REVIEW

A Review on the Epidemiology of Stomach Cancer

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This paper reviews descriptive features of stomach cancer and current evidence for postulated etiological factors. Stomach cancer displays distinct patterns in its distribution: wide international variation, remarkable worldwide decline, and large differences in risk among populations of the same origin but living in different countries. All these descriptive features indicate that dietary factors play an important role in the causation of stomach cancer. Among reported associations with various foods, an inverse association with fresh vegetables and fruits and a positive one with salted foods are the most consistent. Those associations are in part supported by experimental studies. Much evidence from laboratory studies indicates that dietary vitamin C and beta-carotene are protective. A positive relation between Helicobacter pylori infection and stomach cancer risk has been consistently observed, but ubiquitousness of the infection weakens its causal implication. Further case-control studies on diet are unlikely to reveal new findings; exception may be possible protective effects of green tea and garlic. On the basis of current available evidence, it appears desirable to consume less high-salt foods and to eat more fresh fruits and vegetables in order to prevent the occurrence of stomach cancer. J Epidemiol, 1994; 4 : 1-11.

stomach cancer, review, descriptive epidemiology, dietary factors, Helicobacter pylori

According to the global estimate, about 755,000 new cases of stomach cancer occurred in the world in 1985; this cancer was the second most frequent cancer following lung cancer and accounting for 10% of all new cancer cases1. The etiology of stomach cancer has not been fully clarified although several causal factors have been suspected2-3. Current epidemiologic evidence for postulated etiological factors are discussed in this paper. Because the distribution of stomach cancer has important etiological implications, the descriptive features are also reviewed.

DESCRIPTIVE FEATURES

International variation

World statistics on stomach cancer mortality have shown a distinct between-country variation, and its pattern has changed little over the past decades4; the highest rates are noted in Japan and Chile; countries in East Europe have the next highest rates; and Australia, Canada, and the United States are at the lowest rates. Cancer statistics in China had not been documented until the ad hoc nationwide cancer mortality survey for the period 1973-19755. Stomach cancer was the most frequent cancer in the whole China, and age-adjusted mortality rates were roughly half of the rates in Japan6.

Although incidence data are limited to certain areas and countries, the international pattern of incidence is in parallel with that noted for mortality data (Figure 1)6. It is notable that Japanese living in the United States have much lower rates than those in Japan but still higher rates than both whites and blacks in the United States. The rates among Chinese in the United States are at the almost same order as those of whites in the United States, but prominently lower than the rates recorded among Chinese in Asia. These findings indicate that environmental factors are important in determining the geographical distribution of stomach cancer.

Migrant study

The comparison of a disease risk among migrants with the risks in home and host countries is much informative.
Figure 1. Age-adjusted annual incidence rates (per 100,000) of stomach cancer in selected populations in the world: average in the mid 1980s. Data for the United States are derived from the SEER program. Age-adjusted to the world population.

in understanding the disease etiology. Haenszel and Kurihara examined cancer mortality in Japanese migrants in the United States. The first generation (born in Japan) tended to maintain the high stomach cancer risk characteristic of Japan, and it was the second generation (born in the United States) that showed a risk closer to that of whites in the United States. Continuation of stomach cancer risks characteristic of the populations of origin has been observed in other migrant populations to the United States, and also in migrants from high risk areas to low risk areas within a country. Tsugane and his colleagues recently reported that Japanese immigrants to São Paulo, where stomach cancer rates were 50% lower than in Japan, had the high mortality and incidence rates close to those in Japan. These observations suggest that exposure to environmental factors in early life may be critical in the development of stomach cancer.

Within-country variation

A regional variation within a country has been noted in many countries, but the within-country variation is much smaller than the international variation. In Japan, mortality rates are highest in prefectures in the northern part along the Sea of Japan and lowest in prefectures of southern Kyushu; the highest rates are nearly three times the lowest rates. China is an exception, showing a prominent geographical variation as noted in the international comparison; the provincial difference reaches about eight folds between the highest and lowest rates.

