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Development of a Computer Mapping System and an Application for the Purpose of Epidemiological Studies in Northern Japan.

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Abstract

It is almost impossible to plot incidence of death rate on a map of Hokkaido and Tohoku district which have 863 municipalities of cities, towns and villages in order to observe regional convergence of the occurrence and mortality of a disease. We tried to develop a mapping system showing the geographical distributions of standardized mortalities of main diseases in 863 municipalities of cities, towns and villages in northern Japan (Hokkaido and Tohoku district) by use of technics of the computer graphics. Regional convergence could be found for the deaths due to gastric cancer, lung cancer, and cerebral vascular disease in northern Japan, suggesting the necessity of future studies of the factors causing regional difference such as customs in life and hereditary sensitivity of the populations. Computer graphics analysis was found to be quite effective for our epidemiological observations and to be superior to only a data analysis of death rate.

1. Introduction

It is thought that an occurrence of diseases of adult people and a death caused by them are much affected by various factors including natural environment, social and economic conditions and ways of life. Based on this idea, it is an ordinary epidemiological method to study regional differences of the fatal and relative factors which may lead to death.¹⁾ However, it is almost impossible to plot incidence of the diseases on a map of Hokkaido and Tohoku district which have 863 municipalities of cities, towns and villages in order to observe regional convergence of the occurrence and mortality of a disease. We tried to develop a computer mapping system by which standardized mortalities of each of main diseases are visualized, suggesting regional differences and occurrences of the disease.³⁻⁴⁾ This system was effective for our epidemiological study, and here we would like to report our results.

2. Information and methods

1) Information

Under the approval of Prime Minister's Office, Statistic Information Department and

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Secretariat for the Minister of Health and Welfare provided us magnetic tapes of the information by sexes, age classes and municipalities on the dead who died of the diseases of adult people in Hokkaido and Tohoku district from 1974 through 1988 and the results of census taken in 1985.

2) Quantification of death standards

Standardized mortality ratios of gastric cancer, lung cancer, cerebral vascular disease and coronary heart disease were calculated in each of 218 municipalities in Hokkaido and in each of 645 municipalities in Tohoku area as in Mar. 1989. A SMR was obtained from an equation $SMR = (O/E) \times 100$, where O is the number of the dead in a sub-group, that is municipality, and E is the expected number of the dead, provided that the mortality by age classes in the sub-group is equal to that of a whole group in Japan. If a 100 SMR in a municipality is identical with that of Japan, it is 100. At the calculation of a SMR, national mortalities by age classes of 5 years, sexes and diseases were obtained by use of the results of census and dynamic statistics of the population of 1985. Mortalities obtained were defined as standardized mortalities. Using these standardized mortalities, expected numbers of the dead in 863 municipalities in northern Japan were calculated in each municipality and sex. On the other hand, the number of the dead by municipalities, sexes and diseases were summed up to calculate SMRs for 15 years from 1974 through 1988.

3) SMRs calculated by the computer mapping in 2-2)

(1) Distribution maps were automatically prepared by a 5 step grading scale where mean values for Hokkaido and Tohoku district were divided by 0.5SD, 1.5SD and a 5 step grading scale in which SMRs are divided by 120 and 140 of SMRs. The data of areas of 863 municipalities were converted to digital points in 2-dimensional X and Y, which were put into a graphic analysis system.

(2) Combinations of some conditions for a SMR were expressed in 3-dimensions by the prism method.

(3) When the distribution of municipalities are too complicated, the values were converted to the height by drawing overhead views by use of the attenuation function, so that the difference of the heights might be easily recognized and extremely high values might be corrected. (Fig. 3, 7)

(4) Though the significance of regional convergence by jurisdiction of public health centers was studied. With SMRs obtained in 1) regional pairs that were adjacent to 54 public health centers were identified to obtain pairs of mortalities with an identical scale. Then theoretical value (E) was obtained for the pairs with the identical scale to test regional convergence by a test. $E = A \times n_i (n_i - 1) / N(N - 1)$, where N is the total number of areas, A is regionally adjacent pairs, and n_i is the number of areas graded to each of 5 scales. Then using with E(expectation values), it is possible that the bias of incidence was analysed by X^2 test.

(5) The HITAC-M682H system mounted at Hokkaido University was used to make calculations and to draw graphics with power sources of a Laser Beam Printer.

