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Green tea consumption and cause-specific mortality: Results from two prospective cohort studies in China

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ABSTRACT

Background: Green tea is one of the most widely consumed beverages in Asia. While a possible protective role of green tea against various chronic diseases has been suggested in experimental studies, evidence from human studies remains controversial.
Methods: We conducted this study using data from Shanghai Men's Health Study (SMHS) and Shanghai Women's Health Study (SWHS), two population-based prospective cohorts of middle-aged and elderly Chinese adults in urban Shanghai, China. Hazard ratios (HR) and 95% confidence intervals (CI) for risk of all-cause and cause-specific mortality associated with green tea intake were estimated using Cox proportional hazards regression models.
Results: During a median follow-up of 8.3 and 14.2 years for men and women, respectively, 6517 (2741 men and 3776 women) deaths were documented. We found that green tea consumption was inversely associated with risk of all-cause mortality (HR 0.95; 95% CI, 0.90–1.01), particularly among never-smokers (HR 0.89; 95% CI, 0.82–0.96). The inverse association with cardiovascular disease (CVD) mortality (HR 0.86; 95% CI, 0.77–0.97) was slightly stronger than that with all-cause mortality. No significant association was observed between green tea intake and cancer mortality (HR 1.01; 95% CI, 0.93–1.10).
Conclusions: Green tea consumption may be inversely associated with risk of all-cause and CVD mortality in middle-aged and elderly Chinese adults, especially among never smokers.

1. Introduction

Green tea is one of the most popular beverages all over the world and is mainly consumed in Asia, some parts of North Africa, the United States, and Europe.[1] The popularity of green tea makes it critically important to clarify its health impacts.[2] Green tea contains catechins, which have known anti-oxidative stress and anti-cancer properties.[3–5] While a possible protective role of green tea consumption in risk of specific chronic disease mortality in humans has been suggested in epidemiological studies, these findings remain controversial.[6–10]

Recently, several cohort studies[11–13] have suggested that the consumption of green tea may lower the risk of all-cause mortality by reducing the number of deaths due to cardiovascular disease (CVD). However, inconsistent results have been observed in different populations and studies.[6,7,11–13] Meta-analysis of five cohort studies indicated that green tea consumption was associated with a lower risk of total and CVD mortality.[14] However, the evidence was mainly based on Japanese populations. Therefore, it is necessary to conduct research in other populations to provide a comprehensive picture.

In this report, we described a systemic evaluation of the association of green tea consumption with risk of all-cause, CVD, and cancer mortality in two large prospective cohort studies, the Shanghai Men's Health Study (SMHS) and the Shanghai Women's Health Study (SWHS). Additionally, we evaluated these associations restricted to never-smokers in order to reduce the residual confounding of smoking.

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2. Methods

2.1. Study population and follow-up

The SMHS and SWHS are two ongoing population-based prospective cohort studies, which were established in 2002–2006 and 1997–2000, when 61,491 men aged 40–74 years and 74,941 women aged 40–70 years completed a face-to-face baseline survey, respectively. Details of the study designs, scientific rationale, and baseline characteristics of the participants have been published previously.[15,16] Participants were interviewed in person by trained interviewers using a structured questionnaire to obtain information on demographic characteristics, lifestyle and dietary habits, medical history, and family history of cancers, and anthropometric measurements were also taken at baseline. The SMHS and SWHS were approved by all relevant Institutional Review Boards of the Shanghai Cancer Institute, Vanderbilt University, and the National Cancer Institute. Informed consent was obtained from all participants in both cohorts.

All participants were followed up by in-person interviews, which took place every 2–3 years, and by annual linkage with the Shanghai Vital Statistics Registry database.[15,16] Causes of death reported on death certificates were coded according to the International Classification of Diseases, Ninth Revision (ICD-9), with cancer death defined as 140–208 and CVD death as 390–459.[17]

In the current analyses, we excluded participants with (i) loss to follow-up immediately after enrollment (n = 12 for men, n = 4 for women); (ii) extreme values for total energy intake (for men: <800 or >4000 kcal/day, n = 209; for women: <500 or >3500 kcal/day, n = 184); (iii) missing data for any of the covariates of interests or potential confounders (n = 1387 for men and 965 for women); or (iv) prevalent cancer, coronary heart disease, stroke, or diabetes at the baseline survey (n = 7963 for men and 9754 for women). After these exclusions, a total of 115,954 participants (51,920 men and 64,034 women) remained in the present study.