Secular trend

Stomach cancer mortality has declined drastically in nearly all the countries for which data are available, but the decline has not begun uniformly throughout the world. The decreasing trend in the United States dates back to the 1920s. In most European countries, the decline started in much later years but not later than 1950. Japan experienced an upward trend until the late 1950s, and a continuous decline occurred since then (Figure 2). Although the recent decline in stomach cancer mortality in Japan may be ascribed partly to the early detection program, the worldwide decline cannot be explained by any improvements in medical management for this cancer. It was observed by Hirohata that mortality rates of stomach cancer among Japanese in Hawaii declined to one third from 1930 to 1970. For that time period, no significant improvement in survival of stomach cancer cases was accomplished. Data on stomach cancer incidence also show a declining pattern in the countries and areas where such long-term data have been accumulated. The global decreasing trend strengthens the view that environmental rather than genetic factors are important in the causation of stomach cancer.

Demographic characteristics

Both mortality and incidence rates of stomach cancer rise steeply with increasing age in the adulthood. Figure 3 plots age-specific incidence rates among Japanese in Osaka and whites in the United States, which represent the two extreme populations at the highest and lowest rates in the world. It has already been noted in Figure 1 that stomach cancer is approximately twice as common in males as in females across the populations. Male-to-female ratios are, however, not constant over the age groups. The male predominance is restricted to older ages, and sex ratios are close to unity in young adults. This phenomenon, first noted by Griffith, is observed in other populations at different risks.

Another important demographic factor is socioeconomic status. An inverse relation has been consistently observed between various indices of socioeconomic status and stomach cancer in different populations.

HISTOLOGIC TYPES

Since Lauren proposed two major histologic types of gastric carcinoma, diffuse and intestinal types, studies on histologic types have provided interesting findings. Intestinal type is more frequent in males and in older age groups while diffuse type is little different in its frequency between sexes and more common in younger age groups. The histologic difference with respect to sex and age is thus reconciled with the fact that sex ratios of incidence rates are differential with age groups. Yamaguchi et al.
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Figure 2. Age-adjusted annual mortality rates (per 100,000) of stomach cancer in Japan, England and Wales, and the United States (white): quinquennial average from 1953-57 to 1983-87. Age-adjusted to the world population.

Figure 3. Age-specific annual incidence rates (per 100,000) of stomach cancer in Osaka, Japan and the United States (white), 1983-1987. Data for the United States are derived from the SEER program. Age-adjusted to the world population.

Estimating incidence rates of different histologic types at the age of 35 to 79 years in Japan, corroborated this notion; there was little difference between men and women in age-specific incidence rates of poorly differentiated adenocarcinoma and signet-ring cell carcinoma; and these histologic types showed much smaller increase in incidence rates with increasing age than papillary and well or moderately differentiated adenocarcinomas.

Histological studies of stomach cancer in high and low risk areas have found that the intestinal type is more frequent in the high risk area while the diffuse type is little different between the high and low risk areas. It has been argued that the geographical variation in stomach cancer risk is largely attributed to the intestinal type. However, this idea has not been supported by studies of Kubo comparing Japan, Minnesota, and New Zealand.

Munoz and Asvall compared the relative frequency of histologic types in Norway for the three periods, 1940-1944, 1952-1953, and 1964-1966, and reported a marked decrease of the intestinal type in the period 1964-1966. They argued that the decrease of intestinal type cancer was responsible for the overall decline of stomach cancer in Norway. Likewise, Fujimoto and Hanai, estimating incidence rates of stomach cancer by histologic type in Osaka for the two periods, 1966-1971 and 1972-1977, reported that the intestinal type decreased by 19% in males and 25% in females while the corresponding figures for the diffuse type were 7% and 3%, respectively. If descriptive features of stomach cancer are different between the intestinal and diffuse types, then it can be considered that these two types have different etiologies and the intestinal type is more strongly influenced by environmental factors.

