Geographic Distribution of Mortality Rate from Cerebrovascular Disease in European Countries

Eiji Takahashi

Department of Hygiene (Prof. E. Takahashi), Tohoku University School of Medicine, Sendai

For an epidemiologic approach to the etiology of cerebrovascular disease by comparing with that of arteriosclerotic and degenerative heart diseases, the latest regional data for mortality from those diseases were collected from most European countries in 1964. The peculiar gradient of the mortality rate distribution in the respective countries is interpreted by physicochemical factors of natural environment such as climate, geology and character of water, and the socio-economic factors such as urban-rural residency, status of agriculture and industrialization, and local dietary habits. As a result, the effect of calcium and vitamin deficiencies is epidemiologically suggested for the development of cerebro-vascular disease.

The investigation of the geographic distribution of mortality for a specific disease is useful as a means of an epidemiologic approach to the etiology of the disease. Although international differences in mortality rates for some specific causes of death might be partly due to variation in the customs of death certification, because the medical communities of different countries sometimes have different attitude for some diseases, regional comparison of the death rate within the same country reduces much of the error of this kind. A discovery of the simultaneous tendency in the geographic distribution of the mortality rate will contribute to an approach to the etiology.

Japan, having the highest death rate from cerebrovascular disease, shows a peculiar geographic distribution of mortality from the disease. To interpret such a peculiar geographic distribution of the mortality, a number of hypotheses might be advanced. However, such hypotheses might not be always applicable to other countries, where the background of modus vivendi is radically different. Even if in cases where a hypothesis is inapplicable to another country, the hypothesis should not be simply discarded but thoroughly examined in different countries having conditions similar to the one, where it proves to be of value. Such kinds of non-infectious disease as cerebrovascular disease and arteriosclerotic or degenerative heart disease seem to be multifactorial in their etiology. And it is probable that under a certain condition one factor might be a dominant cause of the frequent occurrence of the disease, but under another condition in different countries
another factor might be more important.

For an epidemiologic approach to the etiology of cerebrovascular disease by comparing with that of arteriosclerotic and degenerative heart disease, the latest regional data of the mortality from those diseases were collected from most European countries in 1964. In the present paper, in order to find a rule in the geographic distribution of mortality within the countries, data from 18 countries are used, and factors influencing the geographic distribution of the diseases are discussed.

Many factors might be considered to be plausible reasons for the present status of the geographic distribution of mortality from vascular lesions affecting the central nervous system (VLCNS) and arteriosclerotic and degenerative heart disease (ASDHD): physico-chemical factors of natural environment such as climate, nature of the ground, and the composition of drinking water and food; and socio-economic factors such as the population density of the location, urban-rural residency, regional status of agriculture and industrialization, and local dietary habits.

Concerning the climate, the following factors are taken into consideration: latitude of the location, distribution of land and water, sea current, and not only outdoor temperature but also indoor temperature as an effective factor of micro-climate. On the effect of the chemical composition of drinking water to the mortality due to VLCNS and ASDHD, studies of Kobayashi, Schroeder, and Morris et al. are supplemented by a new information of Biörck et al.

Besides the chemical composition of drinking water, the mineral content of the diet should be considered factors concerning some causes of those diseases. Formerly the author made an international comparison of mortality from VLCNS and ASDHD in connection with the dietary consumption of food stuffs. A correlation coefficient was calculated between the national food supplies and mortality rate for VLCNS and ASDHD in 20 Western countries. A significant positive correlation was found between consumption of cereals and the death rate from VLCNS in both males and females, and a negative correlation between consumption of fats and oils and the death rate from the disease in males. A positive correlation of consumption of sugar and syrups and a negative correlation of consumption of potatoes and other starchy roots were found with the ASDHD death rate.

However, these are the results of an international study, and in most countries there are some regional differences in the causes of the mortalities. In the present paper the common tendency of the geographic distribution of the VLCNS mortality rate within each country is investigated and compared with that of the mortality from ASDHD.
Mortality Rate from Cerebrovascular Disease

Fig. 1. Death rate for cerebrovascular disease (B22) of 45–64 year age group in the United Kingdom, 1960.

Fig. 2. Death rate for arteriosclerotic and degenerative heart disease (B26) of 45–64 year age group in the United Kingdom, 1960.

Present Status in European Countries

United Kingdom (Figs. 1 and 2)

Statistical data of England and Wales and of Northern Ireland for 1960 and of Scotland for 1961 are used for computing the regional death rate from VLCNS and from ASDHD for the age group 45–64 years by sex. England is administratively divided into 9 regions: Northern, East and West Ridings, Northwestern, North-Midland, Midland, Eastern, London and Southeastern, Southern and Southwestern. Wales and Northern Ireland are treated as a single region. Scotland is divided into 3 regions: Northwestern, Eastern and Southern. The borderline between the Northwestern and Eastern divisions coincides with the eastern borderline of Inverness and Argyll counties; the borderline between the Eastern and Southern divisions is on a line combining Firth Clyde and Firth of Forth.

In England, both death rates for VLCNS and ASDHD are low in the southeastern part and high in the northwestern part as shown in Figs. 1 and 2. The mortality for VLCNS is relatively high in Wales, northern England and southern Scotland in both males and
females. For males, northwestern Scotland shows the highest mortality, although eastern Scotland shows a relatively low mortality as well as northern Ireland. For females, the mortality in northwestern Scotland is not so high, and rather lower than that in southern Scotland and northern Ireland as well as in eastern Scotland.

The mortality for ASDHD is higher in Scotland and in northern Ireland than in England and Wales in both males and females; for males, southern Scotland has the highest rate.

Fig. 3. Death rate for cerebrovascular disease (B22) of 45–64 year age group in Ireland, 1960.

Fig. 4. Death rate for arteriosclerotic and degenerative heart diseases (B26) of 45–64 year age group in Ireland, 1960.

Ireland and Northern Ireland (Figs. 3 and 4)

As the data for computing mortality from VLCNS and ASDHD for the age group 45–64 years in Ireland and British Northern Ireland, the number of deaths registered in 1960 and 1961 and population by census in 1961 are used. In this study, Ireland is divided into 8 regions and examined for the geographic distribution of the mortality.

Generally speaking, there is a tendency that the death rates from both VLCNS and ASDHD are high in the east coast region and relatively low in the west coast regions, as Acheson and Thornton and Acheson stated. In detail, the mortality from VLCNS in males is rather lower in the middle regions (Laois, Offaly and Tipperary North) than in both coast regions; but for females the mortality in the west coast regions is the lowest. In most regions the mortality is rather high in females than in males, as Acheson reported. The mortality from ASDHD in British Northern Ireland is the highest in males, and the difference of the mortality by urban-rural residency is remarkable, as shown in Fig. 34. The mortality rate of urban males of 45–64 years is higher than rural males of the same age group by 60%.

Norway (Figs. 5, 6, 7 and 8)

For the study of the geographic distribution of the mortality rate for VLCNS and ASDHD in Norway, the standardized death rate of the 40–69 year age-group in 1959–1962 prepared by the government is used. The territory is divided into 5 administrative regions: East, South, West and North countries and Trøndelag.

As shown in the Fig. 5 the death rate from VLCNS is low in the South country and
Fig. 5. Standardized death rate for cerebrovascular disease (B22) of 40–69 year age group in Norway, 1959–1962.

