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**The Effect of Dietary Vitamin C on Gastric Cancer Risk in the Korean Population**

Hoang BV *et al*. Vitamin C Intake and Gastric Cancer Risk

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**Abstract**

**AIM:** To investigate the effects of dietary vitamin C and vitamin C - contributing foods on the gastric cancer risk.

**METHODS:** Our study included 830 control subjects and 415 patients. Data regarding information on the demographics, medical history, and lifestyles, including dietary and nutrient intake, were collected by reliable self-administered questionnaires. A rapid urease test and a histological evaluation were used to determine Helicobacter pylori (H. pylori) infection. Twenty - three vitamin C - contributing foods were selected, representing 80% of the cumulative vitamin C contribution.

**RESULTS:** In analyses adjusted for first-degree family history of gastric cancer, education level, job, household income, smoking status, and regular exercise, an inverse association with vitamin C intake for the highest vs. the lowest intake category (odds ratio (OR) (95% confidence interval (CI)): 0.64 (0.46 – 0.88)) was observed, with a significant trend across three intake categories (*P* = 0.007). No protective effect of vitamin C was detected after stratification by gender. No effect of vitamin C intake on the gastric cancer incidence was found in either men or women infected with H. pylori. Vitamin C - contributing foods, including cabbage (0.45 (0.32 - 0.63), 0.50 (0.34 - 0.75), 0.45 (0.25 – 0.81)), strawberries (0.56 (0.40 – 0.78), 0.49 (0.32 – 0.74), 0.52 (0.29 – 0.93)), and bananas (0.40 (0.29 – 0.57), 0.41 (0.27 - 0.62), 0.34 (0.19-0.63)), were protective factors against the risk of gastric cancer based on the results of the overall adjusted analyses, and those for both men and women, respectively.

**CONCLUSION:** A protective effect of vitamin C and vitamin C - contributing foods against gastric cancer was observed. Further studies are required to replicate our results using larger sample sizes.

**Keywords:** Vitamin C, Vitamin C Contributing Foods, Helicobacter pylori, Gastric Cancer

**Core tip:** Increased intake of vitamin C and vitamin C - contributing foods, including vegetables and fruits, may protect individuals against the risk of gastric cancer. However, we have no sufficient evidence to support the protective effect of vitamin C against gastric cancer in individuals infected with H. pylori.

**Introduction**

Although the incidence and mortality rates of gastric cancer have decreased worldwide, stomach cancer remains the fifth most common cancer and the third leading cause of cancer death in both sexes worldwide[[1](#_ENREF_1)]. Gastric cancer is the most common cancer among men in Korea, and the estimated age-standardized incidence and mortality rates in 2015 were 41.3 and 7.8 per 100,000 persons, respectively[[2](#_ENREF_2)].

Dietary habits and nutrient intake play an important role in the prevention and causation of gastric cancer[[3](#_ENREF_3)]. According to a recent report from the World Cancer Research Fund and the American Institute for Cancer Research (WCRF/AICR), ‘probable evidence’ indicates that increased consumption of non-starchy vegetables and fruits may decrease the risk of gastric cancer, whereas salt and salted foods may be directly associated with increased risk. There is also ‘limited evidence’ for a role of a number of other foods. However, no specific constituent of these foods has yet been identified to explain these reported associations[[3](#_ENREF_3)]. Vitamin C is one of the most common antioxidants in fruits and vegetables, and it may exert a chemopreventive effect[[4](#_ENREF_4)]. Vitamin C protects cells from oxidative DNA damage, thereby blocking carcinogenesis[[5](#_ENREF_5)]. To date, a number of epidemiological studies have been published exploring the relationship between vitamin C intake and gastric cancer risk. However, the results of these studies are inconsistent.

Helicobacter pylori (H. pylori) is classified as a cause of stomach cancer according to a monograph from the International Agency for Research on Cancer (IARC)[[6](#_ENREF_6), [7](#_ENREF_7)]. Epidemiological studies in humans have linked vitamin C deficiency to more severe H. pylori-associated gastritis and a higher risk of gastric cancer[[8](#_ENREF_8), [9](#_ENREF_9)]. Furthermore, reduced vitamin C levels in the gastric juice and plasma in H. pylori-infected patients returned to normal levels after H. pylori eradication[[9-12](#_ENREF_9)]. Supplementation with vitamin C is associated with reduced gastric cancer risk in some human studies[[9](#_ENREF_9), [13](#_ENREF_13)]. Therefore, H. pylori-induced gastric cancer may be prevented by an appropriate diet.

We performed a case-control study to investigate the effects of dietary vitamin C and vitamin C - contributing foods on gastric cancer risk.

**Materials and methods**

**Study population**

This study is an extension of two previously published case-control studies[[14](#_ENREF_14), [15](#_ENREF_15)]. The control and case groups were obtained from the National Cancer Center Hospital in Korea between March 2011 and December 2014. Individuals who were histologically confirmed as early gastric cancer patients within the preceding three months at the Center for Gastric Cancer were included in the case group. Early gastric carcinoma is defined as invasive carcinoma confined to the mucosa and/or submucosa, with or without lymph node metastases, irrespective of the tumor size[[16](#_ENREF_16)]. Patients in the case group did not have diabetes mellitus, a history of cancer within the past five years, advanced gastric cancer, or severe systemic or mental disease, nor were they women who were pregnant or breastfeeding. We selected the control group from health-screening examinations performed at the Center for Cancer Prevention and Detection at the same hospital.

In total, 1727 participants were recruited, with 1227 in the control group and 500 in the case group, and 1671 individuals provided data through a food frequency questionnaire (FFQ) and a self-administered questionnaire. Participants with a total energy intake of <500 kcal or ≥4000 kcal (n = 15) were excluded due to the implausibility of the data. Of the 1656 individuals remaining, the control and case subjects were frequency matched by age (within 5 years) and sex at a ratio of 2:1 (control:case). The final analysis consisted of 1245 participants, including 830 controls and 415 cases (men, 810; women, 435) (Figure 1). Our study was approved by the Institutional Review Board of the National Cancer Center [IRB Number: NCCNCS-11-438]. We collected written informed consent from all participants.