2.2. Assessment of green tea consumption

Green tea consumption was assessed at the baseline interview for all participants. Each participant was asked whether he/she drank tea regularly (ever drank tea at least 3 times per week for more than 6 months continuously) and at what age he/she started this habit. We then collected the information on the type (green tea, black tea, oolong tea, herbal tea, and others) and amount (dry weight, in grams) of tea consumed per month. Those who were former tea drinkers were further asked when they last drank tea regularly. In the current study, we used green tea intake as the exposure of interest.

2.3. Statistical analysis

Person-years for each participant were counted from the year of enrollment to the date of death or December 31, 2012, whichever came first. Hazard ratios (HRs) and 95% confidence intervals (CIs) for risk of mortality associated with green tea intake were estimated separately for men and women using Cox proportional hazards regression models, with person-years as the underlying time scale. Results were similar when we used age as the time scale. We checked proportional hazards assumptions using the Schoenfeld residual method and found no evidence of violation of these assumptions. Among green tea drinkers, the amounts and years of green tea consumption were dichotomized according to the median amounts or years of consumption; never-drinkers of green tea were used as the reference. The P values for linear trend were calculated by scoring the categories, from one for the lowest category to three for the highest, and entering the number as a continuous term in the regression model. We combined results for men and women to obtain summary risk estimates using the meta-analysis approach, with a random-effects model for risk estimates with significant heterogeneity and a fixed-effects model for risk estimates with non-significant heterogeneity.[18]

We considered the following variables as potential confounders a priori in the multivariate analysis: age at interview (per 5-year intervals), education (illiteracy or elementary school, middle school, high school, or professional education/college or higher), income (four categories: low [<10,000 yuan per family per year for women and <500 yuan per person per month for men], lower middle [10,000 to <20,000 yuan per family per year for women and 500 to <1000 yuan per person per month for men], upper middle [20,000 to <30,000 yuan per family per year for women and 1000 to <2000 yuan per person per month for men] and high [≥30,000 yuan per family per year for women and ≥2000 yuan per person per month for men]), smoking status (never, <20 pack-years, or ≥20 pack-years), alcohol intake (never, <two drinks/day, or ≥ two drinks/day; one drink equals 14.18 g of alcohol), energy intake (kcal, quartiles), body mass index (BMI, four categories:<18.5, 18.5–23.9, 24.0–27.9, or ≥28 kg/m^2), total physical activity (standard metabolic equivalents [METs] as MET-hr/week, quartiles), history of hypertension (yes or no), gastritis (yes or no), and menopause status (yes or no, women only).

To eliminate the residual confounding of cigarette smoking, we carried out additional analyses by restricting participants to never-smokers. To reduce potential reverse causation due to pre-existing diseases or conditions, sensitivity analyses were conducted to exclude participants who died within the first 2 years of follow-up. Additionally, we included dietary factors in our model, such as intake of fruits, vegetables, fish, red meat, rice, and dietary fiber, which were energy-adjusted using the residual method.[19] Furthermore, we repeated all analyses by excluding drinkers of other types of tea, such as black tea, oolong tea, and herbal tea. All analyses were conducted with SAS software (version 9.3; SAS Institute, Cary, NC, USA). Tests of statistical significance were based on two-sided probabilities, and P values < 0.05 were considered statistically significant.

3. Results

Approximately 65.6% of men and 27.5% of women were regular green tea drinkers in our cohorts. Among male green tea drinkers, the median daily consumption amount was 8.22 g of green tea leaves. The median duration of lifetime green tea consumption at baseline was 25 years. Among women, the median daily intake (3.29 g) was less than half of the consumption in men, and the median duration was 30 years.

