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Beverage Habits and Mortality in Chinese Adults[1,2]

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Abstract

Background: There is limited research examining beverage habits, one of the most habitual dietary behaviors, with mortality risk.

Objective: This study examined the association between coffee, black and green tea, sugar-sweetened beverages (soft drinks and juice), and alcohol and all-cause and cause-specific mortality.

Methods: A prospective data analysis was conducted with the use of the Singapore Chinese Health Study, including 52,584 Chinese men and women (aged 45–74 y) free of diabetes, cardiovascular disease (CVD), and cancer at baseline (1993–1998) and followed through 2011 with 10,029 deaths. Beverages were examined with all-cause and cause-specific (cancer, CVD, and respiratory disease) mortality risk with the use of Cox proportional hazards regression.

Results: The associations between coffee, black tea, and alcohol intake and all-cause mortality were modified by smoking status. Among never-smokers there was an inverse dose-response association between higher amounts of coffee and black tea intake and all-cause, respiratory-related, and CVD mortality (black tea only). The fully adjusted HRs for all-cause mortality for coffee for <1/d, 1/d, and ≥2/d relative to no coffee intake were 0.89, 0.86, and 0.83, respectively (*P*-trend = 0.0003). For the same black tea categories the HRs were 0.95, 0.90, and 0.72, respectively (*P*-trend = 0.0005). Among ever-smokers there was no association between coffee or black tea and the outcomes. Relative to no alcohol, light to moderate intake was inversely associated with all-cause mortality (HR: 0.87; 95% CI: 0.79, 0.96) in never-smokers with a similar magnitude of association in ever-smokers. There was no association between heavy alcohol intake and all-cause mortality in never-smokers and a strong positive association in ever-smokers (HR: 1.56; 95% CI: 1.40, 1.74). Green tea and sugar-sweetened beverages were not associated with all-cause or cause-specific mortality.

Conclusions: Higher coffee and black tea intake was inversely associated with mortality in never-smokers, light to moderate alcohol intake was inversely associated with mortality regardless of smoking status, heavy alcohol intake was positively associated with mortality in ever-smokers, and there was no association between sugar-sweetened beverages and green tea and mortality. *J Nutr* 2015;145:595–604.

Keywords: coffee, black tea, green tea, soft drinks, juice, alcohol, Asian, all-cause mortality, cause-specific mortality

Introduction

Beverage intake is one of the most habitual dietary behaviors across cultures and populations. Specifically, consumption of coffee, teas, and alcoholic beverages is one of the oldest and truly most common dietary behaviors documented, whereas sugar-sweetened beverage consumption is a relatively new and prevalent addition to global dietary intake (1). Each one of these beverages fills a dietary niche within the culture in which it is consumed and fits into a broader dietary pattern, and yet is also a potentially important individual contributor to public health given their ubiquity, individual biological properties, and potential health effects (1–4). A small base of literature has examined the association between coffee, tea, and alcohol intake and mortality risk. The data generally show that higher intakes of coffee and teas and light to moderate alcohol intake are associated with lower mortality risk (5–12), demonstrating their public health relevance. However, studies suggest that sugar-sweetened beverages are associated with an increased risk of cardiometabolic diseases (13, 14) and some cancers (15), yet very little is known about the association between sugar-sweetened beverages and mortality risk (10).

The Singapore Chinese Health Study (SCHS)[8] provides a unique population in which to examine beverage habits with

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[8] Abbreviations used: CVD, cardiovascular disease; DSM, dim sum meat–rich; SCHS, Singapore Chinese Health Study; VFS, vegetable-fruit-soy–rich.

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TABLE 1 Baseline demographic, lifestyle, and dietary characteristics according to coffee and black tea intake by smoking status, Singapore Chinese Health Study[1]