3. Results

1) Gastric cancer was the biggest cause of death in Japan. Mortalities of male patients with gastric cancer were recognized to be high in the areas along the Japan Sea, which was similar to the national mortalities (Figs. 1 and 2). On the other hand, mortalities of female patients with the cancer did not show so remarkable tendency (Fig. 3). It was found that SMRs over 120 for both males and females could be found in the areas along the Japan Sea such as Suttsu-cho (town), Shimamaki village, Kuromatsunai-cho, Shakotan-cho, and Mashike-cho, and in Kitami jurisdiction including Shimokawa-cho, Tanno-cho, Saroma-cho, Honbetsu-cho, Rubeshibe-cho, Naka-Tsugaru district and Noshiro-city. Except Yuni-cho regional convergence was divided into two groups (Fig. 4). If SMRs were compared by public health centers, the areas under the jurisdiction of Rumoi and Yakumo public health centers showed rather higher SMRs, but no regional convergence were revealed.⁶⁾

2) Though prophylactics play an important role for the prevention of cerebral vascular disease, high SMRs for males who dies of it were found in the continental areas at the side of the Japan Sea such as Fukagawa city, Moseushi-cho, and Nakagawa-cho (Fig. 5), while those for females were high in Fukagawa city, Nakagawa-cho, Horokanai-cho, etc., which was more lower than Tohoku district (Figs.6). No regional convergence of high SMRs by public health

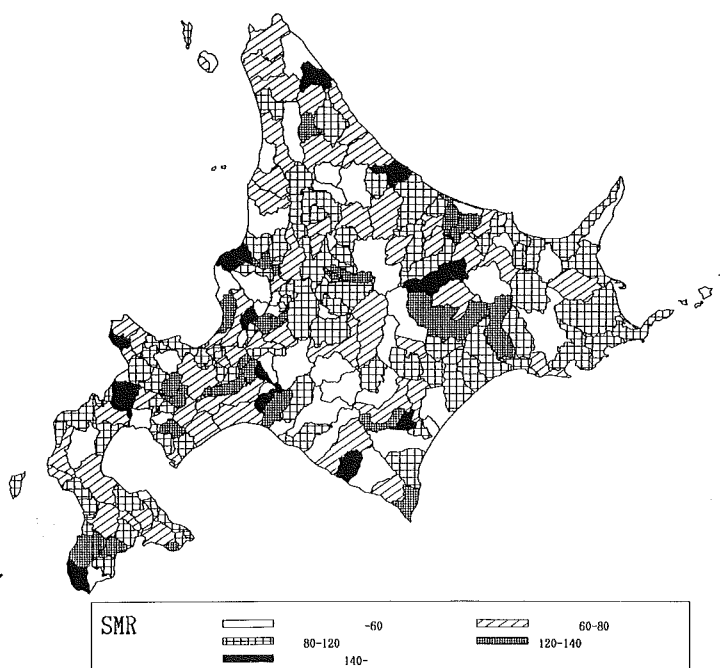


Fig. 1 The map of Hokkaido showing regional distributions on SMRs of female gastric cancer.

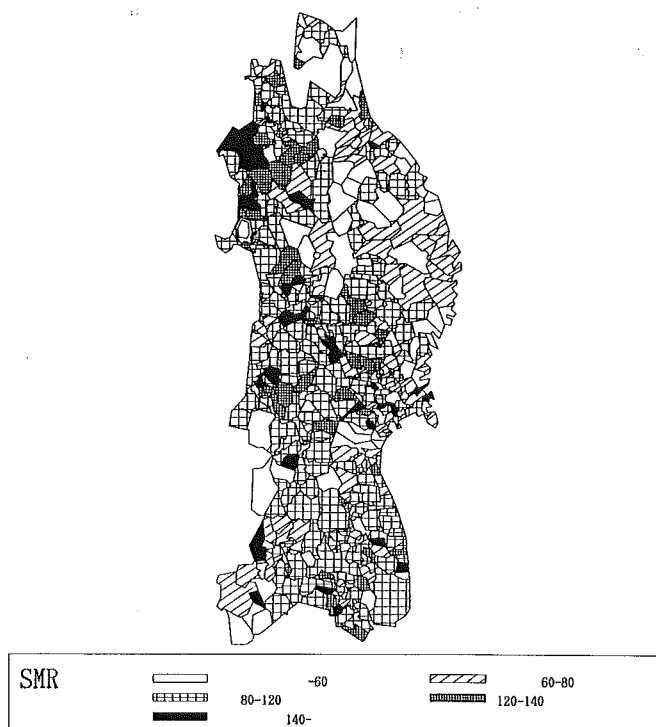


Fig. 2 The map of Tohoku district showing regional distributions on SMRs of female gastric cancer.

