Diet and High Risk of Stomach Cancer in Shandong, China

Wei-Cheng You, William J. Blot, Yun-Shang Chang, Abby G. Ershow, Zhu-Tian Yang, Qi An, Brian Henderson, Guang-Wei Xu, Joseph F. Fraumeni, Jr., and Tian-Gen Wang

ABSTRACT

A case-control investigation involving interviews with 564 stomach cancer patients and 1131 population-based controls was conducted to evaluate reasons for the exceptionally high rates of stomach cancer in Linqu, a rural county in Shandong Province in northeast China. Daily consumption of sour pancakes, a fermented indigenous staple, was associated with a 30% increase in risk. Risks of stomach cancer were also increased by 2- to 3-fold among persons with prior chronic gastriritis or gastric ulcer, by 80% among those with stomach cancer in a family member, by 50% among men who smoked one or more packs of cigarettes/day, by 40% among those who preferred salty foods, and by 50% among families with moldy grain supplies. In contrast, risks tended to decrease in proportion to increasing consumption of fresh vegetables and fruits. This protective effect was more pronounced for vegetables, with those in the highest quartile of intake at less than one-half the risk of those in the lowest. Stomach cancer risks also declined with increasing dietary intake of carotene, vitamin C, and calcium, but not retinol. These findings provide leads to dietary factors that contribute to the high rates in Linqu, where stomach cancer is the leading cause of cancer and has not yet begun to decline as in other parts of the world.

INTRODUCTION

Stomach cancer is the leading form of cancer in China (1). There is substantial geographic variation in mortality within the country, however, with elevated rates in the northern and central provinces. Some of the highest stomach cancer death rates are found in Linqu, a rural county in Shandong Province. Linqu’s annual age-adjusted (China standard) rates/100,000 persons were 55 among males and 19 among females during 1980-1982, approximately double the national levels. To investigate reasons for this clustering of high mortality, a collaborative investigation was launched in 1984 following completion of a pilot study in 1983 which established procedures for study design and conduct (2). Herein, we report findings from this case control study, which focused on the contribution of dietary factors to the etiology of stomach cancer.

METHODS

Incident cases of stomach cancer were identified from county and commune hospitals in Linqu and neighboring Yidu County. All cases among long-term (10+ years) Linqu residents aged 35-64 diagnosed over a 2.5-year period during 1984-1986 were eligible for inclusion and sought for interview. The diagnoses were reviewed locally, with at least 50% of the cases, with a similar distribution with respect to age and sex. A structured questionnaire was developed for use in this study. Although the longest section focused on diet and dietary habits, information was obtained on demographic variables, medical history, occupation, smoking, and other items. Questions were asked about frequency and portion size of 85 food items consumed several years prior to interview (about 1980) and just prior to the Cultural Revolution about 1965. The questionnaire also included items on beverages, including sources and storage of fresh water, and on salt intake and preference for salty foods.

The measure of association between stomach cancer risk and exposure variables was the OR. Adjusted OR estimates were obtained by the Mantel-Haenszel technique and by stratified logistic regression analyses (3). Intake of individual foods, food groups, or nutrients was categorized into quartiles or tertiles defined by yearly consumption among controls. Foods were grouped into several categories (e.g., fresh vegetables, fruits, allium vegetables), with consumption of the group obtained by summing across food items. Indices for daily intake of retinol, carotene, ascorbic acid, calcium, and other nutrients were also created by multiplying the estimated nutrient content of each food, derived from Chinese food composition tables (4), by its yearly consumption after weighting by portion size. Since results for food intake in 1965 and 1980 were similar, we present only the data for the later period. Since findings for males and females also were similar, results are presented for both sexes combined, with the OR adjusted for sex. Finally, analyses of the major variables were conducted for histologically confirmed cases separately from cases confirmed by other means, but except where noted, the patterns of risk tended to be similar and thus only results for the total case series are presented.

