

An Examination Between Death Rate of Cancer and Social/Health Environment

— A Case Study by Japanese Prefectural Data —

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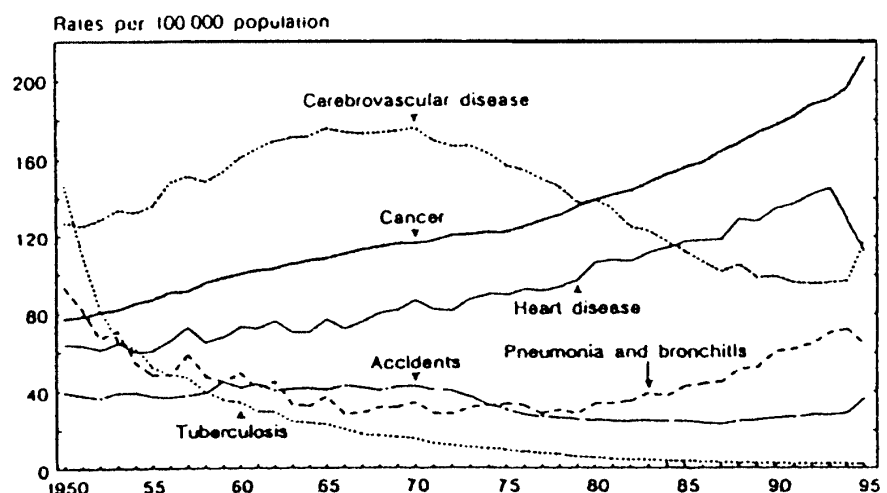
Introduction

Phenomenon

In many countries, the three major adult diseases such as cancer, cerebrovaschlar and heart disease are the most popular cause of death. Above all, cancer ranges as one of the strongest natural enemy which we human beings have ever met. Even though the number of death form cervical cancer tends to decrease in the United States, lung cancer has been skyrocketing since 1930. Still as many as 500,000 Americans die from cancer each year.¹⁾

As far as Japanese concerned, cancer did not use to be the major cause of death at the middle of the twentieth century. However, it became the most serious cause of death in 1995. One of four people dies from cancer these days. As shown in the

Graph 1: Deaths by Leading Cause (Japan)



Source: Ministry of Health and Welfare.

Graph 1, the number of deaths in 1995 was 922,139 in Japan.

By cause, the higher death rate per 100,000 population was that for cancer, at 211.6. Cancer recorded the highest death rate by cause in 1986, and its share has been increasing

continuously.²⁾

Literature review

The cause of cancer is unclear. However, millions of studies have done to make it clear and many things have come out from them.

Mayo Clinic, which is one of the most advanced medical institution of cancer, states that most cancers likely develop from a complex interplay of diet, lifestyle and environmental factors. In the *Mayo Clinic Health Letter*, it points out the fact that the evidence appears to be stronger with the connection between dietary fat and colon cancer than the other cancer. The specific food most strongly associated with increased risk of colon cancer was red meat (beef, pork or lamb). The letter describes, in addition to fat, two or more alcoholic drinks a day can raise the risk of cancer in mouth, throat, esophagus and liver.³⁾

Furthermore, the *HEALTHNEWS*, which is from the publisher of The New England Journal of Medicine, says University of Illinois researchers found a compound in wild blueberries blocks an enzyme that promotes tumor growth. A second study, by US Department of Agriculture scientists at Tufts University, found blueberries have the strongest antioxidant activity of 40 fruits and vegetables. (Both of the research results are unpublished) Like those studies, the effects of nutrients, fiber and other chemicals contained in fruits and vegetables for cancer are reported as the results of researches.⁴⁾

On the other hand, in addition to the nutrition aspect, National Cancer Center of Japan reports there are several factors to avoid cancer. It says "Do not smoke.", "Do appropriate exercise and release your stress.", "Avoid burned and moldy stuff.", "Do not get too much sun tan." and "Reduce salt."⁵⁾

Cause of model

Considering the circumstances and result of study mentioned above, I assumed food, cigarette smoke, alcohol, and exercise and relaxation have relation to the death rate of cancer. Moreover, since cancer is geriatric disease, age has positive effect to the death rate of cancer. Table1 shows my hypothetical factor and positive / negative effect of them.