Characteristics	Intake amount (servings/d)			
	None	Any to <1	1	≥2
Coffee, never-smokers				
n	7387	4387	14,140	11,011
Age, y	55.0 ± 7.9	54.7 ± 7.7	55.3 ± 7.7	54.8 ± 7.4
Female	72.0	68.0	77.0	71.0
Hokkien dialect	50.0	51.0	52.0	53.0
Education[2]	36.0	39.0	28.0	28.0
Hypertension[3]	20.0	22.9	22.5	19.3
Moderate activity[4]	19.0	19.0	16.0	13.0
Vigorous activity[5]	8.0	9.0	7.0	8.0
BMI, kg/m^2	23.0 ± 3.2	23.3 ± 3.3	23.2 ± 3.2	23.2 ± 3.2
Sleep, h	6.9 ± 1.1	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1
Dietary pattern score[6]	25.0	27.0	23.0	19.0
Total energy, kcal/d	1479 ± 493	1508 ± 493	1461 ± 473	1583 ± 510
Black tea, cups/mo	9.4 ± 20.3	9.0 ± 16.9	4.8 ± 11.6	4.8 ± 13.2
Green tea, cups/mo	10.9 ± 27.1	9.5 ± 23.2	8.0 ± 21.2	6.8 ± 19.8
Soft drinks, drinks/mo	2.3 ± 8.3	2.1 ± 6.8	2.1 ± 7.2	2.6 ± 8.6
Alcohol, drinks/wk	0.4 ± 2.1	0.4 ± 2.1	0.4 ± 2.1	0.5 ± 2.5
Coffee, ever-smokers				
n	1984	1306	4809	7560
Age, y	58.7 ± 8.3	57.6 ± 8.3	58.3 ± 8.0	57.0 ± 7.8
Female	13.0	11.0	18.0	14.0
Hokkien dialect	60.0	60.0	56.0	59.0
Education[2]	26.0	34.0	27.0	25.0
Hypertension[3]	20.7	21.9	19.9	14.4
Moderate activity[4]	18.0	17.0	15.0	14.0
Vigorous activity[5]	12.0	13.0	15.0	15.0
BMI, kg/m^2	22.8 ± 3.1	23.0 ± 3.4	22.7 ± 3.2	22.5 ± 3.3
Sleep, h	7.0 ± 1.2	7.0 ± 1.1	7.1 ± 1.2	7.0 ± 1.1
Dietary pattern score[6]	15.0	19.0	16.0	12.0
Total energy, kcal/d	1600 ± 530	1679 ± 561	1616 ± 550	1747 ± 575
Black tea, cups/mo	19.9 ± 31.4	12.9 ± 21.3	7.2 ± 16.4	5.9 ± 15.9
Green tea, cups/mo	17.2 ± 35.9	13.2 ± 30.6	11.3 ± 27.7	8.6 ± 23.3
Soft drinks, drinks/mo	3.2 ± 11.4	2.9 ± 10.1	3.2 ± 10.0	3.7 ± 11.9
Alcohol, drinks/wk	2.6 ± 7.3	2.3 ± 6.9	2.5 ± 6.8	2.2 ± 6.0
Black tea, never-smokers				
n	23,829	9278	2924	864
Age, y	55.7 ± 7.8	53.8 ± 7.2	53.7 ± 7.1	54.2 ± 7.3
Female	78.0	67.0	57.0	49.0
Hokkien dialect	51.0	52.0	51.0	55.0
Education[2]	26.0	38.0	46.0	41.0
Hypertension[3]	21.1	21.1	20.3	21.5
Moderate activity[4]	15.0	17.0	18.0	18.0
Vigorous activity[5]	6.0	10.0	12.0	15.0
BMI, kg/m^2	23.2 ± 3.2	23.2 ± 3.2	23.2 ± 3.2	23.6 ± 3.4
Sleep, h	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1
Dietary pattern score[6]	21.0	25.0	26.0	26.0
Total energy, kcal/d	1448 ± 469	1592 ± 504	1651 ± 545	1729 ± 558
Coffee, cups/mo	33.0 ± 33.4	30.8 ± 31.1	21.9 ± 27.3	22.6 ± 32.6
Green tea, cups/mo	7.9 ± 22.5	8.7 ± 21.0	10.8 ± 22.9	81.4 ± 21.8
Soft drinks, drinks/mo	1.9 ± 7.6	2.6 ± 7.4	3.4 ± 9.2	4.2 ± 11.7
Alcohol, drinks/wk	0.4 ± 2.2	0.5 ± 2.1	0.6 ± 2.3	0.7 ± 2.7
Black tea, ever-smokers				
n	9604	3908	1425	722
Age, y	58.4 ± 8.0	56.5 ± 7.9	56.5 ± 7.7	56.3 ± 7.7
Female	19.0	10.0	8.0	7.0
Hokkien dialect	58.0	59.0	60.0	63.0
Education[2]	23.0	31.0	34.0	32.0
Hypertension[3]	17.0	18.7	17.7	18.1
Moderate activity[4]	15.0	16.0	17.0	15.0
Vigorous activity[5]	12.0	15.0	17.0	19.0
BMI, kg/m^2	22.4 ± 3.6	22.8 ± 3.2	22.8 ± 3.2	22.6 ± 3.1
Sleep, h	7.1 ± 1.2	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1
Dietary pattern score[6]	13.0	16.0	17.0	16.0
Total energy, kcal/d	1618 ± 550	1769 ± 567	1790 ± 566	1866 ± 601
Coffee, cups/mo	52.0 ± 41.6	45.8 ± 38.6	31.2 ± 33.6	29.1 ± 37.6
Green tea, cups/mo	11.0 ± 28.5	9.9 ± 23.6	11.6 ± 26.9	13.7 ± 30.9
Soft drinks, drinks/mo	3.0 ± 11.0	3.8 ± 10.5	4.4 ± 12.2	4.8 ± 13.7
Alcohol, drinks/wk	2.3 ± 6.6	2.2 ± 6.1	2.5 ± 6.9	2.8 ± 6.7