RESULTS

A total of 685 patients with stomach cancer were identified over the study period. Among these 41 had died, 70 were too ill, 8 refused interview, and 2 had only partial interviews. Interviews were thus completed with 564 stomach cancer patients and 1131 controls (only one refused interview). Fifty percent of the cancer diagnoses were derived from histological review of tissue specimens obtained during surgical procedures or endoscopy, 32% from surgery or endoscopy without pathological review, and 17% from radiological and clinical examination. Among those with histological confirmation, the ratio of intestinal to diffuse type cancers was 4.7:1. For 312 patients, the exact location of the tumor within the stomach could be specified: 63% were found in the antrum, 19% in the body, 4% in the cardia and fundus, 3% in the pyloric region, and 11% elsewhere.

Table 1 shows that the distribution of cases and controls was similar with respect to several demographic indices. Almost all the participants were born in Linqu. Most were farmers and had little or no formal education. The cases and controls...
Food Groups and Individual Foods. Table 2 shows that the intake of grains (corn and wheat), the major dietary staples in Linqu, was unrelated to the risk of stomach cancer. Consumption of dried sweet potatoes was associated with a reduced risk, but little trend with intake level was seen. Whereas eating sweet pancakes was associated with a reduced risk (OR = 0.8; 95% CI, 0.6–0.9), sour pancakes were associated with an increased risk (OR = 1.5; 95% CI, 1.0–2.0) was associated with mold in the family grain storage. An OR of 1.5 (95% CI, 1.1–1.9) was observed in those who preferred saltier foods. The information on salt intake was based on household consumption data.

Cross-classifications of vegetable by fruit intake (not shown) revealed decreasing trends in risk with rising vegetable intake in every quartile of fruit intake, but weaker and less consistent trends with fruit consumption within the vegetable quartiles. We also examined trends with several groupings of vegetables, including dark green, cruciferous, and allium vegetables. The first two categories were so highly correlated with total vegetable intake (r = 0.8–0.9) that independent effects could not be easily evaluated, but correlation between allium vegetables (composed of garlic, garlic stalks, scallions, Chinese chives, and onions) and other vegetables was much less (r = 0.3). There were strong inverse trends in stomach cancer risk with increasing allium intake which persisted after adjustment for intake of other fresh vegetables (the adjusted OR for highest compared to lowest allium quartile intake was 0.5; 95% CI, 0.4–0.8), and with increasing nonallium vegetable intake which persisted after adjustment for intake of allium vegetables (the adjusted OR for highest compared to lowest nonallium quartile intake was 0.6; 95% CI, 0.4–0.9).

The last two variables in Table 2 are animal foods (pork, eggs, beef, mutton, and poultry) and soybeans, the major sources of protein in Linqu County. Negative relationships were seen, but there were no clear dose-response trends.

Nutrients. The relationship between stomach cancer risk and estimated daily intake of the nutrients ascorbic acid, retinol, total carotene, and calcium are presented in Table 3. Some reduction in risk was seen for higher values of each index. These indices were correlated with each other, with the highest pairwise association between vitamin C and carotene (r = 0.6). In a logistic model containing categorical terms for vitamin C, retinol, and calcium (carotene was excluded because of its high correlation with vitamin C), independent protective effects were found for vitamin C and calcium, with little trend for retinol.

Salt and Salty and Moldy Food. Table 4 shows relative risks of stomach cancer associated with consumption of salt, salted vegetables, salted fish, moldy food, and a preference for salty foods. The information on salt intake was based on household consumption data.