Baseline characteristics of the study population according to status of green tea consumption are presented in Table 1. Compared with never-drinkers of green tea, regular drinkers were slightly younger and were more likely to smoke cigarettes and drink alcohol. They were less likely to have a history of hypertension and gastritis. Regular drinkers also performed less physical activity and consumed more vegetables and animal foods.

During an average follow-up of 8.3 years (5th–95th percentile: 6.6–10.4 years) in the SMHS and 14.2 years (5th–95th percentile: 12.6–15.6 years) in the SWHS, 6517 death cases (2741 men and 3776 women) were documented.

Table 2 shows the associations between green tea consumption and mortality due to all causes. In general, green tea consumption, though not statistically significant, was inversely associated with all-cause mortality (Pooled HR 0.95; 95% CI, 0.90–1.01). Among never-smokers, the inverse associations were more pronounced

Table 1
Baseline characteristics of participants according to green tea consumption in SMHS (2002–2012) and SWHS (1997–2012).

	Male, mean (SD) or %		P value[d]	Female, mean (SD) or %		P value[d]
	Ever (n = 34,052)	Never (n = 17,868)		Ever (n = 17,641)	Never (n = 46,393)	
Education			<0.001			<0.001
Elementary school or less	4.40	7.73		9.51	22.06	
Middle school	34.52	32.25		36.95	39.59	
High school	38.26	36.06		33.76	27.12	
Professional education/college or higher	22.82	23.96		19.78	11.22	
Income[a]			<0.001			<0.001
Low	12.85	13.72		11.13	16.95	
Lower middle	41.30	42.98		34.15	39.56	
Upper middle	35.77	33.99		32.13	27.39	
High	10.08	9.31		22.59	16.10	
History of hypertension	24.46	25.21	0.059	18.29	19.26	0.004
History of gastritis	14.00	16.67	<0.001	17.94	19.49	<0.001
Smoke status[b]			<0.001			<0.001
Never smoker	20.78	44.72		96.34	97.89	
Pack-years <20	33.35	28.50		3.66	2.11	
Pack-years ≥20	45.87	26.78		–	–	
Alcohol intake			<0.001			<0.001
Never drinker	60.27	77.17		96.48	98.55	
<2 drinks/day	23.55	14.30		3.32	1.35	
≥2 drinks/day	16.18	8.53		0.20	0.10	
Menopause status	–	–	–	35.98	47.43	<0.001
Age at baseline, years	53.46 (8.90)	55.40 (9.79)	<0.001	49.84 (7.73)	52.13 (9.01)	<0.001
Body mass index, kg/m^2	23.66 (3.08)	23.53 (3.03)	<0.001	23.94 (3.27)	23.79 (3.37)	<0.001
Waist:hip ratio	0.90 (0.06)	0.89 (0.06)	<0.001	0.81 (0.05)	0.81 (0.05)	<0.001
Physical activity, MET-h/week	57.54 (32.85)	62.24 (35.6)	<0.001	103.66 (43.91)	108.67 (45.57)	<0.001
Dietary intake[c]						
Total energy, kcal/d	1928.31 (473.29)	1930.78 (474.76)	0.572	1695.65 (386.51)	1681.02 (394.43)	<0.001
Carbohydrate, g/d	314.88 (36.51)	321.16 (35.43)	<0.001	276.06 (27.89)	283.07 (29.1)	<0.001
Protein, g/d	77.8 (13.42)	75.44 (13.04)	<0.001	67.62 (11.05)	64.85 (11.12)	<0.001
Fat, g/d	34.38 (11.92)	32.62 (11.45)	<0.001	29.98 (8.8)	28.09 (9.24)	<0.001
Fiber, g/d	11.29 (3.48)	11.12 (3.32)	<0.001	11.19 (3.31)	10.55 (3.25)	<0.001
Vegetables, g/d	337.54 (173.34)	329.85 (176.84)	<0.001	302.13 (156.63)	282.81 (150.73)	<0.001
Fruits, g/d	149.15 (119.61)	157.28 (121.43)	<0.001	289.35 (167.79)	257.85 (169.19)	<0.001
Red meat, g/d	64.57 (39.25)	58.37 (36.98)	<0.001	51.84 (32.04)	49.25 (31.34)	<0.001
Fish, g/d	52.68 (45.13)	48.47 (43.28)	<0.001	54.88 (43.76)	48.02 (41.66)	<0.001