**Data collection**

Participants were asked to complete a self-administered questionnaire, including demographic, lifestyle, and medical history information. Dietary intake was collected from the participants using the FFQ, which has been previously reported as a reliable and valid questionnaire[[17](#_ENREF_17)]. The FFQ contains nine food consumption frequency categories (never or rarely, once a month, 2 or 3 times a month, once or twice a week, 3 or 4 times a week, 5 or 6 times a week, once a day, twice a day, and 3 times a day) and three portion size categories (small, medium, and large) for specific food items consumed within the past 12 months. We used CAN-Pro 4.0 (Computer Aided Nutritional Analysis Program, The Korean Nutrition Society, Seoul, Korea) to calculate the average daily nutrient intake for each participant and summed the amounts of vitamin C obtained from various food groups to compute the vitamin C intake (mg/d). A rapid urease test and histological evaluation were used to assess H. pylori infection.

**Statistical analysis**

We used t-tests and chi-square tests for continuous and categorical variables, respectively, to compare the characteristics of the control and case groups. We conducted a contribution analysis to select vitamin C - contributing foods, which were ranked by the percentage of the total vitamin C intake that they provide for the population. A total of 23 vitamin C - contributing foods were selected, representing over 80% of the cumulative contribution.To compare the difference in dietary vitamin C intake and vitamin C - contributing foods, consumption was adjusted for total energy intake using the linear residual regression method[[18](#_ENREF_18)]. The intake levels of vitamin C and vitamin C - contributing foods were categorized into tertiles according to the distribution of the control group. The lowest tertile group was used as the reference group. The median values of each tertile category of the dietary vitamin C intake and vitamin C - contributing foods were used as a continuous variable to test for trends.

The association between dietary factors and gastric cancer risk was assessed by an analysis with logistic regression models with adjustment for potential confounding variables, and the odds ratios (OR) and their 95% confidence intervals (CIs) were calculated. Multivariate models were adjusted for first-degree family history of gastric cancers (yes, no), education level (middle school or less, high school, and college or more), job (managers and professionals, clerical, sales and service, production workers and laborers, and not in the labor force), monthly household income (<2000000 KRW, 2000000-4000000 KRW, ≥4000000 KRW), smoking status (nonsmoker, ex-smoker, and current smoker), regular exercise (yes, no), and H. pylori infection (positive, negative). SAS 9.3 software (SAS Institute., Cary, NC, USA) was used to perform the calculations, and a two-sided *P* value less than 0.05 was considered statistically significant.

**Results**

**General characteristics**

Table 1 shows the distribution of 830 control subjects and 415 patients with gastric cancer according to general characteristics. Gastric cancer patients who had higher percentage of family history of gastric cancer (*P* = 0.001) and tended to have a lower education level (*P* < 0.001), job (*P* < 0.001), and household income (*P* < 0.001) reported using more tobacco (*P* < 0.001), performing less regular exercise (*P* < 0.001), and having a higher proportion of H. pylori infection (*P* < 0.001). Compared to control group, both men and women in the case group had a lower education level, job, and household income, used more tobacco, performed less regular exercise, and had a higher proportion of H. pylori infection. In particular, the men in the case group had a higher percentage of family history of gastric cancer than the control group (*P* = 0.002).

A description of vitamin C and vitamin C - contributing food consumption is shown in Table 2. Lower vitamin C intake (*P* < 0.001), increased consumption of potatoes and starches (*P* = 0.013) and fruits (*P* < 0.001), and higher energy intake (*P* < 0.001) were found in the case group. In general, the case group consumed less cabbage (*P* < 0.001), lettuce (*P* = 0.004), mandarins (*P* < 0.001), strawberries (*P* < 0.001), orange juice (*P* < 0.001), watermelon (*P* = 0.004), apples (*P* < 0.001), and bananas (*P* < 0.001) than control group. Compared to the control group, the men and women in the case group also consumed less vitamin C, cabbage, lettuce, fruits, strawberries, orange juice, watermelon, apples, and bananas. Some differences in vitamin C - contributing food consumption were found in the case and control groups between genders. Men in the case group consumed more energy (*P* < 0.001), fewer potatoes and starches (*P* = 0.005), potatoes (*P* = 0.035), sweet potatoes (*P* = 0.030), and green peppers (*P* = 0.044) than the control group. Fewer mandarins (*P* < 0.001) and persimmons (*P* = 0.004) were consumed by women in the case group than in the control group.

**Vitamin C intake and the risk of gastric cancer**

Table 3 reports the ORs and corresponding 95% CIs for vitamin C intake. Vitamin C intake exhibited a negative association with gastric cancer in both the unadjusted model (OR (95% CI): 0.53 (0.40 – 0.71), *P* for trend < 0.001) and adjusted model (family history of gastric cancer, education level, job, household income, smoking status, and regular exercise) (0.64 (0.46 – 0.88), *P* for trend = 0.007). However, the association was marginally significant after an additional adjustment for H. pylori status (0.71 (0.50 – 1.00), *P* for trend = 0.052). No protective effect of vitamin C was observed in either gender as a result of the adjusted model.

The results were stratified by H. pylori status and sex in the present study. In the crude model, vitamin C intake was a protective factor for gastric cancer for participants infected with H. pylori (0.62 (0.45 – 0.87), *P* for trend = 0.006). However, the association was weakened after an adjustment for confounding factors (0.74 (0.51 – 1.08), *P* for trend = 0.116). No effect of vitamin C intake was observed on the gastric cancer incidence in both men and women infected with H. pylori (data not shown in Table).

**Vitamin C - contributing food consumption and the risk of gastric cancer**

Table 4 shows the association between vitamin C - contributing food consumption and the gastric cancer risk. Overall, consumption of total fruit (0.57 (0.41 – 0.81)), sweet potatoes (0.62 (0.44-0.87)), cabbage (0.45 (0.32-0.63)), Chinese cabbage (0.58 (0.41-0.81)), lettuce (0.67 (0.49-0.93)), strawberries (0.56 (0.40-0.78)), orange juice (0.61 (0.44-0.85), watermelon (0.69 (0.50-0.95)), apples (0.60 (0.43-0.85)), persimmons (0.56 (0.40-0.78)), and bananas (0.40 (0.29-0.57)) are protective factors against gastric cancer based on the results of the adjusted model. Inverse associations of cabbage, strawberry, and banana consumption with gastric cancer risk were also observed in both men and women. Some different protective factors were found between genders. Potatoes and starches, potatoes, sweet potatoes, spinach, Chinese cabbage, lettuce, orange juice, and apples decreased the risk of gastric cancer in men, and fruits and persimmons decreased the risk of gastric cancer in women. In particular, zucchini consumption increased the gastric cancer risk in women (1.87 (1.06-3.28)).