Source and Feature of Data

Data were taken mainly from the following sources. Dependent data were derived from *Vital Statistics* (Statistics and Information Department, Minister's Secretariat,

Table 1

Effects of factors	Hypothetical factors
	ratio of aged people, red meat, alcohol, smoke vegetable, exercise, relaxation

Ministry of Health and Welfare). Independent data were taken from *Population Estimates* (Statistics and Information Department, Minister's Secretariat, Ministry of Health and Welfare), *Family Income and Expenditure Survey* (Statistics Bureau, Management and Coordination Agency) and *Survey on Time Use and Leisure Activities* (Statistics Bureau, Management and Coordination Agency). The followings are the matters that require attention for each survey.

Vital Statistics: Findings of the survey are obtained from the questionnaires submitted by shi (cities), machi (towns), and mura (villages) for every declaration of live birth, death, marriage, divorce of foetal death to the head of shi, machi or mura. The population used for the computation of rates is the Japanese population as of October 1 of the year stated obtained from the Population Census or the Population Estimates.⁶⁾

Population Estimates: Besides the quinquennial Population Censuses which enumerate Japanese population in detail, the Population Estimates are available for intercensal year. With respect to the population of the whole country, the estimates of the population classified by age group as of October 1 of each year are obtained based on the population enumerated in the Population Census, by adding or subtracting it the live births, deaths and entries into and departures from Japan. For the population by prefectures, the estimates are obtained by further adding or subtracting the migrants between prefecture.⁷⁾

Family Income and Expenditure Survey: The survey is conducted every month and covers nationwide non-agricultural, forestry and fishery households with 2 or more household members. As is understood by the survey system, the "all households" in this survey refer to households excluding agricultural, forestry and fishery households and one-person households.⁸⁾

Survey on Time Use and leisure Activities: The 1991 survey covered about 250,000 persons of 15 years old and over from among about 99,000 households selected from among the households within 6,600 of the 1990 Population Census enumeration districts. The survey was conducted as of October 1, but the data on the distribution of hours and minutes per day spent on daily activities were surveyed by each enumeration district as to the activities in two designated consecutive days during the period from September 28 through October 6.⁹⁾

I have 47 observations which were collected at every 47 local administrative division of Japan which is so called prefecture. Names and locations of them are following:

1 Hokkaido, 2 Aomori, 3 Iwate,
 4 Miyagi, 5 Akita, 6 Yamagata,
 7 Fukushima, 8 Ibaraki, 9 Tochigi,
 10 Gunma, 11 Saitama, 12 Chiba,
 13 Tokyo, 14 Kanagawa, 15 Niigata,
 16 Toyama, 17 Ishikawa, 18 Fukui,
 19 Yamanashi, 20 Nagano, 21 Gifu,
 22 Shizuoka, 23 Aichi, 24 Mie,
 25 Shiga, 26 Kyoto, 27 Osaka,
 28 Hyogo, 29 Nara, 30 Wakayama,
 31 Tottori, 32 Shimane, 33 Okayama,
 34 Hiroshima, 35 Yamaguchi, 36 Tokushima,
 37 Kagawa, 38 Ehime, 39 Kochi,
 40 Fukuoka, 41 Saga, 42 Nagasaki,
 43 Kumamoto, 44 Oita, 45 Miyazaki,
 46 Kagoshima, 47 Okinawa.

