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Association of Green Tea Consumption with Mortality from All-cause, Cardiovascular Disease and Cancer in a Chinese cohort of men

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Abstract

Tea is the most ancient and popular beverage in the world and its beneficial health effects has attracted tremendous attention worldwide. However, the effects of green tea consumption on the risk of mortality from all-cause, cardiovascular disease (CVD) and cancer in epidemiological studies are still scant and inconclusive. We studied male participants free of pre-existing disease status aged 40-79 from the Chinese Prospective Smoke Study, who were followed up for mortality from 1990 until 2006. Green tea consumption and other covariates were assessed by the standardized questionnaire. Cox regression analyses were used to quantify the associations of green tea consumption with all-cause, CVD and cancer mortality. During 15 years of follow-up (mean, 11years; total person-years, 1,961,791), 32,700 men died among the sample size of 164,681. After multivariate adjustment for potential confounders, green tea drinkers as compared with non-green tea drinkers had significantly reduced risk of dying from all-cause, CVD and cancer. The hazard ratios (HRs) for death from all-cause among subjects who drank green tea, as compared with those who did not drink green tea, were as follows: 0.94 (95% CI: 0.89, 0.99) for ≤5 grams/day, 0.95 (0.91, 0.99) for 5-10 grams/day and 0.89 (0.85, 0.93) for >10 grams/day. The HRs for death from CVD and cancer among people who drank green tea, as compared with those who did not drink green tea, were as follows: 0.93 (0.85, 1.01) for ≤5 grams/day, 0.91 (0.85, 0.98) for 5-10 grams/day and 0.86 (0.79, 0.93) for >10 grams/day and 0.86 (0.78, 0.98) for ≤5 grams/day, 0.92 (0.83, 1.00) for 5-10 grams/day and 0.79 (0.71, 0.88) for >10 grams/day, respectively. The patterns of these associations differ by smoking, alcohol drinking and locality. This study

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suggests that green tea consumption might reduce the risk of death from all-cause, CVD and cancer.

Keywords

Green tea consumption; mortality; cardiovascular disease; cancer; smoking; alcohol drinking

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Tea is the most ancient and popular beverage in the world. It originated from China, known as the “Divine Healer,” almost 5,000 years ago and is currently being cultivated in more than thirty countries worldwide.1, 2,3,4 In 2010, the Chinese population consumed the equivalent weight of 1,360,060 tons in tea leaves. 5,6 The annual consumption of tea is up to 550 million cups in China.5,6 Therefore, even the small effects of tea are considered of major interest to public health at a population level.

All tea is derived from one plant called Camellia sinensis, a member of the Theaceae family. According to processing or harvested leaf development, tea can be classified into three major types: black (fermented), oolong (semi-fermented) and green (non-fermented). Jasmine tea is made from green tea leaves with additional heating process and is further scented with jasmine flowers.7 The worldwide composition of tea consumption according to type is as follows: ~78% of all tea consumed is black tea, 20% green tea, and a small remainder in others such as oolong and white tea.8 Green tea is consumed primarily in eastern countries like China, Japan, and a few countries in North Africa and the Middle East, while black tea is mostly consumed by western countries.9 Green tea is rich in catechin polyphenols in which catechins (epicatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate) and flavanols represent 80–90% and <10% of total flavonoids, respectively.10 With more than 4000 chemical compounds, green tea is hypothesized to be a promising tool for maintaining health and reducing the risk of various health outcomes.1, 11–13

During the past 20 years, green tea has attracted great attention from both researchers and the general public. Numerous studies have been performed regarding the potential beneficial effects of green tea on cardiovascular disease (CVD) risk profile such as reducing body fat, serum LDL-cholesterol, total cholesterol, triglycerides and blood pressure.3, 14–20 However, prospective epidemiological studies examining the association of green tea consumption with all-cause and CVD mortality are still scarce. The majority of studies have been conducted in Japan, and the findings are inconsistent.21–33 Another most frequently studied outcome relating to green tea consumption is cancer in response to its potential anti-carcinogenic and anti-mutagenic properties. Most of the animal studies were conducted with green tea or green tea polyphenol preparations.34 These studies demonstrate that green tea and its major constituents such as catechins might inhibit tumorigenesis at a number of organ sites, involving stomach, prostate, liver, colon, bladder, esophagus and lung.34 However, in contrast to the strong accumulating evidence from animal models, a Cochrane review published conflicting results regarding the cancer-preventive effects of green tea consumption in humans. 35, 36, 37 Furthermore, recent studies provide heterogeneous finding as well. 24, 27,39 Additionally, previous studies did not address the potential confounding bias from smoking, alcohol drinking and locality. Therefore, the aim of our

study is twofold. First, we examined the effects of green tea consumption on the risk of mortality from total, CVD and cancer in a large prospective cohort of Chinese adult men. Second, the large sample size of this study supported stratified analyses by smoking, alcohol drinking and area.