[1] Values are means ± SDs or percentages. One serving was assigned a value of 237 mL, or ~1 cup. However, serving size was not directly assessed.
[2] Percentage of population with a secondary education or greater.
[3] Percentage of population who self-reported physician-diagnosed hypertension.
[4] Percentage of population who reported ≥2 h/wk.
[5] Percentage of population who reported ≥1.5 h/wk of vigorous work or strenuous physical activity.
[6] Proportion of category in the top 20% of the vegetable-fruit-soy–rich dietary pattern score, which is strongly inversely associated with all-cause and cause-specific mortality during the follow-up period.

longevity. The culture has both Western and South Asian dietary influences. In addition to the foods and dishes, the population pattern of beverage intake is distinct, with usual consumption of coffee, black tea, green tea, and sugar-sweetened beverages (13, 16). The mortality patterns of Singapore mirror Western countries as well (17). Therefore, we examined the association between beverages (coffee, teas, alcoholic beverages, and sugar-sweetened beverages) and all-cause and cause-specific (CVD, cancer, and respiratory) mortality in this population. Based on the literature and biological plausibility, we hypothesized that higher intake of coffee and black and green tea would display an inverse association, sugar-sweetened beverages would display a positive association, and alcoholic beverages would display a J-shape with mortality during follow-up. We also hypothesized that smoking status might modify the diet–mortality association as it has for other diet–disease relations in the SCHS and elsewhere (18–21).

Methods

Study population. The design of the SCHS has been described previously (22). Briefly, the cohort was drawn from men and women aged 45–74 y who belonged to one of the major dialect groups (Hokkien or Cantonese) of Chinese in Singapore. Between April 1993 and December 1998, 63,257 individuals (~85% of the eligible subjects invited agreed to participate) completed an in-person interview that included questions on usual diet, demographics, height and weight, use of tobacco, usual physical activity, menstrual and reproductive history (women only), medical history, and family history of cancer. The institutional review boards at the National University of Singapore, the University of Minnesota, and the University of Pittsburgh approved this study.

Assessment of diet and covariates. A past-year semiquantitative FFQ that was specifically developed for this population included 165 commonly consumed food and beverage items and was administered during the baseline interview. During the interview respondents referred to accompanying photographs to select from 8 food frequency categories

ranging from "never or hardly ever" to "≥2 times/d" and 3 portion sizes for foods. The FFQ has been validated subsequently against a series of 24-h dietary recall interviews (22), as well as selected biomarker studies (23, 24). In conjunction with this cohort, the Singapore Food Composition Table, a food nutrient database that lists the amounts of 96 nutritive and nonnutritive components per 100 g raw food, cooked food, and beverages in the diet of the Singaporean Chinese, was developed (22).

For beverage intake, study subjects were asked to choose the intake frequency of soft drinks, juices (fruit or vegetable), coffee, green tea, and black tea from 9 predefined categories (never or hardly ever, 1–3 times/mo, 1 time/wk, 2–3 times/wk, 4–6 times/wk, 1 time/d, 2–3 times/d, 4–5 times/d, and ≥6 times/d). One serving was assigned a value of 237 mL, or ~1 cup. However, serving size was not directly assessed and there is likely heterogeneity in serving size; our analysis is focused on frequency. Because decaffeinated coffee is rarely consumed in our study population, only caffeinated coffee was assessed; this decision was made during the development of the FFQ specific for this population. The beverage categories for the analysis were based on intakes that allowed for logical cutoffs and provided sufficient participants.