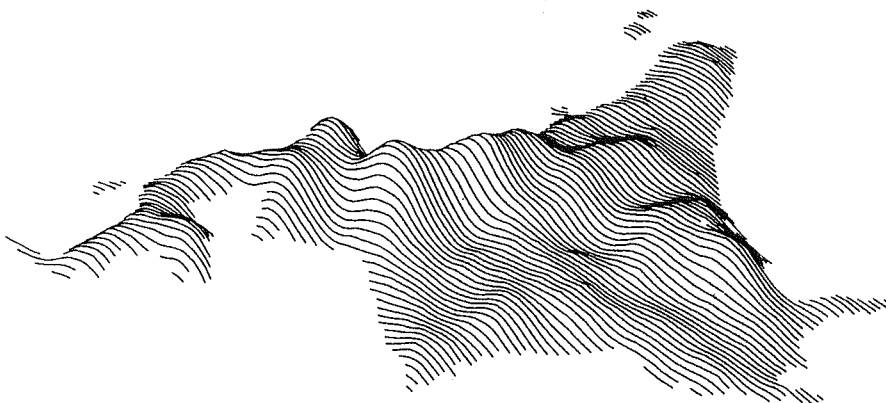


Fig. 3 The map of a bird's-eye view showing regional distributions on SMRs of male gastric cancer.

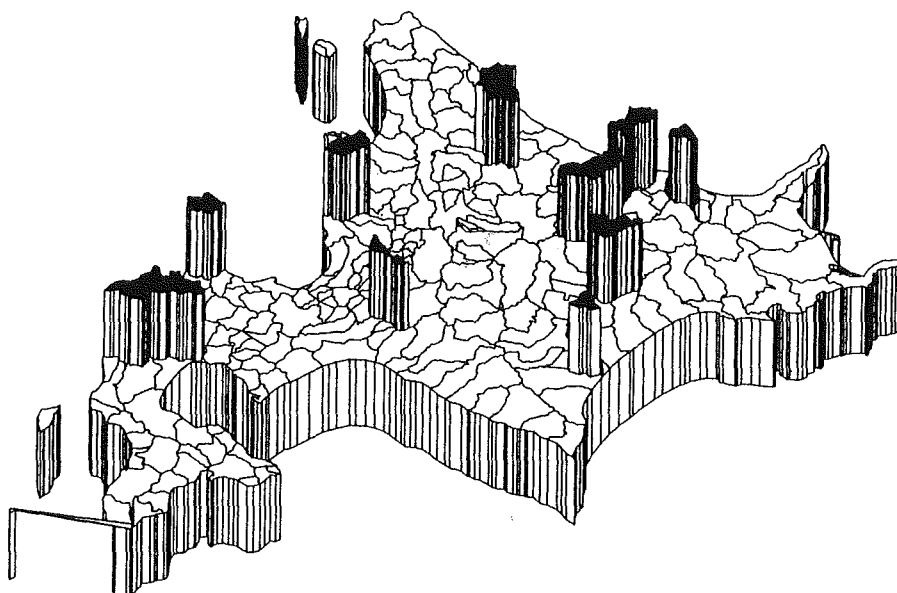


Fig. 4 The map of municipalities in Hokkaido showing distributions over 120 on SMRs in both male and female gastric cancer by the prism method.

