Mortality Risks of Oesophageal Cancer Associated with Hot Tea, Alcohol, Tobacco and Diet in Japan

Yoshihide Kinjo 1,2, Yadong Cui 3, Suminori Akiba 4, Shaw Watanabe 5, Naohito Yamaguchi 2, Tomotaka Sobue 2, Shoichi Mizuno 6, and Valerie Beral 1

To clarify mortality risks of oesophageal cancer associated with hot tea, alcohol, tobacco and diet, further analyses on the data from a large prospective cohort study in Japan were conducted. The subjects for analysis were 220,272 men and women aged 40 to 69 at the baseline of 1965. There were 440 oesophageal cancer deaths during the period from January 1966 to December 1981. Person-years at risk were 3,065,182 in total. Rate ratio and 95% confidence interval adjusted for attained age, prefecture, occupation and sex were (RR (95%CI)): 1.6 (1.2-2.0) for hot tea (drinking green tea at high temperatures) in comparison with not-hot tea (drinking green tea at moderate temperatures); 2.4 (1.8-3.1) for daily (4 times/week or more) alcohol drinking in comparison with non-drinking; and 2.3 (1.7-3.1) for heavy smoking (15 cigarettes/day or more) in comparison with non-smoking. Dose-response relationships were found in alcohol drinking and smoking among men and women (p for trend; p<0.001). The rate ratios were not significantly associated with the dietary factors except for green-yellow vegetables (1-3 times/month or less in comparison with daily; RR=2.0, 95%CI: 1.2 -3.1), where a no dose-response trend was observed (p=0.45). In comparison based on the binary variables, the RR for the subjects with daily alcohol drinking and current smoking was 3.9 with 95%CI of 2.7 to 5.4, relative to those exposed to neither habit. The joint effect of alcohol drinking (A) and smoking (S) was more than additive (A*S > A+S: 3.9>1+(1.0-1)+(1.6-1)). Further sub-analysis showed that the RR for the subjects with daily alcohol drinking and smoking and hot tea was 5.7 with 95%CI of 3.7 to 8.9, when the reference was the subjects with not-daily alcohol drinking, non-smoking and not-hot tea. Similar results were obtained from further adjustment of green-yellow vegetables. It is concluded that mortality risks of oesophageal cancer in the present cohort were substantially associated with thermal effect of hot tea, alcohol drinking, smoking and lower consumption of green-yellow vegetables. This finding suggests that life-style modification for smoking and dietary habits is essential to reduce the risks of oesophageal cancer in Japan. J Epidemiol, 1998; 8 : 235-243.

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1 Imperial Cancer Research Fund Cancer Epidemiology Unit, University of Oxford, Oxford, UK.
2 Cancer Information and Epidemiology Division, National Cancer Center Research Institute, Tokyo, Japan.
3 Department of Epidemiology and Preventive Medicine, University of Maryland, Baltimore, USA.
4 Department of Public Health, Kagoshima University School of Medicine, Kagoshima, Japan.
5 Department of Applied Bioscience, Tokyo University of Agriculture, Tokyo, Japan.
6 Department of Information Dynamics, Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan.
Address for correspondence : Yoshihide Kinjo, Cancer Information and Epidemiology Division, National Cancer Center Research Institute, 5-1-1 Tsukiji, Chuo-ku Tokyo, 104-0045 Japan.
of the herb) in South America were related to oesophageal cancer. In Japan, an ecological study showed that a traditional food tea-gruel, which was eaten customarily at extremely high temperatures, was a risk factor of oesophageal cancer. A case-control study in Japan indicated that the combined intake of bracken fern and hot tea gruel presented a significant risk of this cancer.

A large prospective cohort study based on census population in Japan was conducted by Dr. Hirayama and colleagues from 1966 to 1981. This study has been extremely valuable in leading to cancer prevention in Japan. For oesophageal cancer, drinking green tea at high temperatures (hot tea) was not a significant mortality risk in the first analysis of the cohort data during the follow-up period from 1966 to 1970. Too few individuals drank no green tea at all, so it was not feasible to investigate whether green tea itself has an effect on oesophageal cancer. The second analysis using standardized mortality ratio for the follow-up period from 1966 to 1973 showed that hot tea was associated with oesophageal cancer among male cohort members. Therefore in the final analysis for the full follow-up period it would seem useful to determine the effects of hot tea and other factors on oesophageal cancer mortality.