Study population

The Chinese Prospective Smoking Study (CPSS) was established between 1990 and1991 by the Chinese Center for Disease Control and Prevention (China CDC) (at the time of study, known as the Chinese Academy of Preventive Medicine). The population for this study was derived by random sampling from 45 nationally representative "Disease Surveillance Points" (DSPs). Since the cohort was originally aimed to investigate the tobacco hazard in the Chinese population with most prevalent cigarette use in men, no women were included in the study. All adult Chinese men aged >40 years from 2 to 3 randomly selected residential units within 45 DSPs were invited and approximately 80% of the invitees agreed to participate this study. As a result, the original study population consisted of 222,279 men.

Details of the study purpose and design have been described elsewhere.38 Briefly, all the participants attended the local health screening clinics which were set up specifically for this study and were interviewed by trained health workers using a standardized questionnaire. The questionnaire included information on demographic status, physical measurements of height, weight and blood pressure, education, occupation, smoking, alcohol drinking, tea consumption and diet. The self-reported medical history included the participants' self-assessed health status and whether they had been medically diagnosed with cancer or other chronic diseases.

For the current analysis, we excluded subjects with prior diagnosed of cancer (n=947), stroke (n=1894), heart disease (n=8919), chronic obstructive pulmonary disease (n=27525), asthma (n=1043), tuberculosis (n=4145), peptic ulcer (n=8728), diabetes (n=733), hypertension (n=6400), kidney disease (n=1730), cirrhosis (n=271), chronic hepatitis (n=2169). We further excluded 394 men with BMI<15 or BMI≥35kg/m^2, 2 with missing green tea data and 2332 men who were over 80 year old due to difficult to determine reliably the underlying cause of death at older ages. Hence, the final sample size for this analysis was 164,681. The study was approved by the China CDC ethics committee and by each provincial CDC research board. All participants gave oral informed consent.

Exposure variable

Tea consumption was assessed by the standardized questionnaire. Participants were asked about their consumption of green tea, black tea, jasmine tea and other tea and further asked to list tea consumption in grams in a regular month. Furthermore, the quantity of daily tea consumption were constructed and categorized into 4 categories in grams: 0, 1-5, 5-10, >10.

Mortality follow-up

Subjects were followed up after the baseline survey until 2006. The vital status of the study population was monitored regularly by DSP staff through the death registries previously established in these areas. This status was confirmed annually by local residential

committees. The underlying cause of each death was sought from official death certificates, supplemented (if necessary) with information from medical records. The underlying cause was coded by central DSP staffs in Beijing, who were blinded to baseline information using the International Classification of Disease 9th revision (ICD-9). For the few cases where deaths occurred without recent medical attention, standard procedures were used by local DSP staff to determine the probable cause of death according to the symptoms or signs provided by family members. All CVD endpoint was determined using ICD-9 codes 390-459 and 798. All cancer endpoint was determined using ICD-9 codes 140-208.

Covariates

The potential confounders considered in this study included age, BMI (<18.5, 18.5-24.9, 25.0-29.9, ≥30.0), systolic blood pressure (SBP), diastolic blood pressure (DBP), marital status (yes or no), area (urban or rural), education <6 years (yes or no), job status (employed or unemployed), black tea drinker (yes or no), jasmine tea drinker (yes or no) and other tea drinker (yes or no). With detailed information on cigarette consumption, smoking status was categorized as never smoker, current smoker or ex-smoker. Similarly, we defined alcohol drinking as three categories: not regular alcohol, regular alcohol-moderate (<28 units/week) and regular alcohol-heavy (>=28 units/week). Dietary information included frequency within weekly consumption of fish, meat, domestic poultry, egg and milk. Furthermore, the frequency was categorized as none, 1-3 times, 4-7 times, or ≥8 times.

Statistical Analysis

The baseline characteristics were tabulated across green tea consumption categories. Means and standard deviations were used to display the distribution of continuous variables while percentages were used for categorical variables. Trends in covariates by green tea consumption were estimated using F tests for categorical variables and ANOVA for continuous variables. Person-time in each category of green tea consumption was calculated from the baseline examination until the date of death, the date of withdrawal, or until the last examination, whichever occurred first.

Cox proportional hazard model was applied to calculate hazard ratios (HRs) and their 95% confidence intervals (CIs) for all-cause, CVD and cancer mortality in each of the four categories of green tea consumption (i.e. non-drinker, ≤5, 5-10 and >10 grams/day) for two different models, and non-drinker was used as a reference. Model 1 was age-adjusted. Model 2 was multivariate adjusted for age, BMI, SBP, DBP, marital status, urban locality, education, job status, smoking status, alcohol drinking status, frequency within weekly consumption of fish, meat, poultry, egg and milk, black tea drinker, jasmine tea drinker and other tea drinker. The proportional hazards assumption was confirmed using log-log survival plots. In the analyses for black tea, jasmine tea and other tea as a main exposure, their categories of daily consumption in grams were specified as the same as green tea consumption, and the non-drinker category was used as a reference. To tests for linear trends across categories of green tea consumption, we assigned the median intake for each green tea category and fitted this as continuous variable in the models.