For alcoholic beverages (beer, wine, Western hard liquor, and Chinese hard liquor), participants were asked to choose from 8 frequency categories (never or hardly ever, 1 time/mo, 2–3 times/mo, 1 time/wk, 2–3 times/wk, 4–6 times/wk, 1 time/d, and ≥2 times/d), as well as portion sizes (25, 26). One drink was defined as 375 mL beer (13.6 g ethanol), 118 mL wine (11.7 g ethanol), or 30 mL Western or Chinese hard liquor (10.9 g ethanol) (26). Alcohol intake was classified as never, light-moderate (>0–≤7 drinks/wk for women and >0–≤14 drinks/wk for men), and heavy (>7 drinks/wk for women and >14 drinks/wk for men).

At the baseline interview all lifestyle factors were collected by self-report. Height and weight were used to calculate BMI as weight in kilograms divided by height in meters squared. Inquiry on smoking habits included smoking status (never, former, or current smoker), and former and current (i.e., ever) smokers were further asked for age when they started or quit smoking, number of cigarettes per day, and number of years of smoking (27). For physical activity, participants were asked the number of hours per week spent on moderate activities such as brisk walking, bowling, bicycling on level ground, tai chi or chi kung, and on strenuous sports such as jogging, bicycling on hills, tennis, squash, swimming laps, or aerobics. The physical activity portion of the questionnaire was modeled after the EPIC (European Prospective Investigation into Cancer) study physical activity questionnaire, which has been shown to be valid and repeatable (28). Usual sleep duration was assessed by the following question: "On average, during the last year, how many hours in a day did you sleep?," with response categories of ≤5 h, 6 h, 7 h, 8 h, 9 h, and ≥10 h.

Assessment of mortality. Information on date and cause of death was obtained through linkage with the nationwide registry of birth and death in Singapore. Up to 6 different International Classification of Diseases version 9 codes were recorded in the registry. The primary cause of death was used for analysis. Vital status for cohort participants was updated through 31 December 2011. Follow-up for mortality is considered virtually complete due to linkage analysis and negligible emigration (0.0004%). The end points in our cause-specific analyses were deaths from cardiovascular disease (CVD) (codes 394.0–459.0), all cancers (codes 140.0–195.8 and 199–208.9), and respiratory disease (e.g., influenza, pneumonia, and chronic obstructive pulmonary disease) (codes 480–488 and 490–96).

Statistical analysis. For the analysis we excluded 1936 subjects with a history of invasive cancer (except nonmelanoma skin cancer) or superficial, papillary bladder cancer at baseline because they did not meet study inclusion criteria. We further excluded those with a reported history of diabetes (5469) or CVD (2399) at baseline, as well as 869 who reported extreme sex-specific energy intakes (<600 or >3000 kcal for women and <700 or >3700 kcal men). The final analysis included 52,584 participants.

We derived a "food only" diet pattern with the same methodologic approach as previous studies of this cohort (18). We used principal component analysis to reduce the 152 nonbeverage foods into a single covariate to better deal with potential residual confounding by the overall diet. Two patterns were derived that were highly similar to the main patterns published in multiple manuscripts and showing strong relations with morbidity and mortality—a vegetable-fruit-soy–rich (VFS) dietary pattern and a dim-sum meat–rich (DSM) dietary pattern (18, 25, 29, 30). Food-wise, participants with higher VFS food-only scores had higher intakes of vegetables, fruits, and soy foods and lower

TABLE 2 Baseline demographic, lifestyle, and dietary characteristics according to alcohol intake by smoking status, Singapore Chinese Health Study[1]