**Discussion**

In our study, a negative association between vitamin C intake and gastric cancer was found in the crude model and the adjusted model, which became less apparent after an additional adjustment for H. pylori status. After adjustment for confounders, no protective effect of vitamin C intake was observed for participants infected with H. pylori. Inverse associations with gastric cancer risk were reported for cabbage, strawberries, and bananas based on the results of the overall adjusted model and for both genders.

The association between vitamin C intake and the risk of gastric cancer is supported by many observational and meta-analysis studies. In a meta-analysis of 11 observational studies, a dose-response analysis was conducted for vitamin C intake (100 mg/day), which showed a significant reduction in the risk of gastric cancer (RR (95% CI): 0.74 (0.69 – 0.79))[[19](#_ENREF_19)]. An inverse association between the intake of vitamin C and the risk of gastric cancer was consistent among case-control studies[[11](#_ENREF_11), [20-25](#_ENREF_20)] and cohort studies[[26](#_ENREF_26), [27](#_ENREF_27)]. For example, in a Spanish study, the strongest protection was observed for vitamin C from fruits and vegetables[[24](#_ENREF_24)]. Another case-control study in Italy also reported that increased vitamin C consumption exhibited an inverse relationship to the risk of gastric cancer[[25](#_ENREF_25)]. Our result is consistent with the Netherlands cohort study, which reported that an inverse association of vitamin C with the risk of gastric carcinoma was found in age and gender – adjusted analyses. However, this association became weaker and was of borderline significance in the multivariate analysis (age, gender, smoking history, education, stomach disorders, and family history of gastric cancer) (RR (95% CI): 0.70 (0.50 – 1.00))[[26](#_ENREF_26)]. Therefore, it appears that vitamin C is among the most consistent protective factors against gastric carcinogenesis. This may be related to its antioxidant effects, free radical scavenger effects, and the inhibition of nitrosamine formation[[28](#_ENREF_28), [29](#_ENREF_29)]. Another biological explanation for an inverse association is the direct action of vitamin C on the growth of H. pylori[[30](#_ENREF_30)]. However, no clear protective effect of vitamin C intake was observed in participants infected with H. pylori in our study.

In contrast, some observational studies did not successfully demonstrate a significant association between vitamin C intake and gastric cancer. Two case–control studies that were conducted in Mexico and Italy, which included a small number of participants, showed no protective effect of vitamin C[[31](#_ENREF_31), [32](#_ENREF_32)]. The Shanghai Women’s and Men’s Health study showed that none of the dietary nutrients examined, including vitamin A, vitamin C, vitamin E, carotene, retinol, selenium, or folic acid, were associated with distal gastric cancer risk among the men and women in this study[[33](#_ENREF_33)].

In the present study, we failed to show a protective effect of vitamin C against gastric cancer for participants infected with H. pylori. At least two explanations should be considered for this finding. First, fruit and vegetable consumption, which are the main sources of vitamin C, is highly prevalent among the Korean population[[34](#_ENREF_34)]. In our study, a difference between case and control groups was observed only for the total fruit consumption. Therefore, if an association between vitamin C intake and gastric cancer truly exists, the small difference between the case and control groups in our study may have limited the statistical power to detect this association. Second, this finding may be related to the habit of eating picked or processed vegetables in the Korean population, which includes many types of kimchi. Kimchi is a fermented vegetable with a high concentration of salt and pepper, which are important risk factors for gastric cancer incidence[[3](#_ENREF_3)]. Moreover, high dietary salt intake can exacerbate H. pylori infection in gastric cancer patients[[35](#_ENREF_35)]. Therefore, it is not surprising that no difference in vegetable consumption was observed between the case and control group, which may weaken the protective effect of vitamin C. Additionally, the exacerbating role of H. pylori infection may modify the true association between vitamin C intake and gastric cancer risk in the adjusted model. Therefore, the protective effect of vitamin C should be considered in the model without adjusting for H. pylori status.

In the vitamin C - contributing food consumption analyses, our findings are consistent with a meta-analysis of prospective cohort studies, which reported an inverse association between fruit intake and gastric cancer incidence (RR (95% CI): 0.82 (0.73 – 0.93)), which was stronger for follow-up periods of ≥ 10 years (0.66 (0.52 – 0.83)), but this was not observed for vegetable consumption (0.88 (0.69 – 1.13))[[36](#_ENREF_36)]. Another meta-analysis of 8 observational studies on the Korean and Japanese populations also showed that increased intake of fresh vegetables was significantly associated with a decreased risk of gastric cancer (OR (95% CI): 0.62 (0.46 – 0.85))[[37](#_ENREF_37)]. Other meta-analyses of observational studies have also supported the protective effect of fruits and vegetables against gastric cancer incidence[[38-41](#_ENREF_38)]. Additionally, the protective effect of fruits and vegetables has been consistently reported in many other case-control studies[[20](#_ENREF_20), [23](#_ENREF_23), [42-47](#_ENREF_42)] and prospective cohort studies[[48-51](#_ENREF_48)]. However, some cohort studies were not successful in investigating this association[[52-55](#_ENREF_52)]. For example, our findings are inconsistent with a cohort study from Japan that reported non-significant associations for the consumption of fruits and vegetables and gastric cancer incidence[[55](#_ENREF_55)]. This finding is comparable with the results of the Netherlands Cohort Study that showed inverse associations for total vegetables, pulses, raw leaf vegetables, total fruits, citrus fruits, and apples and pears in the crude analysis, which became weaker or disappeared in the multivariate analysis[[52](#_ENREF_52)].

The cooking methods of fruits and vegetables may play an important role in the relationship between fruit and vegetable consumption and gastric cancer risk. Some studies have reported that increased consumption of pickled or processed vegetablesincreases the risk of gastric cancer[[37](#_ENREF_37), [47](#_ENREF_47), [56-58](#_ENREF_56)]. A meta-analysis of 14 observational studies demonstrated that increased intake of pickled vegetables was significantly associated with an increased risk of gastric cancer (OR (95% CI): 1.28 (1.06 - 1.53))[[37](#_ENREF_37)]. Moreover, a Korean study reported that increased intake of salt-fermented fish and kimchi was associated with an elevated risk of early gastric cancer[[47](#_ENREF_47)]. These findings explain the non-significant associations in our study because Koreans frequently consume processed vegetables, such as cooked, salted, or pickled vegetables instead of fresh vegetables, and they often include a high concentration of salt. As a consequence of increased salt consumption, the protective effect of vegetables against gastric cancer could be weakened.