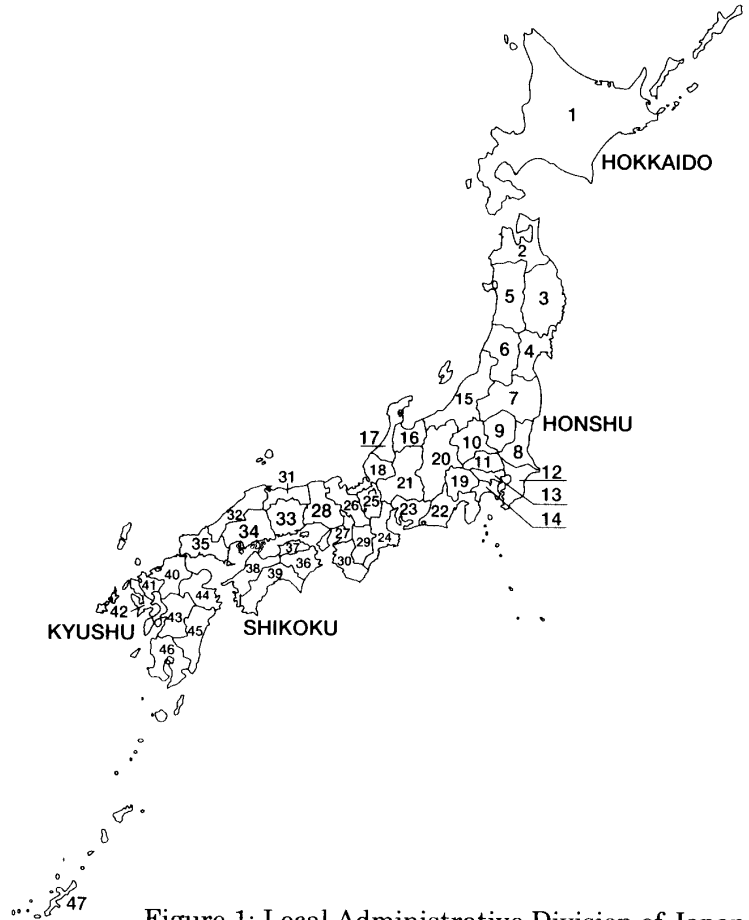


Figure 1: Local Administrative Division of Japan

Discussion of Variables

I tried to adopt one dependent data and five independent data. I eliminated vegetable consumption because the positive effect of beef consumption represents its negative effect as the effect of eating good foods and avoiding bad foods. Because I could not find appropriate data about average ratio of individual cigarette smoking, I did not take the variable. Each of variable is named as follows.

CANJPN : Death Rate of Cancer in Japan (1993)

OVER65 : Population Rate 65 years old and over (1993)

ALCOH : Yearly Amount of Alcoholic Beverages Consumption per Capita (1993)

BEEF : Yearly Amount of Quantities per Household by Food -beef- (1993)

HOBBY : Weekly Average Time Spend per Day on Hobbies and Amusement (1991)

SPORT : Weekly Average Time Spend per Day on Sports (1991)

Dependent Variable

I chose Death Rate of Cancer (CANJPN) of Japan as dependent valuable which is measured per 100,000 population. Cause of death on the Simplified Classification prepared for the Vital Statistics which is pursuant to the 9th international Statistical Classification of Diseases, Injuries, and Cause of Death. The number I took in my model is based on data of 1993 and sum of 10 Malignant neoplasms.

Independent Variables

1. Population Rate 65 years old and over (OVER65)

Generally speaking, the older, the easier to come down from the illness. Indeed, as the ratio of the aged people or average life expectancy increase during past four decade, the death rate of cancer is also increasing. Therefore, I included this variable in my model under assumption that these two variables are possible to have some relationship. The data is based on 1993 and taken from Population Estimates. Unit of this data applies to the number of person per 100,000 people.