	Alcohol intake		
Characteristics	None	Light to moderate[2]	Heavy[2]
Never-smokers			
n	31,600	4801	524
Age, y	55.2 ± 7.7	53.7 ± 7.2	54.9 ± 7.6
Female	78.0	46.0	57.0
Hokkien dialect	53.0	46.0	51.0
Education[3]	29.0	41.0	31.0
Hypertension[4]	21.9	16.1	15.5
Moderate activity[5]	16.0	18.0	13.0
Vigorous activity[6]	7.0	16.0	11.0
BMI, kg/m^2	23.2 ± 3.2	23.2 ± 3.1	23.1 ± 3.0
Sleep, h	7.0 ± 1.1	7.0 ± 1.1	6.9 ± 1.2
Dietary pattern score[7]	22.0	24.0	22.0
Total energy, kcal/d	1468 ± 474	1731 ± 538	1812 ± 570
Coffee, cups/mo	30.8 ± 32.3	34.7 ± 33.6	36.9 ± 34.3
Black tea, cups/mo	5.8 ± 14.6	8.6 ± 17.4	6.4 ± 15.2
Green tea, cups/mo	8.0 ± 21.7	11.5 ± 26.1	8.6 ± 20.0
Soft drinks, drinks/mo	2.1 ± 7.4	3.5 ± 9.8	3.1 ± 9.2
Alcohol, drinks/wk	0	1.8 ± 2.2	13.9 ± 9.5
Ever-smokers			
n	10,443	4135	1081
Age, y	58.5 ± 8.0	56.1 ± 7.9	55.6 ± 7.3
Female	19.0	6.0	8.0
Hokkien dialect	59.0	56.0	61.0
Education[3]	24.0	32.0	25.0
Hypertension[4]	18.7	15.3	14.8
Moderate activity[5]	15.0	16.0	12.0
Vigorous activity[6]	11.0	18.0	17.0
BMI, kg/m^2	22.6 ± 3.6	22.6 ± 3.5	21.9 ± 3.4
Sleep, h	7.1 ± 1.2	7.0 ± 1.1	7.1 ± 1.3
Dietary pattern score[7]	15.0	15.0	10.0
Total energy, kcal/d	1608 ± 540	1786 ± 568	2008 ± 604
Coffee, cups/mo	47.5 ± 41.4	47.9 ± 39.1	46.3 ± 39.3
Black tea, cups/mo	8.4 ± 19.6	9.1 ± 19.6	9.8 ± 22.0
Green tea, cups/mo	10.3 ± 26.5	11.9 ± 28.3	12.5 ± 31.6
Soft drinks, drinks/mo	3.2 ± 11.2	3.7 ± 10.4	4.5 ± 13.1
Alcohol, drinks/wk	0	3.1 ± 3.1	22.1 ± 11.6

[1] Values are means ± SDs or percentages. One drink was defined as 375 mL beer (13.6 g ethanol), 118 mL wine (11.7 g ethanol), or 30 mL Western or Chinese hard liquor (10.9 g ethanol).
[2] Light to moderate consumption is defined as >0 to ≤7 drinks/wk for women and >0 to ≤14 drinks/wk for men. Heavy consumption is defined as >7 drinks/wk for women and >14 drinks/wk for men.
[3] Percentage of population with a secondary education or greater.
[4] Percentage of population who self-reported physician-diagnosed hypertension.
[5] Percentage of population who reported ≥2 h/wk.
[6] Percentage of population who reported ≥1.5 h/wk of vigorous work or strenuous physical activity.
[7] Proportion of category in the top 20% of the vegetable-fruit-soy–rich dietary pattern score, which is strongly inversely associated with all-cause and cause-specific mortality during the follow-up period.

intakes of rice, noodles, and red and processed meats. Nutrient-wise, participants with higher VFS scores reported consuming fewer carbohydrates but more fiber, dietary fat mainly from plant sources, and protein. Food-wise, participants with higher DSM food-only scores had higher intakes of noodles and red and processed meats and lower intakes of vegetables, fruits, and dairy foods. Nutrient-wise, participants with higher DSM scores reported consuming fewer carbohydrates with corresponding decreases in dietary fiber, more dietary fat mainly from animal sources, and more protein.

Baseline and dietary characteristics were calculated for participants across each beverage. For each study subject, person-years were counted from the date of baseline interview to the date of death, date of last contact (for the few who migrated out of Singapore), or 31 December 2011, whichever occurred first. HRs per category of beverage were estimated by Cox proportional hazards regression models with the use of SAS statistical software (SAS Institute). There was no evidence that proportional hazards assumptions were violated, as indicated by the lack of significant interaction between the beverages and a function of survival time in the models. Tests for trend for all beverages besides alcohol were performed by assigning the median value of the beverage to the respective categories and entering this as a continuous variable into the models.

Three models were constructed to examine the association between beverages and risk of mortality during follow-up. All beverages were included simultaneously and the covariates included in model 1 were baseline age (<50 y, 50–54 y, 55–59 y, 60–64 y, or ≥65 y), year of interview (1993–95 or 1996–98), dialect (Hokkiens or Cantonese), sex, and education (none, primary, or secondary or more). Model 2 included smoking status (never, light, or heavy) (26), moderate activity (≥2 vs. <2 h/wk), strenuous physical activity (≥1.5 vs. <1.5 h/wk), sleep (6–8 h/d vs. <6 or ≥9 h/d,), baseline BMI (in kilograms per meter squared) as the original BMI and its quadratic term (BMI^2) (31), and history of physician-diagnosed hypertension (yes vs. no, except for cancer). Model 3 additionally included the nonbeverage VFS dietary pattern score and total energy intake in kilocalories per day. Because there were no material differences between point estimates in model 1 vs. model 3 we present the final, fully adjusted model 3 in the results. Analyses were conducted to test for interactions between the beverages and age, sex, education, BMI, and smoking. Interactions with smoking and BMI were hypothesized to have a biological basis because of the biological enhancement of overall risk conferred by obesity and cigarette smoking, where the age, sex, and education interaction tests were carried out to check for differential results due to varying distributions of the beverages and confounding factors. To reduce potential bias due to nonreported pre-existing disease or underlying illness, sensitivity analyses excluded participants who died within the first 3 y, as well as the first 5 y of follow-up.

