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Original Article

An Ecological Study on Relationship between Average Life Expectancy and Social, Economic and Cultural Factors after the Economic Bubble Burst in Japan

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Abstract

After the collapse of the economic bubble, with the subsequent social upheaval and accentuated schism in the social classes, it is necessary to examine in detail the relationship between a variety of factors related to society, economics and culture and the "health disparities." The results are presented below.

The average life expectancy for men increased when such metrics as the percentage smoking, those with metabolic syndrome, number of physicians, medical expenses and the number of hospital beds were reduced. For the correlation with labor force and financial factors, average life expectancy is extended with increases in the employment rate, cash salaries, resident's income and the amount of savings, and with decreases in the unemployment rate and the total actual working hours.

The correlation with daily consumption trends and factors related to living conditions indicated that average life expectancy is extended with increases in consumption for the purchase of clothes, shoes and bread, wider use of the water supply and sewage system, increased purchase of major durable consumer goods and the prevalence of a flushing toilet system. The average life expectancy also increased in those areas where commuting time was long and time for sleep was short.

For the correlation with educational factors, the average life expectancy appeared to have been extended in those areas where more high school graduates go to higher educational institutions and fewer went to work.

The findings given above suggested that average life expectancy is higher in those areas where economic conditions are satisfactory; the residential environment is well-maintained; the educational level is maintained high; and a larger percentage of residents engage in health-maintaining behavior.

Key words: ecological study, average life expectancy, social, economic and cultural factors, economic bubble burst

Ⅰ. Introduction

Medicine has made notable advances with the aid of the "bio-medical model", which treats man as a living organism and explains him from a biological aspect [1]. For human health, this model was applied from the molecular level to its behavior as an independent organism. However, even this model is limited when it comes to explain the recent events concerning man: one should note that the "bio-psycho-social model" defines a man as a living organism as well as a social animal with an independent mind. One must note the interaction between a man and his environment and comprehend him in his environment holistically and comprehensively. Reflecting on this thought, a new epidemiological field, called "social epidemiology" [2,3] − a discipline that not only explains the health and biological factors but also elucidates the distribution of psychological and social factors affecting one's health and the relationship between these factors by employing epidemiological techniques − has been attracting attention.

In this current trend, studies have been undertaken that focus on the social, economic and cultural characteristics of the area as a factor that contributes to area-related differences in

one's health status. It has been well-known that infections are strongly related to poverty; but life-style-related diseases, the major illnesses of current concern, are also under the notable influence of socioeconomic conditions. In Japan, although some studies have been conducted on the relationship between regional differences in mortality and morbidity and local socioeconomic conditions, they are still inadequate. In particular, after the collapse of the economic bubble, with the subsequent social upheaval and accentuated schism in the social classes, it is necessary to examine in detail the relationship between a variety of factors related to society, economics and culture and the "health disparities." Thus in this study, the mean life expectancy, a comprehensive health index, and 123 other metrics-such as health-related, economic and social indices-were comprehensively analyzed. The results are presented below.

Ⅱ. Subject and Method

1. Materials for the analyses

1) Target index data: average life expectancy for males and females (from the Medical White Paper 2006)[4)]

2) Explanatory index data: social, economic and cultural factors (Kensei 2007)[5)]

(1) Life style and prevention data:

① Percentage smoking (overall), ② Percentage smoking (males), ③ Percentage smoking (females), ④ Percentage of obesity (males), ⑤ Percentage of obesity (females), ⑥ Percentage of subjects with metabolic syndrome (males), ⑦ Percentage of subjects with metabolic syndrome (females), ⑧ Percentage of those having health examinations

(2) Regional Health Care data:

① Number of physicians*1, ② Number of physicians (per 100 beds), ③ Number of nurses*1, ④ Number of practical nurses**1**, ⑤ Nursing personnel (per 100 beds), ⑥ Number of hospitals (all hospitals) *1, ⑦ Number of beds (all)*1, ⑧ Number of beds (general)*1, ⑨ Number of beds (used for care)*1, ⑩ Number of MRIs*1, ⑪ Number of X-ray CT machines*1, ⑫ Percentage of referrals (hospitalization), ⑬ Percentage of referrals (ambulatory care), ⑭ Medical charge (per person), ⑮ Medical charge for the aged (per person), ⑯ Mean number of days of hospitalization (all hospitals), ⑰ (all general hospi-tals), ⑱ (general wards of ordinary hospitals), ⑲ (hospitals supporting reginal health services),

(3) Population data:

① Percentage population stratified by age (2005)(0-14 years), ② (15-64 years), ③ (65 years and older), ④ Number of people per family

(4) Labor force data:

① Percentage labor force (overall), ② Percentage labor force (males), ③ Percentage labor force (females), ④ Percentage of those who are employed (overall), ⑤ Percentage of those who are employed (males), ⑥ Percentage of those who are employed (females), ⑦ Percentage of those who are totally unemployed (overall), ⑧ Percentage of those who are totally unemployed (males), ⑨ Percentage of those who are totally unemployed (females), ⑩ Total hours of work (establishments employing 30 or more) (Industrial Survey)*2, ⑪ Total hours of work (establishments employing 30 or more) (manufacturing)*2, ⑫ Total hours of work (establishments employing 5 or more) (Industrial Survey)*2, ⑬ Total hours of work (establishments employing 5 or more) (manufacturing)*2, ⑭ Total cash payment (establishments employing 30 or more) (Industrial Survey)*2, ⑮ Total cash payment (establishments employing 30 or more)(manufacturing)*2, ⑯ Total cash payment (establishments employing 5 or more) (Indust-rial Survey)*2, ⑰ Total cash payment (establishments employing 5 or more) (manufac-turing)*2

(5) Finance data:

① Income per prefectural resident (1990)*2, ② (1995)*2, ③ (2000)*2, ④ (2003)*2, ⑤ Balance of savings per person, ⑥ Amount of insurance*4

(6) costs data:

① Region-specific consumer price index (comprehensive)*3, ② food)*3, ③ (overall excluding rent)*3, ④ Quantities of food purchased per year (rice)*4, ⑤ (bread)*4, ⑥ (fresh seafood)*4, ⑦ (beef)*4, ⑧ (pork)*4, ⑨ (butter)*4, ⑩ (fresh vegetabl), ⑪ (fresh fruits)*4, ⑫ Income and expenditures of a working family (actual income)*5, ⑬ (actual expenditure)*5, ⑭ (food)*5, ⑮ (housing)*5, ⑯ (heat, electricity and water)*5, ⑰ (clothing and shoes)*5, ⑱ (health care)*5, ⑲ (transportation and communication)*5, ⑳ (education)*5, ㉑ (cultural entertainment)*5, ㉒ (entertainment)*5, ㉓ (taxes and others)*5

(7) Housing milieu data:

① Number of people per house, ② Percentage of detached houses, ③ Number of rooms used for living (per residential building), ④ Total surface area, ⑤ Nnmber of tatami in the rooms used for living (per person per residential building), ⑥ Percentage utilization of city water (1980), ⑦ (1990), ⑧ (2000), ⑨ (2005), ⑩ Percentage utilization of city sewers (1981), ⑪ (1990), ⑫ (2000), ⑬ (2006), ⑭ Major durable consumer goods possessed (customized kitchen)*6, ⑮ (toilet with bidet using warm water)*6, ⑯ (liquid crystal television set)*6, ⑰ (personal computer)*6

(8) Personal time allocation data:

Table 1-1 The items that showed a statistically significant correlation

Items	Standard Correlation Coefficient	p value
Life style and prevention		
Percentage smoking (males)	-0.374	0.010
Percentage of subjects with metabolic syndrome (males)	-0.360	0.013
Regional Health Care		
Number of physicians (per 100 beds)	0.451	0.002
Number of practical nurses*1	-0.436	0.002
Nursing personnel (per 100 beds)	0.410	0.005
Number of hospitals (all hospitals)*1	-0.314	0.032
Number of beds (all)*1	-0.378	0.009
Number of beds (used for care)*1	-0.304	0.038
Medical charge (per person)	-0.501	＜0.001
Mean number of days of hospitalization (all hospitals)	-0.491	＜0.001
Mean number of days of hospitalization (all general hospitals)	-0.448	0.002
Population		
Percentage population stratified by age (2005) (15-64 years)	0.297	0.043
Percentage population stratified by age (2005) (65 years and older)	-0.298	0.042
Labor force		
Percentage labor force (overall)	0.319	0.029
Percentage labor force (males)	0.359	0.014
Percentage of those who are employed (overall)	0.452	0.002
Percentage of those who are employed (males)	0.482	＜0.001
Percentage of those who are totally unemployed(overall)	-0.453	0.002
Percentage of those who are totally unemployed (males)	-0.460	0.002
Total hours of work (establishments employing 5 or more) (Industrial Survey)*2	-0.307	0.036
Total hours of work (establishments employing 5 or more) (manufacturing)*2	-0.335	0.022
Total cash payment (establishments employing 30 or more) (Industrial Survey)*2	0.312	0.033
Total cash payment (establishments employing 30 or more)(manufacturing)*2	0.405	0.005
Total cash payment (establishments employing 5 or more) (Industrial Survey)*2	0.331	0.023
Total cash payment (establishments employing 5 or more) (manufacturing)*2	0.426	0.003

① Personal time allocation within a day (males)(sleep), ② (males) (meals), ③ (males)(commuting to work or school), ④ (males)(work), ⑤ (males)(housework), ⑥ (males)(TV, radio, newspaper, magazine), ⑦ (males)(rest and relaxation), ⑧ (males)(hobby and entertainment), ⑨ (males) (sports), ⑩ Personal time allocation within a day (females)(sleep), ⑪ (females)(meals), ⑫ (females) (commuting to work or school), ⑬ (females)(work), ⑭ (females) (housework), ⑮ (females) (TV, radio, newspaper, magazine), ⑯ (females)(rest and relaxation), ⑰ (females) (hobby and entertainment), ⑱ (females)(sports)

(9) Education data:

① Percentage of high school graduates selecting various options (males)(universities), ② (vocational schools), ③ (employment), ④ Percentage of high school graduates selecting various options (females)(universities), ⑤ (vocational schools), ⑥ (employment)

(10) Living conditions data:

① Percentage receiving public assistance (per 1,000 population), ② Number of complaints about environmental

Table 1-2 The items that showed a statistically significant correlation

Items	Standard Correlation Coefficient	p value
Finance		
Income per prefectural resident (1990)*2	0.420	0.004
Income per prefectural resident (1995)*2	0.442	0.002
Income per prefectural resident (2000)*2	0.478	< 0.001
Income per prefectural resident (2003)*2	0.454	0.002
Balance of savings per person	0.336	0.021
Amount of insurance*3	0.319	0.029
costs		
Quantities of food purchased per year (bread)*3	0.360	0.013
Quantities of food purchased per year (fresh seafood)*3	-0.304	0.038
Income and expenditures of a working family (clothing and shoes)*4	0.308	0.036
Housing milieu		
Percentage utilization of city water (1980)	0.360	0.013
Percentage utilization of city water (1990)	0.333	0.023
Percentage utilization of city water (2000)	0.291	0.048
Percentage utilization of city sewers (2000)	0.371	0.010
Percentage utilization of city sewers (2006)	0.416	0.004
Major durable consumer goods possessed (customized kitchen)*5	0.379	0.009
Major durable consumer goods possessed (toilet with bidet using warm water)*5	0.511	< 0.001
Major durable consumer goods possessed (liquid crystal television set)*5	0.431	0.003
Major durable consumer goods possessed (personal computer)*5	0.540	< 0.0001
Personal time allocation		
Personal time allocation within a day (males)(sleep)	-0.538	< 0.0001
Personal time allocation within a day (males)(commuting to work or school)	0.339	0.020
Personal time allocation within a day (males)(TV, radio, newspaper, magazine)	-0.325	0.026
Education		
Percentage of high school graduates selecting various options (males)(universities)	0.529	< 0.0001
Percentage of high school graduates selecting various options (males)(employment)	-0.508	< 0.001
Living conditions		
Percentage receiving public assistance (per 1,000 population)	-0.435	0.003
Rate of waste disposal and recycling	0.310	0.034
Use of flush toilet	0.504	< 0.001

