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 tables 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 $\mu_{70}$ and $\dot{e}_{70}$ ensued. A law on the welfare of olds was then issued. $\mu_{70}$ decreased and $\dot{e}_{70}$ 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 Japan. 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 simultaneously. The panic caused much troubles for Japanese olds since new hospitals were not build. But GDC started to recover in 1995. To lessen these difficulties high-tech medicine was introduced to a larger extent in Japan.
Life expectancy of olds and the force of death

Historical changes of the life of olds in Japan are analyzed by use of $\mu_{70}$ and $\hat{e}_{70}$. Values of $\hat{e}_x$ are more frequently used in many reports than the values of $\mu_x$ and the value of $\hat{e}_x$ 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 ($\hat{e}_{70}$, solid line) is given in Fig. 1. Values of life expectancies of males are used. The values of $\hat{e}_{70}$ 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 $\hat{e}_0$ are depicted in Fig. 1, which increase at a faster rate than that of $\hat{e}_{70}$ between 1947 and 1952. The values of the life expectancy at birth, $\hat{e}_0$ (dotted line) are denoted as BL values (life expectancy at birth). These curves show the different rates of the increase, reflecting the age of members involved in two populations, on which $\hat{e}_0$ and $\hat{e}_{70}$ are based. A curve for $\hat{e}_{25}$ resembled to that of $\hat{e}_0$. The change of the increase of $\hat{e}_{70}$ in 1990 is more remarkable than that of $\hat{e}_0$. A curve of the survivors at 70 years also shows a change at 1990 (not shown). The values of $\hat{e}_{70}$ shows the changes of olds more clearly than $\hat{e}_0$. 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 $\mu_{70}$. Values of males are used. They continue to decrease from 1947 ($\mu_{70}, 0.07504$) to 1990 ($\mu_{70}, 0.02030$). 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.
In order to show the association of the decrease of $\mu_{70}$ with the number of beds, their curves between 1960 and 1990 are depicted. The period in which force of death, $\mu_{70}$ 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 $\mu_{70}$ and the change in $\dot{\varepsilon}_{70}$ between 1955 and 1960 are discussed later.

**SL values of Japan and its metamorphosis**

The SL values of $\dot{\varepsilon}_{70}$ 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 Bangladesh. 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). 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.
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 Argentine 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 Argentine 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
Japan had higher infant death rate (124 per 1000 live birth) in 1930. But it decreased to 2.8 per 1000 births in 2004. 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 increase. 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 1983.

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 arteriosclerosis. 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 Japan is given in Fig. 4. Its

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.
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 2007 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 $\mu_{70}$ 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 $\mu_{70}$ 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 $\mu_{70}$ and $\dot{e}_{70}$, values of GDC and the number of hospital beds increase during this period. These change differ from the change between 1990 and 1995, in which the changes of $\mu_{70}$ 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 law, which was later amended by Makeham. Recently a notion was made that an attempt to calculate human life expectancy simply by mathematics is doubtful and regarded as alchemy. This method is, however, widely used and useful, if the mathematical procedure 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 reliable. To avoid the possible errors by complex mathematical procedures, values of $\mu_{70}$ 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 $\mu_{70}$ 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 $\mu_{70}$ values is also observed on $\mu_{65}$ and $\mu_{80}$. The criticism on the actual methods of mathematical calculations is not the subject of the discussion in this paper.

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 countries. Japan is one of the typical capitalist 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 say 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). Only shorter stays are possible with current insurance system. The average length of hospitalization was shortened from

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50.5 days in 1990 to 35.7 days in 2005\textsuperscript{15}. 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 outliner in the practice of high-tech medicine. The importance of CT and MRI was verified\textsuperscript{16}. 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 2005\textsuperscript{17}. 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


17) http://www.soumu.go.jp/