The purpose of the present analysis is to clarify the mortality risks of oesophageal cancer associated with hot tea, alcohol, tobacco and diet in this large prospective cohort.

**MATERIALS AND METHODS**

**Profile of cohort**

A cohort of 265,070 residents, aged 40 or over, from 29 public health districts in six prefectures of Japan (Kagoshima, Okayama, Hyogo, Osaka, Aichi and Miyagi) were followed from January 1966 to December 1981 by Dr. Hirayama and colleagues. A one-page questionnaire used in the baseline survey on December 1965 included questions about occupation, cigarette smoking, alcohol drinking, frequency of food consumption (green-yellow vegetables, pickles, miso soup, fish, meat, milk, rice) and so on. At the beginning of each follow-up year, a migration survey was conducted through reference to the local residence registration. During the follow-up period, the deaths were annually ascertained by vital statistics kept at each public health center. The causes of deaths were coded by Dr. Hirayama according to the 7th revision of the International Classification of Disease (ICD-7).

Occupation was coded into the following 10 categories: 1) professional and technical workers, 2) managers and officials, 3) clerical and related workers, 4) sales workers, 5) farmers, lumbermen and fishermen, 6) workers in mining and quarrying, 7) workers in transport and communication, 8) craftsmen, production process workers and labourers, 9) service workers, and 10) either not classifiable (house wife) or not reported. These categories can be reclassified into the following five categories taking into account the average number of years of schooling: (I) farmers, mining (5 + 6), (II) transport, craftsmen (7 + 8), (III) clerical, sales, service (3 + 4 + 9), (IV) professional, managers (1 + 2), and (V) job unknown.

Hot tea was divided into two groups: hot tea (drinking green tea at high temperatures) and not-hot tea (drinking green tea at moderate temperatures). Non-tea-drinkers (2.8% in total) were excluded from the present analysis. Cigarette smoking was categorized into four groups, i.e., non-smokers (never smoked), ex-smokers, light smokers (1-14 cigarettes/day) and heavy smokers (15+ cigarettes/day). Frequency of alcohol consumption was classified into four categories, i.e., none (non-drinkers), 1-3 times/month, 1-3 times/week and 4 times/week or more. Dietary factors including green-yellow vegetables were classified by the following three categories: 4 times/week or more, 1-3 times/week and 1-3 times/month or less. Frequency of rice consumption was excluded from the present analysis because about 91% of men and women consumed rice with 3 times per day at the baseline.

Finally, the following cohort members were excluded from the 265,070 subjects based on the information at the baseline: (1) those with a history of cancer (n=1,091), (2) those 70 years old or over (n=4,490), (3) those with no information available on green tea, tobacco, alcohol, green-yellow vegetables and other dietary factors (n=39,217). After this exclusion, a total of 220,272 (100,840 men and 119,432 women) cohort members remained for analysis.

**Statistical procedure**

The person-years and the numbers of deaths were aggregated and stratified by attained age (5-year interval), sex, prefecture, occupation and other factors using DATAB computer program. Thereafter, AMFIT regression program was used for survival analysis with the Poisson regression model. The rate ratio (RR) and its 95% confidence interval (95%CI) were also estimated by the method of maximum likelihood. A more detailed description of the statistical methods is available elsewhere.

**RESULTS**

During the study period, there were 328 deaths and 112 deaths from oesophageal cancer among men and women, respectively. Person-years at risk were 3,065,182 in total, 1,360,307 for men, and 1,704,875 for women, respectively.

Table 1 shows the frequency distribution of the exposure factors, i.e., hot tea, alcohol and tobacco according to potential confounding factors, e.g., sex, age, prefecture, occupation and...
green-yellow vegetables. As shown in Tables 1-1 and 1-2, there were no large differences of proportion of hot tea between men and women. There was also no special correlation between hot tea and other factors. On the other hand, a positive correlation was observed between alcohol and tobacco consumption, although there was a sex difference in the frequency distribution. Thus, the percent of alcohol drinking with 4 times/week or more increased with the increase of cigarettes smoked per day.