Another development in histological aspects is the recog-
nition of precursor lesions of stomach cancer. It is now widely accepted that intestinal metaplasia and chronic atrophic gastritis precedes the development of adenocarcinoma\(^{(13,27)}\). A recent prospective study in Japan reported that atrophic gastritis diagnosed endoscopically was associated with a six-fold increase in stomach cancer risk over the subsequent four years\(^{(29)}\). Furthermore, again in Japan, prevalence rates of atrophic gastritis determined by serum pepsinogen levels in selected areas were almost linearly correlated with mortality rates of stomach cancer\(^{(29,30)}\).

**DIETARY FACTORS**

In view of descriptive features of stomach cancer, it is natural that dietary factors have been suspected of being responsible for the occurrence of this cancer. Over the past three decades, a number of case-control studies\(^{(31-59)}\) and few cohort studies\(^{(60-65)}\) have investigated the relation between dietary factors and stomach cancer (Tables 1 and 2). The most consistent findings are a positive association with salted foods and an inverse relation to fresh vegetables and fruits. Considering methodological difficulties in dietary assessment and relatively homogeneous nature in dietary intake in the same region, it is noteworthy that a similar finding has been reproduced in many studies using different methods and in different populations. High consumption of rice used to be a typical Japanese diet, and high intake of rice or carbohydrates also has been suspected as a possible etiological candidate. A limited number of studies have shown a positive association between starchy foods and stomach cancer.

Since it is hypothesized that environmental factors are linked with the intestinal type rather than diffuse type of stomach cancer, it is of particular interest whether dietary risk factors are differential with respect to histological types. Few case-control studies addressed this question, but there was no clear difference in dietary risk factors between the intestinal and diffuse types\(^{(36,38,55,66)}\).

**Salted foods**

Many, but not all, epidemiologic studies have found a positive association between salted food intake and stomach cancer. Experimental evidence also support this association. High intake of salt shows both co-initiating and promoting effects in carcinogenesis in the glandular stomach of rodents, probably by disturbing the mucous barrier\(^{(67,68)}\). Smoked or preserved meats are not listed as salted foods in Table 1. If they are counted as salted foods, evidence for the salt hypothesis is further augmented\(^{(38,40,44,49,52,53)}\). There are, however, some studies finding no association with preserved meats\(^{(41,48)}\).

The similarity of stroke and stomach cancer with respect to worldwide distribution and secular trend is apparently consistent with the salt hypothesis\(^{(69)}\). In Japan, prefectural variation of stomach cancer is not correlated with that of stroke nor with per capita salt consumption\(^{(70)}\). Nevertheless, recent ecological studies for selected areas in Japan have reported an almost linear correlation between stomach cancer mortality and urinary salt excretion\(^{(71)}\) or salt intake estimated from the consumption of salty foods\(^{(72)}\). In particular, salt from highly salted foods, rather than total amount of salt, was associated with stomach cancer mortality\(^{(72)}\).

**Nitrite and nitrate**

Potent carcinogenicity of N-nitroso compounds in animals and the possible formation of such compounds in the human stomach have raised an epidemiologic interest concerning nitrite and nitrate\(^{(73,74)}\). Nitrites are found in drinking water, vegetables, and cured meat, and are converted to nitrites by certain species of bacteria in the mouth and stomach. Nitrites react with suitable substances in foods to produce N-nitroso compounds. Indeed, endogenous N-nitrosation has been observed in human subjects\(^{(75)}\).

Earlier comparative studies of high and low risk areas found that nitrate intake was higher in the high risk area than in the control area\(^{(6,77)}\). In Chile, a strong geographical correlation was observed between the use of nitrate fertilizer and stomach cancer mortality\(^{(78)}\). Recent studies, however, reported lower exposures to nitrate in populations at high risk than in low risk populations\(^{(79,80)}\). Some case-control studies reported a positive association of stomach cancer risk with nitrite intake\(^{(6,81)}\), but not with nitrate intake\(^{(60,52,81)}\). A reported relation between nitrite intake and stomach cancer may have reflected a positive association with preserved meats\(^{(40,49)}\). Since nitrate exposure mostly derives from leafy vegetables, the effect of nitrate, if any, may be balanced by inhibitors of N-nitrosation such as vitamin C and beta-carotene in the vegetables\(^{(80)}\).