Yearly consumption of total fresh vegetables and fruits was calculated from 36 kinds of common vegetables and 9 kinds of fruits. Both fresh vegetables and fruits showed a negative dose-response relationship to the risk of stomach cancer (Table 2). Cross-classifications of vegetable by fruit intake (not shown) revealed decreasing trends in risk with rising vegetable intake in every quartile of fruit intake, but weaker and less consistent trends with fruit consumption within the vegetable quartiles. We also examined trends with several groupings of vegetables, including dark green, cruciferous, and allium vegetables. The first two categories were so highly correlated with total vegetable intake (r = 0.8–0.9) that independent effects could not be easily evaluated, but correlation between allium vegetables (composed of garlic, garlic stalks, scallions, Chinese chives, and onions) and other vegetables was much less (r = 0.3). There were strong inverse trends in stomach cancer risk with increasing allium intake which persisted after adjustment for intake of other fresh vegetables (the adjusted OR for highest compared to lowest allium quartile intake was 0.5; 95% CI, 0.4–0.8), and with increasing nonallium vegetable intake which persisted after adjustment for intake of allium vegetables (the adjusted OR for highest compared to lowest nonallium quartile intake was 0.6; 95% CI, 0.4–0.9).

The last two variables in Table 2 are animal foods (pork, eggs, beef, mutton, and poultry) and soybeans, the major sources of protein in Linqu County. Negative relationships were seen, but there were no clear dose-response trends.

Nutrients. The relationship between stomach cancer risk and estimated daily intake of the nutrients ascorbic acid, retinol, total carotene, and calcium are presented in Table 3. Some reduction in risk was seen for higher values of each index. These indices were correlated with each other, with the highest pairwise association between vitamin C and carotene (r = 0.6). In a logistic model containing categorical terms for vitamin C, retinol, and calcium (carotene was excluded because of its high correlation with vitamin C), independent protective effects were found for vitamin C and calcium, with little trend for retinol.

Salt and Salty and Moldy Food. Table 4 shows relative risks of stomach cancer associated with consumption of salt, salted vegetables, salted fish, moldy food, and a preference for salty foods. The information on salt intake was based on household consumption data.

Yearly consumption of total fresh vegetables and fruits was calculated from 36 kinds of common vegetables and 9 kinds of fruits. Both fresh vegetables and fruits showed a negative dose-response relationship to the risk of stomach cancer (Table 2). Cross-classifications of vegetable by fruit intake (not shown) revealed decreasing trends in risk with rising vegetable intake in every quartile of fruit intake, but weaker and less consistent trends with fruit consumption within the vegetable quartiles. We also examined trends with several groupings of vegetables, including dark green, cruciferous, and allium vegetables. The first two categories were so highly correlated with total vegetable intake (r = 0.8–0.9) that independent effects could not be easily evaluated, but correlation between allium vegetables (composed of garlic, garlic stalks, scallions, Chinese chives, and onions) and other vegetables was much less (r = 0.3). There were strong inverse trends in stomach cancer risk with increasing allium intake which persisted after adjustment for intake of other fresh vegetables (the adjusted OR for highest compared to lowest allium quartile intake was 0.5; 95% CI, 0.4–0.8), and with increasing nonallium vegetable intake which persisted after adjustment for intake of allium vegetables (the adjusted OR for highest compared to lowest nonallium quartile intake was 0.6; 95% CI, 0.4–0.9).

The last two variables in Table 2 are animal foods (pork, eggs, beef, mutton, and poultry) and soybeans, the major sources of protein in Linqu County. Negative relationships were seen, but there were no clear dose-response trends.

Nutrients. The relationship between stomach cancer risk and estimated daily intake of the nutrients ascorbic acid, retinol, total carotene, and calcium are presented in Table 3. Some reduction in risk was seen for higher values of each index. These indices were correlated with each other, with the highest pairwise association between vitamin C and carotene (r = 0.6). In a logistic model containing categorical terms for vitamin C, retinol, and calcium (carotene was excluded because of its high correlation with vitamin C), independent protective effects were found for vitamin C and calcium, with little trend for retinol.

Salt and Salty and Moldy Food. Table 4 shows relative risks of stomach cancer associated with consumption of salt, salted vegetables, salted fish, moldy food, and a preference for salty foods. The information on salt intake was based on household consumption data.