Tables 2 shows the results on the exposure factors. The rate ratios presented here were adjusted for attained age, prefecture, occupation and sex (both sexes). The results from men only were similar to those from men and women. The RR for hot tea was statistically significant in comparison with not-hot tea in men and women (RR=1.6, 95%CI: 1.2-2.0). The RR for hot tea from women (RR=1.8, 95%CI: 1.1-2.9) was slightly higher than from men (RR=1.5, 95%CI: 1.1-2.0). For alcohol drinking, the RR in men and women who drank daily (4 times/week or more) was 2.4 with 95%CI of 1.8 to 3.1 in comparison with non-drinking. The trend test for a dose-response was significant among either men only or both sexes (p<0.001). For cigarette smoking, the RR from heavy smokers was 2.7 (95%CI: 1.8-3.8) for men and 2.3 (95%CI: 1.7-3.1) for men and women. The trend test was also significant among either men only.
Table 1-2. Frequency distribution on exposure factors (hot tea, alcohol, tobacco) according to potential confounding factors among women from six-prefecture cohort (1966-1981).

| Factors                        | Categories   | Number | Not-hot | Hot | None | 1-3 times/month | 1-3 times/week | 4 times/week or more | Non-smokers | Ex-smokers | Light 1-14 | Heavy 15+ |
|--------------------------------|--------------|--------|---------|-----|------|-----------------|----------------|----------------------|--------------|------------|-----------|-----------|
| Age at baseline                |              |        |         |     |      |                 |                |                      |              |            |           |           |
| 40-49                          |              | 49,700 | 86.1    | 11.4| 82.8 | 11.4            | 5.1            | 0.8                  | 91.9         | 0.2        | 6.6       | 1.3       |
| 50-59                          |              | 42,099 | 88.1    | 11.9| 83.1 | 10.4            | 5.5            | 1.0                  | 88.0         | 0.4        | 10.0      | 1.6       |
| 60-69                          |              | 27,533 | 86.2    | 13.8| 82.6 | 9.7             | 6.1            | 1.6                  | 87.9         | 0.8        | 10.1      | 1.2       |
| Prefecture (residential area)  |              |        |         |     |      |                 |                |                      |              |            |           |           |
| Kagoshima                      |              | 21,353 | 76.6    | 23.4| 84.5 | 10.1            | 4.1            | 1.3                  | 88.8         | 0.4        | 94.0      | 1.3       |
| Hyogo                          |              | 20,938 | 92.4    | 7.6 | 84.6 | 9.7             | 4.9            | 0.8                  | 92.3         | 0.3        | 66.0      | 0.8       |
| Aichi                          |              | 18,867 | 92.3    | 7.7 | 85.5 | 10.1            | 3.8            | 0.6                  | 91.1         | 0.4        | 7.0       | 1.5       |
| Osaka                          |              | 18,869 | 91.0    | 9.0 | 76.8 | 13.7            | 7.9            | 1.6                  | 82.0         | 0.8        | 14.6      | 2.7       |
| Okayama                        |              | 21,127 | 91.5    | 8.5 | 79.7 | 12.5            | 6.8            | 1.0                  | 91.2         | 0.5        | 7.3       | 1.0       |
| Miyagi                         |              | 18,278 | 83.7    | 16.3| 86.1 | 7.8             | 5.3            | 0.9                  | 92.0         | 0.2        | 6.7       | 1.2       |
| Occupation*                    |              |        |         |     |      |                 |                |                      |              |            |           |           |
| (I) farmers, mining            |              | 55,008 | 86.7    | 13.3| 84.4 | 10.1            | 4.7            | 0.8                  | 93.9         | 0.2        | 5.2       | 0.6       |
| (II) transport, craftsmen      |              | 6,925  | 89.1    | 10.9| 80.8 | 11.7            | 6.1            | 1.4                  | 86.1         | 0.4        | 11.5      | 1.9       |
| (III) clerical, sales, service |              | 21,079 | 89.1    | 10.9| 78.9 | 12.5            | 7.0            | 1.6                  | 85.3         | 0.6        | 11.5      | 2.6       |