**Vitamin C and beta-carotene**

Since fresh vegetables and fruits are rich in vitamin C and the latter is known to inhibit the formation of N-nitroso compounds\(^{(82)}\), an inverse relation between these foods and stomach cancer risk suggest that vitamin C may be protective against the occurrence of stomach cancer. Indeed, dietary intake of vitamin C has been consistently shown to be inversely associated with stomach cancer risk\(^{(38,40,44,47,52,81)}\).

Fresh vegetables and fruits also are a major source of beta-carotene, a precursor of vitamin A and a potent antioxidant. Thus an inverse relation between these dietary factors and stomach cancer can be linked with anticarcinogenic effects of retinoids or beta-carotene\(^{(83)}\). Current evidence suggests a direct, protective effect of beta-carotene; retinol intake was not clearly associated
Table 1. Summary of case-control studies on diet and stomach cancer.

| Author (year) | Country       | Dietary method* | Salt use or salty foods | Vegetables             | Fruits         | Cereals or starchy foods |
|--------------|---------------|-----------------|--------------------------|------------------------|----------------|--------------------------|
|              |               |                 |                          | Green-yellow*          | Raw/fresh      |                          |
| Wynder (1963) | Japan and 3 others | F | salty foods | (-) | NA | (-) | (-) | (-) | (-) |
| Acheson (1964) | England       | F | salted fish | (-) | (-) | (-) | (-) | (-) | (-) |
| Higginson (1966) | US           | F | NA       | NA | [3]0.6 | [3]0.8 | NA | (-) | (-) |
| Graham (1967)  | US            | F | salt use   | (-) | (-) | lettuce | [2]0.6* | (-) | potato | [2]1.5 |
| Hirayama (1971) | Japan         | F | salted veg | (+)* | (-) | NA | NA | rice | (-) |
| Haenszel (1972) | US (Japanese) | F | salted fish | [4]2.6* | (-) | [2]0.5* | (-) | rice | [2]1.5* |
| Modan (1974)   | Israel        | F | salty foods | (-) | NA | NA | NA | (+) |
| Haenszel (1976) | Japan         | F | salted fish | [3]1.2 | (-) | lettuce | [3]0.7* | [3]0.7* | rice | [2]0.9 |
| Correa (1985)  | US (white) (black) | F | table salt | [2]1.4 | broccoli | [2]0.5* | lettuce | [2]0.7 | [4]0.5* | [2]1.4* |
| Risch (1985)   | Canada        | Q | salted fish | (-) | NA | NA | INV* | (+) |
| Trichopoulos (1985) | Greece       | F | NA       | NA | INV* | INV* | paste | (+) |
| Tajima (1985)  | Japan         | F | salted fish | [2]2.0* | carrot | [3]1.1 | lettuce | [3]1.1 | [3]0.9 | rice | [2]1.8* |
| Jedrychowski (1986) | Poland       | F | NA       | NA | [3]1.0 | [3]0.3 | NA | (-) |
| La Vecchia (1987) | Italy        | F | salt use   | [3]1.5 | NA | lettuce | [3]0.8 | [3]0.4* | pasta | [3]1.9* |
| Kono (1988)    | Japan         | F | salty foods | [3]1.4 | [3]1.3 | [3]0.8 | [3]0.6* | rice | [3]0.7 |
| Hu (1988)      | China         | Q | soya paste | (+)* | Chinese cabbage | [2]0.5* | NA | potato | [2]1.5* |
| You (1988)     | China         | Q | salted fish | [3]1.4 | (-) | NA | [4]0.4* | [4]0.6* | corn | [4]1.1 |
| Coggan (1989)  | England       | F | salt intake | [3]3.0* | NA | [3]0.3* | [3]0.4* | NA | (-) |
| Builatti (1989) | Italy         | F | salted fish | [3]1.4* | NA | [3]0.6* | [3]0.6* | bread and pasta | [3]1.0 |
| Graham (1990)  | US (male) (female) | Q | salt intake | [4]3.1* | (-) | INV* | (-) | (-) | [4]2.5** |
| Demirer (1990) | Turkey        | F | salted food | [2]3.8* | (-) | raw GY | [2]0.1* | [2]0.1* | (-) |
| Boeing (1991)  | Germany       | Q | salted fish | [3]1.0 | NA | [3]0.6 | [3]0.6* | bread | [3]0.9 |
| González (1991) | Spain         | Q | salted fish | [2]1.8* | (-) | [4]0.5* | [4]0.8 | [4]0.6* | [4]0.6 |
| Yu (1991)      | China         | F | NA       | NA | NA | [2]0.5* | NA | (-) |
| Boeing (1991)  | Poland        | F | table salt | [2]1.6* | carrot | [3]0.8 | lettuce | [3]0.9 | [3]0.7* | (-) |
| Hoshiyama (1992) | Japan         | F | preference | [3]2.3* | (-) | [3]0.5* | [3]0.4* | rice | [3]2.1* |
| Tuyns (1991-92) | Belgium       | Q | table salt | [3]1.8* | (-) | [4]0.6* | [4]0.8* | [4]0.6* | [4]2.4* |
| Ramón (1993)   | Spain         | Q | salt intake | [4]2.1* | (-) | raw GY | [4]0.6* | [4]0.7* | [4]2.0* |