Yearly consumption of total fresh vegetables and fruits was calculated from 36 kinds of common vegetables and 9 kinds of fruits. Both fresh vegetables and fruits showed a negative dose-response relationship to the risk of stomach cancer (Table 2). Cross-classifications of vegetable by fruit intake (not shown) revealed decreasing trends in risk with rising vegetable intake in every quartile of fruit intake, but weaker and less consistent trends with fruit consumption within the vegetable quartiles. We also examined trends with several groupings of vegetables, including dark green, cruciferous, and allium vegetables. The first two categories were so highly correlated with total vegetable intake (r = 0.8–0.9) that independent effects could not be easily evaluated, but correlation between allium vegetables (composed of garlic, garlic stalks, scallions, Chinese chives, and onions) and other vegetables was much less (r = 0.3). There were strong inverse trends in stomach cancer risk with increasing allium intake which persisted after adjustment for intake of other fresh vegetables (the adjusted OR for highest compared to lowest allium quartile intake was 0.5; 95% CI, 0.4–0.8), and with increasing nonallium vegetable intake which persisted after adjustment for intake of allium vegetables (the adjusted OR for highest compared to lowest nonallium quartile intake was 0.6; 95% CI, 0.4–0.9).

The last two variables in Table 2 are animal foods (pork, eggs, beef, mutton, and poultry) and soybeans, the major sources of protein in Linqu County. Negative relationships were seen, but there were no clear dose-response trends.

Nutrients. The relationship between stomach cancer risk and estimated daily intake of the nutrients ascorbic acid, retinol, total carotene, and calcium are presented in Table 3. Some reduction in risk was seen for higher values of each index. These indices were correlated with each other, with the highest pairwise association between vitamin C and carotene (r = 0.6). In a logistic model containing categorical terms for vitamin C, retinol, and calcium (carotene was excluded because of its high correlation with vitamin C), independent protective effects were found for vitamin C and calcium, with little trend for retinol.

Salt and Salty and Moldy Food. Table 4 shows relative risks of stomach cancer associated with consumption of salt, salted vegetables, salted fish, moldy food, and a preference for salty foods. The information on salt intake was based on household consumption data.
supply. The OR was 2.1 (95% CI, 1.3–3.2) among those who were asked about a history of stomach diseases diagnosed at least 5 years prior to the time of investigation. Table 5 shows ORs of 2.9 (95% CI, 1.7–4.6) and 2.0 (95% CI, 1.2–3.2) for prior chronic gastritis and stomach ulcers, respectively. An OR of 1.4 (95% CI, 1.1–1.9) was observed for individuals reporting at least one case of cancer among first degree relatives. The familial excess was accounted for entirely by an increased frequency of stomach cancer: the OR for familial stomach cancer was 1.8 (95% CI, 1.3–2.7), while no increase of other cancers was detected among family members (OR = 1.0; 95% CI, 0.7–1.5). This familial association was stronger for diffuse than intestinal type stomach cancer, although small numbers of observations limited evaluation by cell type.

### Logistic Regression Analysis
Based on the analyses of individual factors, logistic regression models were constructed to evaluate simultaneously the effects of multiple variables on the risk of stomach cancer. Included were indicator variables for drinking and alcohol drinking also adjusted for cigarette smoking.

### Table 5 Relative risks of stomach cancer among males in relation to cigarette smoking and alcohol drinking

<table>
<thead>
<tr>
<th>Number of subjects</th>
<th>Case</th>
<th>Control</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cigarettes smoked/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>62</td>
<td>163</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>≥1</td>
<td>158</td>
<td>326</td>
<td>1.3</td>
<td>0.9–1.9</td>
</tr>
<tr>
<td>Alcohol drinking/yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>140</td>
<td>250</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&lt;365 times</td>
<td>150</td>
<td>315</td>
<td>0.9</td>
<td>0.7–1.3</td>
</tr>
<tr>
<td>≥365 times</td>
<td>153</td>
<td>323</td>
<td>0.8</td>
<td>0.6–1.1</td>
</tr>
</tbody>
</table>

* Adjusted for age and family income. Smoking also adjusted for alcohol drinking and alcohol drinking also adjusted for cigarette smoking.