| (IV) professional, managers    |              | 1,908  | 90.8    | 9.2 | 72.9 | 17.8            | 7.8            | 1.5                  | 89.3         | 0.6        | 7.8       | 2.3       |
| (V) job unknown                |              | 34,512 | 88.6    | 11.4| 83.8 | 9.8             | 5.5            | 0.9                  | 86.0         | 0.6        | 11.6      | 1.7       |
| Green-yellow vegetables        |              |        |         |     |      |                 |                |                      |              |            |           |           |
| 4 times/week or more           |              | 89,597 | 87.0    | 13.0| 83.0 | 10.5            | 5.4            | 1.1                  | 90.4         | 0.4        | 8.0       | 1.2       |
| 1-3 times/week                 |              | 27,583 | 90.9    | 9.1 | 82.2 | 11.2            | 5.6            | 1.0                  | 87.3         | 0.5        | 10.3      | 1.8       |
| 1-3 times/month or less        |              | 2,252  | 86.2    | 13.8| 83.8 | 9.5             | 5.1            | 1.6                  | 84.1         | 0.8        | 12.3      | 2.9       |
| Hot tea                        |              |        |         |     |      |                 |                |                      |              |            |           |           |
| not-hot                        |              | 104,947| 83.2    | 10.6| 83.2 | 10.6            | 5.3            | 0.9                  | 90.2         | 0.4        | 8.1       | 1.3       |
| hot                            |              | 14,485 | 80.2    | 11.4| 80.2 | 11.4            | 6.7            | 1.8                  | 85.5         | 0.6        | 11.8      | 2.0       |
| Alcohol                        |              |        |         |     |      |                 |                |                      |              |            |           |           |
| none (non-drinkers)            |              | 98,962 | 88.3    | 11.7| 85.2 | 9.9             | 4.4            | 0.6                  | 92.1         | 0.3        | 6.7       | 0.9       |
| 1-3 times/month                |              | 12,721 | 87.1    | 12.9| 83.2 | 9.7             | 4.7            | 0.7                  | 83.2         | 0.7        | 14.1      | 2.0       |
| 1-3 times/week                 |              | 6,504  | 85.2    | 14.8| 71.6 | 11.1            | 14.1           | 3.9                  | 22.2         | 1.1        | 22.2      | 1.1       |
| 4 times/week or more           |              | 1,245  | 79.0    | 21.0| 50.4 | 19.1            | 31.7           | 15.9                 |              |            |           |           |
| Tobacco (cigarettes/day)       |              |        |         |     |      |                 |                |                      |              |            |           |           |
| non-smokers                    |              | 107,013| 88.4    | 11.6| 85.2 | 9.9             | 4.4            | 0.6                  |              |            |           |           |
| ex-smokers                     |              | 514    | 82.9    | 17.1| 62.2 | 17.7            | 14.4           | 4.7                  |              |            |           |           |
| light smokers (1-14)           |              | 10,256 | 83.3    | 16.7| 64.6 | 17.4            | 14.1           | 3.9                  |              |            |           |           |
| heavy smokers (15+)            |              | 1,549  | 82.0    | 18.0| 52.3 | 15.5            | 20.1           | 12.0                 |              |            |           |           |

* Refer to text.

only or both sexes (p<0.001). These rate ratios and p value for trend were not significantly affected by further adjustment with green-yellow vegetables and three exposure factors listed here, as shown in the last column of Table 2.

Tables 3 shows the results on the dietary factors. The mortality risk for oesophageal cancer was not significantly associated with the dietary factors except for green-yellow vegetables. The RR for green-yellow vegetables with 1-3 times/month or less was 2.0 (95%CI: 1.2-3.1) in comparison with 4 times/week or more, where no dose-response relationship was observed among men and women (p for trend, p=0.45).

