are required by olds, who were able to stay longer in 1983 (i.e. 31.5 days for young between 15-34 years, 49.6 days for middle aged between 35-64 years and 89.4 days for olds over 65 years, in case of diabetic patients)⁶⁾. Only shorter stays are possible with current insurance system. The average length of hospitalization was shortened from

50.5 days in 1990 to 35.7 days in 2005¹⁵⁾. The number of inpatients from 1990 to 2007 given in Fig. 4 was counted by the number of inpatients at hospitalization. Accordingly one patient who was transferred from a hospital to another hospital was counted doubled. The actual number of inpatients is thus less than the figures given in Fig. 4, but these figures suggest the increased needs for the medical performances.

Japan is the outlier in the practice of high-tech medicine. The importance of CT and MRI was verified¹⁶⁾. The costs for treatments with high-tech medicine are covered by insurance, though it costs much. The total number of MRI equipments in use in Japan is largest in the world. Japanese patients are egalitarians in medical treatments. Discriminatory use of high-tech medicine is not accepted in Japan. It differs from Europe where MRI is less frequently used.

Nevertheless the practice of high-tech medicine is restricted to key hospitals in Japan due to financial problems. The olds in areas, where sparsely resided, called as Kasochi or “depopulated area” according to a Japanese law, are in trouble. The rate of olds in depopulated area increase from 10% in 1970 to 30% in 2005¹⁷⁾. They are not benefitted by high-tech medicine. It contradicts to the concept of the equal right and regarded as medical injustice, which is now being subjected to public discussions.

REFERENCES

- 1) The 20th Life Tables (in Japanese). Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare, Tokyo: 2009.
- 2) Development of Japan's Social Security System. Institute for International Cooperation, Japan International Cooperation Agency, Tokyo: 2004.
- 3) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 2005.
- 4) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 2009.
- 5) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 1984.
- 6) Suzuki T. Epidemiology in Gerontology. In New Gerontology (2nd Ed.) (in Japanese): Tokyo University Press, Tokyo: 1999.
- 7) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 1987, 1989, 2001.
- 8) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 1997.
- 9) National Medicine; Almanac (in Japanese). The Japan Medical Association. Tokyo: 1969.
- 10) Gompertz B. On the nature of the function of the law of human mortality, and a new mode of determining the value of life contingencies. In a letter to Francis Baily. Philosophical Transactions of the Roy Soc Lond. 115: 513–585, 1825.
- 11) Makeham WM. On the law of mortality, and the construction of annuity tables. Assur Mag J Inst. Actuar, 18: 301–310, 1860.
- 12) Gerber HU. Life Insurance Mathematics. Springer, Berlin: 1997.
- 13) Bongaarts J. Trends in senescent life expectancy. Popul Stud, (Camb) 63: 203–213, 2009.
- 14) World Development Indicators 2007. The World Bank, Washington D.C.: 2007.
- 15) Statistic Abstracts on Health and Welfare in Japan (in Japanese). Health and Welfare Statistics Association, Tokyo: 2009.
- 16) Fuchs VR, Sox HC. Physician's views of the relative importance of thirty medical innovations. Health Aff, 20: 30–42, 2001.
- 17) <http://www.soumu.go.jp/>