

Intakes of selected foods and beverages and the incidence of gastric cancer among the Japanese residents of Hawaii: a prospective study

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Background	We report on the associations between the intake of certain foods and beverages and the incidence of gastric cancer in a cohort of 11 907 randomly selected Japanese residents of Hawaii (6297 women and 5610 men).
Methods	The daily intake of six beverages, cigarettes and alcohol and the weekly frequency of intake of 13 foods and food groups was estimated with a short food frequency questionnaire. Over an average follow-up period of 14.8 years, 108 cases of gastric cancer (44 women, 64 men) were identified via linkage to the Hawaii Tumor Registry.
Results	In gender-combined proportional hazards analyses, the consumption of fresh fruit seven or more times per week was associated with a significantly reduced risk of gastric cancer, compared to lower levels of consumption (relative hazard (RH): 0.6, 95% confidence interval (CI) : 0.4–1.0, $P = 0.03$). The combined intake of fresh fruit and raw vegetables was inversely associated with the risk of gastric cancer in the total cohort, and among the men ($P < 0.05$). No significant relationships were found between gastric cancer incidence and the intake of pickled vegetables, miso soup, dried or salted fish, or processed meats among either gender. Compared to non-drinkers, men who drank one cup of coffee per day had a significantly elevated risk of gastric cancer (RH: 2.5, 95% CI : 1.0–6.1, $P = 0.05$), but there was no evidence of a dose-response relationship. Cigarette smoking and consumption of alcohol were not related to gastric cancer, in analyses restricted to the men.
Conclusions	The results related to fruit and vegetable intake are consistent with an anti-nitrosating effect of these foods, while the unexpected association between coffee consumption and gastric cancer is difficult to explain and may represent a chance finding.
Keywords	Stomach neoplasms, Japanese Americans, Hawaii, diet, prospective studies
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The incidence rates of gastric cancer among men and women in Japan are more than three times greater than the rates among Japanese residents of Hawaii.¹ Previous studies indicated higher gastric cancer incidence and mortality rates among Japanese migrants to the United States compared to their American-born descendants.^{2–3} These observations indicate that environmental factors are key determinants of the risk for this disease among the Japanese, an ethnic group with one of the highest incidence and mortality rates of stomach cancer in the United States.⁴

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Dietary intake has been postulated as an important factor in the aetiology of gastric cancer.⁵ A proposed model for the aetiology of gastric cancer includes the intake of highly salted foods and foods containing nitrates and nitrites as risk factors.⁶ Protection against gastric cancer may be afforded by dietary intake of foods rich in vitamins C and E and polyphenols;⁷ these compounds have been shown to inhibit the production of carcinogenic N-nitroso compounds in humans.^{8–10} However, epidemiological studies of dietary intake and gastric cancer have yielded equivocal results. Likewise, few clear associations have emerged from studies of alcohol and cigarette consumption and gastric cancer.¹¹ In this report, we present results from a prospective study of the intake of certain foods and beverages,

cigarette and alcohol consumption, and the incidence of gastric cancer among Japanese residents of Hawaii, a high-risk population for this cancer in the US.

Methods

The Hawaii State Department of Health annually conducts a random survey of 2% of all households in Hawaii to collect demographic and health-related data.¹² The participation rate is very high (95%), since the survey is mandated by law. From 1975 to 1980, we added a short questionnaire to the survey, to be administered to all participants 18 years and older. The supplementary questionnaire included questions on height, weight, smoking, alcohol use and diet. Dietary information consisted of estimates of the weekly frequency of intake of 13 foods and food groups, and the daily frequency of intake of six beverages. We present results from analyses of six food items (fresh fruit, raw vegetables, miso soup, pickled vegetables, dried or salted fish and processed meats) and four beverages (green tea, black tea, coffee and milk) previously studied in association with gastric cancer. Participants also provided information on their cigarette smoking status, the number of cigarettes smoked per day, and their weekly intake of beer, wine, sake and hard liquor. Analyses were restricted to the cohort members of Japanese ancestry since 65% of the incident gastric cancer cases occurred in this group, and this was the only ethnic group in which there was significant consumption of miso soup, pickled vegetables, dried or salted fish, or green tea.