For further analyses, cigarette smoking was divided into non-smoking and current smoking (1 cigarette/day or more) after the ex-smokers were excluded. Alcohol drinking groups were divided into either daily or not-daily (3 times/week or less) types. In Table 4, the RR for daily alcohol drinking and current smoking was 3.9 with 95%CI of 2.7 to 5.4, relative to men and women exposed to neither habit. Thus, the joint effect of alcohol and tobacco was more than additive (e.g., 3.9>1+(1.0-1)+(1.6-1)). These results were not significantly affected by further adjustment of green-yellow vegetables.
Table 2. Mortality risks of oesophageal cancer for hot tea, alcohol and tobacco from six-prefecture cohort (1966-1981).

| Factors      | Categories      | Number of deaths | RR* (95%CI) | Women | RR* (95%CI) | Number of deaths | RR** (95%CI) | Men and Women | RR*** (95%CI) |
|--------------|-----------------|------------------|-------------|-------|-------------|------------------|--------------|--------------|--------------|
| Hot tea      | not-hot         | 257              | 1.0         | 87    | 1.0         | 344              | 1.0          | 1.0          |              |
|              | hot             | 71               | 1.5 (1.1-2.0) | 25    | 1.8 (1.1-2.9) | 96               | 1.6 (1.2-2.0) | 1.5 (1.1-1.9) |
| Alcohol      | none (non-drinkers) | 56                | 1.0         | 93    | 1.0         | 149              | 1.0          | 1.0          |              |
|              | 1-3 times/month | 24               | 0.8 (0.5-1.3) | 7     | 0.6 (0.3-1.3) | 31               | 0.7 (0.5-1.1) | 0.7 (0.4-1.1) |
|              | 1-3 times/week  | 67               | 1.1 (0.7-1.6) | 9     | 1.3 (0.6-2.5) | 76               | 1.1 (0.8-1.5) | 1.0 (0.7-1.4) |
|              | 4 times/week or more | 181              | 2.4 (1.8-3.3) | 3     | 2.0 (0.6-6.2) | 184              | 2.4 (1.8-3.1) | 2.1 (1.6-2.8) |
| *            | for trend       | <0.001           | 0.57        |       |             | <0.001           | <0.001       |              |
| Tobacco      | non-smokers (never smoked) | 36                | 1.0         | 93    | 1.0         | 129              | 1.0          | 1.0          |              |
| (cigarettes/day) | ex-smokers    | 12               | 1.9 (0.9-3.6) | 0     | -           | 12               | 1.6 (0.8-2.9) | 1.5 (0.8-2.8) |
|              | light smokers (1-14) | 117              | 2.3 (1.5-3.3) | 19    | 1.8 (1.1-3.0) | 136              | 2.0 (1.5-2.7) | 1.8 (1.3-2.5) |
|              | heavy smokers (15+) | 163              | 2.7 (1.8-3.8) | 0     | -           | 163              | 2.3 (1.7-3.1) | 1.9 (1.4-2.7) |
| *            | for trend       | <0.001           | 0.18        |       |             | <0.001           | <0.001       |              |

RR: Rate ratio, 95%CI: 95% confidence interval.
* adjusted for attained age, prefecture, and occupation.
** adjusted for attained age, prefecture, occupation, and sex.
*** adjusted for attained age, prefecture, occupation, sex, green-yellow vegetables and three variables listed.

Table 3. Mortality risks of oesophageal cancer for dietary factors from six-prefecture cohort (1966-1981).

| Dietary factors     | Categories          | Number of deaths | Men and Women RR* (95%CI) |
|---------------------|---------------------|------------------|--------------------------|
| Green-yellow vegetables | 4 times/week or more | 338              | 1.0 **                   |
|                     | 1-3 times/week      | 83               | 0.9 (0.6-1.1)            |
|                     | 1-3 times/month or less | 19           | 2.0 (1.2-3.1)            |
| Pickle              | every meal          | 284              | 1.0 **                   |
|                     | 1 time/day          | 85               | 0.9 (0.6-1.1)            |
|                     | 1-3 times/week or less | 71           | 1.0 (0.7-1.3)            |
| Miso soup           | 4 times/week or more | 327              | 1.0 **                   |
|                     | 1-3 times/week      | 96               | 1.0 (0.7-1.3)            |
|                     | 1-3 times/month or less | 17           | 1.0 (0.6-1.7)            |
| Fish                | 4 times/week or more | 205              | 1.0 **                   |
|                     | 1-3 times/week or less | 212           | 0.8 (0.6-1.0)            |
|                     | 1-3 times/month or less | 23            | 0.9 (0.6-1.5)            |
| Meat                | 4 times/week or more | 35               | 1.0 **                   |
|                     | 1-3 times/week      | 300              | 0.9 (0.6-1.3)            |
|                     | 1-3 times/month or less | 105           | 0.9 (0.5-1.3)            |
| Milk                | 4 times/week or more | 104              | 1.0 **                   |
|                     | 1-3 times/week      | 85               | 0.9 (0.7-1.3)            |
|                     | 1-3 times/month or less | 251           | 1.0 (0.7-1.3)            |