MET, metabolic equivalent; SD, standard deviation; SMHS, Shanghai Men's Health Study; SWHS, Shanghai Women's Health Study.
[a] Income level, four categories: Low: less than ¥10,000 per family per year for women and less than ¥500 per person per month for men; lower middle: ¥10,000–19999 per family per year for women and ¥500–999 per person per month for men; Upper middle: ¥20,000–29999 per family per year for women and ¥1000–1999 per person per month for men; high: greater than ¥30,000 per family per year for women and more than ¥2000 per person per month for men.
[b] Smoking status was collapsed into two groups in SWHS.
[c] Dietary nutrients intake (except for energy) was energy-adjusted by residual methods.
[d] P value was calculated by using *t*-test for continuous variables and the Pearson chi-square test for categorical variables.

(pooled HR 0.89; 95% CI, 0.82–0.96). There was an inverse dose-response association between higher amounts of green tea intake and all-cause mortality in never-smokers (P for trend = 0.025), especially among men (P for trend = 0.013). Similarly, a long duration of green tea consumption was associated with a lower risk of all-cause mortality in all participants (P for trend = 0.002) and in never-smokers (P for trend<0.001). However, among never-smokers, these inverse associations were less pronounced in women than in men.

We further investigated the association between green tea consumption and mortality due to CVD and cancer (Table 3). We found that green tea consumption was significantly associated with mortality from CVD (HR 0.86; 95% CI, 0.77–0.97). The point estimates were similar when restricted to never-smokers. Overall, there were no associations between green tea consumption and total cancer mortality. However, a non-significant inverse association was observed among never-smokers (HR 0.92; 95% CI, 0.83–1.02).

In our sensitivity analysis, exclusion of the first 2 years of follow-up did not substantially change the findings. Additionally, we observed a similar pattern when we included dietary factors (such as intake of vegetables, fruit, fish, red meat, rice, and fiber) in our multiple regression model. Finally, when we excluded drinkers of other types of tea, such as black tea, oolong tea, and herbal tea, the results remained robust and stable. Results of sensitivity analyses are provided in eTable 1.

4. Discussion

Through analysis of two population-based prospective cohorts of 115,954 middle-aged and elderly Chinese adults, we found that green tea consumption may be inversely associated with risk of all-cause and CVD mortality. These associations may be more pronounced among never-smokers, especially among men. However, no significant associations were observed between green tea consumption and risk of cancer mortality.

Kuriyama et al. found an inverse association between green tea consumption and mortality due to all causes and CVD but not with mortality due to cancer.[6] These associations have been confirmed in other Japanese cohort studies.[13] Recently, Saito et al. reported that higher consumption of green tea was associated with a lower risk of mortality from all causes, heart disease, cerebrovascular disease, and respiratory disease.[11] In contrast, two studies from Singapore[12] and Japan[7] indicated that there was no association between green tea consumption and all-cause mortality. In the current study, the inverse associations between green tea consumption and all-cause

Table 2
Cox proportional hazard ratios for all-cause mortality with green tea consumption in SMHS (2002–2012) and SWHS (1997–2012).