A total of 50 655 interviews were completed. The interviews of 4553 military personnel were excluded since they were considered temporary residents. A further 2881 interviews were excluded because of incomplete information for name or age, 825 were excluded because the participant had cancer at the time of interview, and an additional 1821 were duplicate interviews over the 5-year period. The final study population was therefore made up of 40 575 individuals, of whom 12 789 were Japanese. Of the latter group, 882 (6.9%) were excluded for missing information on study covariates used in these analyses. Those who were excluded from the study were significantly older than the other study participants (mean age at baseline + SD: 50.8 + 18.7 versus 46.4 + 16.6 years), and were more likely to have been born in Japan (16% versus 10%). Incidence rates of gastric cancer were not significantly different ($P > 0.3$ for χ^2 test) between the excluded group (1.1%) and the remaining study sample (0.9%).

Follow-up surveillance of the cohort was accomplished by a passive method, since emigration from Hawaii has previously been shown to be low among this cohort. In an active follow-up of 2018 cohort members, the rate of emigration was found to have stabilized after 13 years at 10.7%. Ascertainment of cancer outcomes for this cohort was accomplished by linkage with the Hawaii Tumor Registry, a member of the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute.¹³ Before linkage to the Hawaii Tumor Registry, names and other identifying data were updated and verified by linkage to the state's marriage and divorce files, death files and voter's registration files. These linkages were made using a probabilistic linkage procedure described previously.¹⁴

Proportional hazards regression was used to determine the relative hazards (RH) and 95% confidence intervals (CI) of gastric

cancer for different levels of the dietary exposure variables.¹⁵ All models controlled for age at the time of interview, years of education, place of birth (Japan versus elsewhere) and gender (in combined analyses). It was decided not to include income as a covariate, as this information was missing in 11% of the sample, and years of education was considered a suitable surrogate for income. (The correlation coefficient between income and years of education was 0.83.) Analyses among the men were additionally controlled for cigarette smoking and drinking status, because these behaviours may influence risk of gastric cancer.¹¹ These factors were not analysed among women because the proportions of smokers (23.2%) and drinkers (5.8%) were low, and there were few gastric cancer cases among women smokers (6) or drinkers (2). Entered last into all models were indicator terms for categories of intake of the various beverages and food items. Indicator terms were used because of the skewed distributions of estimated frequency of intake. For variables with more than three consumption categories trend tests were conducted, using an ordinal variable that was assigned the median value for each category. With the time of the interview as baseline, person-years at risk were determined by the diagnosis date for cases, the date of death for non-cases who had expired, and the end of 1994 for all others. All analyses were conducted using SAS software (SAS Institute Inc., Cary, NC).

Results

Among the men, the consumption of fresh fruit seven or more times a week was associated with a significantly decreased risk of stomach cancer ($P = 0.04$), relative to lower levels of consumption (Table 1). The relative hazard for this category of fruit consumption was also decreased among the women, and in gender-combined analyses higher fresh fruit consumption was associated with a statistically significant 40% decrease in the incidence of stomach cancer. Risks were also decreased in both sexes for higher compared to lower consumption of raw vegetables, but the differences were not statistically significant. When the intakes of fresh fruits and raw vegetables were considered together, significantly lower risks of gastric cancer were found in the highest two frequency categories among the men and in both sexes combined ($P < 0.05$).

Apart from these findings related to the intake of fresh fruits and raw vegetables, there were no clear associations between levels of intake of the other foods in Table 1 and the risk of gastric cancer. There was an elevated risk among women in the middle consumption category for nitrate-containing foods, but not in the highest consumption category.

Compared to non-drinkers, men who drank coffee had increased risk of gastric cancer, although there was no evidence of a dose-response relationship (Table 2). The excess risks associated with the consumption of one cup and two or more of coffee per day were of borderline statistical significance among the men ($0.05 \leq P < 0.10$). Similarly, in gender-combined analyses, the risk of gastric cancer was elevated to the same extent among those who drank one cup a day (RH: 1.8, $P = 0.07$) and those who drank two or more cups per day (RH: 1.8, $P = 0.05$). Compared to non-drinkers, coffee drinkers (men and women combined) were significantly older (mean age at interview + SD: 49.3 + 15.1 versus 39.5 + 18.0), and had received fewer years of education (12.2 + 3.8 versus 12.8 + 3.5). Among the men, coffee drinkers

Table 1 Adjusted relative hazard (95% confidence interval) for gastric cancer incidence among Japanese-American residents of Hawaii, classified by the frequency of intake of selected foods