### Table 6 Relative risks of stomach cancer in relation to history of gastric disorders and occurrence of cancer in a close relative

<table>
<thead>
<tr>
<th>Number of subjects</th>
<th>Case</th>
<th>Control</th>
<th>OR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach ulcer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>529</td>
<td>1094</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>35</td>
<td>37</td>
<td>2.0</td>
<td>1.1–3.2</td>
</tr>
<tr>
<td>Chronic gastritis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>517</td>
<td>1099</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>47</td>
<td>32</td>
<td>2.9</td>
<td>1.7–4.6</td>
</tr>
<tr>
<td>Family's cancer history</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>459</td>
<td>965</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>102</td>
<td>155</td>
<td>1.4</td>
<td>1.1–1.9</td>
</tr>
</tbody>
</table>

* Adjusted for sex, age, and family income. Stomach ulcer and chronic gastritis were diagnosed 5 years prior to interview.
income, sour pancakes, dried sweet potatoes, allium vegetables, other fresh vegetables, animal foods, salty fish, preference for salty food, moldy grain, eating gruel at hot temperatures, drinking deep well water, stomach ulcer, and chronic gastritis. The OR estimates from the logistic regression analysis were quite similar to those from the univariate and stratified analyses, although the associations with sour pancakes and drinking deep well water were somewhat decreased and the associations with salted fish and chronic gastritis somewhat enhanced. The regression model was repeated for males alone after adding terms for cigarette smoking; the trend of increasing risk with amount smoked persisted and the estimates for the other variables were essentially unchanged.

DISCUSSION

This relatively large population-based study suggests that dietary factors contribute significantly to the etiology of stomach cancer in Linqu. Elevated risks were associated with consumption of sour pancakes, a preference for salty foods, and moldy grain supplies, while protective effects were associated with consumption of fresh vegetables. The findings are generally in line with studies of stomach cancer in other parts of the world, which have implicated diets with high salt content and low fresh vegetable and fruit intake (5-13).

The dietary constituent which distinguishes Linqu from other areas in China is sour pancakes. These are made of corn, wheat, dried sweet potatoes, and a small amount of soybeans. Water is added to this mixture of flour which is then allowed to ferment. Individuals who ate sour pancakes daily experienced a 30% increase in risk. Since about one-half the general population of Linqu eats sour pancakes, we estimate that this exposure (if causally related to stomach cancer) could account for about a 15% elevation in stomach cancer mortality, thus accounting for only a portion of the nearly 100% excess above national levels. Similar ingredients are used to make sweet pancakes, but these are not fermented. Individuals in Linqu reported eating one or the other, but generally not both types of pancakes, with adults nearly split in half as to preference for sour or sweet. Since these 2 variables are highly negatively correlated, the increased risk associated with sour pancakes could reflect a protective effect associated with sweet pancakes. This explanation seems unlikely, however, since sour pancake juice has shown evidence of mutagenic activity and contains N-nitroso compounds (14), which are suspected to play a role in gastric carcinogenesis (15). Sour pancake juice also contains mycotoxins (14), especially sterigmatocystin, which has produced papillomatous lesions of the stomach in laboratory animals (16). Mycotoxins may also play a role in the excess risk associated with moldy family grain supplies, although no dose-response relationship was seen. Further research is required to clarify the role of sour pancakes and moldy grain supplies, and their constituents, as risk factors for stomach cancer in Linqu.