Group	All participants				Never smokers			
	Person-years	Number of cases	Age-adjusted HR (95% CI)	Multivariate HR (95% CI)[c]	Person-years	Number of cases	Age-adjusted HR (95% CI)	Multivariate HR (95% CI)[c]
Combined								
Drinking green tea regularly								
No	791,744	4054	1.00	1.00	697,159	3310	1.00	1.00
Yes	533,316	2463	0.99 (0.93–1.04)	0.95 (0.90–1.01)	299,981	957	0.82 (0.76–0.88)	0.89 (0.82–0.96)
Amount of green tea consumed[a]								
Never	791,744	4054	1.00	1.00	697,159	3310	1.00	1.00
0- < Median	177,213	820	0.87 (0.80–0.94)	0.90 (0.82–0.97)	106,953	360	0.75 (0.66–0.84)	0.83 (0.74–0.93)
≥Median	356,103	1643	1.06 (1.00–1.13)	0.98 (0.91–1.04)	193,027	597	0.87 (0.80–0.94)	0.93 (0.85–1.02)
Test for trend			0.210	0.319			<0.001	0.025
Years of green tea consumed[b]								
Never	791,744	4054	1.00	1.00	697,159	3310	1.00	1.00
0- < Median	212,748	910	1.13 (1.04–1.22)	1.04 (0.96–1.13)	104,114	290	0.90 (0.80–1.01)	0.99 (0.88–1.12)
≥Median	320,503	1553	0.92 (0.87–0.98)	0.90 (0.85–0.96)	195,829	667	0.79 (0.73–0.86)	0.86 (0.79–0.93)
Test for trend			0.025	0.002			<0.001	<0.001
Men								
Drinking green tea regularly								
No	148,699	1035	1.00	1.00	66,960	472	1.00	1.00
Yes	284,816	1706	1.07 (0.99–1.15)	0.96 (0.88–1.04)	60,171	292	0.74 (0.64–0.85)	0.81 (0.70–0.95)
Amount of green tea consumed[a]								
Never	148,699	1035	1.00	1.00	66,960	472	1.00	1.00
0- < Median	102,153	620	0.92 (0.84–1.02)	0.93 (0.84–1.03)	33,334	174	0.74 (0.62–0.88)	0.82 (0.69–0.98)
≥Median	182,663	1086	1.17 (1.08–1.28)	0.97 (0.89–1.07)	26,837	118	0.73 (0.60–0.89)	0.80 (0.65–0.99)
Test for trend			<0.001	0.575			<0.001	0.013
Years of green tea consumed[b]								
Never	148,699	1035	1.00	1.00	66,960	472	1.00	1.00
0- < Median	123,553	660	1.22 (1.11–1.35)	1.04 (0.94–1.16)	18,537	76	0.81 (0.64–1.03)	0.89 (0.70–1.14)
≥Median	161,214	1046	0.99 (0.91–1.08)	0.91 (0.84–1.00)	41,613	216	0.72 (0.61–0.84)	0.79 (0.67–0.93)
Test for trend			0.803	0.038			0.000	0.006
Women								
Drinking green tea regularly								
No	643,045	3019	1.00	1.00	630,199	2838	1.00	1.00
Yes	248,500	757	0.89 (0.82–0.97)	0.94 (0.86–1.02)	239,810	665	0.85 (0.78–0.93)	0.92 (0.84–1.01)
Amount of green tea consumed[a]								
Never	643,045	3019	1.00	1.00	630,199	2838	1.00	1.00
0- < Median	75,060	200	0.76 (0.66–0.88)	0.83 (0.72–0.96)	73,619	186	0.75 (0.64–0.87)	0.83 (0.71–0.96)
≥Median	173,440	557	0.95 (0.87–1.04)	0.98 (0.89–1.08)	166,190	479	0.90 (0.82–0.99)	0.96 (0.87–1.06)
Test for trend			0.064	0.350			0.003	0.210
Years of green tea consumed[b]								
Never	643,045	3019	1.00	1.00	630,199	2838	1.00	1.00
0- < Median	89,195	250	0.99 (0.87–1.12)	1.04 (0.91–1.18)	85,577	214	0.93 (0.81–1.07)	1.03 (0.89–1.18)
≥Median	159,289	507	0.85 (0.78–0.94)	0.89 (0.81–0.98)	154,216	451	0.82 (0.74–0.90)	0.88 (0.80–0.97)
Test for trend			0.001	0.039			<0.001	0.023

Abbreviation: Q, quintiles; SMHS, Shanghai Men's Health Study; SWHS, Shanghai Women's Health Study.
[a] For SMHS, Median = 8.22 g/day; For SWHS, Median = 3.29 g/day.
[b] For SMHS, Median = 25 years; For SWHS, Median = 30 years.
[c] Adjusted for age (per 5-y intervals), education (4 categories), income (4 categories), smoking status (pack-years, 3 categories for men and 2 categories for women), alcohol intake (3 categories), energy intake (quartiles), body mass index (4 categories), physical activity (quartiles), history of hypertension (yes/no), gastritis (yes/no), menopause status (yes/no, women only).

and CVD mortality were consistent with the findings of previous studies. We observed a non-significant inverse association between green tea consumption and cancer mortality when restricted to never-smokers.