Fig. 6. Standardized death rate for arteriosclerotic and degenerative heart disease (B26) of 40–49 year age group in Norway, 1959–1962.

Fig. 7. Comparison of standardized death rate for cerebrovascular disease of 40–69 year age group by divisional population density in Norway, 1959–1962.
high in the North country. Also the mortality from ASDHD is high in the North country in both sexes. However, the mortality in males is low not only in the South country but also in Trøndelag and in the West Country, and in females these two countries show a rather high mortality.

In the mortality of ASDHD, as shown in Fig. 8, there seems to be a difference by urban-rural residency in each country. According to the Norwegian governmental statistics, a densely populated municipality shows a higher death rate than a sparsely populated

![Fig. 8. Comparison of standardized death rate for ASDHD of 40–69 year age group by divisional population density in Norway, 1959–1962.](image)

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**Fig. 9. Standardized death rate for cerebrovascular disease (B22) of all ages in Sweden, 1959–1962.**
mortality by urban-rural residency is not found for the mortality from VLCNS.

**Sweden (Figs. 9 and 10)**

Standardized mortality rates of VLCNS and ASDHD in 1959–1962 prepared by the government are used to study the geographic distribution of the mortality rate in Sweden. The whole territory is administratively divided into 25 areas.

As shown in the figure, the tendency is apparent that the death rate for VLCNS is densely distributed in the northern area and dilutely distributed especially in the southern coast area in both males and females. The general tendency of the mortality distribution of ASDHD is similar to that of VLCNS, except for the male mortality rate in the capital, Stockholm.

**Finland (Figs. 11 and 12)**

The territory of Finland is divided into 7 regions in this study: northern (Lapin lääni and Oulun l.), eastern (Pohjois-Karjalan l. and Kuopion l.), southeastern (Kymen l. and Mikkelin l.), western (Vasaan l. and Keski-Suomen l.), middle (Hämeen l.), southwestern (Turun ja Porin l. and Ahvenanmaa) and southern (Uudenmaan l.). To compute the regional mortality rates for VLCNS and ASDHD of 45–64 year age group, census population of 31st December 1960 and number of deaths in 1962 are used.

For males, the death rate from VLCNS is high in the eastern inland area and low in the southwestern coast area. For females, the geographic distribution of the mortality is a little different from that of males; the northern area is the highest, and the eastern area is rather low. However, the death rate is low in the southwestern and southern coast areas in both males and females, particularly in the islands of the southwestern part (Ahvenanmaa), though the population is small.

As regards the difference by urban-rural residency in males, the death rate is lower in rural areas (124.7) than in urban areas (136.8), but in females the relation is reversed, the death rate is a little higher in rural areas (121.1) than in urban areas (116.3).

The death rate from ASDHD is high in the northern and the northeastern area and low in the southwestern area. The southern capital area shows a little higher mortality than the west coast area. For the difference by urban-rural residency over the whole country, urban inhabitants (male 710.8; female 162.7) show a little higher death rate than rural inhabitants (male 626.4; female 152.1). It is peculiar that in the northern area the death rate is very high in males, but much lower in females.
Fig. 11. Death rate for cerebrovascular disease (B22) of 45–64 year age group in Finland, 1962.

Fig. 12. Death rate for arteriosclerotic and degenerative heart disease (B26) of 45–64 year age group in Finland, 1962.

Fig. 13. Comparison of death rate for cerebrovascular disease (B22) and arteriosclerotic and degenerative heart disease (B26) among 3 areas by geographic division in Denmark, 1961.

M: Male,  F: Female; A area: Capital (Kopenhagen) and suburbs.  B area: Islands and coast area of the eastern part of Jutland.  C area: Inland area, i.e., other parts of Jutland.
Denmark (Fig. 13)

Although the territory of Denmark is administratively divided into 10 areas, a division into 3 areas is adopted in this study. A: the capital and its suburbs; B: island and coast area, including the eastern part of Jutland; C: inland area, i.e., northern, western and southern parts of Jutland. The death rates from VLCNS and ASDHD for the 45-65 year age group are used.

In comparison of the 3 areas, capital area (A) and inland farm area (C) show a higher mortality for VLCNS than the island and coast area (B), in males. In females, the capital area shows a rather lower mortality than other areas. The mortality from ASDHD in the capital area is not higher than in other areas, and rather lower than in island and coast areas. This is a different tendency of the geographic distribution of the mortality from that in Sweden and Norway.

Fig. 14. Crude death rate for cerebrovascular disease (B22) in the Netherlands, 1960-1962.

Fig. 15. Crude death rate for arteriosclerotic and degenerative heart disease (B26) in the Netherlands, 1960-1962.
The Netherlands (Figs. 14 and 15)

Figs. 14 and 15 show the geographic distribution of the crude death rate from VLCNS and ASDHD in 1960-1962 for 11 districts.

The Netherlands is a country of low mortality of VLCNS, especially in males. However, the mortality rate is relatively high in northeastern (Groningen) and southwestern parts (Zeeland). Neighbouring to these areas, middle-eastern (Drenthe and Ober-ijssel) and southern part (Noord Brabant and Limburg) show a low mortality in both males and females. As to ASDHD, those inland districts show a lower mortality than the coast area.

Fig. 16. Crude death rate of male and female for cerebrovascular disease (B22) and for arteriosclerotic and degenerative heart disease (B26) in Belgium, 1960.

Belgium (Fig. 16)

Fig. 16 shows the geographic distribution of the crude death rate of males and females for VLCNS and ASDHD in 1960. The territory of Belgium is administratively divided into 9 districts.

The mortality from VLCNS is densely distributed in the southern districts (especially in Namur) and dilutely distributed in the northeastern districts (Limbourg, Anvers and Brabant) which are neighbourhood of the low mortality area in the southern Netherlands (Noord-Brabant and Limburg). Also, the west coast district (Flanders occidatale) and the southeastern (Luxembourg) show a relatively low mortality rate.

The mortality rate from ASDHD is densely distributed in the southern industrial districts (Namur and Hainaut) bordering France, and dilutely distributed in the eastern inland districts (Limbourg and Luxembourg).

France (Figs. 17 and 18)

The main territory of France is administratively divided into 90 prefectures. On this study, however, it is divided into 18 blocs to make possible simple comparison of the geographic distribution of the death rate from VLCNS and ASDHD for 45-64 year age group in 1962. Each bloc contains 4 to 8 prefectures, except Paris and the surrounding suburban area (Seine and Seine-et-Oise) and Corsica, an isolated island prefecture.

The death rate from VLCNS in males is the highest in the Normandy bloc, and Brittany bloc is the next. The death rate is the lowest in Corsica, and is followed by that in Paris bloc, relatively low in the blocs of Ile de Paris et Champagne, Savoie et Dauphine, Provence and Pyrenees.

The death rate from ASDHD is the highest in Alsace et Lorraine bloc which borders
Mortality Rate from Cerebrovascular Disease

Fig. 17. Death rate for cerebrovascular disease (B22) of 45–64 year age group in France, 1962.

Fig. 18. Death rate for arteriosclerotic and degenerative heart disease (B26) of 45–64 year age group in France, 1962.