Some strengths of the present study include that we used a comprehensive, validated FFQ to assess of the exposure to factors of interest. Additionally, we also collected information about the prevalence of H. pylori infection among the participants, which is classified as a cause of stomach cancer according to a monograph from the IARC[[6](#_ENREF_6), [7](#_ENREF_7)].

However, some potential limitations are also present in our hospital - based case-control study, such as selection and recall bias. Selection bias occurs in a case–control study when subjects for the "control" group are not truly representative of the population that is included in the case group. The hospital-based control group may not represent the Korean population. Moreover, the small number of participants in our study may not be sufficient to detect the protective effects of vitamin C and vitamin C - contributing foods on the gastric cancer risk. Finally, subgroup analyses by anatomical site (cardia versus non-cardia) or histological type (intestinal vs. diffuse) would be helpful because these may modify the epidemiological characteristics of gastric cancer.

In conclusion, an inverse association was found between vitamin C and the risk of gastric cancer. Sufficient evidence is lacking to support the protective effect of vitamin C intake in participants infected with H. pylori. The total fruit consumption and some vitamin C - contributing foods showed a negative association with gastric cancer. Further studies that replicate our results in larger sample sizes are required.

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 **Figure Legends**

1. **Figure 1** Flow Diagram for Included Participants
2. **Table 1** General Characteristics of the Study Subjects
3. **Table 2** Comparison ofIntakes ofVitamin C and Vitamin C Contributing Foods
4. **Table 3** ORs and 95% CIs of Gastric Cancer by Tertiles of Dietary Vitamin C
5. **Table 4** ORs and 95% CIs of Gastric Cancer by Tertiles of Vitamin C Contributing Foods Consumption

**Figure 1 Flow Diagram for Included Participants**



**Table 1 General Characteristics of the Study Subjects**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Total (n=1,245) | Men (n=810) | Women (n=435) |
| 　 | Case(n=415) | Control(n=830) | *P*-valuea | Case(n=270) | Control (n=540) | *P*-value | Case(n=145) | Control(n=290) | *P*-value |
| Age (years), mean±SD | 53.8±9.3 | 53.7±9.0 | 0.892 | 54.9±8.7 | 54.8±8.4 | 0.905  | 51.7±10.0 | 51.6±9.8 | 0.942  |
| Body mass Index (kg/m2) |  |  |  |  |  |  |  |  |  |
|  < 23 | 159(38.3) | 314(37.8) | 0.975 |  91(33.7) | 161(29.8) | 0.509  |  68(46.9) | 153(52.8) | 0.533  |
|  23 - 25 | 122(29.4) | 249(30.0) |  |  78(28.9) | 170(31.5) |  |  44(30.3) |  79(27.2) |  |
|  ≥ 25 | 133(32.1) | 266(32.1) |  | 101(37.4) | 209(38.7) |  |  32(22.1) |  57(19.7) |  |
| First-degree family history of gastric cancer |  |  |  |  |  |  |  |  |  |
|  No | 332(80.0) | 725(87.4) | 0.001 | 209(77.4) | 464(85.9) | 0.002  | 123(84.8) | 261(90.0) | 0.114  |
|  Yes |  82(19.8) | 103(12.4) |  |  60(22.2) |  74(13.7) |  |  22(15.2) |  29(10.0) |  |
| Marital status |  |  |  |  |  |  |  |  |  |
|  Married | 361(87.0) | 716(86.3) | 0.611 | 243(90.0) | 478(88.5) | 0.475  | 118(81.4) | 238(82.1) | 0.975  |
|  Others |  52(12.5) | 113(13.6) |  |  26( 9.6) |  61(11.3) |  |  26(17.9) |  52(17.9) |  |
| Education level |  |  |  |  |  |  |  |  |  |
|  Under middle school | 142(34.2) | 119(14.3) | <0.001 |  91(33.7) |  71(13.2) | <0.001 |  51(35.2) |  48(16.6) | <0.001 |
|  High school | 174(41.9) | 253(30.5) |  | 112(41.5) | 140(25.9) |  |  62(42.8) | 113(39.0) |  |
|  College or more |  97(23.4) | 426(51.3) |  |  66(24.4) | 301(55.7) |  |  31(21.4) | 125(43.1) |  |
| Job |  |  |  |  |  |  |  |  |  |
|  Managers and professionals |  70(16.9) | 156(18.8) | 0.001 |  59(21.9) | 117(21.7) | 0.010  |  11( 7.6) | 39(13.5) | 0.002 |
| Clerial, sales and service | 122(29.4) | 266(32.1) |  |  81(30.0) | 203(37.6) |  |  41(28.3) |  63(21.7) |  |
|  Production workers, and laborers | 104(25.1) | 128(15.4) |  |  83(30.7) | 111(20.6) |  |  21(14.5) |  17( 5.9) |  |
|  Not in labor force | 117(28.2) | 277(33.4) |  |  46(17.0) | 106(19.6) |  |  71(49.0) | 171(59.0) |  |
| Monthly household income b |  |  |  |  |  |  |  |  |  |
|  <200 | 133(32.1) | 149(18.0) | <0.001 |  85(31.5) |  85(15.7) | <0.001 |  48(33.1) |  64(22.1) | 0.016  |
|  200-400 | 148(35.7) | 341(41.1) |  | 106(39.3) | 232(43.0) |  |  42(29.0) | 109(37.6) |  |
| ≥400 |  96(23.1) | 273(32.9) |  |  55(20.4) | 168(31.1) |  |  41(28.3) | 105(36.2) |  |
| Alcohol consumption  |  |  |  |  |  |  |  |  |  |
|  Non-drinker | 119(28.7) | 236(28.4) | 0.243 |  44(16.3) |  89(16.5) | 0.282  |  75(51.7) | 147(50.7) | 0.819  |
|  Ex-drinker |  41( 9.9) |  60( 7.2) |  |  33(12.2) |  47( 8.7) |  |  8( 5.5) |  13( 4.5) |  |
|  Current drinker | 254(61.2) | 534(64.3) |  | 193(71.5) | 404(74.8) |  |  61(42.1) | 130(44.8) |  |
| Smoking status |  |  |  |  |  |  |  |  |  |
|  Non-smoker | 167(40.2) | 384(46.3) | <0.001 |  39(14.4) | 106(19.6) | <0.001 | 128(88.3) | 278(95.9) | 0.021  |
|  Ex-smoker | 119(28.7) | 284(34.2) |  | 110(40.7) | 277(51.3) |  |  9( 6.2) |  7( 2.4) |  |
|  Current-smoker | 128(30.8) | 162(19.5) |  | 121(44.8) | 157(29.1) |  |  7( 4.8) |  5( 1.7) |  |
| Regular exercise  |  |  |  |  |  |  |  |  |  |
|  No | 268(64.6) | 361(43.5) | <0.001 | 161(59.6) | 234(43.3) | <0.001 | 107(73.8) | 127(43.8) | <0.001 |
|  Yes | 147(35.4) | 466(56.1) |  | 109(40.4) | 303(56.1) |  |  38(26.2) | 163(56.2) |  |
| H. pylori infection |  |  |  |  |  |  |  |  |  |
|  Negative |  33( 8.0) | 320(38.6) | <0.001 | 18( 6.7) | 187(34.6) | <0.001 |  15(10.3) | 133(45.9) | <0.001 |
|  Positive | 382(92.1) | 486(58.6) |  | 252(93.3) | 333(61.7) |  | 130(89.7) | 153(52.8) |  |