The finding that the inverse association between green tea consumption and risk of mortality was less pronounced in all participants than among never smokers is plausible given the strong confounding effect of smoking. The effects of smoking on mortality may likely explain the attenuated association among populations with high prevalence of smoking.[6,12] Our results in men indicate that higher rates of smoking may attenuate or mask the association of green tea consumption with risk of all-cause mortality.

The health-promoting effects of green tea are thought to be mainly attributable to its polyphenols content.[20] Most of the green tea polyphenols are flavonols, commonly known as catechins. Some animal studies have suggested that green tea might reduce blood glucose, blood pressure, and body weight and act as anti-tumorigenic agents.[20–22] In epidemiological studies, evidence is accumulating on the healthy properties of green tea.[23–25] Results from epidemiological and animal studies indicate that catechins may have a positive impact on endothelial and overall vascular function, with a number of potential molecular mechanisms, including inhibition of oxidation and vascular inflammation and amelioration in blood lipid concentrations.[26,27] A meta-analysis of 14 randomized controlled trials indicated that consumption of

Table 3
Cox proportional hazard ratios for CVD and cancer mortality with green tea consumption in SMHS (2002–2012) and SWHS (1997–2012).

Group	CVD				Cancer			
	All participants		Never smokers		All participants		Never smokers	
	Number of cases	Multivariate HR (95% CI)	Number of cases	Multivariate HR (95% CI)	Number of cases	Multivariate HR (95% CI)	Number of cases	Multivariate HR (95% CI)
Combined								
Drinking green tea regularly								
No	1139	1.00	905	1.00	1901	1.00	1574	1.00
Yes	616	0.86 (0.77–0.97)	231	0.87 (0.74–1.01)	1309	1.01 (0.93–1.10)	501	0.92 (0.83–1.02)
Amount of green tea consumed[a]								
Never	1139	1.00	905	1.00	1901	1.00	1574	1.00
0- < Median	201	0.79 (0.67–0.93)	85	0.77 (0.61–0.98)	433	0.98 (0.87–1.10)	186	0.86 (0.73–1.01)
≥Median	415	0.90 (0.80–1.03)	146	0.92 (0.77–1.10)	876	1.04 (0.95–1.14)	315	0.95 (0.84–1.08)
Test for trend		0.039		0.175		0.454		0.242
Years of green tea consumed[b]								
Never	1139	1.00	905	1.00	1901	1.00	1574	1.00
0- < Median	224	0.97 (0.83–1.15)	70	1.06 (0.82–1.36)	496	1.13 (1.01–1.26)	152	0.97 (0.82–1.16)
≥Median	392	0.82 (0.72–0.93)	161	0.80 (0.67–0.95)	813	0.97 (0.89–1.07)	349	0.90 (0.79–1.01)
Test for trend		0.003		0.021		0.806		0.096
Men								
Drinking green tea regularly								
No	297	1.00	134	1.00	475	1.00	205	1.00
Yes	440	0.86 (0.74–1.00)	82	0.83 (0.63–1.11)	903	1.06 (0.94–1.19)	136	0.84 (0.67–1.06)
Amount of green tea consumed[a]								
Never	297	1.00	134	1.00	475	1.00	205	1.00
0- < Median	156	0.8 (0.66–0.98)	46	0.80 (0.56–1.12)	329	1.06 (0.92–1.22)	86	0.91 (0.70–1.18)
≥Median	284	0.9 (0.76–1.07)	36	0.88 (0.61–1.29)	574	1.06 (0.93–1.21)	50	0.75 (0.54–1.03)
Test for trend		0.232		0.342		0.358		0.074
Years of green tea consumed[b]								
Never	297	1.00	134	1.00	475	1.00	205	1.00
0- < Median	168	0.96 (0.78–1.17)	24	1.09 (0.70–1.70)	359	1.17 (1.01–1.35)	32	0.81 (0.55–1.19)
≥Median	272	0.82 (0.69–0.97)	58	0.76 (0.55–1.04)	544	1.01 (0.89–1.14)	104	0.85 (0.67–1.09)
Test for trend		0.018		0.103		0.947		0.184
Women								
Drinking green tea regularly								
No	842	1.00	771	1.00	1426	1.00	1369	1.00
Yes	176	0.87 (0.73–1.03)	149	0.88 (0.73–1.05)	406	0.97 (0.86–1.08)	365	0.94 (0.84–1.06)
Amount of green tea consumed[a]								
Never	842	1.00	771	1.00	1426	1.00	1369	1.00
0- < Median	45	0.77 (0.57–1.04)	39	0.75 (0.54–1.04)	104	0.82 (0.67–1.01)	100	0.83 (0.67–1.02)
≥Median	131	0.91 (0.75–1.10)	110	0.93 (0.76–1.14)	302	1.03 (0.91–1.17)	265	0.99 (0.87–1.14)
Test for trend		0.19		0.304		0.959		0.639
Years of green tea consumed[b]								
Never	842	1.00	771	1.00	1426	1.00	1369	1.00
0- < Median	56	1.00 (0.76–1.32)	46	1.04 (0.77–1.41)	137	1.06 (0.88–1.27)	120	1.02 (0.84–1.24)
≥Median	120	0.82 (0.67–1.00)	103	0.82 (0.67–1.01)	269	0.93 (0.81–1.06)	245	0.91 (0.79–1.04)
Test for trend		0.056		0.090		0.364		0.217