Several investigations have linked high salt intake to the risk of stomach cancer, perhaps by inducing precancerous changes (5-8). High salt concentration, by irritating the gastric mucosa, may result in desquamation and atrophy that involves both parietal and chief cells (17-20). Although we found relatively weak associations between salt or salted food intake and stomach cancer risk, it was difficult to obtain precise information on an individual's salt consumption. A measure of per capita salt intake was developed using the amount of salt purchased for the household and the household size. Ranking of salt intake based on this crude measure is subject to misclassification and to OR estimates that may be biased towards the null value of 1.0. However, we did find significantly elevated risks for individuals who had a preference for salty food and a high intake of salted fish (although the amount of fish consumed in Linqu is small). Thus, salt may contribute in part to the area's high rates of stomach cancer. Although comparable data throughout China are not available, the levels of estimated salt intake (median, 46 g/day) in Linqu were high by Western standards. This figure is also more than double the per capita daily salt intake reported in a survey of 118 counties in Henan Province where the mean level was 17 g/day, and maximum county level was 31 g/day in the 1960s and 1970s (21). Among counties in Henan there was also a significant correlation between salt intake and stomach cancer mortality.

Most striking were the protective effects of vegetable intake. Risks of stomach cancer among those in the upper quartile of vegetable consumption were less than one-half of those in the lowest quartile. A similar but less pronounced association was seen for fruit intake. The findings are consistent with epidemiological studies of stomach cancer in Japan, North and South America, and Europe (5, 6, 9-13), although reduced risks have not always been found (22, 23). The mechanisms are unclear, but micronutrients have been suspected, particularly vitamin C which may inhibit endogenous formation of carcinogenic nitrosamines (15). We found reduced risks among persons with high intake of several nutrients, including carotene, vitamin C, and calcium, but not retinol. Serological studies in areas of Colombia at high risk of stomach cancer have shown lower blood levels of carotene and tocopherol, but not retinol or vitamin C among persons with gastric dysplasia than among persons with less advanced or no precursor lesions (24). Dietary deficiencies of total vitamin A have been reported among stomach cancer patients in the United States (25), and among persons with intestinal metaplasia, a precursor to stomach cancer, in Japan (26).

The relationship of stomach cancer to low calcium intake in Linqu is of interest. Few studies have evaluated this association, although a negative geographic correlation between dietary calcium and stomach cancer rates has been reported in Japan (27). Animal studies indicate that salt-induced damage to the gastric mucosa might be inhibited by increasing intake of calcium (28). Recent studies have indicated the possible role of dietary calcium in inhibiting the development of colon cancer (28, 29). Our study appears to be the first analytical investigation to report a possible protective effect of calcium against stomach cancer.

Reductions in risk were associated with several of the individual vegetables asked about, including dark green, cruciferous, and allium vegetables. The finding with allium vegetables is new and of interest in view of recent experimental studies showing that oils or extracts from garlic and onion inhibit several types of tumors in laboratory animals (30-33). A more detailed description of the association is presented in a separate paper, where it is shown that that protection seems to be afforded by each of the several types of allium vegetables. A common chemical constituent, such as an allyl sulfide compound, with carcinogen inhibitory properties is suspected. It may also be that antibacterial and antifungal properties of allium inhibit gastric bacterial growth in humans (34), thus lessening the conversion of nitrates to nitrites and reducing the formation of N-nitroso compounds (19). We had no information on levels of nitrates or nitrites in Linqu water or food

supplies to help evaluate the hypothesis of endogenous production of N-nitroso compounds including nitrosamines. Higher risks were associated with drinking deep-well compared to surface waters, but relative nitrate contents are not known. However, a survey is planned to determine concentrations of nitrates, nitrites, and several nitrosamines in urine and gastric juice among persons with precancerous lesions, including chronic atrophic gastritis, intestinal metaplasia, and dysplasia.