Values are expressed as the mean ± SD (range) or n (%).

a *P*-values were calculated by t-test (for continuous variable) or chi-square test (for categorical variable)

b Unit is 10,000 Won in Korean currency ($ 1 equivalent to 1,200 Korean Won)

**Table 2 Comparison of Intakes of Vitamin C and Vitamin C Contributing Foodsa**

|  |  |  |  |
| --- | --- | --- | --- |
| Food (g/day) (mean±SD) | Total (n=1,245) | Men (n=810) | Women (n=435) |
| Case(n=415) | Control(n=830) | *P*-valueb | Case(n=270) | Control (n=540) | *P*-value | Case(n=145) | Control(n=290) | *P*-value |
| Energy (Kcal/day) | 1924.1±612.9 | 1713.6±545.5 | <0.001 | 2038.5±634.8 | 1760.6±541.5 | <0.001 | 1711.1±507.0 | 1626.0±543.1 | 0.116 |
| Vitamin C (mg/day) | 96.1±50.5 | 108.4±56.1 | <0.001 | 89.0±45.3 | 97.1±44.2 | 0.014 | 109.3±56.7 | 129.5±68.5 | 0.001 |
| **Potatoes and starches** | 39.3±38.1 | 45.5±45.4 | 0.013 | 32.8±34.6 | 40.3±36.5 | 0.005 | 51.5±41.2 | 55.1±57.4 | 0.456 |
| Potato | 32.3±34.0 | 35.0±35.0 | 0.209 | 27.7±32.2 | 32.7±30.3 | 0.035 | 41.0±35.7 | 39.1±42.1 | 0.635 |
| Sweet potato | 24.8±210.0 | 42.3±234.4 | 0.183 | 8.2±41.9 | 15.1±47.1 | 0.030 | 55.6±349.4 | 92.8±386.8 | 0.329 |
| **Vegetables** | 327.4±185.0 | 328.2±166.2 | 0.947 | 318.4±177.5 | 320.5±157.4 | 0.873 | 344.3±197.7 | 342.5±180.8 | 0.926 |
| Korean cabbage Kimchi | 99.3±71.0 | 96.1±69.3 | 0.450 | 94.9±66.6 | 97.3±69.0 | 0.639 | 107.4±78.1 | 93.8±70.0 | 0.068 |
| Green Pepper | 7.3±11.0 | 7.9±10.6 | 0.347 | 6.4±6.8 | 7.5±9.5 | 0.044 | 9.0±16.0 | 8.6±12.5 | 0.769 |
| Radish | 20.3±17.5 | 21.2±18.3 | 0.375 | 20.3±16.8 | 21.5±17.5 | 0.348 | 20.3±18.8 | 20.8±19.6 | 0.801 |
| Spinach | 9.9±21.6 | 10.7±22.8 | 0.572 | 8.0±18.5 | 9.1±17.3 | 0.380 | 13.6±26.2 | 13.6±30.4 | 0.994 |
| Kkakdugi | 27.1±80.2 | 28.5±58.9 | 0.765 | 20.7±40.1 | 26.8±52.3 | 0.065 | 39.1±123.6 | 31.5±69.6 | 0.491 |
| Cabbage | 6.6±13.9 | 13.4±27.1 | <0.001 | 4.6±10.3 | 9.7±20.0 | <0.001 | 10.3±18.3 | 20.4±35.8 | <0.001 |
| Chonggak Kimchi | 15.7±44.9 | 16.5±33.6 | 0.769 | 12.1±23.1 | 15.6±29.9 | 0.072 | 22.4±68.7 | 18.1±39.4 | 0.486 |
| Zucchini | 18.0±22.1 | 17.5±20.4 | 0.711 | 16.1±20.3 | 15.4±18.3 | 0.650 | 21.6±24.9 | 21.5±23.2 | 0.956 |
| Chinese cabbage | 22.3±118.0 | 32.7±142.8 | 0.172 | 20.7±132.2 | 34.0±164.8 | 0.217 | 25.1±85.7 | 30.3±88.5 | 0.564 |
| Lettuce | 7.2±10.1 | 9.3±15.5 | 0.004 | 6.1±8.8 | 7.6±10.7 | 0.039 | 9.1±11.9 | 12.4±21.4 | 0.040 |
| Onion | 14.5±8.7 | 15.0±9.2 | 0.375 | 13.4±7.6 | 14.3±8.6 | 0.166 | 16.4±10.2 | 16.3±10.2 | 0.887 |
| Leaf mustard kimchi | 10.5±61.5 | 14.2±118.4 | 0.469 | 8.1±62.4 | 8.2±58.9 | 0.990 | 14.9±59.8 | 25.4±183.1 | 0.377 |
| Green onion | 4.8±3.0 | 5.0±3.3 | 0.410 | 4.9±3.01 | 5.1±3.3 | 0.410 | 4.7±2.9 | 4.8±3.5 | 0.811 |
| **Fruits** | 136.0±165.8 | 191.8±209.1 | <0.001 | 115.5±149.4 | 152.0±163.5 | 0.002 | 174.1±187.4 | 266.0±259.0 | <0.001 |
| Mandarin | 16.0±26.3 | 23.2±44.9 | <0.001 | 12.9±22.6 | 14.6±23.4 | 0.319 | 21.8±31.5 | 39.2±66.0 | <0.001 |
| Strawberry | 5.2±8.7 | 8.8±15.8 | <0.001 | 4.3±7.7 | 6.7±11.2 | <0.001 | 7.0±10.0 | 12.6±21.4 | <0.001 |
| Orange juice | 8.9±22.2 | 20.8±56.1 | <0.001 | 6.4±14.2 | 16.9±54.8 | <0.001 | 13.6±31.6 | 28.0±57.8 | 0.001 |
| Watermelon | 13.4±21.7 | 21.0±69.4 | 0.004 | 11.3±21.2 | 15.3±36.5 | 0.050 | 17.5±22.2 | 31.8±105.6 | 0.028 |
| Apple | 30.4±57.1 | 52.3±89.7 | <0.001 | 23.8±49.1 | 42.7±77.3 | <0.001 | 42.7±68.1 | 70.2±107.0 | 0.001 |
| persimmon | 17.4±110.5 | 20.3±57.6 | 0.617 | 17.2±133.6 | 12.9±43.3 | 0.603 | 17.8±41.9 | 34.1±75.5 | 0.004 |
| Banana | 10.5±26.5 | 20.3±40.9 | <0.001 | 7.3±16.0 | 15.2±28.9 | <0.001 | 16.4±38.5 | 29.8±55.8 | 0.004 |
| Citrus tea | 23.6±142.9 | 58.5±729.7 | 0.184 | 11.8±62.8 | 18.1±67.4 | 0.201 | 45.5±225.0 | 133.7±1228.9 | 0.237 |