Results

During ~793,948 person-years of follow-up (median 16.3 person-years per participant) there were 10,029 deaths. Of those 10,029 deaths, 4092 were due to cancer, 3097 were due to CVD, and 1636 were due to respiratory-related disease. There was evidence that the association between coffee and all-cause mortality differed by smoking status ($P = 0.002$), as well as with alcohol and all-cause mortality ($P = 0.01$). There was also evidence that the association between black tea and CVD mortality differed by smoking status ($P = 0.0007$). Of note, the P value for interaction with black tea and smoking for all-cause mortality was 0.10. Therefore, we present the results for these beverages stratified by smoking status, whereas the results for green tea, soft drink, and juice intake were not modified by smoking. Baseline demographic, lifestyle, and dietary characteristics according to coffee and black tea habits by smoking status are presented in **Table 1**.

TABLE 3 Baseline demographic, lifestyle, and dietary characteristics according to soft drink intake, Singapore Chinese Health Study[1]

	Soft drink intake				
Characteristics	None	Monthly[2]	1/wk	2–6/wk	≥1/d
n	39,064	5320	2783	3685	1732
Age, y	56.5 ± 7.9	54.4 ± 7.5	53.4 ± 7.1	53.2 ± 6.9	52.7 ± 6.7
Female	58.0	57.0	52.0	46.0	36.0
Hokkien dialect	54.0	51.0	50.0	52.0	55.0
Education[3]	27.0	32.0	39.0	37.0	34.0
Hypertension[4]	20.2	19.0	19.5	20.3	18.2
Ever smoked	29.0	26.0	29.0	33.0	43.0
Moderate activity[5]	17.0	14.0	13.0	12.0	9.0
Vigorous activity[6]	8.0	10.0	12.0	15.0	18.0
BMI, kg/m^2	22.9 ± 3.5	23.1 ± 3.5	23.2 ± 3.4	23.3 ± 3.3	23.3 ± 3.2
Sleep, h	7.0 ± 1.1	7.1 ± 1.1	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.2
Dietary pattern score[7]	21.0	18.0	19.0	18.0	13.0
Total energy, kcal/d	1509 ± 500	1572 ± 502	1675 ± 529	1799 ± 566	1946 ± 596
Coffee, cups/mo	35.9 ± 35.7	34.7 ± 35.3	36.4 ± 36.4	38.4 ± 36.8	41.6 ± 39.6
Black tea, cups/mo	6.4 ± 16.2	7.0 ± 16.2	8.1 ± 16.3	9.7 ± 19.4	11.0 ± 21.1
Juice, drinks/mo	0.8 ± 3.6	1.1 ± 3.8	1.3 ± 4.2	1.3 ± 4.1	1.5 ± 5.2
Green tea, cups/mo	9.2 ± 24.2	9.2 ± 24.3	8.8 ± 22.9	9.2 ± 23.2	7.7 ± 21.2
Alcohol, drinks/wk	1.0 ± 4.0	0.9 ± 3.8	1.0 ± 3.9	1.3 ± 4.3	1.9 ± 5.9

[1] Values are means ± SDs or percentages. One serving was assigned a value of 237 mL, or ~1 cup. However, serving size was not directly assessed.
[2] Any to <1/wk.
[3] Percentage of population with a secondary education or greater.
[4] Percentage of population who self-reported physician-diagnosed hypertension.
[5] Percentage of population who reported ≥2 h/wk.
[6] Percentage of population who reported ≥1.5 h/wk of vigorous work or strenuous physical activity.
[7] Proportion of category in the top 20% of the vegetable-fruit-soy–rich dietary pattern score, which is strongly inversely associated with all-cause and cause-specific mortality during the follow-up period.