Food	Women (n = 6297)		Men (n = 5610)		Combined sample
	No. of cases/ non-cases	Relative hazard (95% CI)	No. of cases/ non-cases	Relative hazard (95% CI)	Relative hazard (95% CI)
Fresh fruit					
0–6 times/week	14/2381	1.0	26/2389	1.0	1.0
7 or more times/week	30/3872	0.7 (0.4–1.4)	38/3157	0.6 (0.3–1.0)	0.6 (0.4–0.9)
Raw vegetables					
0–6 times/week	14/1801	1.0	19/1730	1.0	1.0
7 or more times/week	30/4452	0.7 (0.4–1.4)	45/3816	0.9 (0.5–1.5)	0.8 (0.5–1.2)
Fresh fruit and raw vegetables					
0–7 times/week	6/1022	1.0	18/1138	1.0	1.0
8–13 times/week	15/1892	1.2 (0.4–3.0)	10/1732	0.3 (0.1–0.6)	0.5 (0.3–0.9)
14 or more times/week	23/3339	0.7 (0.3–1.7)	36/2676	0.4 (0.2–0.8)	0.5 (0.3–0.8)
<i>P</i> -value for trend test		0.22		0.04	0.02
Dried or salted fish					
None	37/5488	1.0	55/4759	1.0	1.0
1 or more times/week	7/765	1.1 (0.5–2.6)	9/787	1.0 (0.5–1.9)	1.0 (0.6–1.7)
Pickled vegetables					
None	10/2155	1.0	19/1809	1.0	1.0
1–6 times/week	18/2395	1.7 (0.8–3.7)	24/2184	1.2 (0.6–2.1)	1.3 (0.8–2.2)
7 or more times/week	16/1703	1.4 (0.6–3.1)	21/1553	0.9 (0.5–1.8)	1.1 (0.7–1.8)
<i>P</i> -value for trend test		0.41		0.72	0.75
Processed meats					
none	16/1511	1.0	18/1083	1.0	1.0
1–2 times/week	13/2625	0.7 (0.3–1.4)	26/2245	1.1 (0.6–2.0)	0.9 (0.6–1.4)
3 or more times/week	15/2117	1.2 (0.6–2.4)	20/2218	1.0 (0.5–1.9)	1.0 (0.6–1.7)
<i>P</i> -value for trend test		0.77		0.58	0.37
Miso soup					
None	20/4019	1.0	31/3577	1.0	1.0
1 or more times/week	24/2234	1.3 (0.7–2.4)	33/1969	1.2 (0.7–2.0)	1.2 (0.8–1.8)
High-salt foods^a					
None	7/1554	1.0	12/1323	1.0	1.0
1–3 times/week	9/1971	0.9 (0.3–2.3)	20/1711	1.1 (0.5–2.2)	1.0 (0.6–1.8)
4 or more times/week	28/2728	1.5 (0.6–3.4)	32/2512	0.9 (0.5–1.8)	1.1 (0.7–1.8)
<i>P</i> -value for trend test		0.17		0.60	0.65
Nitrate-containing foods^b					
0–3 times/week	13/2561	1.0	26/2022	1.0	1.0
4–7 times/week	17/1829	2.0 (1.0–4.0)	21/1672	0.9 (0.5–1.6)	1.3 (0.8–2.0)
8 or more times/week	14/1863	1.3 (0.6–2.8)	17/1852	0.7 (0.4–1.2)	0.9 (0.5–1.4)
<i>P</i> -value for trend test		0.62		0.18	0.53

All analyses adjusted for age, years of education, Japanese place of birth, and gender (in combined analyses). Analyses among men were also adjusted for cigarette smoking and alcohol intake status.

^a High-salt food category is the combined frequency of intake of miso soup, pickled vegetables and dried fish.

^b Nitrate-containing food category is the combined frequency of intake of dried fish, pickled vegetables and processed meats.

were significantly more likely to have smoked (60% versus 34%) or consumed alcohol (37% versus 28%) than non-coffee drinkers.

Increasing trends of gastric cancer risk were noted across green tea consumption categories among the men, and in combined analyses. The consumption of milk or black tea appeared to have little relation to risk of gastric cancer in either gender.

The incidence of gastric cancer among the men was not associated with the indicators of cigarette smoking status or smoking intensity (Table 3). The risk of gastric cancer was lower among

those who drank alcoholic beverages ($P = 0.15$), but there was no dose-response trend based on number of drinks per day.