**a** Adjusted for total energy intake using the residuals method

b *P*-values were calculated by t-test.

**Table 3 ORs and 95% CIs of Gastric Cancer by Tertiles of Dietary Vitamin C**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Range (mg/day)** | **No. of** **controls/cases** | **Model I** | **Model II** | **Model III** |
|  | **OR (95% CI)** | **OR (95% CI)** | **OR (95% CI)** |
| **Total (n=1245)** |  |  |  |  |
| **T1** | <80.14 | 276/186 | 1.00 | 1.00 | 1.00 |
| **T2** | 80.14-120.67 | 277/130 | 0.70 (0.53-0.92) | 0.81 (0.59-1.10) | 0.81 (0.58-1.12) |
| **T3** | ≥120.67 | 277/99 | 0.53 (0.40-0.71) | 0.64 (0.46-0.88) | 0.71 (0.50-1.00) |
| *P* for trenda |  | <0.001 | 0.007 | 0.052 |
| **Men (n=810)** |  |  |  |  |
| **T1** | <73.18 | 180/107 | 1.00 | 1.00 | 1.00 |
| **T2** | 73.18-110.59 | 180/93 | 0.87 (0.62-1.23) | 1.11 (0.75-1.64) | 1.07 (0.70-1.61) |
| **T3** | ≥110.59 | 180/70 | 0.65 (0.45-0.94) | 0.78 (0.52-1.18) | 0.91 (0.59-1.41) |
| *P* for trend |  | 0.022 | 0.229 | 0.659 |
| **Women (n=435)** |  |  |  |  |
| **T1** | <91.70 | 96/69 | 1.00 | 1.00 | 1.00 |
| **T2** | 91.70-139.52 | 97/45 | 0.65 (0.40-1.03) | 0.81 (0.48-1.36) | 0.85 (0.49-1.48) |
| **T3** | ≥139.52 | 97/31 | 0.45 (0.27-0.74) | 0.57 (0.32-1.00) | 0.61 (0.34-1.12) |
| *P* for trend |  | 0.002 | 0.051 | 0.109 |

aTest for trend calculated with the median intake for each category of dietary vitamin C intake as a continuous variable; Model I: unadjusted; Model II: adjusted by first-degree family history of gastric cancer, education level, job, household income, smoking status, regular exercise; Model III: additionally adjusted for *H. pylori* infection

