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Rapid increase in Japanese life expectancy after World War II

Yasuo Sugiura, Young-Su Ju, Junko Yasuoka, Masamine Jimba

Corresponding author: Yasuo Sugiura
Affiliation: Bureau of International Cooperation, International Medical Center of Japan, Ministry of Health, Labour and Welfare
Postal Address: 1-21-1 Toyama, Shinjyuku-ku, Tokyo 162-8655, Japan
Telephone: +81-3-3202-7181, Fax: +81-3-3205-7860
E-mail: yasugiura@hotmail.com

Co-author: Young-Su Ju
Affiliation: Department of Occupational & Environmental Medicine, Hallym University College of Medicine
Postal Address: 896 Pyongchon-Dong, Dongan-Gu, Anyang, Gyeonggi, 431-070, Republic of Korea
Telephone: +82-31-380-6035, Fax: +82-31-380-1583
E-mail: zorro@hallym.ac.kr

Co-author: Junko Yasuoka
Affiliation: Department of International Community Health, Graduate School of Medicine,
The University of Tokyo
Postal Address: 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
Telephone: +81-3-5841-3698, Fax: +81-3-5841-3422
E-mail: jyasuoka@post.harvard.edu

Co-author: Masamine Jimba
Affiliation: Department of International Community Health, Graduate School of Medicine,
The University of Tokyo
Postal Address: 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
Telephone: +81-3-5841-3698, Fax: +81-3-5841-3422
E-mail: ohjimba@yahoo.co.jp

Abstract

Japanese life expectancy increased by about 13.7 years during the first decade after World War II, despite the country's post-war poverty. Although it is known the medical progress explains part of this increase, roles of non-medical factors have not been systematically studied. This study hypothesizes that non-medical factors, in addition to medical factors, are associated with the rapid increase in life expectancy in Japan. We analyzed the time trends of potential explanatory factors and used regression analysis with historical data from the Ministry of Internal Affairs and Communications' Historical Statistics of Japan during the period between 1946 and 1983. Time trends analysis revealed that the rapid increase in life expectancy preceded the dramatic growth of per capita Gross Domestic Product (GDP) by 10 years. In education, the nearly universal enrollment in elementary schools and increased advancement to upper secondary schools for both sexes were associated with better health. Regarding legislation, 32 health laws were passed in the first decade after the war and these laws were associated with improved health. Using regression analysis, we found the enrollment rate in elementary schools, the number of health laws, and expansion of community-based activity staff were significantly associated with the increased life expectancy during the first decade after World War II. To conclude, in addition to medical factors, non-medical factors applied across the country, particularly education, community-based activities and legislation were associated with the rapid increase in Japanese life expectancy after World War II.

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Introduction

The Japanese currently have the longest life expectancy at birth in the world, averaging 82.0 years among men and women [1]. Numerous factors have been associated with the high life expectancy in Japan, such as high quality of health services, a national health insurance system, a social security system, economic prosperity, as well as nutritional and environmental factors [2,3,4]

The decade following World War II was a breakthrough period, during which Japanese life expectancy dramatically increased by an average of 13.7 years: 13.5 years for males (from 50.1 to 63.6 years) and 13.8 years for females (from 54.0 to 67.8 years) between 1947 and 1955. Factors used to explain this phenomenon include: rigorous public health campaigns aimed at controlling infectious diseases, the widespread use of antibiotics and chemotherapeutic drugs in medical practice, and urbanization [5,6,7]. Epidemiological research indicates that improved management of gastroenteritis,

pneumonia and tuberculosis significantly contributed to the survival rate of children and youth in the 1950s and the 1960s [8]. Since life expectancy is calculated by a life table that contains the proportion of people dying at each age interval, decline in infant mortality and mortality caused by major infectious diseases would have had considerable impact on life expectancy.

While these explanations for increased life expectancy are plausible, little systematic analysis has been conducted on the societal changes that occurred in the 10 years following the war. In countries such as the United Kingdom (England and Wales), the United States and India, life expectancy has gradually increased since the end of the war [9]. Further, there is evidence of positive correlation between national income and life expectancy worldwide [10], and it is generally believed that the Japanese economic growth contributed to raising Japanese life expectancy after World War II. However, we wondered whether economic growth would sufficiently account for the rapid increase in life expectancy during the decade after the war in Japan. The Japanese economy on the whole was weakened by war, and it took nearly 10 years to restore it to pre-war levels through substantial financial support from the United States. Further, people faced serious food shortages due to the poor rice crop in 1945, exacerbated by an inefficient system of food distribution. This study hypothesizes that non-medical factors, in addition to medical factors, were associated with the rapid increase in life expectancy in Japan. Determinants of mortality have been argued to include nutrition, hygienic measures, economic development, literacy, and health-related knowledge and technology[11,12,13,14]. In this study, we focused on the state of the economy, nutrition, and education as basic background variables of health outcomes and examined legislation and community-based activities to reflect top-down and bottom-up health initiatives, respectively.