* adjusted for attained age, prefecture, occupation and sex.
** reference category
This analysis was not available for women only due to the small number of deaths, but the results were similar between men only and both sexes (Table 4). In addition, the statistical interactions between the average number of cigarettes smoked per day in each smoking category and the average amount of alcohol consumed (times/week) were evaluated using an excess relative risk model in which the interaction term between alcohol and tobacco was statistically significant (likelihood ratio test; change in deviance=5.03, p=0.025). Thus, the joint effect of alcohol drinking and smoking was a synergy observed in both groups, i.e., hot-tea and not-hot-tea (Table 5). However, the rate ratios from hot tea were higher than those from not-hot tea in the same combination of alcohol drinking and smoking, when the subjects with not-hot-tea, not-daily alcohol drinking and non-smoking were used for the reference. Thus, the rate ratios from the subjects with daily alcohol drinking and current smoking were 5.7 (95%CI: 3.7-8.9) and 3.9 (95%CI: 2.7-5.6) for hot tea and not-hot tea, respectively. Although not statistically significant, the effect of daily alcohol drinking among non-smoking subjects seemed to appear in the presence of hot tea (RR=2.6, 95%CI: 0.9-7.2).

### DISCUSSION

Laboratory studies have indicated that tea has inhibitory effects against tumor formation and growth. This is believed to be mainly due to the antioxidative and possible antiproliferative effects of polyphenolic compounds in green or black tea. The protective effects of green tea were reported in several epidemiological studies. In Japan, two case-control studies of stomach cancer have reported reduced risks for frequent consumers of green tea. In Shanghai, China, a protective effect of green tea consumption was observed among women with a dose-response trend from a large case-control study of oesophageal cancer. That study, however, suggested that drinking scalding-hot tea might reduce or eliminate any protective effect due to the constituents of green tea. Our results support this suggestion (Tables 2, 4, 5).

A recent case-control study of oesophageal cancer in Argentina found no dose-response relationship among mate drinkers (mainly men), suggesting a minor effect of hot mate drinking compared to alcohol and tobacco consumption. In our study, no information on the amount of green tea con-

| Table 4. Joint effect of alcohol and tobacco on oesophageal cancer among men and women from six-prefecture cohort (1966-1981). |
| --- |
| Alcohol (daily*1) | Tobacco (current*2) | Men | Men and Women |
| **Number of deaths** | RR* (95%CI) | Number of deaths | RR** (95%CI) |
| No | No | 28 | 1.0 (reference) | 120 | 1.0 (reference) |
| Yes | No | 8 | 1.0 (0.4-2.1) | 9 | 1.0 (0.4-2.0) |
| No | Yes | 112 | 1.6 (1.0-2.4) | 129 | 1.6 (1.1-2.1) |
| Yes | Yes | 168 | 4.0 (2.6-6.0) | 170 | 3.9 (2.7-5.4) |

*1 Yes: daily drinking (4 times/week or more); No: not-daily drinking (3 times/week or less)
*2 Yes: current smoking (1 cigarette/day or more); No: non-smoking (never smoked)
** Adjusted for attained age, prefecture and occupation.

| Table 5. Joint effect of alcohol and tobacco on oesophageal cancer by hot tea among men and women from six-prefecture cohort (1966-1981). |
| --- |
| Alcohol (daily*1) | Tobacco (current*2) | Not-hot | Hot tea |
| **Number of deaths** | RR* (95%CI) | Number of deaths | RR** (95%CI) |
| No | No | 95 | 1.0 (reference) | 25 | 1.7 (1.1-2.6) |
| Yes | No | 5 | 0.7 (0.3-1.8) | 4 | 2.6 (0.9-7.2) |
| No | Yes | 105 | 1.6 (1.1-2.3) | 24 | 2.1 (1.3-3.4) |
| Yes | Yes | 130 | 3.9 (2.7-5.6) | 40 | 5.7 (3.7-8.9) |