To examine the potential effect modification, analyses were performed in subgroups defined by smoking status, alcohol drinking categories and urban or rural locality. Nonparametric restricted cubic splines with 2 knots defined at the 33 rd and 66th percentiles of the green tea measurement were used to assess the potential non-linear relationship between green tea consumption and mortality from all-cause, CVD and cancer. All the tests are two-sided at a significant level of 0.05. The analyses were performed using SAS software 9.3 version (SAS Inc, Cary, NC) and R software (version 3.2.2)

Results

The baseline characteristics of Chinese adult men were tabulated across categories of green tea consumption in Table 1. In comparison to non-green tea drinkers (82.3% of total participants), those who drank green tea tend to be older, leaner, less educated, with lower mean of blood pressure and higher proportions of married and unemployed. Strong apparent aggregation of smoking-alcohol-green tea was demonstrated by showing that green tea drinkers tended to smoke cigarettes and consume alcohol. Moreover, moderate green tea drinkers would be more likely to reside in urban areas. However, green tea drinkers were less likely to eat fish, domestic poultry, egg and milk and less likely to drink black tea, jasmine tea and other tea.

During 15 years of follow-up (mean, 11 years; total person-years, 1,961,791), 32,700 men died among the sample size of 164,681. After multivariate adjustment, green tea consumption was inversely associated with mortality from all-cause, CVD and cancer. Compare with those never green-tea-drinkers, the HRs for death from all-causes were 0.94 (95% CI: 0.89, 0.99), 0.95 (0.91, 0.99) and 0.89 (0.85, 0.93) for those drank green tea ≤ 5, 5-10, >10 grams/day respectively; and the corresponding HRs for CVD mortality were 0.93 (0.85, 1.01), 0.91 (0.85, 0.98) and 0.86 (0.79, 0.93) ; and for cancer mortality were 0.86 (0.81, 1.05), 0.92 (0.83, 1.00) and 0.79 (0.71, 0.88), respectively.

In comparison to the results in the Table 2 from the whole population, Table 3 showed the results for stratified analyses by smoking. Among never smokers, the inverse associations of green tea consumption with all-cause and CVD mortality tended to be strengthened while only daily green tea consumption of ≤5 grams was inversely associated with cancer mortality. Compared with those who did not drink green tea, the HRs of death from all-causes were 0.75 (0.66, 0.86), 0.70 (0.61, 0.79) and 0.68 (0.59, 0.79) for those drank ≤ 5, 5-10, >10 grams/day respectively, and for CVD mortality were 0.73 (0.59, 0.91), 0.63(0.50, 0.79) and 0.77 (0.62, 0.96), respectively. The HRs for death from cancer among subjects who drank green tea of ≤ 5 grams/day compared with those who did not drink green tea were 0.60 (0.44, 0.82). In contrast, no significant associations of green tea consumption with mortality from all-cause and CVD were observed while daily green tea consumption of >10 grams was inversely associated with cancer mortality among current smokers.

Table 4 showed the results for stratified analyses by alcohol drinking. The inverse associational patterns of green tea consumption with mortality from all-cause, CVD and cancer were different among non-regular alcohol drinkers, moderate alcohol drinkers and heavy alcohol drinkers. Compared with non-green tea drinkers, subjects who drank >10

grams/day had reduced risk of death among non-regular alcohol drinkers, and the HRs for all-cause, CVD and cancer mortality were 0.87 (0.83, 0.95), 0.87 (0.77, 0.98) and 0.68 (0.57, 0.82) respectively. These associational patterns of green tea consumption with mortality from all-cause, CVD and cancer were more pronounced among heavy alcohol drinkers. However, no association of green tea consumption with CVD mortality was found among moderate alcohol drinkers.

Table 5 showed the results for stratified analyses by locality. The inverse associations of green tea consumption with mortality from all-cause, CVD and cancer were observed among subjects residing in rural areas (Table 5). The findings regarding to other types of tea consumption (i.e., black tea, jasmine tea and other tea) were shown in Supplemental Table Positive associations of black tea and other tea consumption with mortality from all-cause, CVD and cancer were observed in certain groups of tea consumption (Supplemental Table 1). No association was observed except a positive association of daily consumption of jasmine tea of 5-10 grams with cancer mortality (Supplemental Table 1).

The potential dose-response relationships of mortality from all-cause, CVD and cancer with green tea consumption on a continuous scale across whole population, by smoking, alcohol drinking and locality were visualized by Supplemental Figure 1, 2 and 3, respectively. Curvilinear relationships of green tea consumption with mortality from all-cause, CVD and cancer were observed among the whole population, and the patterns were differentiated by smoking, alcohol drinking and locality. U-shape relationships of green tea consumption with mortality from all-cause, CVD and cancer were suggested among never smokers. These U-shape associations were also observed among heavy alcohol drinkers.

Discussion

In this 15-year large prospective cohort study of 164,681 healthy Chinese adult men, green tea consumption was inversely associated with mortality from all-cause, CVD and cancer, and this inverse relationship is curvilinear. To our knowledge, this study was among the first to address the potential modifying effects from smoking, alcohol drinking and locality on the association of green tea consumption and mortal outcomes. The results from stratified analyses by smoking status suggested that the inverse associations with mortality from all-cause and CVD were strengthened among non-smokers while no associations were observed among current smokers. Daily green tea consumption of ≤5 grams was inversely associated with cancer mortality among never smokers, while daily green tea consumption of >10 grams was inversely associated with cancer mortality among current smokers. Additionally, the inverse associations with mortality from all-cause, CVD and cancer were primarily observed among non-regular alcohol drinkers, and these inverse associations were also observed among heavy alcohol drinkers. Furthermore, the inverse associations of green tea consumption with mortality from all-cause, CVD and cancer were more pronounced among rural residents than urban residents.