Germany, and that in the bloc of Artois et Picardie bordering Belgium follows. Both blocs are highly industrialized and densely populated. In males, the death rate is the lowest in Corsica, and the Atlantic side blocs (Bretagne, Anjou et Poitou, Orleanais et Berry, and Guyenne et Gascone) are the areas of low mortality from ASDHD.

Portugal (Fig. 19)

The crude death rate in males and females from VLCNS and ASDHD in 1960–1962 is used for this study. The territory is administratively divided into 18 districts.

The death rate from VLCNS is densely distributed in the middle western coast area (Coimbra, Leiria and Lisboa) and in the southern districts (Evora, Beja and Faro), dilutely distributed in the middle-eastern area (Guarda and Castelo Branco). The death rate from ASDHD is densely distributed in 3 isolated districts (Viseu, Evora and Lisboa). Lisbon, the capital district, is one of the highest mortality both for VLCNS and ASDHD.

Switzerland

Data received from Switzerland are not divided into regions. The death rate from VLCNS for the 45–64 year age group (male 68.6; female 57.3 in 1960) is rather lower than in the surrounding countries, though the bordering regions of neighboring countries
generally show lower mortality than the average of respective countries (for instance: Savoie et Douphine in France, Valle d’Aosta in Italy, and Tyrol in Austria).

The death rate from ASDHD (male 254.3; female 98.6 in 1960) is fairly high in Switzerland compared to that in France, but lower than in Germany and Austria.

**Germany (Federal Republic) (Figs. 20 and 21)**

Figures of regional distribution of mortality from VLCNS and ASDHD are drawn from the data of deaths in 1960–1962 and of population at the census of June 6, 1961, for 45–64 year age group. The territory belonging to the Federal Republic is administratively divided into eleven districts. However, in this study Bremen is included in Niedersachsen and West Berlin is omitted in the figure. In the Fig. 20 and 21, divisions are shown: Schleswig-Holstein, Hamburg, Niedersachsen, Nordrhein-Westfalen, Hessen, Rheinland-Pfalz, Baden-Württemberg, Bayern and Saarland.

One of the characteristics of regional distribution of mortality from VLCNS in the Federal Republic is that the death rate is lower in the northern regions (Schleswig-Holstein, Hamburg and Niedersachsen) and higher in the southern regions, especially, in the southwestern part neighbouring France and Luxemburg the death rate is the highest (Rheinland-Pfalz and Saarland). Also the males of West Berlin show a higher mortality.
Fig. 21. Death rate for arteriosclerotic and degenerative heart disease (B26) of 45-64 year age group in Germany (Federal Republic), 1960-1962.

from VLCNS (males 122, females 77, in 1960-62). The geographical gradient of mortality for VLCNS from the dilutely distributed northern regions to densely distributed southwestern regions is not steep.

The geographic distribution of the death rate from ASDHD shows a far different figure from that of VLCNS. The death rate is high in both males and females in Nordrhein-Westphalen, a highly industrialized and very densely populated region. The death rate in males from the disease is higher in West Berlin (males 428, females 112 in 1960-62) than in Nordrhein-Westphalen, which is not shown in the figure. The death rate is low in both males and females in Niedersachsen and Baden-Württemburg.

**Austria (Fig. 22)**

Death rates from VLCNS and ASDHD for the 45-64 year age group are computed from data of the capital Vienna and 8 provincial districts in 1961.

Fig. 22. Death rate for cerebrovascular disease (B22) and arteriosclerotic heart disease (B26) of 45-64 year age groups in Austria, 1961.
The death rate from VLCNS is relatively high in the northern plain area along the Danube (Upper and Lower Austria and Burgenland), especially in males, and relatively low in the southwestern, mountainous area (Salzburg, Styria and Tyrol). Also the bordering areas of the neighboring countries (Bayern, Switzerland and Trentino Alto Adige) show relatively low mortality from the disease.

In males, the death rate from ASDHD is the highest in the capital Vienna, and the surrounding district (Lower Austria) follows this trend. In females, the capital and the surrounding district do not show a high death rate.

**Czechoslovakia (Fig. 23)**

The death rates from VLCNS and ASDHD of each 5-year age group from 45 to 64 in 1960 are given for two regions of Czech and Slovak. The Czech region, more industrialized than the Slovak region, shows a little lower mortality for VLCNS, but remarkably higher mortality from ASDHD in every 5-year age group in both males and females than in the latter region, as shown in Fig. 23.

**Hungary (Fig. 24)**

Crude death rates of VLCNS and ASDHD are given for 19 provincial districts including 4 cities and the capital in 1961.

The mortality from VLCNS is low in the northern part, especially in the north-central,
Mortality Rate from Cerebrovascular Disease

Fig. 24. Crude death rate for cerebrovascular disease (B22) and arteriosclerotic heart disease (B26) in Hungary, 1961.

Fig. 25. Death rate for cerebrovascular disease (B22) of 60–64 year age group in Yugoslavia, 1962.

Fig. 26. Death rate for arteriosclerotic and degenerative heart disease (B26) of 60–64 year age group in Yugoslavia, 1962.
most industrialized area (Komarom and Nógrád) in this country, and in the northeastern farm area (Szabolcs-Szatmár, Borsod-Abauj-Zemplén and Hajdu-Bihar) in both males and females, higher in the southeastern (Bekes, Csongrád and Szolnok) and southwestern (Somogy, Tolna and Baranya). The mortality in the capital and 4 cities is generally not higher than in the surrounding districts with the exception of Szeged.

A similar tendency of geographic distribution of the mortality is also found in case of ASDHD. The death rate is higher in the southern area, and highest in the southeastern (Bekes). Although this is a similar farm area, the northeastern district (Szabolcs-Szatmár) shows a lower mortality from VLCNS and ASDHD in both males and females than in most other districts.

**Yugoslavia (Figs. 25 and 26)**

Figs. 25 and 26 show the geographic distribution of the age-specific death rates for VLCNS and ASDHD in the 60-64 year age group. The whole territory is divided into 8 regions: Slovenia, Croatia, Bosnia and Hercegovina, Montenegro, Vojvodina, Serbia (including Serbia proper), Kosovo and Metohija, and Macedonia.

In males, the death rate from VLCNS is densely distributed in the northern part especially in Slovenia and in Vojvodina. In the latter region the female death rate is also high as well as in Macedonia. Montenegro has the lowest rate in both males and females. The death rate from ASDHD is dilutely distributed in the mountainous regions facing the Adriatic Sea: Croatia, Bosnia and Hercegovina, and Montenegro. The death rate is high in the eastern plain regions along the Danube and its branches, c. more densely populated area: Servia, Kosovo and Metohija, and Vojvodina.

**Italy (Fig. 27)**

Although the data given are only the crude death rate in both sexes in 1961, the geographic distribution of the mortality from VLCNS and ASDHD in Italy is epidemiologically interesting.

The crude death rate of VLCNS is densely distributed in the northern and central parts of the territory and dilutely distributed in the southern part of the peninsula and in the islands of Sicily and Sardinia. In detail, the death rate is relatively high in the northwestern

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Fig. 27. Crude death rate for cerebrovascular disease (B22) and arteriosclerotic and degenerative heart disease (B26) in Italy, 1961.
region bordering France and Switzerland (Piedmont), though in the mountain areas of the Alps (Valle d’Aosta, Trentino-Alto Adige) it is rather low as well as in the northeastern region bordering Yugoslavia (Friuli-Venezia-Giulia). The death rate is densely distributed in the central regions (Toscana, Umbria, Marche, Abruzzo and Molise), especially in Umbria where it is the highest. The plain regions of the Po basin (Lombardia, Veneto, Emilia-Romagna) show a lower death rate than in the central regions.