Figures are relative risks for the highest versus lowest consumption levels of categories specified in brackets: adjusted for age, sex, and non-dietary variables in most studies. *Significant at least at the 5% level.

NA: not available, (+): positive relation, (-): no relation, INV: inverse relation, veg: vegetables, GY: green-yellow.

*F: frequency method, Q: quantitative method.

Including carrot, pumpkin, and dark-green vegetables if not specified by investigators.

cTotal carbohydrates.
with stomach cancer risk while dietary beta-carotene was almost consistently related to a decreased risk of stomach cancer (Table 3). A prospective study of Japanese men in Hawaii showed that serum beta-carotene levels at baseline were lower in men developing stomach cancer than in men free of cancer; there was no relation between serum retinol levels and stomach cancer. In this regard, green-yellow vegetables such as carrot, pumpkin, and dark-green vegetables may be more relevant because beta-carotene is more abundant in such vegetables than in other vegetables. Epidemiologic evidence is, however, less convincing as to the relation between green-yellow vegetables and stomach cancer (Tables 1 and 2). Some of the previous studies did not specify individual vegetables but ascertained collectively the consumption of green-yellow vegetables. In green-yellow vegetables, it would be more difficult for study subjects to distinguish between green-yellow and other vegetables than between raw and cooked vegetables.

Green tea and garlic

It would be worthwhile to discuss the possibility that green tea and garlic may be protective against stomach cancer because experimental evidence supports observational data. Experimental investigations have shown that the extracts of green tea as well as of garlic have anticarcinogenic properties although animal studies have not so far demonstrated that these extracts or their constituents inhibit carcinogenicity in the stomach. At least two case-control studies in Japan suggested a protective effect of green tea consumption in the development of stomach cancer. In case-control studies of Japanese in Hawaii and Japan, Haenszel et al actually ascertained green tea consumption (a supplement booklet prepared by late Dr M Segi), but the findings on green tea were not referred to. Two case-control studies, one in China and the other in Italy, found that garlic consumption was associated with a decreased risk of stomach cancer; none of the other studies specifically addressed the relation to garlic consumption.

REFRIGERATOR USE

In conjunction with the findings on fresh vegetables, fruits, and salted foods, the use of refrigerator has been connected with a decline in stomach cancer incidence in developed countries. Some of the previous case-control studies have investigated directly the relation between refrigerator use and stomach cancer risk. The findings are fairly consistent in that the long-term use of refrigerator is associated with a decreased risk of stomach cancer. These findings further strengthen an idea that intake of fresh vegetables and fruits and avoidance of salted foods are protective against stomach cancer.

SMOKING AND ALCOHOL USE

The association between smoking and stomach cancer has been comprehensively reviewed in the reports of the United States Surgeon General. While case-control studies are disparate in their findings, cohort studies have almost consistently observed an excess risk of stomach cancer among smokers compared with nonsmokers. Yet a dose-response relationship is not a universal finding in these cohort studies, and risk increment among the heaviest smokers is no more than two folds. These aspects may mitigate the causality of smoking on stomach cancer.