TABLE 4 Baseline demographic, lifestyle, and dietary characteristics according to juice intake, Singapore Chinese Health Study[1]

Characteristics	Juice intake			
	None	Monthly[2]	1/wk	≥2/wk
n	43,438	5150	2047	1949
Age, y	56.4 ± 7.9	53.1 ± 6.9	52.7 ± 6.9	53.3 ± 7.0
Female	57.0	50.0	48.0	45.0
Hokkien dialect	55.0	49.0	50.0	50.0
Education[3]	26.0	41.0	49.0	50.0
Hypertension[4]	19.9	20.9	19.5	21.1
Ever smoked	30.0	31.0	30.0	32.0
Moderate activity[5]	15.0	16.0	18.0	20.0
Vigorous activity[6]	9.0	13.0	15.0	15.0
BMI, kg/m^2	23.0 ± 3.5	23.2 ± 3.5	23.1 ± 3.4	23.2 ± 3.4
Sleep, h	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1
Dietary pattern score[7]	18.0	21.0	32.0	42.0
Total energy, kcal/d	1523 ± 504	1652 ± 542	1801 ± 578	1871 ± 589
Coffee, cups/mo	36.4 ± 36.0	35.9 ± 36.0	34.5 ± 34.5	15.5 ± 11.5
Black tea, cups/mo	6.5 ± 16.2	8.4 ± 17.6	10.0 ± 18.6	9.3 ± 18.5
Green tea, cups/mo	8.7 ± 23.5	10.4 ± 25.0	11.6 ± 25.4	13.4 ± 28.6
Soft drinks, cups/mo	2.4 ± 8.6	3.7 ± 10.3	4.0 ± 10.3	3.9 ± 11.0
Alcohol, drinks/wk	1.0 ± 4.0	1.1 ± 3.8	1.3 ± 4.6	1.6 ± 5.4

[1] Values are means ± SDs or percentages. One serving was assigned a value of 237 mL, or ~1 cup. However, serving size was not directly assessed.
[2] Any to <1/wk.
[3] Percentage of population with a secondary education or greater.
[4] Percentage of population who self-reported physician-diagnosed hypertension.
[5] Percentage of population who reported ≥2 h/wk.
[6] Percentage of population who reported ≥1.5 h/wk of vigorous work or strenuous physical activity.
[7] Proportion of category in the top 20% of the vegetable-fruit-soy–rich dietary pattern score, which is strongly inversely associated with all-cause and cause-specific mortality during the follow-up period.

Among never-smokers, participants with more frequent coffee consumption had lower levels of education, lower moderate activity, and a lower VFS dietary pattern score (in which higher scores are inversely associated with mortality). In contrast to coffee, with more frequent black tea consumption, a greater proportion of participants were male, more educated, and more physically active, and had a higher VFS dietary pattern score. The descriptive characteristics across black tea consumption apply to light to moderate alcohol intake (**Table 2**) when comparing participants to never or heavy consumers. The demographic, lifestyle, and dietary characteristics were divergent with higher soft drink intake (**Tables 3–5**). With higher juice intake, participants had higher levels of education, a greater proportion were male, and they had higher levels of physical activity and a higher VFS dietary pattern score. Participant characteristics across categories of green tea were similar to juice intake.

The HRs for all-cause and cause-specific mortality according to coffee, black tea, and alcohol intake and stratified by smoking status are displayed in **Tables 6** and **7**. Among never-smokers there was a strong inverse dose-response association between higher coffee intake and all-cause mortality. The strongest graded association among cause-specific categories was observed in relation to respiratory mortality and this likely influenced the all-cause results, although there was also a suggestive inverse association with CVD mortality. Similarly, there was a strong, graded inverse association between higher black tea intake and all-cause mortality with significant inverse associations in relation to both respiratory and CVD causes of mortality. There was no association between coffee or black tea intakes and mortality among ever-smokers. In contrast to coffee and tea intake, alcohol intake had associations across smoking strata with all-cause and each of the main cause-specific categories of mortality. Relative to no alcohol intake, light to moderate intake was inversely associated with all-cause mortality (HR: 0.87; 95% CI: 0.79, 0.96) in never-smokers with a similar magnitude of association in ever-smokers. However, there was no association between heavy alcohol intake and all-cause mortality in never-smokers and a strong positive association in ever-smokers (HR: 1.56; 95% CI: 1.40, 1.74).These results in heavy smokers appeared to be largely due to cancer, whereas the light to moderate alcohol intake association was apparent in both CVD and respiratory cause-specific categories.

The HRs for all-cause and cause-specific mortality according to green tea, soft drink, and juice intake are presented in **Table 8**. There was no association between these beverages and all-cause or cause-specific mortality, save for a suggestive inverse association between higher soft drink intake and respiratory mortality. In addition to the nonspecific juice assessment, orange juice intake was specifically assessed. There was no association between orange juice and mortality (data not presented).