**Table4 ORs and 95% CIs of Gastric Cancer by Tertiles of Vitamin C Contributing Foods Consumption**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Total****(n=1,245)** | **P for trendb** | **Men****(n=810)** | **P for trend** | **Women****(n=435)** | **P for trend** |
| **Potatoes and starches** |  |  |  |  |  |  |
| Model I ORa (95% CI) | 0.74(0.54-1.59) | 0.020 | 0.55(0.37-0.82) | 0.001 | 0.97(0.60-1.57) | 0.996 |
| Model II OR (95% CI) | 0.72(0.52-1.01) | 0.028 | 0.55(0.36-0.85) | 0.003 | 0.94(0.55-1.60) | 0.889 |
| Model III OR (95% CI) | 0.85(0.59-1.21) | 0.277 | 0.65(0.41-1.03) | 0.042 | 1.01(0.57-1.79) | 0.891 |
| **Total vegetables consumption** |  |  |  |  |  |
| Model I OR (95% CI) | 0.87(0.66-1.16) | 0.366 | 0.91(0.64-1.31) | 0.593 | 0.86(0.54-1.37) | 0.549 |
| Model II OR (95% CI) | 0.91(0.66-1.25) | 0.575 | 1.01(0.67-1.52) | 0.955 | 0.83(0.49-1.39) | 0.496 |
| Model III OR (95% CI) | 0.96(0.68-1.34) | 0.800 | 1.09(0.71-1.68) | 0.744 | 0.82(0.47-1.43) | 0.494 |
| **Total fruits consumption** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.41(0.30-0.56) | <0.001 | 0.52(0.36-0.75) | 0.001 | 0.34(0.21-0.57) | <0.001 |
| Model II OR (95% CI) | 0.57(0.41-0.81) | 0.002 | 0.73(0.49-1.10) | 0.148 | 0.52(0.30-0.92) | 0.032 |
| Model III OR (95% CI) | 0.59(0.41-0.85) | 0.005 | 0.73(0.47-1.13) | 0.179 | 0.57(0.31-1.05) | 0.089 |
| **Potato** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.82(0.61-1.10) | 0.114 | 0.60(0.41-0.87) | 0.003 | 1.19(0.73-1.93) | 0.444 |
| Model II OR (95% CI) | 0.79(0.57-1.09) | 0.105 | 0.55(0.36-0.85) | 0.003 | 0.99(0.57-1.70) | 0.867 |
| Model III OR (95% CI) | 0.91(0.64-1.29) | 0.458 | 0.65(0.41-1.02) | 0.034 | 1.10(0.61-1.97) | 0.572 |
| **Sweet potato** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.57(0.42-0.77) | <0.001 | 0.54(0.37-0.80) | <0.001 | 0.71(0.44-1.16) | 0.244 |
| Model II OR (95% CI) | 0.62(0.44-0.87) | 0.002 | 0.60(0.39-0.92) | 0.003 | 0.68(0.39-1.18) | 0.196 |
| Model III OR (95% CI) | 0.69(048-1.00) | 0.018 | 0.66(0.42-1.05) | 0.016 | 0.76(0.42-1.37) | 0.294 |
| **Korean Cabbage Kimchi** |  |  |  |  |  |  |
| Model I OR (95% CI) | 1.08(0.81-1.43) | 0.547 | 0.90(0.63-1.28) | 0.572 | 1.47(0.91-2.39) | 0.087 |
| Model II OR (95% CI) | 1.08(0.79-1.48) | 0.629 | 0.91(0.61-1.35) | 0.693 | 1.41(0.81-2.43) | 0.163 |
| Model III OR (95% CI) | 1.11(0.80-1.55) | 0.511 | 0.99(0.65-1.51) | 0.976 | 1.27(0.71-2.28) | 0.342 |
| **Green Pepper** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.85(0.64-1.14) | 0.252 | 0.78(0.54-1.12) | 0.141 | 0.99(0.60-1.62) | 0.894 |
| Model II OR (95% CI) | 0.87(0.64-1.20) | 0.328 | 0.74(0.49-1.12) | 0.090 | 0.99(0.57-1.72) | 0.973 |
| Model III OR (95% CI) | 0.81(0.57-1.13) | 0.167 | 0.67(0.44-0.04) | 0.037 | 0.93(0.51-1.68) | 0.844 |
| **Radish** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.97(0.72-1.31) | 0.599 | 0.89(0.62-1.28) | 0.468 | 1.22(0.72-2.06) | 0.870 |
| Model II OR (95% CI) | 0.92(0.67-1.28) | 0.348 | 0.90(0.60-1.35) | 0.489 | 1.16(0.65-2.07) | 0.799 |
| Model III OR (95% CI) | 0.98(0.69-1.39) | 0.495 | 0.92(0.60-1.43) | 0.578 | 1.27(0.68-2.35) | 0.893 |
| **Spinach** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.77(0.58-1.03) | 0.173 | 0.62(0.44-0.90) | 0.024 | 0.93(0.58-1.51) | 0.923 |
| Model II OR (95% CI) | 0.80(0.58-1.09) | 0.283 | 0.66(0.45-0.99) | 0.071 | 1.02(0.59-1.77) | 0.851 |
| Model III OR (95% CI) | 0.86(0.61-1.20) | 0.532 | 0.78(0.51-1.20) | 0.360 | 0.94(0.52-1.70) | 0.821 |
| **Kkakdugi** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.82(0.62-1.10) | 0.193 | 0.69(0.48-0.99) | 0.038 | 1.33(0.80-2.22) | 0.592 |
| Model II OR (95% CI) | 0.82(0.59-1.12) | 0.195 | 0.70(0.47-1.05) | 0.090 | 1.21(0.69-2.11) | 0.937 |
| Model III OR (95% CI) | 0.80(0.57-1.12) | 0.192 | 0.73(0.47-1.13) | 0.142 | 1.06(0.58-1.94) | 0.816 |
| **Cabbage** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.34(0.25-0.46) | <0.001 | 0.37(0.26-0.53) | <0.001 | 0.33(0.19-0.55) | <0.001 |
| Model II OR (95% CI) | 0.45(0.32-0.63) | <0.001 | 0.50(0.34-0.75) | 0.004 | 0.45(0.25-0.81) | 0.016 |
| Model III OR (95% CI) | 0.50(0.35-0.72) | 0.0009 | 0.53(0.35-0.82) | 0.015 | 0.54(0.29-1.00) | 0.094 |
| **Chonggak Kimchi** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.83(0.62-1.10) | 0.215 | 0.69(0.48-0.99) | 0.038 | 1.33(0.80-2.20) | 0.589 |
| Model II OR (95% CI) | 0.83(0.60-1.04) | 0.253 | 0.69(0.46-1.04) | 0.077 | 1.21(0.69-2.11) | 0.933 |
| Model III OR (95% CI) | 0.81(0.58-1.13) | 0.244 | 0.72(0.47-1.11) | 0.113 | 1.06(0.58-1.94) | 0.818 |
| **Zucchini** |  |  |  |  |  |  |
| Model I OR (95% CI) | 1.01(0.76-1.35) | 0.898 | 0.96(0.67-1.37) | 0.772 | 1.38(0.84-2.25) | 0.195 |
| Model II OR (95% CI) | 1.09(0.79-1.51) | 0.783 | 0.99(0.66-1.48) | 0.846 | 1.87(1.06-3.28) | 0.026 |
| Model III OR (95% CI) | 1.11(0.78-1.56) | 0.749 | 1.97(0.63-1.50) | 0.784 | 1.82(1.00-3.30) | 0.045 |