The geographic distribution of the mortality from ASDHD seems to roughly coincide with that from VLCNS showing a tendency of being high in the northern regions and low in the southern regions. In detail, however, the mortality distribution of ASDHD is a little different from that of VLCNS. The mortality rate of ASDHD in the central regions is rather low, contrary to that of VLCNS.

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**Greece (Figs. 28 and 29)**

Figs. 28 and 29 show specific death rates VLCNS and ASDHD for 5-year age groups from 45 to 64 by urban-rural residency in Greece calculated from the data of deaths in 1960–1962 and that of the population census of March 19, 1961. Four groups are made by resident areas, capital area, urban area (including the capital), semi-urban area and rural area.

In both males and females, the death rate of VLCNS is the highest in the capital area and the lowest in the rural area. Urban and semi-urban areas are intermediate in all the 4 age groups. The same tendency is also found in the mortality of ASDHD. For males, the difference of the mortality by residence area is larger than that of VLCNS, and the
mortality seems to be in direct proportion to the density of the area’s population. For females, the mortality is generally low and the curve is irregular in the semi-urban area.

**Relation to Environmental Factors**

In general, the geographic distribution of the mortality rate from both VLCNS and ASDHD shows a density gradient from one region to another within a country, though the former seems to be more continuous than the latter. For instance, in Germany the gradient of the mortality rate of VLCNS is from Rheinland-Pfalz (high) to the North Sea coast Schleswig-Holstein (low), but the continuity of the mortality rate of ASDHD is rather indistinct.

Such tendency of the gradient in the geographic distribution of the mortality rate should be investigated in connection with environmental factors such as physical and socio-economic: latitude and natural climate, nature of the ground and character of the water, urban-rural residency, civilization and industrialization, topography and alimentary habits, *etc.*

1) **Latitude and natural climate**

The climate of a location depends usually on latitude. In Scandinavian countries which are a long-stretched territory from north to south show more or less such a tendency that the mortality rate from VLCNS and ASDHD are distributed with a gradient from the northern region to the southern region. The same is true in England.

This characteristic seems to be similar to that in Japan where the northeastern part of the main island shows the highest death rate from VLCNS (Figs. 30 and 31). Formerly Takahashi and his colleagues interpreted the peculiar geographic distribution of the mortality as partly being due to environmental low temperature in winter, especially low indoor temperature, which raises the arterial pressure and makes stress *in vivo* as a long-term effect. In the Tohoku area, the northeastern farm area of the main island of Japan, inhabitants do not usually use stoves for heating their houses and are exposed to low temperatures below 10°C during long winter. It is clear that exposure to a cold environment physiologically contracts the peripheral arteries, and that repeated exposure to a cold environment eventually leads to sustained hypertension. Not only the direct effect of the cold environment but also the indirect effect of increased weight of their winter clothing and of increased calorie intake and so on should be considered. The close relation between hypertension and cerebrovascular lesions is well known. But the reason why in Hokkaido, the northern island of Japan, where the temperature is lower than the main island, the death rate from VLCNS is lower than in Tohoku area is partly interpreted by the fact that in Hokkaido almost every house is heated by stoves and the indoor temperature in winter is decidedly higher than in the Tohoku area.

Of course, such a specific tendency in Japan is not to compare with the situation in Western countries where most nations usually have good heating facilities in winter.
In Norway the difference of annual average temperature is not so large as expected from its latitude, because of the influence of the Gulf-Stream, as it is the case with the United Kingdom and Ireland. But, in the inland area of Sweden and Finland the difference between the annual temperature in the northern and southern part is a little larger. The effect of the difference in the natural climate between northern and southern regions of Scandinavian countries is regarded as a factor having some influence on the north-south gradient of the mortality from VLCNS and ASDHD in these countries.

In the other countries of Europe, the effect of the natural climate on the geographic distribution of the death rate is less significant, as pointed out in the United States by Stallones. As for the north-south gradient of the mortality
rate distribution in Italy, other factors might also be important beside the natural climate as stated later. In Germany, no gradient of average temperature is found between the northern and southern regions, and the average temperature is rather slightly higher in the north than in the south.

Another evidence of the effect of climate on the mortality of VLCNS and ASDHD is the seasonal variation of the death rate from these diseases, which is usually recognized in most countries. One of the reasons for greater amplitude of the seasonal variation of the mortality in Japan is large fluctuation of temperature between hot summer and cold indoor environment in winter.

2) Geology and character of water

Some relation is found between the geographic distribution of the mortality from VLCNS and ASDHD in European countries and that of the geologic constitution. For the study of the nature of the ground in European countries, the atlas of geology in the Physicogeographical World Atlas compiled by the Academy of Sciences of Soviet Russia was used. Table 1 shows an outline of the geological classifications.

In England, a geological gradient is found from the southeastern part to the northwestern, as shown in Fig. 32. The former consists of comparatively new

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![Fig. 32. Geological distribution in Great Britain and Ireland. (Roughly sketched from Russian Atlas (1964).)]
strata such as Cretaceous and Paleogene Tertiary, and the latter consists of older strata through Jurassic and Triassic to Palaeozoic such as Permian, Carboniferous and Devonian. Wales, Ireland and Scotland consist of still older strata such as Silurian, Ordovician, Cambrian and Precambrian. In England and Wales, the gradient of the geographic distribution of the mortality rate from VLCNS and ASDHD is associated to the distribution of the pattern of geological constitution, though in Ireland and in Scotland, which also have Paleozoic Plutonic rocks, the relation is not always distinct.

It might be assumed that old strata are more deficient in minerals than modern strata, where the superficial ground has been washed out by precipitation for several hundred million years longer. If some minerals in drinking water are effective in preventing VLCNS and ASDHD, there might be found a parallelism between the geographic distribution of geological strata and that of the death rate of these diseases.

Cretaceous stratum, which contains more calcium than other strata, is found from southeastern England across the Strait of Dover to northern France. In France, the nature of the ground in the north-western regions (Normandie, Bretagne, Maine and Anjou) and the middle mountainous regions (Bourgogne, Auvergne and Marche et Limousin) are markedly different from that of the northern area, as seen in Fig. 33. These regions as well as Corsica and Sardinia are covered by older strata containing Paleozoic Plutonic rocks. Normandy and Brittany are higher in mortality from VLCNS than the northern region around Paris. A similar relation as seen in England between the geological constitution and the death rate from VLCNS is found also in France, with the exception of Corsica.

Fig. 33. Geological distribution in Europe. (Roughly sketched from Russian Atlas(1964).)
The area of the east side of the Rhone (Savoie et Dauphine) as well as the north foot of Pyrenees, Sicily and northern regions of Germany consists of Neogene Tertiary, and these areas mostly show a low mortality from VLCNS and ASDHD.

In Germany, the geological gradient is roughly parallel to the distribution of the death rate of VLCNS from north to southwest, though an exception is found in Westphalia where the ground consists of Cretaceous and the death rate from VLCNS is higher.