Our findings of the inverse association between green tea consumption and mortality from all-cause and CVD are in line with most of the previous studies, while results for cancer mortality are largely inconsistent. Koriyama and colleagues found that subjects who

consumed five or more cups per day, as compared to subjects who consumed less than one cup, had 16% lower risk of all-cause mortality and 26% lower risk for CVD mortality. 26 This same study also reported that the inverse association was more pronounced in women generally and in men who had never smoked. However, no association was reported for cancer mortality. Saito and colleagues reported that those who consumed five cups of green tea per day or more, compared with subjects who consumed less than one cup, had a risk of all-cause mortality that was 13% lower in men and 17% lower in women, while null association was reported for cancer mortality.39 Another study from Japan reported that both men and women who consumed seven or more cups of green tea per day, compared with subjects who consumed less than one cup, had a risk of total and CVD mortality that was 55% lower and 75% lower, respectively.24 This study suggested that while green tea consumption was not significantly associated with overall cancer mortality, it could reduce the mortality from colorectal cancer. Another study from Japan found that those who consumed six or more cups per day, compared with non-green tea drinkers, had a risk of CVD mortality that was 38% lower in women, while no association was observed in men.25 A recent systematic review and meta-analysis studying the relation of green tea consumption and mortality from total and CVD reported that an increase in green tea consumption by three cups per day could reduce the risk of cardiac death and all-cause mortality by 26% and 24%, respectively.40 In contrast, another meta-analysis revealed null associations.41 Additionally, a recent meta-analysis of eighteen prospective cohort studies reported an inverse association of green tea consumption and mortality from all-cause and CVD when adjusted for smoking. This inverse association was more evident in women than in men. 42 No association was reported for cancer mortality. Therefore, inverse associations of green tea consumption with all-cause and CVD mortality were supported by previous studies; however these associations by gender are inconsistent. In addition, the patterns of the associations might be different by smoking, and future studies are warranted.

In contrast to the null findings regarding the relation of green tea consumption and cancer mortality reported by previous studies, 24, 26,27,39 our study found an inverse association of green tea consumption with cancer mortality, and this finding was also suggested by several other studies. 22, 43–45 In particular, our study found that the patterns of inverse associations between green tea consumption and cancer mortality were differentiated by smoking status, alcohol drinking and locality. A recent study conducted in a large sample of the French population did not specify the type of tea consumed by the study sample and found that drinking tea reduced non-cardiovascular mortality by 24%. Notably, most of the effect of tea on non-CVD mortality was found in current or ex-smokers, while tea had a neutral effect in non-smokers.46 The association of tea consumption with non-CVD mortality among current smokers was partially in line with our findings regarding cancer mortality. However the findings among never smokers were contradictory with our study. Differential associations of green tea consumption with mortal outcomes by alcohol drinking might represent the complex synergistic effects of smoking-alcohol-green tea. During the period of our cohort study, cigarette consumption became more pervasive in urban areas due to limited availability and affordability of cigarettes in urban areas. The hazard associated with a given current smoking pattern is more extreme in urban than in rural areas. Therefore,

the differential patterns of green tea-mortality relationship by locality might be explained by residual confounding from smoking.

Regarding other types of tea consumption, we found positive associations with mortal outcomes to some extent for teas other than green tea (i.e., black tea, jasmine tea, and other tea). Our finding is in contrast to the most recent meta-analysis of the eighteen prospective studies supporting inverse associations of black tea consumption and mortality from total and cancer, and null association for CVD morality. However, another meta-analysis reported the null association between black tea consumption and total mortality.40 To our knowledge, data on the association of jasmine tea and other tea with mortal outcomes is currently unavailable except the findings from our study.

The etiologic mechanisms of green tea consumption contributing to the reduced mortality risk from all-cause, CVD and cancer have been proposed in multiple ways. From a biological standpoint, green tea contains numerous bioactive compounds including catechins, flavonols, lignans and phenolic acids, and exerts a variety of physiological actions; these bioactive compounds have potential to be beneficial for health. Catechins are essential components in green tea which are mainly comprised of epigallolatechin gallate (EGCG), epicatechin-3-gallate (ECG), epigallocatechin (EGC) and epicatechol (EC).47 Catechins account for 8-15% of the dry green tea leaves.48 A wide spectrum of beneficial effects of catechins on vascular function have been demonstrated through anti-oxidative, anti-inflammatory, anti-hypertensive and favorably modulate plasma lipid profiles.49, 50 Previous researchers have also been proposed mechanisms for the various potential chemopreventive biological activities of green tea polyphenols including inhibiting nitrosation, reducing cell proliferation and tumorigenesis, inducing carcinoma cell apoptosis and suppressing angiogenesis. Among all types of tea, green tea has the highest concentration of EGCG, which possesses the highest antioxidant potential. 51 During fermentation, catechins are transformed through polymerization into theaflavins which are the main components in black tea. Therefore, if catechins account for the major beneficial effect of green tea, black tea might not have the beneficial effects on health as green tea because it lost catechins during fermentation. On the other hand, tea is vulnerable to be contaminated by air pollution, industrial discharge, or human waste due to its high-surfaced tea leaves and the mixture with water from open sources.52 As a consequence, the accumulation of heavy metals, fluoride, and pesticides have been found in most of tea samples.52, 53 Furthermore, studies have shown that polycyclic aromatic hydrocarbons (PAHs), a class of compounds consisting of two or more fused aromatic rings, are a well-known class of carcinogens for humans.54 The concentrations of PAHs among different types of teas were examined and found that black tea has the highest contents of PAHs (8800 μg/kg) while green tea has lowest contents of PAHs (323-566 ug/kg).52 Jasmine tea is in the middle containing PAHs of 1220 ug/kg.52 Moreover, PAH concentrations in jasmine tea (28ng BaP/gram) are comparable to those in cigarettes (25ng BaP/cigarette).55, 56 Therefore, it is plausible that PAH exposure plays a role in the observed tea-mortality relationship.