Discussion

The incidence of gastric cancer appears to be influenced to a considerable extent by environmental exposures, among which dietary intake is an obvious aetiological candidate. There have been many case-control studies of diet and gastric cancer, but

Table 2 Adjusted relative hazard (95% confidence interval) for gastric cancer incidence among Japanese-American residents of Hawaii, classified by the intakes of selected beverages.

Beverage	Women (n = 6297)		Men (n = 5610)		Combined sample
	No. of cases/ non-cases	Relative hazard (95% CI)	No. of cases/ non-cases	Relative hazard (95% CI)	Relative hazard (95% CI)
Green tea, cups/day					
None	22/4605	1.0	35/4350	1.0	1.0
1	9/796	1.3 (0.6–2.9)	10/609	1.2 (0.6–2.5)	1.3 (0.7–2.1)
2 or more	13/852	1.3 (0.6–2.6)	19/587	1.6 (0.9–2.9)	1.5 (0.9–2.3)
P-value for trend test		0.50		0.11	0.10
Black tea, cups/day					
None	37/5196	1.0	55/4743	1.0	1.0
1 or more	7/1057	0.9 (0.4–1.9)	9/803	0.8 (0.4–1.6)	0.8 (0.5–1.4)
Coffee, cups/day					
None	8/1860	1.0	6/1641	1.0	1.0
1	17/1709	1.3 (0.6–3.1)	26/1343	2.5 (1.0–6.1)	1.8 (1.0–3.2)
2 or more	19/2684	1.6 (0.7–3.8)	32/2562	2.2 (0.9–5.3)	1.8 (1.0–3.3)
P-value for trend test		0.26		0.32	0.13
Milk, cups/day					
None	29/4012	1.0	41/3464	1.0	1.0
1 or more	15/2241	1.0 (0.5–1.8)	23/2082	1.0 (0.6–1.7)	1.0 (0.7–1.5)

All analyses adjusted for age, years of education, Japanese place of birth, and gender (in combined analyses). Analyses among men were also adjusted for cigarette smoking and alcohol intake status.

Table 3 Adjusted relative hazard (95% confidence interval) for gastric cancer incidence among male Japanese-American residents of Hawaii, classified by cigarette smoking and alcohol intake.

	Number of cases/non-cases	Relative hazard	95% CI
Cigarette smoking			
Smoking status			
Never	34/2652	1.0	
Former	13/876	1.0	0.5–1.9
Current	17/2018	1.1	0.6–2.0
Number of cigarettes/day			
Non-smoker	34/2652	1.0	
1–19	11/1015	1.0	0.5–2.0
20 or more	19/1879	1.1	0.6–1.9
Alcohol intake			
Drinking status			
Non-drinker	51/3639	1.0	
Drinker	13/1907	0.6	0.3–1.2
Number of alcoholic drinks/day			
Non-drinker	51/3639	1.0	
1–2	7/1363	0.5	0.2–1.1
3 or more	6/544	1.2	0.5–2.6

Adjusted for age, years of education, Japanese place of birth, and smoking or drinking status.

few prospective studies. Among the present cohort of Japanese residents of Hawaii, we found that the consumption of fresh fruit seven or more times per week was associated with a lower incidence of gastric cancer.

The major strengths of this study include the prospective design and sample characteristics. Information on the intake of the foods and beverages was collected before subsequent diagnosis of gastric cancer, thus avoiding the exposure recall bias that

is inherent in case-control studies. Additionally, participants were asked to describe their current dietary intake at the time of interview, compared to the more distant recall period commonly used in case-control studies. The findings of this study can be generalized to the Japanese residents of Hawaii, since study participants were randomly selected from the general population of the state and the participation rate was very high. The Japanese are an appropriate group for the study of gastric

cancer, as incidence rates are high in both the US and Japan, and the consumption of many foods and beverages putatively related to risk is common in this group.

A major limitation of this study was the small number of cases, particularly among the women. This restricted our ability to stratify the analyses by key variables, such as subsite, and limited the range and statistical power in some of the exposure categories. The negative results for many of the food and beverage items must therefore be interpreted with caution. This study was also limited by the dietary intake information, which consisted of the frequency and amount of six beverages and the weekly frequency of intake of 13 foods. We were therefore not able to adjust for total calories or total food intake.