CI, confidence interval; CVD, cardiovascular disease; HR, hazard ratio; Q, quintiles; SMHS, Shanghai Men's Health Study; SWHS, Shanghai Women's Health Study.
Adjusted for age (per 5-year intervals), education (4 categories), income (4 categories), smoking status (pack-years, 3 categories for men and 2 categories for women), alcohol intake (3 categories), energy intake (quartiles), body mass index (4 categories), physical activity (quartiles), history of hypertension (yes/no), gastritis (yes/no), menopause status (yes/no, women only).
[a] For SMHS, Median = 8.22 g/day; For SWHS, Median = 3.29 g/day.
[b] For SMHS, Median = 25 years; For SWHS, Median = 30 years.

green tea beverages or extracts was associated with significant reduction in serum total cholesterol and low-density lipoprotein cholesterol concentrations.[28] Consequently, green tea consumption could be related to longevity, given its protective effects in reducing risk factors of various chronic medical conditions, especially CVD.[29]

Our study has several strengths. We comprehensively assessed the relationship between green tea consumption and cause-specific mortality in two large cohort studies conducted in Shanghai. Other strengths include a population-based design, complete follow-up, and adjustment for most potential confounders.

There are also several important limitations to the current study. First, green tea intake was measured at the time of the baseline interview, and we cannot exclude the possibility of misclassification of green tea intake. Non-differential misclassification of exposure may tend to attenuate the true association. Second, residual confounding may remain; however, we prudently chose potential confounders in our final models, and additional adjustments for dietary factors did not change our main findings. We did not adjust coffee intake in our models due to lack of essential information. However, it seems to be negligible because coffee consumption is relatively lower in China than other Asia countries, as

reported by the International Coffee Organization.[30] Furthermore, we reanalyzed the data restricted to never-smokers to address the effect of cigarette smoking.

5. Conclusions

In summary, the results of our cohort study extended evidence that green tea consumption may be associated with a reduced risk of all-cause and CVD mortality. Future studies on the relationship between green tea consumption and cancer mortality should be conducted.

Conflicts of interest

None declared.

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Y. B. X. conducted the design and interpreted the results; L. G. Z. and H. L. L. conducted the research and analyzed the data; L. G. Z. wrote the first draft. Y. B. X. had primary responsibility for final content. All authors read, critically reviewed, and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.je.2016.08.004.

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