The present study has certain strengths compared with previous investigations. This population-based prospective study with a large sample size and ~15 years of follow-up

significantly contributes to the extant literature on the association of green tea consumption and mortal outcomes among Chinese adult men. The relatively large number of cases provided high statistical power, which contributed to stable risk estimates. In addition, the large sample size enabled subgroup analysis in order to control as finely as possible for the potential confounding by cigarette smoking, alcohol drinking and locality. Furthermore, the standardized questionnaire has provided more detailed information on potential confounding factors and allowed us to adjust them in the models. Several limitations have to be laid out for our study. First, self-reported green tea consumption was used in our study, and this might misrepresent the true consumption. However, due to the nature of follow-up study, this misclassification is typically non-differential and leads the results towards null. Second, a single measure of green tea consumption at baseline might not reflect its longevity and bias the true association between green tea consumption and mortal outcomes. Another concern is lost to follow-up. During 15 years of follow-up, 5.53% were lost follow-up. However, the proportion of lost to follow-up did not significantly vary across the green tea consumption categories (5.38%, 9.22%, 4.98%, and 5.07% of participants were lost to follow-up across non-drinker, ≤5, 5-10 and >10 grams per day, respectively). Fourth, even though a variety of potential confounding factors were statistically controlled in our study, residual confounding still might exist. For instance, detailed information on dietary intake was not available, which might leave a room for residual confounding. Future studies with detailed dietary information are needed to further investigate the association of green tea consumption with mortality. Fifth, due to the certain number of cases in some categories of green tea consumption, we could not perform the analyses for subcategories of CVD and site-specific cancer. Furthermore, subjects could change their green tea consumption due to their health status which would influence our results. However, excluding subjects with chronic diseases at baseline might reduce this potential bias from reverse causality. Finally, extrapolating our results to other populations should be taken cautiously because the green tea-mortality relationship might have difference among gender and ethnicity.

Conclusion

The current study linked green tea consumption with mortal outcomes and suggested that green tea consumption might reduce the risk of death from all-cause, CVD and cancer. This association was further strengthened among subjects who were nonsmokers, non-regular alcohol drinkers and rural residents. Future longitudinal studies with large sample sizes are needed to reevaluate these associations in other populations with more detailed information on lifestyle factors such as physical activity and diet.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Basic characteristics of Chinese men across green tea consumption categories aged 40–79 at baseline 1990-1991.

		Amount drunk (in grams) of green tea				
Characteristics	**Overall**	**non-drinker**	**≤5**	**5-10**	**>10**	**P-value**
No. of participants	164,681	135,673	8,288	11,864	8,856	
Age (years)	53.2(10.0)	53.1(10.0)	53.1(9.9)	53.7(10.1)	54.3(9.8)	<0.001
Height (cm)	164.3(0.6)	164.(0.7)	164.8(0.7)	164.8(0.6)	164.5(0.6)	<0.001
Weight (kg)	58.7(8.4)	58.8(8.4)	59.3(9.1)	58.3(8.4)	57.1(7.8)	<0.001
SBP (mmHg)	122.6(16.8)	122.9(16.8)	121.1(17.4)	121.1(16.8)	120.9(16.5)	<0.001
DBP (mmHg)	78.1(10.3)	78.2(10.2)	77.2(10.8)	77.3(10.6)	76.9(10.9)	<0.001
Body Mass Index (BMI), Kg/m^2						
<18.5	8.0	7.3	9.1	9.4	11.2	
18.5-24.9	82.9	83.5	79.0	82.5	82.7	<0.001
25.0-29.9	8.8	8.9	11.3	7.5	6.0	
≥30.0	0.5	0.5	0.6	0.6	0.3	
Married status, %	91.6	90.9	94.6	95.4	94.7	<0.001
Urban locality, %	21.5	20.7	39.1	23.4	14.0	<0.001
Education <6 years, %	69.8	71.5	73.0	73.5	75.6	<0.001
Job status						
Employed	20.4	19.7	35.8	20.8	15.1	<0.001
Smoking status,%						
Never	29.2	31.5	25.6	15.9	14.5	
Current	67.0	64.8	68.5	79.8	82.1	<0.001
Former	3.8	3.7	5.8	4.3	3.4	
Alcohol drinking status,%						
Non-regular	67.2	69.5	61.9	55.9	52.1	
Moderate	19.0	17.0	25.0	30.7	28.0	<0.001
Heavy	13.8	13.5	13.1	13.4	20.0	
Weekly dietary consumption						
Fish						
None	78.3	78.1	70.7	79.6	86.6	
1-3 times/week	13.5	12.8	24.7	15.9	10.2	
4-7 times/week	2.8	2.7	3.7	3.5	2.6	<.0001
≥8 times/week	5.4	6.4	0.9	1.0	0.6	
Meat						
None	21.8	24.6	10.9	10.0	5.3	
1-3 times/week	50.5	48.6	49.3	62.1	65.2	
4-7 times/week	16.6	15.3	26.9	19.6	23.3	<.0001
≥8 times/week	11.1	11.5	12.9	8.2	6.1	
Domestic poultry						
None	86.0	86.0	81.4	85.7	90.8	