The Scandinavian Peninsula and Finland dominantly consist of old strata (Precambrian Stratum of sedimentary and Plutonic rocks, and Silurian). Only the southern point of Sweden (Malmöhus county), where mortality rates from VLCNS and ASDHD are low, consists of Cretaceous, and consequently water-hardness especially calcium content of drinking water is the highest in this area. The Cretaceous stratum continues across the strait to the eastern part of Zeeland (Sjaelland) and Lolland (Lolland) of Denmark, an area which shows a lower death rate from VLCNS in males, and the northern part of Jutland. Other areas of this country consist of Neogene and Paleogene Tertiary.

The drainage basin of the downstream of the Rhine, the Garrone and the Po consist of Quarternary Stratum as well as that of the middle stream of the Danube. In Yugoslavia, where the Dalmatian coast is mainly covered by Cretaceous, the main part of the Dinaric Alps consists of Mesozoic Stratum of Triassic and ultrabasic Plutonic rocks, and the drainage basin of the Danube and the Sau consists of Quarternary. The association between geologic constitution and the death rate from VLCNS is not always evident in this country. Most of Italy is covered by Cenozoic, except for Sardinia. The parallelism between the geological nature of the ground and the death rate is not found in Italy. Eventually, the presumption of such parallelism is permissible in some countries, but not in other countries where different factors may be dominant.

In Japan, another factor seems to be more important. The Tohoku Area, the northeastern region of the main island, which has the highest death rate from VLCNS, consists mainly of Cenozoic strata (Quarternary, Tertiary) and Plutonic rocks. On the contrary, the southwestern regions containing two island surrounding the Inland Sea, where the death rate from VLCNS is lower than the northeastern region, consists mainly of rather old strata such as Mesozoic, Palaeozoic and Precambrian. One of the major differences between Japan and the Western countries is that the largest part of the agricultural area in Japan is occupied by rice paddy fields and the superficial ground has been washed out for thousands of years. The Tohoku Area is the rice-granary of Japan and the ground is deprived of alkali reserve and tends to be acid. Moreover, in this area there are many acid hot springs (mostly sulfuric) and river water tends to be acid.

According to Data of Geochemistry, if minerals are contained in a high concentration in river and lake water in Europe, they are generally of predominantly calcium bicarbonate type.

In England, the concentration of dissolved solids, especially of calcium, in river
water is higher in the south-eastern part and lower in the north-western part, and its distribution is roughly parallel to that of the geology of the region. Both total dissolved solids and calcium bicarbonate are higher in England than in Scotland and Ireland where the ground is older than in the former.

In France, among the four big rivers the Seine contains the highest total dissolved solids and calcium (74 ppm at Berry). The Rhone, especially its branch from Lake Leman, contains a higher calcium content (45 ppm at Geneva) and other solids than the Garrone and the Loire. Evian water contains 78 ppm of calcium. The Rhine and the Danube have practically the same quantity of calcium of about 50 ppm in their upper streams.

The fact that the big rivers rising in the Alps and Jura Mountains contain a large amount of dissolved solids such as calcium seems to be natural because these mountains consist of younger strata. On the contrary, most of the Scandinavian Peninsula and the northwestern part of the British Isles consist of older strata, and their rivers and lakes mostly have an only small amount of dissolved solids such as calcium. Most Japanese rivers contain under 20 ppm of calcium. Especially, those in the Tohoku Area, northeastern part of the main island, where the death rate from VLCNS is the highest, mostly contain calcium in a quantity less than 10 ppm.

Kobayashi, who analysed the chemical ingredients of water of more than 600 rivers in Japan, suggested that the geographical distribution of $\text{SO}_4/\text{CO}_3$ ratio in the dissolved solids of river water in Japan is proportional to that of the death rate from VLCNS. In water $\text{CO}_3$ exists mostly as $\text{CaCO}_3$. Later, Schroeder found highly significant correlations between the average hardness of drinking water and mortality from cardiovascular disease in different states and larger cities of the United States. Morris et al. recognized a significant negative correlation between the hardness of local water-supplies in the 83 county boroughs of England and Wales and the cardiovascular death rate, especially of VLCNS and myocardial degeneration. Correlations of these cardiovascular mortalities to calcium content of drinking water were found specifically high. Recently, Biöck et al. found a highly significant negative correlation between calcium ion concentration of drinking water and the death rate from myocardial degeneration in 29 Swedish towns; a probably significant correlation between the ion content and the death rate from VLCNS is found only for the 45-64 year old female group. In the department of the author, Kamiyama et al. tried a long term experimental study of 24 months on the effect of calcium deficient diet on rats and found histopathological changes only in the heart and the brain, but not in the liver, kidney or spleen, etc. Significantly higher incidence of myocardial degeneration was found in the calcium deficient group than in the control group, and a slight difference was found in the incidence of scattered softening foci of status spongiosus accompanied with glia cell swelling in the diencephalon of the animals, though the arteriosclerotic changes were not ascertained.

The relation between chronic calcium deficiency and myocardial degeneration
seems to coincide in the results of some research workers. According to Acheson and Thornton,\textsuperscript{8} the mortality rate from myocardial degeneration shows little change for the period 1926-1956 in Ireland, notwithstanding the clear increase in the mortality due to coronary artery disease during the same period. The existence of the relation between chronic calcium deficiency and cerebrovascular disease is highly suspected specifically in Japan, which is known for relatively low calcium intake of the people not only from water but also from the diet.

With many new findings concerning the significance of calcium ion in the functional reaction of muscle and nerve tissues as well as of glands, a new conception seems to be developing that intracellular calcium release, especially transmembrane calcium influx, at conduction of stimulation is considered to be an active principle of the physiological transformation of stimulation in specific cell function.\textsuperscript{15}

3) Civilization, Industrialization and Socio-economical Status

(1) Urban-rural residency. No definite difference in mortality rate from VLCNS and ASDHD is found in Scotland among inhabitants of counties of cities, of large burghs and of counties without cities and large burghs, in 1961. But in Northern Ireland, the death rate in males from ASDHD is by 60\% higher in urban districts than in rural districts, and the death rate in females from VLCNS is by 49\% higher in urban districts than in rural districts as seen in Fig. 34. According to Acheson,\textsuperscript{9} in respect of cerebrovascular disease, the average standardized death rates for the period 1950-1955 tended to be higher in urban than in rural districts in Ireland. Coronary artery disease is more frequently certified as a cause of death in the boroughs of Cork, Dublin, and Dun Laoghaire than in any rural area; the
incidence of deaths attributed to this cause is much higher in rural areas in the east of the Republic than those in the west.\textsuperscript{8}

In Norway, the death rate distribution of ASDHD in males is regularly proportional to the population density, though it is not the same for VLCNS. Higher mortality from ASDHD in the North country might be due to its municipality population, if it is true that the northern countries have proportionally more town-dwellers than the southern countries. In Greece, the death rate seems to be regularly proportional to population density for both ASDHD and VLCNS. In Japan, according to the governmental life statistics special report,\textsuperscript{16} the death rate from VLCNS is by 5.6\% higher in rural areas than in urban areas, and from ASDHD by 1.4\%, lower, especially the death rate from arteriosclerotic heart disease only (420) is lower in rural areas than in urban area by 15.9\%, in 1960.