The protective association between fruit consumption and gastric cancer is a consistent finding in epidemiological studies. These were reviewed by Block *et al.*¹⁶ who reported significant inverse associations in 13 out of 18 case-control studies. More recent reports have also indicated a protective effect of fruit consumption against gastric cancer.¹⁷⁻²⁰ Reports from two prospective studies also suggest a protective role for fruits.^{21,22}

In contrast, the present study was not able to corroborate the common epidemiological finding of a protective association between the intakes of vegetables and gastric cancer. We had information only on the consumption of raw vegetables, which have been proposed to be especially protective, since cooking can destroy the anti-cancer properties of some vegetables.^{22,23} Most case-control studies have reported an inverse association between consumption of raw vegetables and gastric cancer,^{17,18,24-30} although not always to a statistically significant degree.³¹⁻³⁵ The inability to replicate these findings in the present study may be due to the heterogeneous grouping of raw vegetables. It is possible that participants in the present study did not consume to a sufficient extent the types of vegetables that are thought to be protective against cancer, although a previous study of male Japanese residents of Hawaii reported a protective association between total vegetable intake and gastric cancer incidence.²² These considerations aside, it should be noted that consumption of raw vegetables was associated with a decreased incidence of gastric cancer among both men and women in the present study, although these inverse associations were not statistically significant.

Several mechanisms have been proposed for the protective effects of fruits and vegetables and gastric cancer. These foods are major sources of vitamins C and E, and beta carotene; nutrients which have antioxidant and free radical scavenging properties, and can also inhibit the formation of N-nitroso compounds in the stomach.^{7,36-38}

Despite the well-documented carcinogenicity of N-nitroso compounds,³⁹ the epidemiological literature on the intake of nitrate- and nitrite-containing foods and gastric cancer is inconclusive.¹¹ In the present study, we found little elevated risk associated with the frequency of consumption of processed meats, dried or salted fish, pickled vegetables, or the total intake of these items. Some case-control studies have found increased risk of gastric cancer with the intake of smoked or processed meats,^{25,28,31,32,40} while others have not reported statistically significant associations.^{17,18,26,27,30,33,41} Most case-control studies have reported no significant association between gastric cancer and the intake of dried, salted or smoked fish,^{17,26,31,33,35} with a few exceptions.^{28,41} In a previous prospective study of

Japanese-American male residents of Hawaii, no significant associations were found between gastric cancer and the intake of processed meats or pickles, when measured either by a food frequency questionnaire,⁴² or from 24-hour dietary recall.²² Intake of dried fish from the 24-hour recall (not included on the food frequency questionnaire) also was not significantly associated with gastric cancer incidence.²² Perhaps many dietary studies have failed to substantiate the nitrate/nitrite hypotheses because the *in vivo* production of N-nitroso compounds is not predominantly dependent upon food intake.⁴³ Exposure to nitrates can come endogenously from saliva or from the water supply, and further conversion into N-nitroso compounds may be dependent upon the presence of gastritis and achlorhydria, intragastric bacteria and macrophages, or other dietary constituents, such as ascorbic acid.^{6,7,44}

Another factor which may influence the ultimate carcinogenicity of nitrates is salt. A positive interaction was recently reported between urinary levels of sodium and nitrate in the prediction of the stomach cancer mortality rates of the 24 countries in the INTERSALT study.⁴⁵ The hypothesized mechanisms by which sodium and nitrates influence risk of gastric cancer have been presented in detail.^{6,7,44} Briefly, a high salt intake could result in atrophic gastritis, which, through changes in the intragastric bacterial milieu, results in enhanced conversion of nitrates into nitrites and N-nitroso carcinogens. In support of the salt hypothesis, several epidemiological studies have reported significant associations between salt intakes or salt attitudes and stomach cancer,^{19,26,27,29,30,41} but these are not universal findings.^{22,24,25,33,42,46} Part of the reason for these discrepant results may be that the intake of sodium, like that of nitrate, is difficult to quantify. In the present study, we found no association between gastric cancer incidence and the individual or total intake of several types of high-salt foods, although we recognize these limited data do not provide a valid estimation of salt intake. Without the use of rigorous dietary intake methodology, including information on discretionary use of table salt and soy sauce, it would seem preferable to use more direct measures of salt metabolism. Levels of salt excretion in the 24-hour urine samples of Japanese men were more highly correlated ($r^2 = 0.995$) with regional stomach cancer mortality rates than was salt intake measured by a 3-day dietary intake record ($r^2 = 0.265$).⁴⁷ Results from this Japanese study and the INTERSALT study indicate the salt and nitrate hypotheses may not be adequately appraised with standard dietary intake methodologies.