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		Amount drunk (in grams) of green tea				
Characteristics	**Overall**	**non-drinker**	**≤5**	**5-10**	**>10**	**P-value**
1-3 times/week	12.7	12.6	17.9	13.3	8.4	
4-7 times/week	1.1	1.2	0.8	0.7	0.7	<.0001
≥8 times/week	0.2	0.2	0.1	0.2	0.1	
Egg						
None	51.4	51.4	45.6	54.3	58.2	
1-3 times/week	32.7	32.7	33.9	32.6	32.5	<.0001
4-7 times/week	14.6	14.9	19.1	12.0	8.6	
≥8 times/week	1.3	1.3	1.4	1.2	0.7	
Milk						
None	93.9	94.1	90.3	93.3	95.5	
1-3 times/week	2.4	2.4	3.3	2.3	1.5	<.0001
4-7 times/week	3.5	3.3	6.2	4.2	2.9	
≥8 times/week	0.1	0.1	0.2	0.2	0.1	
Black tea drinker, %	8.0	9.5	2.8	1.1	0.6	<0.001
Jasmine tea drinker, %	11.0	12.9	6.0	1.3	0.6	<0.001
Other tea, drinker %	3.3	4.0	0.7	0.2	0.3	<0.001

Note: continuous variables represented as mean (standard deviation); Categorical variables represented as percentage P-value was calculated using analysis of variance test for continuous variables and chi-square test for categorical variables.

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Table 2

Cox Proportional Hazard Ratios (HRs) for mortality from all-cause, cardiovascular disease and cancer by green tea consumption in Chinese adult men

	Amount drunk (in grams) of green tea				P for trend
Mortality outcomes	**non-drinker**	**≤5**	**5-10**	**>10**	
No. of person-years	1611535	97974.48	143095.7	109185.5	
All-cause					
No. of deaths	26912	1453	2458	1877	
Age adjusted HR (95% CI)	1.00	0.87(0.82,0.91)	0.97(0.93,1.01)	0.94(0.90,0.98)	0.0008
Multivariate HR (95% CI)[#]	1.00	0.94(0.89,0.99)	0.95(0.91,0.99)	0.89(0.85,0.93)	<.0001
Cardiovascular disease					
No. of deaths	9873	513	825	628	
Age adjusted HR (95% CI)	1.00	0.83(0.76,0.91)	0.88(0.82,0.95)	0.85(0.78,0.92)	<.0001
Multivariate HR (95% CI)[#]	1.00	0.93(0.85,1.01)	0.91(0.85,0.98)	0.86(0.79,0.93)	<.0001
Cancer					
No. of deaths	5904	291	477	330	
Age adjusted HR (95% CI)	1.00	0.80(0.71,0.89)	0.87(0.80,0.96)	0.76(0.68,0.85)	<.0001
Multivariate HR (95% CI)[#]	1.00	0.86(0.78,0.98)	0.92(0.83,1.00)	0.79(0.71,0.88)	<.0001

Abbreviation: CI, confidence interval.

[#]The multivariate HR has been adjusted for age(continuous), BMI (<18.5, 18.5-24.9, 25.0-29.9, ≥30.0), marital status (yes or no), urban locality (yes or no), education <6 years (yes or no), job status(employed or unemployed), smoking status (never, current or former), alcohol drinking(non-regular, moderate or heavy), times of weekly fish consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly meat consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly poultry consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly egg consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly milk consumption (none, 1-3 times, 4-7 times, or ≥8 times), black tea drinker (yes or no), jasmine tea drinker (yes or no) and other tea drinker (yes or no).