* Adjusted for attained age, prefecture, occupation, and sex.
*1 Yes: daily drinking (4 times/week or more); No: not-daily drinking (3 times/week or less)
*2 Yes: current smoking (1 cigarette/day or more); No: non-smoking (never smoked)
asured was collected, so it was not possible to examine a dose-response relationship. A multicenter case control study in Japan showed that the amount of alcohol consumed and a preference for high-temperature food or drink were associated with an increased risk of oesophageal cancer. The present results were consistent with this finding (Table 2), although the difference between hot tea and not-hot tea was subjective. Possible misclassification might have attenuated the true association between green tea and oesophageal cancer.

The present results indicate that the joint effect of daily alcohol drinking and current smoking was a synergy (Table 4), which was possibly affected by hot tea (Table 5). These findings imply that alcohol and hot tea might increase the solubility of carcinogens in the oesophagus. Thus, alcohol and hot tea would irritate the mucous membrane, accelerate cell turnover and increase the contact between the target cell and the carcinogens from smoking. From this point of view, hot alcohol beverages are of interest. In our study, about 85% of drinkers in Kagoshima drank shochu (a Japanese spirit with high ethanol content), while the drinkers in other prefectures preferred sake (55-83%), beer (4-15%) or shochu (0.5-6%). Shochu is a popular alcohol beverage in Kagoshima, where people drink shochu with hot water even in summer. Hot sake is also popular in winter in Japan. However, there were no data on hot alcohol beverages and oesophageal cancer. Further study will be needed to clarify the joint effect of alcoholic and thermal irritation.

Epidemiological studies on tea and cancer were reviewed by the working group of the International Agency for Research on Cancer, but no concrete conclusions were made. A large clinical trial in Linxian, China, suggested that beta carotene and vitamin E protect against cancers of the oesophagus and gastric cardia. In a recent cohort study, inverse associations between non-herbal tea consumption and incidence of digestive tract and the urinary tract cancers were reported from post-menopausal women. This incidence study carefully analyzed the potential confounders such as age, education, cigarette smoking, physical activity, fruit or vegetable intake, waist/hip ratio and family history of cancer. The inconsistency in tea and cancer results among previous studies may be partly explained by the difference in analysis for potential confounders taken into account. Although oesophageal cancer was not reported, a recent prospective cohort study did not support the protective effects of black tea against stomach, colorectal, lung or breast cancers.

The protective effects of vegetables and fruit against oesophageal cancer have been reported, but these effects contribute to squamous cell carcinoma. Although no histologic data were available, it is assumed that squamous cell carcinoma accounted for nearly 70% of the cases in our data with reference to oesophageal cancer registry data from 1965 to 1986 in Japan. The present results on the dietary factors showed that lower consumption of green-yellow vegetables was a risk for oesophageal cancer in line with the previous analyses. However, neither these nor the present analysis could find a significant dose-response relationship between green-yellow vegetables and oesophageal cancer. This might be due to the high proportion of adenocarcinoma in the data. Unfortunately, no data on fruit were collected for our study.

Ingestion of pickled vegetables was positively associated with oesophageal cancer in a case-control study on Hong Kong Chinese, suggesting the carcinogenicity of N-nitroso compounds. A recent study in Japan showed that the joint exposure to salty foods and alcohol abuse among men gave a highest odds ratio of 10 or over. The frequency of pickle consumption, however, was not associated with oesophageal cancer mortality in our study (Table 2). In Linxian, China, no statistical association of pickled vegetables was obtained from a retrospective cohort study, whereas a decreasing trend of pickled vegetables was observed in China. It is well known that a nationwide reduction of salt intake occurred in the 1970s to mid-1980s in Japan. Therefore the contribution of pickled vegetables to oesophageal cancer may depend on the difference in study populations.

In conclusion, the mortality risks of oesophageal cancer in the present cohort were substantially associated with the thermal effect of hot tea, alcohol drinking, smoking and lower consumption of green-yellow vegetables. Therefore lifestyle modification of smoking and dietary habits is necessary to reduce the risks of oesophageal cancer in Japan.

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