After all, a higher incidence of deaths in urban areas due to ASDHD, especially that of arteriosclerotic heart disease, seems to be a universal phenomenon, but in the case of VLCNS the relation is not always evident.

\textit{(2) Civilization and industrialization}. On the grade of civilization in Europe Huntington's map of civilization\textsuperscript{17} is referred to beside George's geographical books.\textsuperscript{18,19} Although the investigation was made in 1913, Huntington's map seems to be helpful in comparing the development of regional civilization within European countries where relatively little change has happened since World War I. People who were 10 years old in 1913 were 60 years old in 1963, and probably they lived under similar environmental conditions from their youth to middle or old age. Of non-infectious chronic diseases of adults such as VLCNS and ASDHD, environmental and living conditions from youth might be considered an etiological factor. Huntington indicated the development of civilization of a region with a score of one hundred as the full mark, which was given only to England in Europe. England and Wales, Scotland, Southern Norway, Southern Sweden, Denmark, Germany, Netherlands, Belgium, France (except the middle mountainous and south-western parts), Switzerland, north-western Italy, and Austria proper belonged to the highest class of civilization, i.e., 90 or more in score. Ireland, central mountainous and south-western France, central and northern Italy, Austrian Tyrol, Bohemia and Moravia, central part of Sweden and Norway, and southern Finland belonged to the second class of civilization with a score of 80s. Portugal, Southern Italy and Sicily, Greece, central-southern Finland and the central-northern part of Sweden and Norway belonged to the third class; Corsica, Sardinia, Servia and the Adriatic states of present Yugoslavia, middle Finland and the northern part of Sweden and Norway belonged to the fourth class of 60s.

Marked regional differences of civilization are not found in England. However, if there is a gradient of economic level from southeast to northwest, the distribution of the death rate of VLCNS and ASDHD is reversed to it. In France, industrialization is more advanced in the area around Paris, the northern region bordering Belgium, and the northeastern region bordering Luxemburg and Germany.\textsuperscript{18} Normandy and Brittany, where the death rate of VLCNS is high in the male, belong
to a less industrialized farm area producing cereals and cattle.20

The Czech region of Czechoslovakia, which is more industrialized than the Slovak region, has a little lower death rate from VLCNS and a higher death rate from ASDHD than the latter. The Hungarian government gave the author demographic data of Hungary on the social stratum of agriculture and industry, besides the mortality data. As shown in Fig. 35, the northern part, especially the north-central part, where the death rate from VLCNS is low, is more industrialized than other areas in this country. According to these data, there is apparently a rule that the distribution of the death rate of VLCNS is inversely related with the gradient of civilization, industrialization or economic level. However, the situation is reversed in other countries.

In Ireland, the eastern area around the capital, which seems to be more developed than the western area,9 has a higher death rate from VLCNS and also from ASDHD than the latter. The most industrialized state in the Federal Republic of Germany is Nordrhein-Westphalia, which is situated in the middle-western region. Although the state of the highest death rate from VLCNS in this country is Rhineland-Pfalz which borders on the former state, the distribution of the death rate seems to be roughly parallel to that of industrialization. Also in Austria, the death rate is lower in the Tyrol than in the northeastern plain area which is apparently more civilized than the former. Northwestern Italy, more industrialized, more civilized and economically higher than southern Italy, has a higher death rate from VLCNS than the latter.

Finally, no definite relation is found between the death rate from VLCNS and industrialization, civilization, or the economic level of the population.

The relation to the death rate from ASDHD seems to be a little different. In England, it is difficult to find regional differences of industrialization. However, if it is true that the northwestern region is more industrialized, the parallelism between the death rate and industrialization might be found also in this country. In higher industrialized regions, the ASDHD death rate is roughly higher in France, Germany, Austria, Czechoslovakia, Italy and Ireland. Of course, there are a few exceptions. In Hungary and in Scandinavian three long stretched countries, the death rate from ASDHD is parallel to that from VLCNS and in reversed relation to the regional industrialization. In these countries another factor may be more dominant. Considering the difference of the death rate by urban-rural residency, the relation between the death rate from ASDHD and industrialization, civilization or economic
Mortality Rate from Cerebrovascular Disease

TABLE 2. Cerebro-coronary mortality ratio* for 45-64 year age group in 1962

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Male</th>
<th>Female</th>
<th>No.</th>
<th>Country</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Japan</td>
<td>3.64</td>
<td>3.50</td>
<td>14</td>
<td>England &amp; Wales</td>
<td>0.24</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>Spain†</td>
<td>1.09</td>
<td>1.68</td>
<td>15</td>
<td>Ireland</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>3</td>
<td>Bulgaria‡</td>
<td>1.05</td>
<td>1.80</td>
<td>16</td>
<td>Finland</td>
<td>0.19</td>
<td>0.75</td>
</tr>
<tr>
<td>4</td>
<td>Greece</td>
<td>0.83</td>
<td>1.97</td>
<td>17</td>
<td>Germany</td>
<td>0.31</td>
<td>0.70</td>
</tr>
<tr>
<td>5</td>
<td>France</td>
<td>0.83</td>
<td>1.96</td>
<td>18</td>
<td>Sweden</td>
<td>0.23</td>
<td>0.70</td>
</tr>
<tr>
<td>6</td>
<td>Portugal</td>
<td>0.98</td>
<td>1.82</td>
<td>19</td>
<td>Scotland</td>
<td>0.22</td>
<td>0.61</td>
</tr>
<tr>
<td>7</td>
<td>Rumania</td>
<td>0.98</td>
<td>1.41</td>
<td>20</td>
<td>Netherlands</td>
<td>0.16</td>
<td>0.67</td>
</tr>
<tr>
<td>8</td>
<td>Poland</td>
<td>0.41</td>
<td>1.08</td>
<td>21</td>
<td>Belgium</td>
<td>0.21</td>
<td>0.61</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>0.49</td>
<td>0.88</td>
<td>22</td>
<td>Yugoslavia</td>
<td>0.48</td>
<td>0.57</td>
</tr>
<tr>
<td>10</td>
<td>Austria</td>
<td>0.34</td>
<td>0.89</td>
<td>23</td>
<td>Northern Ireland</td>
<td>0.23</td>
<td>0.59</td>
</tr>
<tr>
<td>11</td>
<td>Czechoslovakia</td>
<td>0.34</td>
<td>0.85</td>
<td>24</td>
<td>Switzerland</td>
<td>0.26</td>
<td>0.54</td>
</tr>
<tr>
<td>12</td>
<td>Norway</td>
<td>0.30</td>
<td>0.79</td>
<td>25</td>
<td>Denmark</td>
<td>0.17</td>
<td>0.53</td>
</tr>
<tr>
<td>13</td>
<td>Hungary</td>
<td>0.44</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) The ratio of the mortality of "vascular lesions affecting central nervous system" (B22) to "arteriosclerotic and degenerative heart disease" (B26).
†) 1961
‡) Age group of 40-64 years.
(Calculated from the data of World Health Statistics Annual, 1965)

status of the population is understandable.