*1: per 100,000 population

*2: 100 set for the figure for Tokyo

*3: Per household

*4: Per household per month

*5: Per 1,000 households

pollution (2004) *1, ③ Waste generated (per day per person), ④ Rate of waste disposal and recycling, (5)Use of flush toilet

*1: per 100,000 population, *2: 100 set for the figure for Tokyo, *3: 100 set for the figure for the whole country, *4: Per household, *5: Per household per month, *6: Per 1,000 households,

2. Statistical analysis

A correlation analysis between the average life expectancy, the target index, and social, economic and cultural factors (123 items) was conducted. Pearson's product-moment correlation coefficient was computed for analysis6).

Ⅲ. Results

1. For men

A correlation analysis of average life expectancy and 123 items on social, economic and cultural factors was conducted. The items that showed a statistically significant correlation are listed in Table 1.

For life style and prevention data, the incidence of smoking (among men) and that of metabolic syndrome (men) showed statistically significant negative correlations.

The data on regional medical services, 9 items including medical expense per person and mean number of days for hospitalization showed statistically significant negative correlation (except the number of physicians and nurses).

Among the data on population, the age-stratified population percentage (15 to 64 years) showed a statistically significant positive correlation, while the age-stratified population percentage (65 years and older) showed a statistically significant negative correlation.

For the labor force, 12 items including the percentage of the labor force (men) and complete unemployment (both sexes) showed statistically significant correlations. The percentage employment and total salary in cash were positively correlated while the percentage unemployment and total work hours were negatively correlated.

In the area of finance, the annual income of a prefectural resident, the amount of savings per person and the amount of insurance per family were positively correlated with statistical significance.

For prices, annual expenditures per family for food (bread and seafood) and monthly expenditures per working family (for clothing and shoes) showed statistically significant correlations.

For the home environment, 9 items, including the availability of a city water supply, access to the sewage system, major durable consumer goods (e.g., a custom-built kitchen and a toilet seat with warm water bidet) showed statistically significant positive correlations.

For time schedules, 3 items, including one's daily schedule (men, for sleep) showed statistically significant correlations. The time spent for commuting to work and to school (men) were positively correlated.

In the area of education, the percentage of those enrolling in colleges after high school was associated with a positive correlation with statistical significance, while a those high school graduates who went to work exhibited a negative correlation also with statistical significance.

Among the conditions related to everyday life, the percentage of waste disposal and recycling service and a flush toilet with public sewage service were positively correlated while the percentage of those on public assistance was negatively correlated, both with statistical significance.

2. For women (the results of the analysis are shown in Table 2)

In the area of life style and disease prevention, the percentage of smoking and of those seeking health checkups showed a statistically significant negative correlation.

For regional medical care, a statistically significant positive correlation was found with 4 items (e.g.the number of nurses).

On the population, the percentage of the population segment (0 to 14 years) had a statistically significant positive correlation, while the percentage of the 15 to 64 year segment had a statistically significant negative correlation.

In addition, the 8 items shown in the table had statistically significant correlations.

Ⅳ. Discussion

Following the collapse of the economic bubble, dramatic social changes have taken place in Japan and the schism between social classes is widening [7]. In this situation, widening in the gap in regional health status has also attracted attention. Average life expectancy is believed to be an index that is most important for a comprehensive expression of the health status in the country, prefectures, cities, towns and villages. Therefore, in this study, the correlation between this average life expectancy and social, economic and cultural elements was comprehensively analyzed.