Previous case-control studies have not reported significant associations between the consumption of coffee and risk of gastric cancer.^{17,20,25,40,41,48,49} The positive associations we found were of borderline statistical significance, and there was no evidence of a dose-response relationship. Coffee drinkers were more likely to be older, less-educated, and, among the men, smokers and drinkers. It is therefore possible our findings regarding coffee are spurious, or reflect residual or unmeasured confounding. Caffeine is not thought to be carcinogenic in humans when consumed in normal amounts,⁵⁰ although mutagenic substances have been found in coffee, regardless of caffeine content.^{51,52} However, given the pervasive consumption of coffee in the US and other countries,⁵³ future epidemiological studies of gastric cancer might consider possible associations with coffee.

The findings related to the consumption of green tea were also unexpected, since the polyphenols contained in this beverage

have been shown to inhibit nitrosation *in vitro* and in human studies,^{7,9,54} and recent research has described the anti-mutagenic and anti-oxidative properties of this beverage.^{55–58} However, earlier research showed green tea to be mutagenic in the Ames test.^{51,59,60} The few previous studies of green tea and gastric cancer have yielded inconclusive results. Protective associations were reported from case-control studies in Japan and China.^{33,61} However, other studies have found no significant association between green tea consumption and gastric cancer,^{20,41,62} and one study from Taiwan reported a positive association of borderline statistical significance ($P < 0.10$).⁴⁹

Approximately half of the male participants of the present study were current or former smokers. However, we found no association between the incidence of gastric cancer and cigarette smoking habit of the men. Results of case-control studies are mixed among significantly positive associations between smoking and gastric cancer^{20,24,26,31,34,49,62–65} and null associations.^{25,28,30,32,48,66} Only one study has reported a lower risk associated with smoking.³⁵ Significantly positive associations have been reported from longitudinal studies of cigarette smoking and gastric cancer incidence^{67,68} and mortality,^{33,69,70} although two others found no significant relationship with mortality from gastric cancer.^{71,72} Few of the case-control^{26,31,34,49,62} and only one of the cohort studies⁷⁰ have demonstrated clear dose-response relationships between cigarette smoking and gastric cancer incidence or mortality, however.

Likewise, the majority of case-control studies have indicated no significant association between risk of gastric cancer and alcohol consumption,^{25,26,30,40,41,61,62,65,73–75} although positive relationships have been reported from case-control studies in the US,⁴⁶ China,²⁴ France,⁶⁴ Poland⁶⁶ and among Japanese residents in Hawaii.⁷⁴ In a prospective study, Kato *et al.* reported a significantly higher risk of mortality due to gastric cancer among Japanese men who consumed 50 ml or more of ethanol per day, compared to non-drinkers.⁶⁸ However, the other prospective cohort studies have reported no association between alcohol intake and gastric cancer incidence⁴² or mortality.^{33,70}

The relationship between alcohol intake and gastric cancer incidence among the male participants in the present study was unclear. Those who consumed alcohol had a somewhat lowered risk, but there was no dose-response relationship. Since these estimates were based on a small number of cases, we feel it is more reasonable to conclude that alcohol consumption is not related to gastric cancer incidence in this cohort than it is to infer a U-shaped association.

Recent case-control studies have reported stronger associations between alcohol intake and adenocarcinoma of the gastric cardia, compared to other gastric cancer subsites,^{20,34,75,76} although this is not a strong or universal finding.^{62,66} In our study, only six of the cases among men were located in the gastric cardia, so it was not possible to stratify the analyses by subsite.

In conclusion, the results from this prospective study indicate the consumption of fresh fruit at least once a day is associated with a lower risk of gastric cancer. We were not able to demonstrate any significant associations between gastric cancer incidence and the intake of foods thought to promote intragastric nitrosation, although this may reflect difficulties in the measurement of these exposures. The positive association between coffee consumption and gastric cancer incidence may deserve

further investigation. Cigarette smoking did not appear to increase risk among the men, although these and other negative findings may be related to the relatively low number of incident cases of gastric cancer in this study.

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