2. Yearly Amount of Alcoholic Beverages Consumption per Capita (ALCOH)

As some articles point out, the understanding of some relationship between consumption of alcoholic beverages and cancer is now an accepted idea in the medical world. Though many doctors say taking alcoholic beverages is not absolute evil as a Japanese proverb saying, “A little something to drink is the best medicine” but I still assumed there is positive relationship between the amount of alcoholic beverages consumption and death rate of cancer. The reason is that the kind of alcoholic beverages is changing and the amount per capita itself became bigger. Because the calculation of the consumption of alcohol is based on the amount of tax, source of data is Annual Statistical Report of the National Tax Administration Agency. Unit of this variable is liter pre capita per year.

3. Yearly Amount of Quantities per Household by Food -beef- (BEEF)

From ancient times, Japanese main dishes are vegetables and fishery products. After the Japanese high economic growth, however, it became much more easier to get beef, even for ordinary people. Now, beef became one of the most common daily diets for Japanese. Many medical scholars say that as western style food became common, it increased the number of death to grow. Beef represents the former and cancer, the latter. Both of them used to be just minority, beef as daily food and cancer as cause of death. Although chicken and pork also became much more easier to get in the daily life than before the economic growth, I took beef as one of my independent variables because the increase of its consumption is more drastic than the other meats. Thus, I assumed there

would be some positive relationship between beef consumption and death rate of cancer. Source of data is Family Income and Expenditure Survey (1993). Unit is 100g per household per year.

4. Weekly Average of Time Spend per Day on Hobbies and Amusement (HOBBY)

Not only food but also stress can be a possible cause of cancer. There are some possible factor of stress such as the time spend for work hours of commuting, the time spend for the sports and leisure and so on. These factors are marked as characteristic of Japanese people because it is quite famous that Japanese work too hard and take too much time for the commute so that they can not keep enough time to enjoy leisure time. Therefore, I took this independent variable as one of these stress factors under an assumption that lacking of relaxation affects the death rate of cancer. This data was taken from Survey on Time Use and Leisure Activities (1991). Unit is minutes per capita per day.

5. Weekly Average of Time Spend per Day on Sports (SPORT)

As well as hobbies and amusement, sports are one of the good ways of relaxation. Also, like the article of ASAHI newspaper says, moderate exercise is needed to keep basic health. I assumed this independent variable has two aspects to avoid cancer, relaxation and fitness. Therefore, I contained this variable into my model expecting that the longer time spend for sports, the lesser death rate of cancer. Unit of this variable is also minutes per capita per day.

Model and its Interpretation

Causal Model

From my assumption, the higher age of aged people (OVER65) and more consumption of alcohol and fat (ALCOH and BEEF) marks the higher death rate of cancer (CANJPN). Also the more time for relaxation and exercise (HOBBY and SPORT), the less death rate of cancer. I took liner model instead of quadratic model and log-log model because all of my independent variable seem to have liner effect to my dependent data. For example, it seems to be unreasonable that the more consumption of beef or alcoholic beverages beyond specific point brings less death rate of cancer. Therefore, the equation hypothesize as follows:

$$\text{CANJPN} = \alpha + \beta_1 \text{OVER65} + \beta_2 \text{ALCOH} + \beta_3 \text{BEEF} - \beta_4 \text{HOBBY} - \beta_5 \text{SPORT} + e$$

Since we have a lot of uncertainty about cause of cancer, e represents social medical and hereditary factors which is not incorporated into my model.

Interpretation

To make sure if my model is appropriate, I would like to state a null (H_0) and an alternative hypothesis (H_a) and test the hypothesis if they are 90% statistically significant. I have 47 observations and 5 independent data but one prefecture does not have ALCOH data. So, degrees of freedom (d.f.) is 40 ($= 46 - 5 - 1$). The relevant t-value for a two-sided significant test on any variable is 1.68. I regressed my model by 46 observations for ALCOH and 47 for others. The results such as parameter-estimate, t-value and R square is the same as the result used 46 observations for all independent variables.

1. Population Rate 65 years old and over (OVER65)

H_0 : population rate 65 years old and over has no effect on death rate of cancer ($\beta_1 = 0$).

H_a : higher population rate of 65 years old and over results in higher death rate of cancer ($\beta_1 \neq 0$).