We begin with an examination of the relationship between Japanese economic growth and life expectancy. Then, we analyzed non-medical factors to examine how these factors are associated with the rapid increase in Japanese life expectancy.

Results

Association between Japanese life expectancy and per capita GDP

After World War II, both Japanese life expectancy and per capita GDP increased dramatically. However, there is a decade of time lag between these changes (Figure 1). After the war, it took about 10 years for the per capita GDP to rebound to the prewar level. Despite the delay, during that time, the Japanese life expectancy rapidly increased from 50.1 to 63.6 years for males and from 54.0 to 67.8 years for females. After 1955, the per capita GDP sharply increased until 1972, which was considered to be the period of most rapid economic growth in Japan. Hence, the rapid increase in Japanese life expectancy preceded the rapid economic growth.

Daily intake of energy and protein in Japan after World War II

We divided the period from 1946 to 1983 into three phases based on the daily intake of energy and protein after World War II: a restorative phase, a stable phase, and a variable phase (Figure 2). In the restorative phase, Japan experienced serious food shortages and received food aid from General Headquarters, the Supreme Commander for the Allied Powers (GHQ/SCAP), UNICEF and NGOs such as, Licensed Agencies for Relief in Asia (LARA) and Cooperative for American Remissions to Europe (CARE). During this phase, the average Japanese daily intake of energy and protein rapidly increased from 1,903 kcal and 59.2 g in 1946 to 2,125 kcal and 68.3g in 1951, respectively. In the stable phase between 1952 and 1963, both the energy and protein intake remained at approximately 2,100 kcal and 70 g, which was considered to be sufficient nutritional intake at that time. In the variable phase after 1964, however, daily intake of energy and protein varied due to changing eating habits and life style.

Compulsory elementary and upper secondary education and health in Japan

Despite upheaval in education policy and practice brought about by the GHQ/SCAP, the rate of enrollment in elementary schools was consistently above 99.6 % during the first decade after World War II (Figure 3). Following GHQ/SCAP recommendations, nationwide school lunch programs began in 1946, resulting in increased body weight and height of school children. This led the people and the government to enact the school lunch law in 1954. Based on the principal of equal opportunity for the education of both sexes, the rate of advancement to upper secondary schools was 55.5 % for boys and 47.4 % for girls by 1955. By 1975, 99.9% of young Japanese children were enrolled in elementary schools, and by 1973, 88.3 % of males and 90.6 % of females advanced to upper secondary schools. The school health law of 1958 introduced required regular physical checkups and improvement in school hygiene and environment. Health education was also included as a regular subject in the curriculums at the upper secondary schools.

Health laws in Japan

Fifty-five health laws went into effect between 1946 and 1983 in Japan. Most of the health laws (32 out of the 55) were enacted between 1946 and 1955. Additional health laws were gradually introduced between 1956 and 1983. We categorized 55 health laws into 10 groups over the four decades (Table 1). Ten out of 32 health laws enacted between 1946 and 1955 were classified as human resource qualification laws, which regulates licenses to medical doctors, public health nurses, midwives, radiological technologists, and nutritionists, among others. In total, 20 out of the 55 health laws between 1946 and 1983 were classified as the human resource qualification laws.

Community-based activity staff and their activities

After World War II, drastic agricultural land reform was implemented in 1946 and contributed to

equality among farm households in Japan. Community-based activity staff, known as Livelihood Extension Workers, were introduced by the Agricultural Improvement Promotion law of 1948. The Livelihood Extension Workers were women who paid frequent visits to villages to listen carefully to problems in the farmers' daily lives. They served as important facilitators who helped address many issues to improve the quality of life in rural areas. During the first decade after the war, the number of the Livelihood Extension Workers grew to 1,476. Their ranks were further increased to 2,350 by 1966. Thus, community-based activities to improve living standards in this rural society expanded nationwide after the war.

Regression analyses for life expectancy and possible determinants

To examine the associations between different medical and non-medical factors and the rapid increase in life expectancy after World War II, we applied univariate regression analysis using these factors. Among the non-medical factors, there were six significant variables: number of Livelihood Extension Workers ($p = 0.001$, Adj $R^2 = 0.26$), enrollment rate in elementary schools ($p = 0.002$, Adj $R^2 = 0.23$), rate of advancement to upper secondary schools ($p = 0.006$, Adj $R^2 = 0.19$), accumulated number of health laws ($p = 0.006$, Adj $R^2 = 0.19$), height in 15 year old females ($p = 0.008$, Adj $R^2 = 0.17$), and Engel's coefficient ($p = 0.045$, Adj $R^2 = 0.09$). Per capita GDP ($p = 0.153$), daily intake of energy ($p = 0.166$) and daily intake of protein ($p = 0.373$) were not significantly associated with life expectancy. Among the medical factors, there were four significant variables: the number of public health centers ($p < 0.001$, Adj $R^2 = 0.49$), pneumonia death rate ($p < 0.001$, Adj $R^2 = 0.45$), tuberculosis death rate ($p < 0.001$, Adj $R^2 = 0.43$) and infant mortality rate ($p = 0.009$, Adj $R^2 = 0.16$). The number of public health nurses in health centers ($P = 0.737$) was not significantly associated with life expectancy.