To compare the distribution of the mortality from VLCNS with that from ASDHD, cerebro-coronary mortality ratio i.e., the ratio of deaths from VLCNS to those from ASDHD, is calculated for the 45-64-year age group for 24 European countries and Japan in 1962, using data from the World Health Statistics Annual,21 as shown in Table 2. In males, the ratio is larger than 1.00 only in Spain, Bulgaria and Japan; in females, Greece, France, Portugal, Rumania and Poland are further counted as the countries where the cerebro-coronary mortality ratio is over 1.00. According to the data reported directly from the governmental statistical office of each country to the author, females have a ratio over 1.00 in the Slovak region of Czechoslovakia. In Italy Umbria and surrounding districts of the middle region have a ratio over or near 1.00. In almost all districts of France females have a ratio over 1.00, and males also have a ratio higher than 1.00 in the area extending from Normandy, Brittany to Limousin, Auvergne and Gascony.

The country or region which shows the cerebro-coronary mortality ratio higher than 1.00 seems to belong to less industrialized farm areas.

4) Topography and alimentary habits

In general, there seems to be a tendency in mortality rate distribution from VLCNS and ASDHD that the death rate more dilutely distributes in the sea coast area than in the inland area. Such a tendency is found especially along irregular coast lines with rocky shores and many isles as in the southwestern part of Finland and in the Adriatic Sea coast of Yugoslavia. Contrary to that, in the area of regular coast lines with sandy beach as in the Netherlands, the death rate is not always lower than in the inland area.

In some groups of islands the death rates are still lower. The Aran Islands on
the Galway Bay of Ireland might be an example, as Acheson and Thornton* pointed out in detail. According to them "the population at risk is, of course, very small, and these comparisons should be treated with reserve, but the number of deaths reported on the island is, in fact, much lower than the 'expected' figures for both sexes and both notification groups", i.e., for arteriosclerotic heart disease (420) and other myocardial degeneration (422).

A tendency similar to that of the Aran Islands of Ireland is found in the Aland Islands (Ahvenanmaa) of Finland. Also in these islands, the population is too small for a reliable statistical comparison (the number of 45–64 year old males being 2,388, and that of females 2,650 in 1960). In Figs. 11 and 12 those islands are included in the southwestern region of this country. However, the death rates from VLCNS and ASDHD are fairly low, and are about 1/2 to 1/4 of that in the mainland regions.

When we further examine the relation of the islands of Corsica, Sardinia and Sicily with the mainland of the mother countries, it appears that there is a topographic potentiality of lower death rate from VLCNS and ASDHD in these islands where the coastal fishery supports poor inhabitants, though there are many other islands which do not always show low mortality from these diseases. A similar situation is found as regards the mortality from VLCNS in some islands of Japan.22,23

Within the Tohoku Area also, in the northeastern part of the main island of Japan, which shows the highest mortality from VLCNS in the entire country, fishing villages on the rocky coast of the Pacific side exhibit a lower death rate of the disease than in the inland farm area. Inhabitants in the fishing villages take less rice but more kinds of food than those in farm villages, and therefore the former are superior to the latter in their intake of protein, fat, calcium, iron and vitamins B-complex and C. Shallow sea especially at rocky shore harbors many kinds of edible sea products and they contain minerals of sea water in their body. For the inhabitants, various kinds of small fish, shellfish and seaweed provide a rich source of minerals such as calcium and vitamins.

On the contrary, farm-villagers take a large amount of polished rice with much salty 'miso'-soup but only a small amount of other side-dishes. Consequently, their vitamin intake is deficient. Especially noteworthy is the lack of B-complex, which are components of the enzymes or coenzymes necessary for oxidation and decomposition of overeaten carbohydrate in vivo. The intake of other vitamins and calcium is also insufficient. Deficiency of vitamin B-complex will cause an accumulation of intermediate products of carbohydrate metabolism, and it is probable that the pH range of body fluid declines to the acid side.

The hypothesis that high mortality from VLCNS in the Tohoku region of Japan is mainly due to an excessive intake of rice as well as much salt may not easily be accepted especially in the United States, where Kempner's rice-fruit diet therapy for hypertension is most common. However, 5,000 I.U. of vitamin A, 1,000 I.U. of vitamin D, 5 mg each of vitamins B₁ and B₂, 25 mg of nicotinic acid,
2 mg of Ca-pantothenate, and less than 1 g of sodium chloride are prescribed in this therapy, beside 2,000 Calories of energy, 20 g of protein and less than 5 g of fat from rice, a fair amount of sugar and fruit juice. Not only these vitamins are lacking in the diet of farm villagers in the Tohoku region of Japan, but salt intake exceeds 20 g a day.

In Ireland, in spite of decreasing death rate of VLCNS in most of the other European countries, the death rate has steadily increased in the last decade, as well as in Portugal. According to Acheson (private communication), 1965, 'in Ireland certainly many aspects of life have changed little over the past many hundred years, although the economic status of the country improved remarkably in the past decade and therefore things are changing rapidly. There is a good deal of fishing off the Irish coast and the classic diet consists of fish, seaweed, milk, eggs, potatoes, and oatmeal. Over the last thirty years of course wheat flour has become widely available and bread is now largely made from that cereal'. If calcium and vitamins, especially the B-complex, are factors effective for prevention of VLCNS, the classic breakfast of oatmeal with milk might be rather desirable than toast made from white wheat flour. Peoples tend to eat more cereals, when their income is low.

In Italy, the crude death rate from VLCNS is densely distributed in the north-western and central regions, and dilutely distributed in the southern region and the islands. The geological distribution is not an appropriate approach to the interpretation of the geographical distribution of the death rate in this country. Distribution of industrialization and civilization, which are more developed in the northern area than in the southern and island area, seems to be parallel to that of the death rate. However, the relations is opposite to the situation in the U.S.A., where the death rate from VLCNS is higher and industrialization and economic status is lower in the South than in the northern regions. Only one point on which Italy and U.S.A. coincide in the relation with the geographical distribution of the death rate from VLCNS is the geographical distribution of the prevalence of pellagra in the past.

Pellagra prevailed in Italy from the eighteenth century to the beginning of this century. In ‘Encyklopädie der Hygiene’ published in 1905, the spread of pellagra is described as follows: ‘Pellagra has prevailed in Italy, especially in northern Italy. In 1881, 104,017 pellagra patients were found in the whole Kingdom, in 1899, 72,603 patients were counted, and the most of them were found in Veneto and in Lombardy. It is remarkable that during 1881-1899 the pellagra patients decreased in Northern Italy and increased in the central region: Toscana, Latium, Umbria and March, where the number of patients were 1,278 in 1881 and increased to 6,082 in 1899. Pellagra patients are found not only in Italy, but also in Spain, Southern France, Austria, Rumania, etc. and also in Egypt. In Hungary the number of pellagra patients seems to be increasing’. These countries exhibit a high cerebro-coronary mortality ratio as seen in Table 2. Although pellagra is a disease caused by deficiency of nicotinic acid, it is quite possible that intake of other vitamins and calcium is also deficient in these regions where pellagra prevails.