The parameter estimate for this variable is +7.643 which mean if other variable were held constant, 1% increase in ratio of age 65 and over increase death rate of cancer by 7.693 person per 100,000 per year. I can reject my null hypothesis because the t-value of OVER65 is 11.621 and is far above 1.68. The p-value is smaller than 0.006 which serves my cut off point of statistically significant at the 99% level of confidence interval. Hence, I can state it is 99% statistically significant that higher ratio of aged people increase death rate of cancer.

2. Yearly Amount of Alcoholic Beverages Consumption per Capita (ALCOH)

H_0 : yearly consumption of alcoholic beverages per capita has no effect on death rate of cancer ($\beta_2 = 0$).

H_a : higher consumption of alcohol results in higher death rate of cancer ($\beta_2 \neq 0$).

The parameter estimate for this variable is +0.578 which mean if other variables were held constant, 1 liter increase in yearly individual consumption of alcohol increase death rate of cancer by 0.578 person per 100,000 per year. The null hypothesis can be rejected because the t-value of ALCOH is 3.082 and is above 1.68. Also, the p-value is smaller than 0.006 which serves my cut off point of statistically significant at the 99% level of confidence interval. Hence, I can state it is 99% statistically significant that higher individual consumption of alcohol increases death rate of cancer.

3. Yearly Amount of Quantities per Household by Food -beef- (BEEF)

H_0 : yearly amount of quantity of beef per household has no effect on death rate of cancer ($\beta_3 = 0$).

H_a : higher consumption of beef results in higher death rate of cancer ($\beta_3 \neq 0$).

The parameter estimate for this variable is +0.148 which mean if other variables were held constant, 100g increase in yearly consumption of beef per household increase death rate of cancer by 0.148 person per 100,000 per year. The null hypothesis can be rejected because the t-value of BEEF, 3.159 is greater than 1.68. Again, the p-value is smaller than 0.006 which serves my cut off point of statistically significant at the 99% level of confidence interval. Hence, I can state it is 99% statistically significant that higher consumption of beef in household increases death rate of cancer.

4. Weekly Average Time Spend per Day on Hobbies and Amusement (HOBBY)

Ho: weekly average time spend on hobbies and amusement per day has no effect on death rate of cancer ($\beta_4 = 0$).

Ha: higher hobbies and amusement time per day results in lower death rate of cancer ($\beta_4 \neq 0$).

The parameter estimate for this variable is -0.845 which mean if other variable were held constant, 1 minuet increase in daily individual hobby and amusement time decrease death rate of cancer by 0.845 person per 100,000 per year. The null hypothesis can be rejected because the t-value of HOBBY is -1.867 and is below -1.68. The p-value is below the 0.1 level which serve our cut off point of statistically significant at 90% level of confidence interval. Hence, I can decide that it is 90% statistically significant that increase of daily individual hobby and amusement time decreases death rate of cancer.

5. Weekly Average Time Spend per Day on Sports (SPORT)

Ho: weekly average time spend per day on sports has no effect on death rate of cancer ($\beta_5 = 0$).

Ha: longer time spend for sports per day results in lower death rate of cancer ($\beta_5 \neq 0$).

The parameter estimate for this variable is -1.504 which mean if other variables were held constant, 1 minuet increase in daily individual sports time decrease death rate of cancer by 1.504 person per 100,000 per year. Nevertheless, the t-value of SPORT, -1.370, is not less than -1.68 to state 90% statistically significant. The p-value for probability of error in rejecting *Ho* is, therefore, not below the 0.1 level. To state this value is statistically significant, I have to employ 80% confidence interval instead of 90%. Since there is still high percentage of confidence interval and can observe quite clear parameter estimate which is reasonable in terms of empirical effect of sports for health, I retained this variables in my model.