| **Chinese Cabbage** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.64(0.47-0.86) | <0.001 | 0.53(0.36-0.78) | <0.001 | 0.80(0.49-1.31) | 0.342 |
| Model II OR (95% CI) | 0.58(0.41-0.81) | <0.001 | 0.49(0.32-0.76) | <0.001 | 0.72(0.41-1.25) | 0.115 |
| Model III OR (95% CI) | 0.62(0.44-0.89) | <0.001 | 0.57(0.36-0.90) | 0.005 | 0.67(0.37-1.22) | 0.092 |
| **Lettuce** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.64(0.48-0.86) | 0.008 | 0.58(0.41-0.82) | 0.013 | 0.77(0.47-1.26) | 0.301 |
| Model II OR (95% CI) | 0.67(0.49-0.93) | 0.026 | 0.58(0.39-0.86) | 0.023 | 0.79(0.45-1.36) | 0.365 |
| Model III OR (95% CI) | 0.68(0.48-0.95) | 0.031 | 0.58(0.38-0.88) | 0.023 | 0.78(0.43-1.40) | 0.337 |
| **Onion** |  |  |  |  |  |  |
| Model I OR (95% CI) | 1.06(0.79-1.42) | 0.817 | 0.90(0.62-1.30) | 0.436 | 1.21(0.73-1.99) | 0.539 |
| Model II OR (95% CI) | 1.09(0.79-1.51) | 0.693 | 0.84(0.56-1.27) | 0.320 | 1.33(0.76-2.33) | 0.344 |
| Model III OR (95% CI) | 1.13(0.80-1.59) | 0.572 | 0.90(0.58-1.40) | 0.524 | 1.27(0.71-2.30) | 0.457 |
| **Leaf mustard Kimchi** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.84(0.62-1.12) | 0.099 | 0.87(0.60-1.25) | 0.220 | 0.66(0.40-1.08) | 0.207 |
| Model II OR (95% CI) | 0.76(0.55-1.06) | 0.018 | 0.84(0.56-1.27) | 0.089 | 0.60(0.34-1.04) | 0.076 |
| Model III OR (95% CI) | 0.76(0.54-1.08) | 0.038 | 0.90(0.58-1.40) | 0.180 | 0.57(0.32-1.04) | 0.093 |
| **Green onion** |  |  |  |  |  |  |
| Model I OR (95% CI) | 1.03(0.76-1.38) | 0.909 | 0.92(0.64-1.33) | 0.527 | 1.21(0.73-2.01) | 0.612 |
| Model II OR (95% CI) | 1.02(0.73-1.41) | 0.807 | 0.94(0.62-1.42) | 0.588 | 1.11(0.64-1.95) | 0.731 |
| Model III OR (95% CI) | 1.01(0.71-1.44) | 0.744 | 0.94(0.60-1.46) | 0.582 | 1.18(0.65-2.13) | 0.650 |
| **Mandarin** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.60(0.44-0.80) | 0.001 | 0.79(0.55-1.12) | 0.356 | 0.42(0.25-0.71) | 0.002 |
| Model II OR (95% CI) | 0.74(0.53-1.04) | 0.061 | 0.97(0.66-1.44) | 0.941 | 0.60(0.34-1.07) | 0.101 |
| Model III OR (95% CI) | 0.71(0.50-1.01) | 0.038 | 0.95(0.62-1.44) | 0.961 | 0.54(0.29-0.99) | 0.061 |
| **Strawberry** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.44(0.33-0.60) | <0.001 | 0.40(0.27-0.58) | <0.001 | 0.39(0.23-0.67) | 0.001 |
| Model II OR (95% CI) | 0.56(0.40-0.78) | 0.001 | 0.49(0.32-0.74) | 0.001 | 0.52(0.29-0.93) | 0.026 |
| Model III OR (95% CI) | 0.61(0.43-0.86) | 0.009 | 0.50(0.32-0.79) | 0.004 | 0.57(0.30-1.07) | 0.065 |
| **Orange juice** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.43(0.32-0.59) | <0.001 | 0.36(0.25-0.53) | <0.001 | 0.50(0.30-0.85) | 0.006 |
| Model II OR (95% CI) | 0.61(0.44-0.85) | 0.003 | 0.47(0.30-0.71) | 0.001 | 0.83(0.46-1.51) | 0.294 |
| Model III OR (95% CI) | 0.65(0.46-0.94) | 0.014 | 0.49(0.31-0.77) | 0.002 | 0.98(0.52-1.86) | 0.677 |
| **Watermelon** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.59(0.44-0.78) | 0.003 | 0.61(0.43-0.87) | 0.032 | 0.63(0.39-1.02) | 0.117 |
| Model II OR (95% CI) | 0.69(0.50-0.95) | 0.065 | 0.71(0.48-1.06) | 0.211 | 0.72(0.42-1.24) | 0.309 |
| Model III OR (95% CI) | 0.65(0.46-0.92) | 0.043 | 0.67(0.44-1.03) | 0.132 | 0.71(0.40-1.27) | 0.292 |
| **Apple** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.40(0.29-0.54) | <0.001 | 0.38(0.26-0.55) | <0.001 | 0.43(0.26-0.71) | 0.005 |
| Model II OR (95% CI) | 0.60(0.43-0.85) | 0.006 | 0.57(0.37-0.87) | 0.026 | 0.64(0.37-1.11) | 0.204 |
| Model III OR (95% CI) | 0.64(0.45-0.92) | 0.028 | 0.53(0.34-0.83) | 0.013 | 0.82(0.46-1.47) | 0.705 |
| **Persimmon** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.49(0.36-0.66) | <0.001 | 0.62(0.43-0.89) | 0.026 | 0.40(0.24-0.66) | 0.002 |
| Model II OR (95% CI) | 0.56(0.40-0.78) | 0.001 | 0.72(0.48-1.08) | 0.151 | 0.46(0.26-0.80) | 0.018 |
| Model III OR (95% CI) | 0.55(0.38-0.78) | 0.001 | 0.67(0.44-1.03) | 0.086 | 0.45(0.25-0.82) | 0.028 |
| **Banana** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.32(0.24-0.44) | <0.001 | 0.33(0.22-0.47) | <0.001 | 0.26(0.15-0.46) | <0.001 |
| Model II OR (95% CI) | 0.40(0.29-0.57) | <0.001 | 0.41(0.27-0.62) | <0.001 | 0.34(0.19-0.63) | 0.001 |
| Model III OR (95% CI) | 0.44(0.31-0.63) | <0.001 | 0.41(0.27-0.64) | 0.001 | 0.44(0.23-0.83) | 0.014 |
| **Citrus Tea** |  |  |  |  |  |  |
| Model I OR (95% CI) | 0.64(0.48-0.87) | 0.002 | 0.56(0.38-0.81) | 0.001 | 0.81 (0.49-1.34) | 0.281 |
| Model II OR (95% CI) | 0.78(0.56-1.09) | 0.048 | 0.68(0.44-1.04) | 0.017 | 1.00 (0.57-1.76) | 0.669 |
| Model III OR (95% CI) | 0.83(0.59-1.18) | 0.161 | 0.71(0.45-1.11) | 0.040 | 1.14 (0.63-2.09) | 0.992 |

a OR for association with the lowest tertile group compared with the highest tertile group; bTest for trend calculated with the median intake for each category of vitamin C contributing food consumption as a continuous variable; Model I: unadjusted; Model II: adjusted by first-degree family history of gastric cancer, education level, job, household income, smoking status, regular exercise; Model III: additionally adjusted for *H. pylori* infection