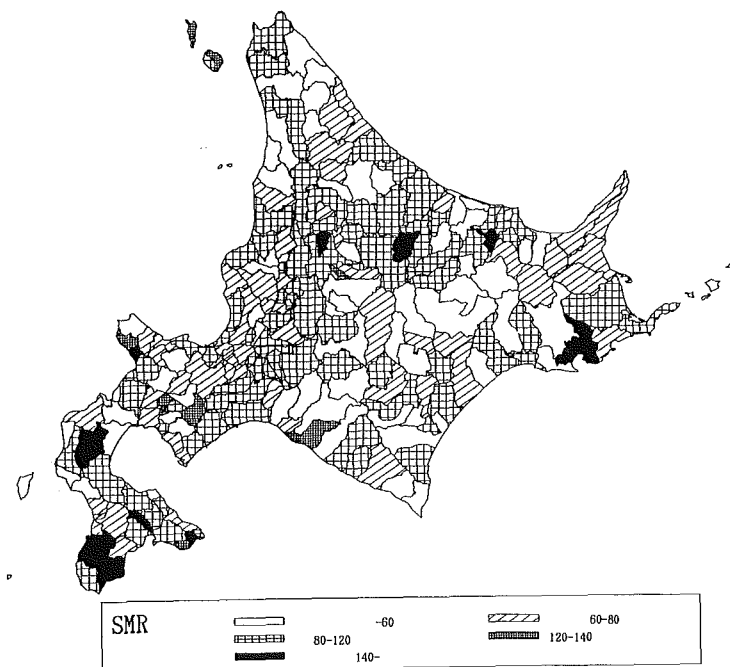


Fig. 5 The map of municipalities in Hokkaido showing regional distributions on SMRs of male cerebral vascular disease.



Fig. 6 The map of municipalities in Tohoku district showing regional distributions on SMRs of female cerebral vascular disease.

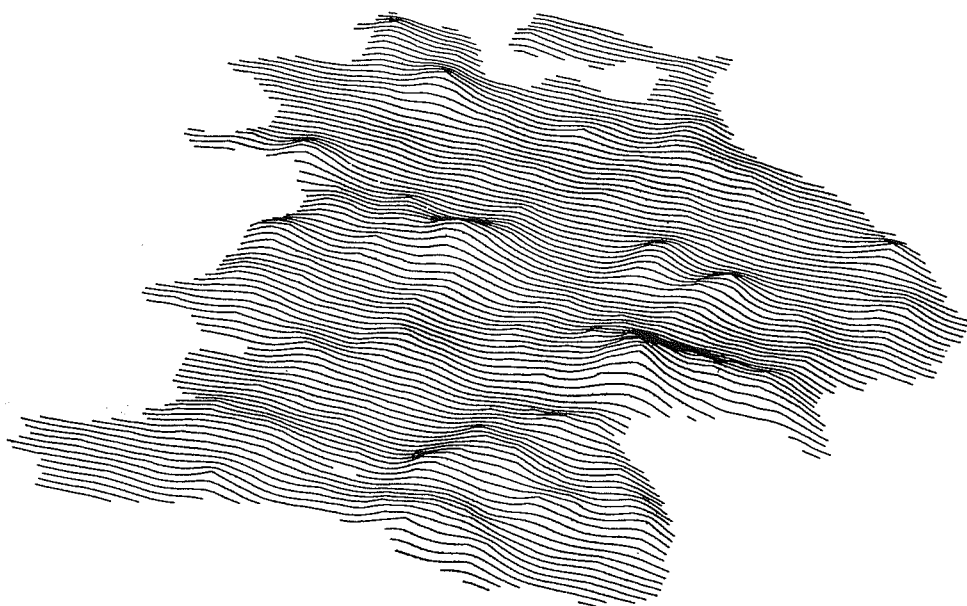


Fig. 7 The map of a bird's-eye view from Tokyo to Aomori prefecture showing regional distributions on SMRs of female coronary infarction.

centers could be found, but regional convergence of low SMRs was significantly observed.

3) Death due to lung cancer has been increasing recent years. The areas where SMRs were over 130 for each of both sexes included municipalities with harbors. It was similar to the national trend (Figs. 8,9 and 10). No regional convergence by the jurisdiction of public health centers could be founded.

4) High SMRs of coronary heart disease for both male and female were found in the areas where it is severely cold in winter and the number of physicians was insufficient for the population (Fig. 7, 11). Only low SMRs by public health centers revealed regional convergence significantly.

5) SMRs of liver cancer were generally low at all areas in Hokkaido, and regional convergence showed significantly low SMRs by public health centers. In contrast, only Hiroo public health center gave very high SMRs of liver cancer.