Evaluation of Model

Evaluation of model

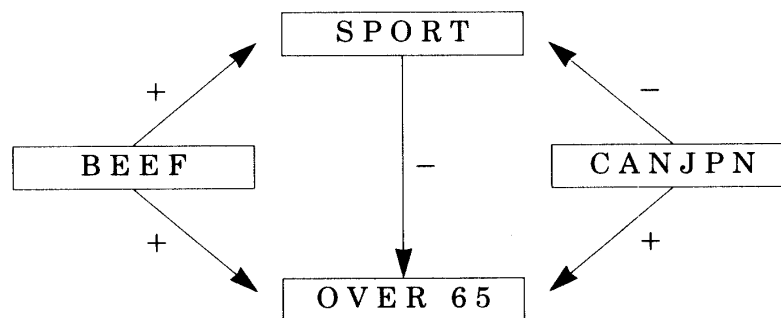
The regression equation that illustrates the effect of independent variables on death rate of cancer is:

$$\text{CANCJPN} = 79.391 + 7.643\text{OVER65} + 0.578\text{ALCOH} + 0.148\text{BEEF} - 0.845\text{HOBBY} - 1.504\text{SPORT} + e$$

R square: 0.817 (11.621) (3.082) (3.159) (−1.867) (−1.370)

The R square of this model is 0.817. This means that 81.7% of variation in the death rate of cancer in Japan could be explained by my 5 independent variables. This can be evaluated as very high outcome. High R square sometimes come easily from high multicollinearity, which occurs when there is correlation between independent variables. Also it sometimes happens that R square is high and some independent data are not statistically significant. Because SPORT is not 90% statistically significant in my model, I checked correlation between my independent variable. However, I could not find such an outstanding correlation among the data. The highest one is −0.244 between Population Rate 65 years old and over and Weekly Average of Time Spend per Day on Sports. The existence of correlation can empirically make sense between these two variables and the number can not be taken as seriously high. Figure 2 is reference in which I confirmed positive and negative relationship among my

Figure 2



dependent variable, SPORT and other specific independent variables. The effect of BEEF and OVER65 toward SPORT is small. (The number can be found in the appendix.)

Possibility of alternative models.

In order to make my regression model more powerful, I tried to put other independent variable into my model. Since t-value of SPORT is not 90% statistically significant, I tried to change this valuable into others. Even though the literature I quoted above does not mention, it is medical doctor's maintenance that the early detection of cancer leads to the better treatment. Also, the more person or household pays for the treatment, the better

recovery. Therefore, I hypothesize that ratio of undergoing of medical examination named MEDEXAM and the amount of medical cost per capita or household MEDCOST relate to death rate of cancer. Each of them is substituted to SPORT. The models with t-value and R square is follows:

$$\text{CANJPN} = 63.839 + 8.046\text{OVER65} + 0.573\text{ALCOH} + 0.119\text{BEEF} - 0.889\text{HOBBY} - 0.145\text{MEDEXAM} + e$$

R square: 0.811 (11.005) (2.995) (2.421) (- 1.913) (- 0.720)

MEDEXAM: Medical Examination Ratio — 1990 —

(Source: Statistics of Activities of Health Centers)

$$\text{CANJPN} = 75.208 + 7.665\text{OVER65} + 0.579\text{ALCOH} + 0.125\text{BEEF} - 0.904\text{HOBBY} - 0.12\text{MEDCOST} + e$$

R square: 0.812 (11.209) (3.034) (2.671) (− 1.938) (− 0.771)

MEDCOST: Yearly Average of Monthly Living Expenditure pre Household — Medical Care (1993) —

(Source: Family Income and Expenditure Survey)

Keeping higher R square, t-value of both MEDEXAM and MEDCOST are impressively low. I can not reject my null hypothesis ($H_0: \beta_5 = 0$) because t-value is larger than -1.68 and p-value is far higher than 0.1 (0.476 for MEDEXAM and 0.445 for MEDCOST). Thus, despite the fact that I can find negative effect of both variables on death rate of cancer as I assumed, it is difficult to state that the higher medical examination or the amount of medical cost per household results in lower death rate of cancer ($H_a: \beta_5 \neq 0$).