Table 2. Summary of cohort studies on diet and stomach cancer.

| Author (year)       | Country | Dietary method | Salt use or salty foods | Vegetables | Fruits | Cereals or starchy foods |
|---------------------|---------|----------------|-------------------------|------------|--------|-------------------------|
| Hirayama (1990)     | Japan   | F              | NA                      | [4]0.7*    | NA     | [5]0.9                  |
| Hirohata (1983)     | Japan   | Q              | salted fish             | (+)*       | NA     | potato                  |
| Ikeda (1983)        | Japan   | F              | salted veg              | (-)        | NA     | (-)                     |
| Nomura (1990)       | US      | F              | salted veg              | [3]1.2     | NA     | [3]0.8                  |
| Kneller (1991)      | US      | F/Q            | salted fish             | [3]1.9     | total vegetables | [4]1.5                      |
| Kato (1992)         | Japan   | F              | salted veg              | [3]0.8     | NA     | [3]1.9                  |

Figures are relative risks for the highest versus lowest consumption levels of categories specified in brackets: adjusted for age, sex, and non-dietary variables in most studies. *Significant at least at the 5% level. NA: not available, (+): positive relation, (-): no relation, INV: inverse relation, veg: vegetables.

F: frequency method, Q: quantitative method.

Including carrot, pumpkin, and dark-green vegetables if not specified by investigators.

Total carbohydrates.
Recently accumulated evidence, however, lends further support to the notion that cigarette smoking is a risk factor for stomach cancer (Table 5). Some case-control studies have suggested that smoking may be related to cancer of the cardia rather than of other sites of the stomach, but evidence is not consistent.

Few case-control studies reported a positive association between heavy alcohol consumption and stomach cancer risk; a 7-fold increase in the risk was observed among Frenchmen consuming alcohol equivalent to one liter of red wine or more per day as compared with those drinking less, and a habit of drinking vodka before breakfast was related to a 2-fold increased risk in Polish men. The majority of case-control studies, however, failed to find a positive association between alcohol and stomach cancer. Two prospective studies, one in Japan and the other in the United States, showed an increased mortality from stomach cancer among those with high alcohol consumption, but deaths from stomach cancer were relatively few: 57 in the former and 17 in the latter. None of the prospective studies observing larger numbers of deaths from or incidences of stomach cancer found no association with alcohol. In the combined analysis of 8 retrospective cohort studies of alcoholics and brewery workers, 234 cases of stomach cancer were observed while 251 cases were expected (relative risk 0.93). Thus the overall evidence is too weak to suggest an etiological role of alcohol intake in the development of stomach cancer.

### HELICOBACTER PYLORI

In the past few years, *Helicobacter pylori* infection has drawn a considerable attention in the epidemiology of stomach cancer. *H pylori* infection causes acute inflam-

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**Table 3.** Dietary intakes of retinol and beta-carotene and stomach cancer risk: summary of case-control studies.

| Author (year) | Country | Comparison | Retinol | Beta-Carotene |
|--------------|---------|------------|---------|---------------|
| Correa (1985) | US (white) | high vs. low (dichotomous) | 1.2* | 0.7 |
| Risch (1985) | Canada | per 10 KIU/day | 0.9 | 0.3* |
| La Vecchia (1987) | Italy | high vs. low tertiles | 0.9 | 0.4* |
| You (1988) | China | top vs. bottom quartiles | 1.0 | 0.5* |
| Buiatti (1990) | Italy | top vs. bottom quintiles | 1.0 | 0.6* |
| Graham (1990) | US (male) | per SD | 1.5* | 0.8* |
| | US (female) | | 1.5* | 1.0 |
| Boeing (1991) | Germany | top vs. bottom quintiles | — | 0.8 |

SD: standard deviation.
*Total vitamin A.
Significant at least at the 5% level.