For men, in comparison with women, a larger number of items with statistically significant correlations were found in social, economic and cultural factors. Because of the correlation with life style and disease prevention and the elements related to the regional health service, the average life

Table 2 The items that showed a statistically significant correlation

Items	Standard Correlation Coefficient	p value
Life style and prevention		
Percentage smoking (females)	-0.356	0.014
Percentage of those having health examinations	-0.355	0.015
Regional Health Care		
Number of nurses*1	0.440	0.002
Nursing personnel (per 100 beds)	0.288	0.050
Number of beds (all)*1	0.305	0.037
Number of MRIs*1	0.316	0.031
Population		
Percentage population stratified by age (2005)(0-14 years)	0.314	0.032
Percentage population stratified by age (2005) (15-64 years)	-0.297	0.043
Labor force		
Total cash payment (establishments employing 30 or more) (manufacturing)*2	-0.312	0.033
Total cash payment (establishments employing 5 or more) (manufacturing)*2	-0.293	0.046
Finance		
Income per prefectural resident (1995)*2	-0.298	0.043
costs		
Quantities of food purchased per year (butter)*3	-0.339	0.020
Quantities of food purchased per year (fresh fruits)*3	-0.322	0.028
Income and expenditures of a working family (cultural entertainment)*5	-0.390	0.007
Personal time allocation		
Personal time allocation within a day (males) (TV, radio, newspaper, magazine)	-0.331	0.024
Education		
Percentage of high school graduates selecting various options (females) (vocational schools)	0.375	0.010

*1: per 100,000 population
*2: 100 set for the figure for Tokyo
*3: Per household

expectancy for men increased when such metrics as the percentage smoking, those with metabolic syndrome, number of physicians, medical expenses and the number of hospital beds were reduced. These findings are totally logical from a medical viewpoint: one may presume that health care is appropriate; life expectancy has been prolonged; and medical facilities are utilized less frequently in the area in question.

Next, for the correlation with labor force and financial factors, average life expectancy is extended with increases in the employment rate, cash salaries, resident' s income and the amount of savings, and with decreases in the unemployment rate and the total actual working hours. It may be concluded that average life expectancy is higher in those areas where economic and labor conditions are optimum.

The correlation with daily consumption trends and factors related to living conditions indicated that average life expectancy is extended with increases in consumption for the purchase of clothes, shoes and bread, wider use of the water supply and sewage system, increased purchase of major durable consumer goods (e.g., custom-built kitchens, bidets with warm water and personal computers) and the prevalence of a flushing toilet system. The average life expectancy also increased in those areas where commuting time was long and time for sleep was short.

For the correlation with educational factors, the average life expectancy appeared to have been extended in those areas where more high school graduates go to higher educational institutions and fewer went to work.

The findings given above suggested that average life expectancy is higher in those areas where economic conditions are satisfactory; the residential environment is well-maintained; the educational level is maintained high; and a larger percentage of residents engage in health-maintaining behavior.

Recently, studies that relate the regional gaps in health status to local socioeconomic characteristics have been attracting attention. It is a well-known fact that infections are strongly related to economic factors such as poverty. But socioeconomic conditions may also have a strong influence on the onset of life-style-related diseases, the focal point. It has been reported in the western world also that the gap in health status is widening among various social classes [8].

Bucher et al. divided social classes into 3 levels and followed-up 3,154 men (ages between 39 and 59 years) for 22 years. He reported that after adjusting for their age and systolic blood pressure, the relative risk of the lowest class vs. the highest class was 1.67 to 1.89 for coronary disease and 2.08 to 2.20 for lung cancer [9]. Raphael of Canada indicated that socioeconomic factors are related to the incidence of coronary artery disease [10]. In England, the mortality from lung cancer is 82 per 100,000 of unskilled laborers but it is significantly lower 17.0 among professionals. Also reported: there is a 1 to 8% difference in the 5-year survival rate for breast, colonic, prostate, and lung cancers [11]. Many have reported that the incidences of bronchial asthma common among young children, depression, alcoholism, suicide and trauma are inversely related to socioeconomic conditions [12].

Among developed countries, modern Japan is reputed to have a high socioeconomic level and the health of its citizens is believed to be little affected by factors such as poverty. Similar to the reports from western countries, the current study indicated that the average life expectancy is extended in those areas where the economic and labor conditions are optimum, better housing conditions are offered and appropriate health services are available. It shows that the average life expectancy is affected by the economic level alone; the local economic gap acts as a significant factor.