Moreover, the result to put these variables into the model together with SPORT is below.

$$\begin{aligned} \text{CANJPN} = & 89.827 + 7.713\text{OVER65} + 0.566\text{ALCOH} + 0.134\text{BEEF} - 0.907\text{HOBBY} - 1.259\text{SPORT} \\ & (9.861) \quad (2.941) \quad (2.497) \quad (-1.916) \quad (-1.056) \\ & - 0.84\text{MEDEXAM} - 0.72\text{MEDCOST} + e \\ & (0.402) \quad (0.463) \end{aligned} \quad (\text{R square: } 0.819)$$

Even though R square is little better than three other models I have ever tried, the t-value of MEDEXAM and MEDCOST are still leveled low or even worse than that in any other models. After all, first one is still better comparing to those four models I have estimated. Therefore, despite of including a variable which have little lower t-value, I believe that it still serves as a good illustration of the relationship between death rate of cancer in Japan and social variables which explain Japanese regional situation.

Conclusion

My regression analysis shows that food, alcohol, exercise and relaxation, and age on prefectural average have relation to the death rate of cancer. That is: the higher aged people ratio and alcohol and beef consumption ratio causes higher death ratio of cancer, and longer time spent for hobby, amusement and sports causes lower death ratio of cancer in Japan. However, in order to interpret the result of this research and analysis, we should pay attentions to the following.

First of all, this is theoretical result and does not always explain the actual phenomenon. For example, though most medical doctors do not deny the earlier detection of cancer does push up the possibility to cure, medical examination rate did not explain the death ratio of cancer well in my regression analysis.

Second, my model reflects on just Japanese situation. We should be very careful to apply it to the other countries. Even though percentage of population over 65 and alcohol consumption ratio seem to have universality, the strong effect of beef consumption ratio and time spent for hobby and sports may be a feature of Japanese life style. As I mentioned before, stress may be a strong cause of cancer especially for Japanese because of over work and bad housing situation putting too much stress. Also, eating beef which does not agree with Japanese traditional foods might be changing Japanese health situation.

Third, since the cause of cancer is still controversial in the medical world, we must take many uncertainties into account such as whether all the red meat make the birth of cancer easier. For example, Okinawa prefecture has lowest death rate of cancer in Japan but highest consumption ratio of pork. Many miner terms may be related to this phenomenon such as the way to cook, combination with other food, feature of climate and so on. Cultural aspect should be taken into account to make sure this matter.

My model can encourage federal and local governments to promote people to avoid stress, try some sports, and eat moderately keeping Japanese traditional cuisine and lower beef and alcohol.

Foot Note

- 1) "Cancer Trends Since 1930's" *Health News*, Aug. 27, Massachusetts Medical Society, 1996.
- 2) *Statistical Handbook of Japan*. Tokyo: Statistics Bureau and Statistics Center, Ministry of Public Management, Home affairs, Posts and Telecommunication, 1992: 132.
- 3) "Cancer," *Mayo Clinic Health Letter*, September, Mayo Foundation for Medical Education and Research, 1995.
- 4) "Assessing Anti-Cancer Food News," *Health News*, Oct. 20, Massachusetts Medical Society, 1997.

- 5) *Asahi Shinbun*. International ed. Oct. 23, 1997.
- 6) *Japan Statistical Yearbook*. Tokyo: Statistics Bureau and Statistics Center, Ministry of Public Management, Home affairs, Posts and Telecommunication, 1995: 28.
- 7) *Japan Statistical Yearbook*. Tokyo: Statistics Bureau and Statistics Center, Ministry of Public Management, Home affairs, Posts and Telecommunication, 1995: 27-28.
- 8) *Japan Statistical Yearbook*. Tokyo: Statistics Bureau and Statistics Center, Ministry of Public Management, Home affairs, Posts and Telecommunication, 1995: 567.

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