The Japanese diet is deficient not only in vitamins but also in calcium, as is shown in the report of FAO/WHO Expert Group. Until quite recently the Japanese took under 400 mg of calcium per person a day. The nation had not a
custom of drinking milk. They depended too much on rice, which is practically lacking calcium as well as vitamins. After Meiji restoration of 1868, the nation gradually began to produce and drink milk, and since World War II the production and consumption of milk has steeply risen. Growth in height of school children has improved corresponding to the steep increase of milk production. According to the results of calculations of correlation coefficients between the height of secondary school pupils and monthly expenditures for 4 main foods, i.e., rice, meat and fish, milk and eggs, and vegetables, the coefficients are the highest for milk and eggs in 46 prefectures in Japan.31 There appears to be some association of stature with expenditures for meat and fish and vegetables, but this is not consistently significant in 4 subsamples. No significant correlation is found between stature and rice consumption. As a source of animal protein, meat and fish might be more important than milk and eggs. However, as a source of calcium, which is important to the growth of bones, milk and eggs are superior to meat and fish. Growth in height mainly depends on the development of long bones.

<table>
<thead>
<tr>
<th>Table 3. Correlation coefficients between death rate from cerebrovascular disease (VLCNS) and socio-economic and agricultural status by 46 prefectures in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>With</td>
</tr>
<tr>
<td>Socio-economic status, 1959</td>
</tr>
<tr>
<td>Quantities possessed per 100 households</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Agricultural status, 1960</td>
</tr>
<tr>
<td>Proportion of farm workers to total population</td>
</tr>
<tr>
<td>Total farm area per person</td>
</tr>
<tr>
<td>Estimated production of rice per person</td>
</tr>
</tbody>
</table>

The geographical distribution of the death rate from VLCNS in 46 prefectures in Japan correlates to that of the socio-economic status, when it is represented by the quantities of durable goods possessed per 100 households such as electric washing machines and television receivers, as seen in Table 3. The correlation with the geographical distribution of the death rate is also found with agricultural status, especially with estimated production of rice per person.

Fig. 36 shows the average stature of young men of conscription ages in 1928, 1930, 1932, 1934 and 1936 for 46 prefectures in Japan. The bars denote the national average stature of this age; diagrams above and below the bars show the average stature of respective prefectures compared to the national average. The location of each numbered prefecture is found in Fig. 37. The geographical distribution of the average stature of young men of conscription ages in 1930 is a
Mortality Rate from Cerebrovascular Disease

Fig. 36. Average stature of young men of conscription age in 1928–1936 for 46 prefectures in Japan.

Fig. 37. Denotation of prefecture in Japan by the serial number.
Correlation coefficients are calculated between the average stature of young men of conscription age in 1930, who became 50 years old in 1960, and age-adjusted and age-specific (for 50–54 and 55–59 year age-groups) death rates from selected causes in 1960 in reference to prefectures. As shown in Table 4, negative correlation coefficients between the average stature of the young men of conscription age and the death rate from cerebrovascular disease are on the highest level of significance, though there were some significant positive correlations with the death rate from tuberculosis, uterine cancer and liver cirrhosis, and negative correlations with heart diseases, and pneumonia and bronchitis.

Table 5 shows the correlation coefficients between the average stature of young men of conscription age in 1930 and age-specific death rates from VLCNS for every 5-year-age group over 34 years in 1960 in reference to 46 prefectures. Significant correlation at 1% level is found in 4 age-groups from 50 to 69 years in

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Age-adjusted death rate</th>
<th>Age-specific death rate for</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>-0.153 -0.095</td>
<td>0.027 -0.143 -0.192</td>
<td>**</td>
<td>-0.381</td>
<td>**</td>
<td>-0.375</td>
<td>*</td>
<td>0.329</td>
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<tr>
<td>Tuberculosis, total</td>
<td></td>
<td>0.077 0.270 0.122 0.221</td>
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<td>0.173 -0.110</td>
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<tr>
<td>Malignant neoplasms</td>
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<td>-0.083 -0.080 0.038 -0.065</td>
<td></td>
<td>0.063 0.080</td>
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</tr>
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<td>-0.388 ** 0.308 ** 0.109 **</td>
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<td>0.299 0.139</td>
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<tr>
<td>Malignant neoplasm of uterus</td>
<td></td>
<td>-0.083 -0.009 -0.038 -0.065</td>
<td></td>
<td>0.063 0.080</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VLCNS</td>
<td></td>
<td>-0.446 **-0.447 **-0.311 ***</td>
<td></td>
<td>0.029 0.484</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart diseases</td>
<td></td>
<td>-0.073 0.362 -0.068 0.036</td>
<td></td>
<td>-0.165 0.117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertensive heart diseases</td>
<td></td>
<td>-0.063 0.055 -0.113 0.059</td>
<td></td>
<td>0.041 0.117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia &amp; bronchitis</td>
<td></td>
<td>-0.069 0.045 -0.056 0.149</td>
<td></td>
<td>-0.017 -0.241</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastritis, enteritis, etc.</td>
<td></td>
<td>-0.040 -0.251 0.184 0.191</td>
<td></td>
<td>-0.199 -0.069</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Cirrhosis of liver</td>
<td></td>
<td>-0.261 -0.135 0.024 0.001</td>
<td></td>
<td>-0.024 0.011</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.01, ***P<0.001

little different from that of secondary school pupils in 1960. Young men in the region of Osaka and Kyoto (prefecture nos. 24–33) are the tallest, and those in the northern part of Kyushu (prefecture nos. 40–42) follow them. Tokyo (prefecture no. 13) as well as Hokkaido (prefecture no. 1) is over the average, but not remarkably so. In prefectures of the Tohoku region and the southern neighbouring prefectures (prefecture nos. 2–11 and 15) they are the lowest.
TABLE 5. Correlation coefficients between age-specific death rates from cerebrovascular diseases (B22) by each 5-year age groups over 34 in 1960 and average stature of young men of conscription age in 1930 by 46 prefectures in Japan

<table>
<thead>
<tr>
<th>Age group</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-39 yrs</td>
<td>-.251</td>
<td>-.0.319</td>
</tr>
<tr>
<td>40-44</td>
<td>-.356</td>
<td>-.494</td>
</tr>
<tr>
<td>45-49</td>
<td>-.367</td>
<td>-.314</td>
</tr>
<tr>
<td>50-54</td>
<td>-.403</td>
<td>-.615</td>
</tr>
<tr>
<td>55-59</td>
<td>-.457</td>
<td>-.484</td>
</tr>
<tr>
<td>60-64</td>
<td>-.551</td>
<td>-.390</td>
</tr>
<tr>
<td>65-69</td>
<td>-.412</td>
<td>-.518</td>
</tr>
<tr>
<td>70-74</td>
<td>-.341</td>
<td>-.319</td>
</tr>
<tr>
<td>75-79</td>
<td>-.289</td>
<td>-.190</td>
</tr>
<tr>
<td>80 yrs. &amp; over</td>
<td>-.178</td>
<td>-.153</td>
</tr>
</tbody>
</table>

* P<0.05, ** P<0.01, *** P<0.001

both sexes between the average stature of young men of conscription ages in 1930 and the death rate from VLCNS in 1960.

In the early decades of this century there was little change of environment, and people 50 to 69 years old in 1960 must have grown up under a similar type of *modus vivendi* in their youth. Consequently, the shorter the prefectural average stature of young men of conscription age 30 years before was, the higher is the death rate from VLCNS. Moreover, the less the calcium intake is, the worse is the growth in height. Therefore, the existence of a relationship between calcium intake and mortality from VLCNS seems to be demonstrated.

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References