We then applied multivariate regression analysis to examine the influence of non-medical factors by adjusting medical factors (Table 2). Among the non-medical factors, four variables were significantly associated with life expectancy: enrollment rate in elementary schools ($p < 0.001$), the number of Livelihood Extension Workers ($p = 0.009$), accumulated number of health laws ($p = 0.015$), and height in 15 year old females ($p = 0.032$). The Engel's coefficient ($p = 0.156$) and per capita GDP ($p = 0.921$) were not significantly associated with life expectancy. Among the medical factors, two variables were significantly associated with life expectancy: pneumonia death rate ($p < 0.001$) and the number of health centers ($p = 0.047$). The adjusted R-square of the model was 0.84.

A relationship among medical factors, non-medical factors and Japanese life expectancy after World War II

Based on the results of our study, combined with previous studies, we diagramed medical factors and non-medical factors that led to the rapid increase in Japanese life expectancy after World War II (Figure 4). We classified medical factors into three categories, including health outcomes,

health technology, and health facilities and staff. We classified non-medical factors in two categories: individual and nationwide systems. Our study indicates both medical and non-medical factors were associated with increased life expectancy prior to the rapid economic growth that began about 10 years later.

Discussion

Our study demonstrates that non-medical factors such as education, health laws, and community-based activities were associated with the rapid increase in Japanese life expectancy after World War II. We also found that the rapid increase in life expectancy preceded the rapid growth of the Japanese economy.

Our analysis of life expectancy and per capita GDP between 1946 and 1983 indicates that the rapid increase in Japanese life expectancy preceded the dramatic growth in per capita GDP by a decade. This runs counter to the analysis by Preston, who assessed the impact of economic conditions on mortality using data from the 1930s and 1960s, and concluded that in Japan, for example, a majority of the expected increase in life expectancy was caused by the rapid national income growth [12]. We believe this inconsistent interpretation derived from differences between Preston's two decades analysis and our time trend analysis. Bloom et. al. found that improved health contributes to rapid growth of per capita GDP, based on cross-country growth regressions [15], which is consistent with our results. Based on this theory, the time lag between the rapid increase in life expectancy and per capita GDP can be explained by the growing number of healthier people and their accumulated savings fueling the rapid growth of the Japanese economy from 1955 to 1972. Cutler et al. describe a similar scenario in China, where a reduction in infant mortality occurred prior to the acceleration in economic growth after 1980, which led them to downplay direct causal mechanisms running from income to health [14].

Regarding nutrition and life expectancy between 1946 and 1983, our results indicate that daily intake of energy and protein at the restorative phase from 1946 to 1951 may have affected the rapid increase in Japanese life expectancy. Body weight and height in school children decreased after the onset of World War II in 1941, and took about 10 to 20 years to rebound to their pre-war levels. These facts suggest that most Japanese people were under calorie restriction for quite a long time. This is interesting to consider in light of current research into the link between calorie restriction and extending life span [16,17].

In terms of legislation between 1946 and 1983, we focused on the reformed health system which involved the implementation of many new health laws, and found that most of these laws were passed in the first decade after World War II. The reason for the large numbers of new health laws is attributable to GHQ/SCAP occupation between 1945 and 1952[18]. Moreover, it is striking that the Japanese people followed the laws, even though they were devastated by the war. However, we

believe that the important point is not the sheet number of health laws, rather political commitment to construct a health system and to train qualified human resources to serve as medical staff, including medical doctors, nurses, and midwives. We also recognize that each law has an individual purpose to improve health status in Japan. For example, there are two health laws which particularly strongly affected the Japanese health system and life expectancy after the war. First, the Public Health Center law of 1947, which shaped the health system in Japan. Under GHQ/SCAP supervision, public health centers were reorganized and established to manage local public health administration with vital statistics and to provide public health services nationwide [19,20,21]. Second, the Tuberculosis control law of 1951 provided physical checkups for about 24 million people per year, and about 12.5 billion Japanese yen (34.7 million US dollar) per year through government commitment by 1955 [5,22]. Thus, the death rate for tuberculosis decreased from 187.2 to 52.3 per 100,000 people from 1947 to 1955.