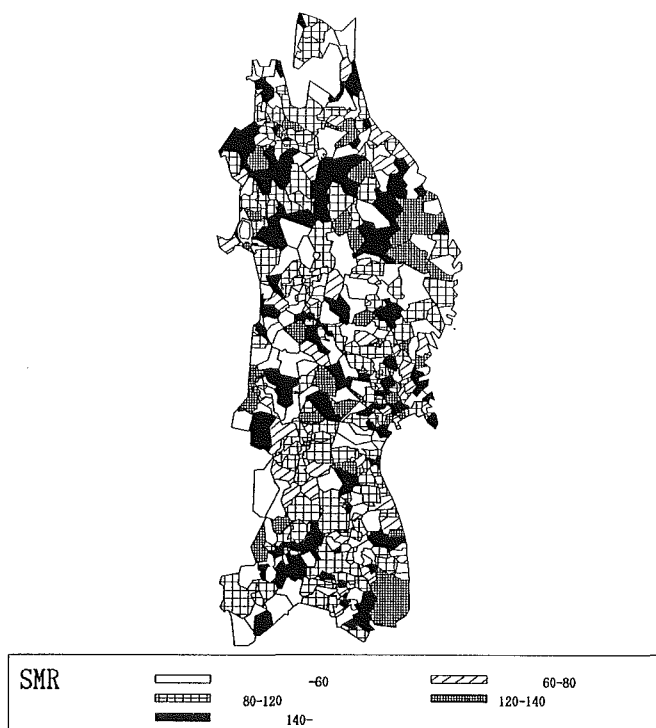


Fig. 8 The map of municipalities in Tohoku district showing distributions on SMRs of female lung cancer(1970s).

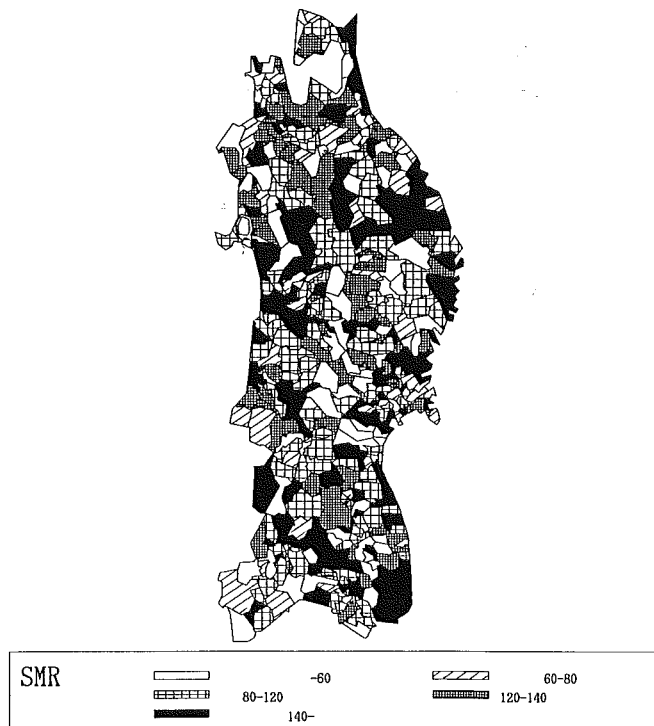


Fig. 9 The map of municipalities in Tohoku district showing distributions on SMRs of female lung cancer(1980s).

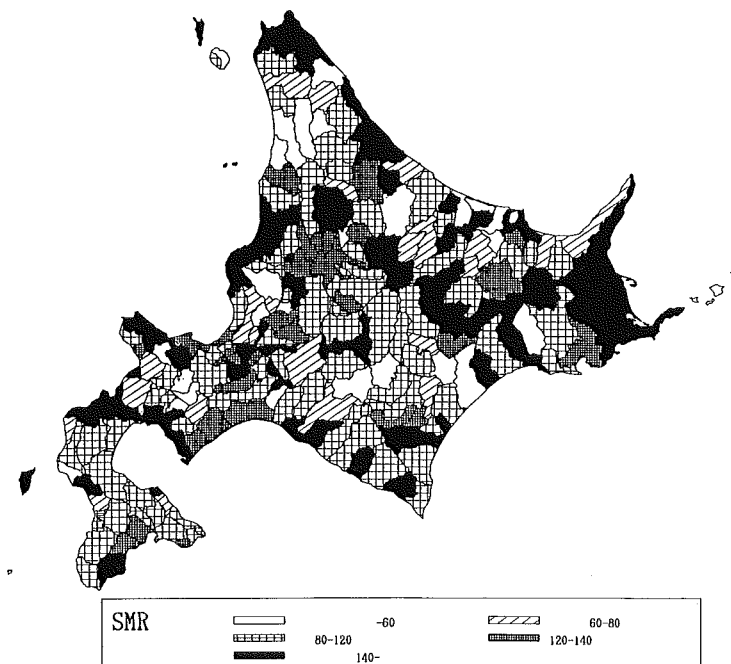


Fig. 10 The map of municipalities in Hokkaido showing distributions on SMRs of female lung cancer(1980s).