Table 3

Stratified Cox Proportional Hazard Ratios (HRs) for mortality from all-cause, cardiovascular disease and cancer by green tea consumption in Chinese adult men by smoking status

	Amount drunk (in grams) of green tea				
Mortality outcomes	**non-drinker**	**≤5**	**5-10**	**>10**	**P for trend**
		Never smoker			
All-cause					
No. of deaths	7890	239	236	203	
Age adjusted HR (95% CI)	1.00	0.59(0.52,0.68)	0.62(0.55,0.71)	0.66(0.58,0.76)	<.0001
Multivariate HR (95% CI) #	1.00	0.75(0.66,0.86)	0.70(0.61,0.79)	0.68(0.59,0.79)	<.0001
Cardiovascular disease					
No. of deaths	2963	84	79	85	
Age adjusted HR (95% CI)	1.00	0.56(0.45,0.69)	0.55(0.44,0.69)	0.72(0.58,0.89)	<.0001
Multivariate HR (95% CI) #	1.00	0.73(0.59,0.91)	0.63(0.50,0.79)	0.77(0.62,0.96)	<.0001
Cancer					
No. of deaths	1642	41	57	44	
Age adjusted HR (95% CI)	1.00	0.49(0.36,0.67)	0.73(0.56,0.96)	0.75(0.56,1.01)	0.0007
Multivariate HR (95% CI) #	1.00	0.60(0.44,0.82)	0.83(0.64,1.09)	0.81(0.60,1.10)	0.03
		Current Smoker			
All-cause					
No. of deaths	17946	1128	2142	1629	
Age adjusted HR (95% CI)	1.00	0.96(0.90,1.02)	1.01(0.97,1.06)	0.97(0.92,1.01)	0.2839
Multivariate HR (95% CI) #	1.00	1.01(0.95,1.07)	1.02(0.98,1.07)	0.94(0.89,1.00)	0.1469
Cardiovascular disease					
No. of deaths	6484	399	726	521	
Age adjusted HR (95% CI)	1.00	0.94(0.85,1.09)	0.95(0.87,1.02)	0.84(0.77,0.92)	0.0001
Multivariate HR (95% CI) #	1.00	1.04(0.94,1.15)	1.01(0.93,1.10)	0.88(0.81,0.97)	0.0299
Cancer					
No. of deaths	4050	230	401	281	
Age adjusted HR (95% CI)	1.00	0.88(0.77,1.00)	0.87(0.79,0.96)	0.75(0.67,0.86)	<.0001
Multivariate HR (95% CI) #	1.00	0.94(0.85,1.08)	0.94(0.85,1.05)	0.82(0.72,0.93)	0.0015

Abbreviation: CI, confidence interval.

The multivariate HR has been adjusted for age (continuous), BMI (<18.5, 18.5-24.9, 25.0-29.9, ≥30.0), marital status (yes or no), urban locality (yes or no), education <6 years (yes or no), job status (employed or unemployed), , alcohol drinking (non-regular, moderate or heavy), times of weekly fish consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly meat consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly poultry consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly egg consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly milk consumption (none, 1-3 times, 4-7 times, or ≥8 times), black tea drinker (yes or no) jasmine tea drinker (yes or no) and other tea drinker (yes or no).

Table 4

Stratified Cox Proportional Hazard Ratios (HRs) for mortality from all-cause, cardiovascular disease and cancer by green tea consumption in Chinese adult men by alcohol drinking status

		Amount drunk (in grams) of green tea			
Mortality outcomes	**non-drinker**	**≤5**	**5-10**	**>10**	**P for trend**
Non-regular drinker					
All-cause					
No. of deaths	18644	933	1384	979	
Age adjusted HR (95% CI)	1.00	0.91(0.86,0.98)	0.98(0.93,1.03)	0.90(0.85,0.96)	0.0011
Multivariate HR (95% CI) #	1.00	1.00(0.93,1.07)	0.95(0.80,1.00)	0.85(0.80,0.91)	<.0001
Cardiovascular disease					
No. of deaths	6838	318	469	339	
Age adjusted HR (95% CI)	1.00	0.85(0.76,0.95)	0.90(0.82,0.99)	0.84(0.75,0.94)	<.0001
Multivariate HR (95% CI) #	1.00	0.96(0.85,1.07)	0.92(0.83,1.01)	0.85(0.76, 0.95)	0.0006
Cancer					
No. of deaths	4178	197	273	150	
Age adjusted HR (95% CI)	1.00	0.87(0.75,1.00)	0.88(0.78,1.00)	0.65(0.55,0.76)	<.0001
Multivariate HR (95% CI) #	1.00	0.96(0.83,1.11)	0.90(0.80,1.02)	0.65(0.55,0.77)	<.0001
Moderate drinker					
All-cause					
No. of deaths	4318	323	768	547	
Age adjusted HR (95% CI)	1.00	0.78(0.70,0.87)	1.03(0.96,1.12)	1.05(0.96,1.14)	0.2896
Multivariate HR (95% CI) #	1.00	0.86(0.77,0.97)	1.00(0.92,1.08)	0.96(0.87,1.05)	0.4334
Cardiovascular disease					
No. of deaths	1590	120	248	185	
Age adjusted HR (95% CI)	1.00	0.78(0.65,0.94)	0.90(0.79,1.03)	0.95(0.82,1.11)	0.1991
Multivariate HR (95% CI) #	1.00	0.91(0.75,1.10)	0.95(0.82,1.09)	0.96(0.81,1.12)	0.3852
Cancer					
No. of deaths	930	64	140	98	
Age adjusted HR (95% CI)	1.00	0.71(0.55,0.91)	0.86(0.74,1.06)	0.85(0.69,1.05)	0.0492
Multivariate HR (95% CI) #	1.00	0.79(0.61,1.03)	0.94(0.78,1.14)	0.90(0.72,1.12)	0.3172
Heavy drinker					
All-cause					
No. of deaths	3920	197	305	351	
Age adjusted HR (95% CI)	1.00	0.83(0.72,0.96)	0.80(0.72,0.90)	0.84(0.75,0.94)	<.0001
Multivariate HR (95% CI) #	1.00	0.82(0.71,0.95)	0.83(0.73,0.93)	0.87(0.77,0.97)	0.0009
Cardiovascular disease					
No. of deaths	1431	75	107	104	
Age adjusted HR (95% CI)	1.00	0.86(0.68,1.09)	0.77(0.63,0.93)	0.68(0.56,0.83)	<.0001
Multivariate HR (95% CI) #	1.00	0.86(0.68,1.09)	0.80(0.66,0.98)	0.71(0.57,0.87)	0.0002