In addition to dietary factors, our study revealed a positive association between cigarette smoking and the risk of stomach cancer, while alcohol drinking showed no effect. The OR associated with smoking one or more packs of cigarettes/day was 1.5. Although stomach cancer is not generally thought of as a smoking-induced cancer, similar excesses have been observed among cohort studies of British physicians, U. S. military veterans, and men and women in Sweden and Japan, although not all studies revealed dose-response relationships (35). Case control studies of stomach cancer have not yielded as consistent results, but the overall data suggest a moderate excess risk of stomach cancer among smokers. Such an effect may account in part for the higher rates of stomach cancer among males than females in various populations around the world, including Linqu.

Chronic atrophic gastritis and dysplasia are closely associated with an increased risk of stomach cancer, especially the intestinal type which predominates in high-risk areas (36, 37). Although error in response may be expected from uncertain knowledge about previous gastric diseases and specific terminology, we found a nearly 3-fold excess of stomach cancer among those reporting chronic gastritis. Differential recall by cases and controls may have contributed to the finding, although we excluded gastritis reported within 5 years of interview. To a lesser degree, prior stomach ulcers were also related to stomach cancer risk. The possible role of gastric ulcer in stomach cancer risk has been debated (5), but the association in high-risk areas is thought to result from an underlying atrophic gastritis (38). Our data cannot adequately evaluate this hypothesis, although the percentage of persons reporting gastric ulcer was the same (3%) whether or not they also reported chronic gastritis. We did detect some familial clustering of stomach cancer in Linqu. Familial predisposition to stomach cancer has been reported in the past, with an excess of blood supply to help evaluate the hypothesis of endogenous production of N-nitroso compounds including nitrosamines. Higher risks were associated with drinking deep-well compared to surface waters, but relative nitrate contents are not known. However, a survey is planned to determine concentrations of nitrates, nitrites, and several nitrosamines in urine and gastric juice among persons with precancerous lesions, including chronic atrophic gastritis, intestinal metaplasia, and dysplasia.

In addition to dietary factors, our study revealed a positive association between cigarette smoking and the risk of stomach cancer, while alcohol drinking showed no effect. The OR associated with smoking one or more packs of cigarettes/day was 1.5. Although stomach cancer is not generally thought of as a smoking-induced cancer, similar excesses have been observed among cohort studies of British physicians, U. S. military veterans, and men and women in Sweden and Japan, although not all studies revealed dose-response relationships (35). Case control studies of stomach cancer have not yielded as consistent results, but the overall data suggest a moderate excess risk of stomach cancer among smokers. Such an effect may account in part for the higher rates of stomach cancer among males than females in various populations around the world, including Linqu.

Chronic atrophic gastritis and dysplasia are closely associated with an increased risk of stomach cancer, especially the intestinal type which predominates in high-risk areas (36, 37). Although error in response may be expected from uncertain knowledge about previous gastric diseases and specific terminology, we found a nearly 3-fold excess of stomach cancer among those reporting chronic gastritis. Differential recall by cases and controls may have contributed to the finding, although we excluded gastritis reported within 5 years of interview. To a lesser degree, prior stomach ulcers were also related to stomach cancer risk. The possible role of gastric ulcer in stomach cancer risk has been debated (5), but the association in high-risk areas is thought to result from an underlying atrophic gastritis (38). Our data cannot adequately evaluate this hypothesis, although the percentage of persons reporting gastric ulcer was the same (3%) whether or not they also reported chronic gastritis. We did detect some familial clustering of stomach cancer in Linqu. Familial predisposition to stomach cancer has been reported in the past, with an excess of blood supply to help evaluate the hypothesis of endogenous production of N-nitroso compounds including nitrosamines. Higher risks were associated with drinking deep-well compared to surface waters, but relative nitrate contents are not known. However, a survey is planned to determine concentrations of nitrates, nitrites, and several nitrosamines in urine and gastric juice among persons with precancerous lesions, including chronic atrophic gastritis, intestinal metaplasia, and dysplasia.