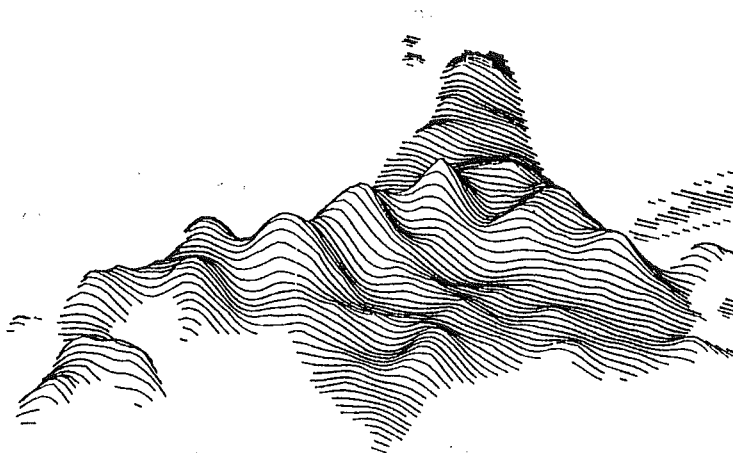


Fig. 11 The map of a bird's-eye view showing regional distributions on SMRs of male coronary heart disease.

4. Discussion

1) When the incidence of a disease is high (low) and the number of those who die of the disease is large (small) in an area, several factors are considered. The factors include :⁶⁾

- (1) high or low incidence of the causes of the disease,
- (2) high or low hereditary sensitivity of the population to the disease,
- (3) environmental factors which accelerate or suppress the occurrence of the disease²⁾.

If the areas where the incidence of a disease is high are extracted by the analysis of the regional difference of incidence, it may be possible to find out any clue to clear these factors. In addition, for a disease which can be rather effectively prevented by prophylactics, it is possible to suggest the areas where prophylactics are particularly required³⁻⁴⁾. Here, many reports have discussed the high death standards of gastric cancer in the areas along the Japan Sea in relation with eating habits. Much is expected in the epidemiological study which is to be made in Mashike-cho where SMRs hardly change all around the year. With cerebral vascular disease, it was found that mortalities were high in the northern continental areas at the side of the Japan Sea, and that they were low in Tokachi. These areas belong to the severely cold areas and the former area has heavy snowfalls in winter. In the former area agriculture and forestry are the chief industries while in the latter dairy farming is dominant. The differences of the fundamental industries or the customs in life may be attributed to the regional difference. It is also thought that the factor such as the delayed prophylactics including primary care at the occurrence of cerebral vascular disease should be discussed.

With heart disease, the matter is quite similar to cerebral disease. With lung cancer, common factors among the background of life of the fishermen should be investigated, for its SMRs were high in the municipalities with harbors²⁾.

2) It is epidemiologically significant to observe and understand standardized mortalities of main diseases by municipalities as a regional pattern under logic conditions by use of the GMAP procedure in SAS/GRAPH. It can be expected to have chances to obtain novel findings by arranging surface and prism functions in the GMAP procedure⁵⁾.

5. Conclusions

We tried to prepare a map showing the geographical distributions of standardized mortalities of main diseases in 863 municipalities of cities, towns and villages in Northern Japan by use of the computer graphics procedure in SAS/GRAPH system. Regional convergence could be found for the deaths due to gastric cancer, lung cancer, cerebral vascular disease and coronary heart disease in northern Japan, suggesting the necessity of future studies of the factors causing regional difference such as customs in life and hereditary sensitivity of the populations. Three dimensional of surface and prism functions were found to be quite effective for our epidemiological observations and to be superior to a conventional choro function by manual script.

6. References

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