		Amount drunk (in grams) of green tea			
Mortality outcomes	**non-drinker**	**≤5**	**5-10**	**>10**	**P for trend**
Cancer					
No. of deaths	796	30	64	82	
Age adjusted HR (95% CI)	1.00	0.63(0.44,0.91)	0.86(0.67,1.11)	0.97(0.77,1.22)	0.4276
Multivariate HR (95% CI) [#]	1.00	0.67(0.46,0.96)	0.92(0.71,1.19)	1.04(0.82,1.32)	0.9724

Abbreviation: CI, confidence interval.

[#]The multivariate HR has been adjusted for age (continuous), BMI (<18.5, 18.5-24.9, 25.0-29.9, ≥30.0), marital status (yes or no), urban locality (yes or no), education <6 years (yes or no), job status (employed or unemployed), smoking status (never, current or former), times of weekly fish consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly meat consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly poultry consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly egg consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly milk consumption (none, 1-3 times, 4-7 times, or ≥8 times), black tea drinker (yes or no), jasmine tea drinker (yes or no) and other tea drinker (yes or no).

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Table 5

Stratified Cox Proportional Hazard Ratios (HRs) for mortality from all-cause, cardiovascular disease and cancer by green tea consumption in Chinese adult men by locality.

		Amount drunk (in grams) of green tea			P for trend
Mortality outcomes	**non-drinker**	**≤5**	**5-10**	**>10**	
		Rural			
All-cause					
No. of deaths	23364	1143	2166	1762	
Age adjusted HR (95% CI)	1.00	0.97(0.91,1.03)	0.99(0.95,1.04)	0.92(0.88,0.97)	0.0017
Multivariate HR (95% CI) #	1.00	0.95(0.89,1.01)	0.96(0.91,1.00)	0.90(0.85,0.94)	<.0001
Cardiovascular disease					
No. of deaths	8660	398	722	587	
Age adjusted HR (95% CI)	1.00	0.90(0.82,1.00)	0.89(0.82,0.96)	0.82(0.75,0.89)	<.0001
Multivariate HR (95% CI) #	1.00	0.92(0.83,1.02)	0.91(0.84,0.98)	0.85(0.78,0.93)	<.0001
Cancer					
No. of deaths	4992	212	378	296	
Age adjusted HR (95% CI)	1.00	0.86(0.76,0.99)	0.83(0.75,0.92)	0.74(0.66,0.83)	<.0001
Multivariate HR (95% CI) #	1.00	0.89(0.78,1.02)	0.87(0.78,0.97)	0.79(0.70,0.89)	<.0001
		Urban			
All-cause					
No. of deaths	3548	310	292	115	
Age adjusted HR (95% CI)	1.00	0.80(0.71,0.90)	0.85(0.75,0.96)	0.76(0.63,0.91)	<.0001
Multivariate HR (95% CI) #	1.00	0.95(0.85,1.08)	0.93(0.82,1.05)	0.78(0.64,0.94)	0.0044
Cardiovascular disease					
No. of deaths	1213	115	103	41	
Age adjusted HR (95% CI)	1.00	0.88(0.73,1.06)	0.88(0.72,1.07)	0.80(0.58,1.09)	0.0429
Multivariate HR (95% CI) #	1.00	1.03(0.84,1.26)	0.93(0.75,1.15)	0.80(0.58,1.10)	0.1534
Cancer					
No. of deaths	912	79	99	34	
Age adjusted HR (95% CI)	1.00	0.77(0.61,0.96)	1.12(0.91,1.37)	0.85(0.61,1.20)	0.6143
Multivariate HR (95% CI) #	1.00	0.86(0.67,1.09)	1.15(0.92,1.44)	0.86(0.60,1.23)	0.8446

Abbreviation: CI, confidence interval.

#The multivariate HR has been adjusted age (continuous), BMI (<18.5, 18.5-24.9, 25.0-29.9, ≥30.0), marital status (yes or no), education <6 years (yes or no), job status (employed or unemployed), smoking status (never, current or former), alcohol drinking(non-regular, moderate or heavy), times of weekly fish consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly meat consumption (none, 1-3 times, 4-7 times, or ≥8 times), times of weekly poultry consumption (none, 1-3 times, 4-7times, or ≥8 times), times of weekly egg consumption (none, 1-3 times, 4-7times, or ≥8 times), times of weekly milk consumption (none, 1-3 times, 4-7 times, or ≥8 times), black tea drinker (yes or no), jasmine tea drinker (yes or no) and other tea drinker (yes or no).