According to a study on the relationship between the wealth of a nation and average life expectancy, the prolongation of the latter is proportional to a rise in GDP up to $5,000, after which it generally reaches a plateau [13]. In other words, the correlation coefficient between GDP and average life expectancy is very small in developed countries; and when Gini's coefficient, which expresses economic disparity, rises, the average life expectancy is reduced or mortality rises. In Japan, it is suspected that the economic disparity in society has an effect on the disparity in health status.

Disparity in health status is also affected by the employment conditions. Kasl et al. in their cohort study reported that the relative risk for death of the unemployed in England is around 1.5 [14]. Studies in Sweden, Denmark, Italy and England found that the standardized mortality of 100 (in a standard cohort made up of individuals of the same age) rises to 150 to 200 when the individuals are unemployed. This effect is more pronounced among younger workers; and what is more interesting — according to a number of reports — is that ill health was reported more frequently when the subjects become concerned with the possibility of losing their jobs, even before they really are unemployed. The results of the present study reported that the average life expectancy was high in those areas where the employment rate was high and the unemployment rate was low or the total working hours were short. It is assumed that the stress caused by unemployment and other related factors contribute to the onset of diseases and eventually to mortality.

The disparity in health status due to educational levels has been noted in various countries. In countries such as Finland, Norway and Italy, mortality is higher among those with a lower educational level; and this discrepancy has become exaggerated in the 10-year period between the 1980s and 1990s [15]. In Japan also, studies on this gap created by educational level have been drawing attention: an increasing number of studies have been introduced on the relationship between educational disparity and health indices. Kondo et al [7]. compared a group with a shorter length of schooling and another with a longer length of schooling: they reported that the percentage of those with a history of falling or with undesirable health-related behavior (such as smoking, habitual alcohol drinking, insufficient exercise, and neglecting to have physical examinations) increases with a statistically significant difference. They noted a tendency for depression and shut-in occurring more frequently in an inverse relationship with the number of years of education. A similar tendency was noted in the current study: in an area where a percentage of those going to universities is greater, the average life expectancy is higher. In a country like Japan where the educational level is high, the factor responsible for the development of the discrepancy in health status may be the gap between years of education, rather than a gap in the educational level. Perhaps faced with relative poverty and being in a low social class, one is more likely to be exposed to greater social and psychological stress, which places the autonomic nervous, endocrine and immunologic systems in less than an ideal state [16,17] .

Next, the process of how socioeconomic factors affect average life expectancy was examined. First, the material environment was considered. The socioeconomic condition creates a disparity in the hygienic conditions of the housing and

work environment [18]. Second to be considered is one's life style. An undesirable life style — as represented by inactivity, obesity due to excessive caloric intake and smoking — is more often seen in those who are in lower socioeconomic strata, which may be characterized by lower income, limited education and low occupational level [19]. Third, the use of medical and social services is considered. It is well-known that people are held back from utilizing medical services when the amount to be borne by the individual (mainly those in the low income class) is raised. A socioeconomic gap is also seen in the use of health education sessions and health screening and the health and welfare system where information gathering or an application procedure is a prerequisite. The fourth point concerns human relationships. The personal interactions among those in a lower socioeconomic stratum tend to be weakened. For example, those with limited education tend to receive or offer little social support, undergo divorce or remarry more often, and if a man, frequently live alone. Fifth, psychological stress is considered. Those in lower social strata are more likely to be exposed to the risk of being unemployed and driven to an economic disaster. Thus their mental and psychological stress is chronically magnified, subsequently raising the possibility for the development of diseases [20].

The results of the present study indicated that in Japan, one's health status is affected by social-economic-cultural factors. It was recognized that in such a condition, it is necessary to expand the bio-medical model that focuses on the disease phenomena based only on natural science: instead, bio-psycho-social models should be utilized if one wishes to understand health and disease states and promote health care activities.

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