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**Table 4.** Refrigerator use and stomach cancer risk: summary of case-control studies.

| Author (year) | Country | Measure of refrigerator use | Association* |
|--------------|---------|----------------------------|--------------|
| Correa (1985) | US | owing or not | none |
| Risch (1985) | Canada | years of use | inverse* |
| Coggon (1989) | England | years of use | [4]0.5 |
| Buiatti (1990) | Italy | years of use | [3]0.7 |
| Graham (1990) | US (male) | years of use | [4]0.4* |
| | US (female) | | [3]0.7 |
| Boeing (1991) | Germany | years of use | [3]0.7 |

*Figures are relative risks for the highest versus lowest levels as categorized in brackets.
Significant at least at the 5% level.
Table 5. Summary of prospective studies on smoking and stomach cancer risk.

| Population                      | Sex | Relative risk* | Dose-response |
|---------------------------------|-----|----------------|---------------|
| US 9 States (ACS Study)         | male| 1.6            | NA            |
| US veterans b                   | male| 1.5            | (+)           |
| Sweden b                        | male| 1.8            | NA            |
| female                          |     | 2.3            | NA            |
| California b                    | male| 1.0            | (-)           |
| US 25 States (ACS Study)        | male| 1.4/1.3c       | NA            |
| British doctors b               | male| 1.4            | (-)           |
| Japan (Hirayama’s Study)        | male| 1.5            | (+)           |
| female                          |     | 1.2            | (-)           |
| Japanese in Hawaii b            | male| 2.7            | (-)           |
| US whites (LBI Study)           | male| 2.6            | (+)           |
| Rural Japanese b                | both| 2.2            | NA            |
| Japanese doctors b              | male| NA             | (+)           |

ACS: American Cancer Society, NA: not available, LBI: Lutheran Brotherhood Insurance.
*Current smokers versus nonsmokers.
*cQuoted from a report of the US Surgeon General.
*Age groups 45-64 and 65-79 years.

Information in the stomach and contributes to the pathogenesis of peptic ulcer. \( H \) pylori infection may well give rise to chronic atrophic gastritis because the infection can persist over many years or decades. A positive association between \( H \) pylori and stomach cancer has been consistently reported in between-population studies and studies of individuals. The latter studies are prospective, and thus it is unlikely that \( H \) pylori infection occurs after the development of stomach cancer. Although reported associations between \( H \) pylori infection as determined by IgG antibody and stomach cancer risk were moderate in strength, it is considered that control of the infection could lead to a substantial reduction in stomach cancer incidence because of the high prevalence of \( H \) pylori infection in the world.

Yet it is this generally high prevalence of \( H \) pylori infection that arises reluctance in granting a causal relationship. The prevalence rates reach as high as 40-60% in several adult populations at low risk of stomach cancer, and show no difference between men and women. Moreover, it is puzzling that \( H \) pylori is strongly associated with peptic ulcer. Stomach cancer is not associated with peptic ulcer, nor does seem to share common etiology with it.

CONCLUSION

Stomach cancer displays distinct patterns in its distribution. In particular, drastic decrease in mortality and incidence in nearly all countries in the world are phenomenal. All these descriptive features indicate that dietary factors play an important role in the causation of stomach cancer.

Among the reported associations with various foods, an inverse relation to fresh vegetables and fruits and a positive one to salted foods are the most consistent. These observations in human are supported by experimental studies as well. Dietary vitamin C and beta-carotene are considered to be protective components, but other unknown constituents of fresh vegetables and fruits may be responsible. On the basis of the current available evidence, it appears desirable to avoid consumption of salted foods and to consume fresh vegetables and fruits for the primary prevention of stomach cancer. \( H \) pylori is a potential, etiological candidate, and further studies are needed; ubiquity of the infection remains puzzling.

It is unlikely that case-control studies of stomach cancer using the dietary questionnaire provide a fresh evidence concerning the etiology of this cancer although possible protective effects of green tea and garlic may deserve further conventional case-control studies. Studies of chronic atrophic gastritis and diet will strengthen the current evidence on dietary factors as suggested by few studies of this precursor lesion.

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