Our study suggests that the enrollment rate in elementary schools and advancement rate to upper secondary schools may be associated with the rapid increase in life expectancy after World War II. We interpret this effect as showing that not just schooling itself, but attendant factors such as an equal educational opportunity for all, school lunch programs and health education all contributed to this increase in life expectancy. This high enrollment rate in elementary schools required political commitment and a general appreciation of education. Japan has a more than 130-year history of compulsory education. The government embarked on the provision of a modern school system with the *Gakusei* (Education Law) in 1872. Elementary schools were standardized regardless of socioeconomic status or gender [23]. The enrollment rate increased to 50.3% by 1891 and reached 98.1% by 1909 [24].

Caldwell pointed out that Japan and Sri Lanka had a similar experience of increases in life expectancy after World War II [25]. Sri Lanka gained 12 years in life expectancy between 1946 and 1953. There were several similar factors in both countries: drastic advancement in the control of infectious diseases such as malaria in Sri Lanka and tuberculosis in Japan, improvement in the food supply, expansion of free education and school medical examinations, introduction of new therapeutic agents and technological innovation in curative and preventive medicine [26]. However, the major difference is that Japanese society was deeply impacted by World War II. The war had caused people to rethink the meaning of a good life and a good society [27]. The Japanese people strongly desired peace and wanted to share a happy family life. For instance, after the baby boom between 1947 and 1949, the people started to choose to have fewer children. With the enactment of the Eugenic Protection Law in 1948, the total fertility rate fell dramatically from 4.57 in 1947 to 2.37 in 1955, a change that was associated with poverty reduction and health improvement in Japan.

From the experiences of Kerala in India, Sri Lanka and Costa Rica, Warren summarized four basic elements for good health at low cost; political and social will; education for all with emphasis on

primary and secondary schooling; equitable distribution of health measures and primary health care; and assurance of adequate caloric intake for all [28]. Our results show that Japan implemented these four elements after the war. Furthermore, Sen states that East Asian economies were comparatively early in their massive expansion of education, and later also of health care, before they broke the restraints of general poverty [29]. Our results show that Japan was a good example of this phenomenon.

In this study, we found that Japanese life expectancy rapidly increased under the following conditions: 1) poor living standards before the Japanese economic growth, 2) a restorative phase in calorie and protein intake, 3) very high enrollment rate in elementary schools and increasing advancement rate to upper secondary schools, 4) enactment of many health laws, and 5) increasing community-based activity staff and their activities. As one of the limitations of this study, we might have overlooked other factors which affect rapid increase in life expectancy. Further analysis needs to be done.

In conclusion, our study demonstrates that non-medical factors based on nationwide systems such as education, health laws, and community-based activities are associated with the rapid increase in Japanese life expectancy during the first decade after World War II. Health improvements preceded the rapid expansion of the Japanese economy. In this regards, post-war Japan exemplifies how compulsory education, political commitment and community initiative, rather than national income improved health of the people. Lessons from Japan's experience demonstrate that the importance of deploying a multi-sector vision, within a nationwide system, and a strategy targeting long term impacts in a country by decision makers at various levels who are focused on vertical health issues.

Methods

We applied a time trend analysis between 1946 and 1983 using annual data from different governmental organizations to examine potential explanatory factors for the rapid increase in Japanese life expectancy.

Data collection

Using the Ministry of Internal Affairs and Communications' Historical Statistics of Japan, annual data were collected on life expectancy, population, daily intake of energy and protein, height, the number of public health centers and public health nurses; enrollment rates in elementary schools and advancement rate to upper secondary schools; death rate by pneumonia and tuberculosis; infant mortality rate; and annual average of monthly household disbursements. Gross Domestic Product (GDP) data were obtained from the Bank of Japan and the Organization for Economic Cooperation and Development [30]. Legislative data were obtained from the Law and Ordinance Data Service System [31]. The numbers of community-based activity staff, who were called Livelihood Extension Workers,

and their activities for rural life improvement were obtained from the Annual Report of the Cooperative Agricultural Extension Service in the Ministry of Agriculture and Forestry.

Data analysis

All raw data were presented in the form of time-series figures to show their relationships. Regression analyses were conducted by using the differences of two continuous years for all variables from 1948 to 1983, except for the data on the rate of advancement to upper secondary schools from 1950 to 1983. A time factor was used in the multivariate model for correcting for the time effect. We also considered multicollinearity effects by examining the correlation coefficients and standard errors among the explanatory variables. As for non-medical factors in the regression analyses, we added the average height of a 15 year old female as an indicator of nutritional conditions. As for medical factors, we selected death rates from tuberculosis and pneumonia, which were the leading causes of death in Japan from 1899 to 1950, and the infant mortality rate as one of the main factors affecting life expectancy. In addition, we added the number of health centers and public health nurses in health centers as indicators of public health measures. All statistical analyses were performed by the statistical package, SAS 8.1 version.

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