In addition to dietary factors, our study revealed a positive association between cigarette smoking and the risk of stomach cancer, while alcohol drinking showed no effect. The OR associated with smoking one or more packs of cigarettes/day was 1.5. Although stomach cancer is not generally thought of as a smoking-induced cancer, similar excesses have been observed among cohort studies of British physicians, U. S. military veterans, and men and women in Sweden and Japan, although not all studies revealed dose-response relationships (35). Case control studies of stomach cancer have not yielded as consistent results, but the overall data suggest a moderate excess risk of stomach cancer among smokers. Such an effect may account in part for the higher rates of stomach cancer among males than females in various populations around the world, including Linqu.

Chronic atrophic gastritis and dysplasia are closely associated with an increased risk of stomach cancer, especially the intestinal type which predominates in high-risk areas (36, 37). Although error in response may be expected from uncertain knowledge about previous gastric diseases and specific terminology, we found a nearly 3-fold excess of stomach cancer among those reporting chronic gastritis. Differential recall by cases and controls may have contributed to the finding, although we excluded gastritis reported within 5 years of interview. To a lesser degree, prior stomach ulcers were also related to stomach cancer risk. The possible role of gastric ulcer in stomach cancer risk has been debated (5), but the association in high-risk areas is thought to result from an underlying atrophic gastritis (38). Our data cannot adequately evaluate this hypothesis, although the percentage of persons reporting gastric ulcer was the same (3%) whether or not they also reported chronic gastritis. We did detect some familial clustering of stomach cancer in Linqu. Familial predisposition to stomach cancer has been reported in the past, with an excess of blood supply to help evaluate the hypothesis of endogenous production of N-nitroso compounds including nitrosamines. Higher risks were associated with drinking deep-well compared to surface waters, but relative nitrate contents are not known. However, a survey is planned to determine concentrations of nitrates, nitrites, and several nitrosamines in urine and gastric juice among persons with precancerous lesions, including chronic atrophic gastritis, intestinal metaplasia, and dysplasia.

In addition to dietary factors, our study revealed a positive association between cigarette smoking and the risk of stomach cancer, while alcohol drinking showed no effect. The OR associated with smoking one or more packs of cigarettes/day was 1.5. Although stomach cancer is not generally thought of as a smoking-induced cancer, similar excesses have been observed among cohort studies of British physicians, U. S. military veterans, and men and women in Sweden and Japan, although not all studies revealed dose-response relationships (35). Case control studies of stomach cancer have not yielded as consistent results, but the overall data suggest a moderate excess risk of stomach cancer among smokers. Such an effect may account in part for the higher rates of stomach cancer among males than females in various populations around the world, including Linqu.

Chronic atrophic gastritis and dysplasia are closely associated with an increased risk of stomach cancer, especially the intestinal type which predominates in high-risk areas (36, 37). Although error in response may be expected from uncertain knowledge about previous gastric diseases and specific terminology, we found a nearly 3-fold excess of stomach cancer among those reporting chronic gastritis. Differential recall by cases and controls may have contributed to the finding, although we excluded gastritis reported within 5 years of interview. To a lesser degree, prior stomach ulcers were also related to stomach cancer risk. The possible role of gastric ulcer in stomach cancer risk has been debated (5), but the association in high-risk areas is thought to result from an underlying atrophic gastritis (38). Our data cannot adequately evaluate this hypothesis, although the percentage of persons reporting gastric ulcer was the same (3%) whether or not they also reported chronic gastritis. We did detect some familial clustering of stomach cancer in Linqu. Familial predisposition to stomach cancer has been reported in the past, with an excess of blood supply to help evaluate the hypothesis of endogenous production of N-nitroso compounds including nitrosamines. Higher risks were associated with drinking deep-well compared to surface waters, but relative nitrate contents are not known. However, a survey is planned to determine concentrations of nitrates, nitrites, and several nitrosamines in urine and gastric juice among persons with precancerous lesions, including chronic atrophic gastritis, intestinal metaplasia, and dysplasia.


Diet and High Risk of Stomach Cancer in Shandong, China

Wei-Cheng You, William J. Blot, Yun-Shang Chang, et al.