In one other sensitivity analysis we adjusted for sugar, artificial sweetener, milk (all kinds), and nondairy creamer reported as added to coffee and tea, and there was no material effect on any of the point estimates. Overall, there was no evidence that the results for any beverage differed by BMI, age, sex, or education. Further, there was no evidence that any of the

TABLE 5 Baseline demographic, lifestyle, and dietary characteristics according to green tea intake, Singapore Chinese Health Study[1]

Characteristics	Green tea intake			
	None	Any to <1/d	1/d	≥2/d
n	31,241	15,019	3344	2980
Age, y	56.0 ± 7.9	55.1 ± 7.8	55.7 ± 7.8	57.0 ± 8.0
Female	59.0	53.0	49.0	42.0
Hokkien dialect	58.0	50.0	44.0	39.0
Education[2]	26.0	34.0	38.0	34.0
Hypertension[3]	18.9	20.8	22.8	25.1
Ever smoked	29.0	29.0	31.0	38.0
Moderate activity[4]	14.0	18.0	21.0	20.0
Vigorous activity[5]	8.0	11.0	12.0	12.0
BMI, kg/m^2	22.8 ± 3.5	23.2 ± 3.5	23.5 ± 3.5	23.7 ± 3.4
Sleep, h	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1	7.0 ± 1.1
Dietary pattern score[6]	16.0	25.0	28.0	26.0
Total energy, kcal/d	1507 ± 506	1630 ± 530	1647 ± 552	1650 ± 536
Coffee, cups/mo	38.0 ± 37.0	34.6 ± 34.2	30.4 ± 32.1	31.1 ± 34.3
Black tea, cups/mo	6.5 ± 16.7	7.0 ± 14.9	9.5 ± 17.1	9.1 ± 21.4
Soft drinks, drinks/mo	2.6 ± 9.3	2.7 ± 8.5	2.3 ± 7.6	2.3 ± 8.4
Alcohol, drinks/wk	1.0 ± 4.1	1.0 ± 3.8	1.1 ± 4.1	1.5 ± 5.2

[1] Values are means ± SDs or percentages. One serving was assigned a value of 237 mL, or ~1 cup. However, serving size was not directly assessed.
[2] Percentage of population with a secondary education or greater.
[3] Percentage of population who self-reported physician-diagnosed hypertension.
[4] Percentage of population who reported ≥2 h/wk.
[5] Percentage of population who reported ≥1.5 h/wk of vigorous work or strenuous physical activity.
[6] Proportion of category in the top 20% of the vegetable-fruit-soy–rich dietary pattern score, which is strongly inversely associated with all-cause and cause-specific mortality during the follow-up period.

TABLE 6 HRs and 95% CIs of all-cause and cause-specific mortality according to coffee, black tea, and alcohol intake in Chinese men and women for never smokers, Singapore Chinese Health Study[1]

Mortality and beverage	Deaths, *n*/total *n*	HR (95% CI)	P-trend
All cause			
Coffee			0.0003
None	1115/7387	1.00	
Any to <1/d	554/4387	0.89 (0.80, 0.98)	
1/d	1901/14,140	0.86 (0.80, 0.92)	
≥2/d	1425/11,011	0.83 (0.77, 0.90)	
Black Tea			0.0005
None	3496/23,829	1.00	
Any to <1/d	1057/9278	0.95 (0.88, 1.02)	
1/d	347/2924	0.90 (0.80, 1.00)	
≥2/d	95/864	0.72 (0.59, 0.88)	
Alcohol[2]			—
None	4400/31,600	1.00	
Light to moderate[2]	518/4801	0.87 (0.79, 0.96)	
Heavy[2]	77/524	1.08 (0.86, 1.35)	
Cancer			
Coffee			0.61
None	387/7387	1.0	
Any to <1/d	208/4387	0.94 (0.79, 1.11)	
1/d	724/14,140	0.94 (0.83, 1.06)	
≥2/d	563/11,011	0.94 (0.83, 1.08)	
Black Tea			0.64
None	1262/23,829	1.00	
Any to <1/d	437/9278	1.04 (0.93, 1.16)	
1/d	142/2924	1.02 (0.85, 1.22)	
≥2/d	41/864	0.90 (0.66, 1.23)	
Alcohol[2]			—
None	1619/31,600	1.00	
Light to moderate[2]	229/4801	1.05 (0.90, 1.21)	
Heavy[2]	34/524	1.33 (0.95, 1.87)	
Cardiovascular disease			
Coffee			0.28
None	351/7387	1.00	
Any to <1/d	181/4387	0.93 (0.78, 1.12)	
1/d	608/14,140	0.87 (0.76, 0.99)	
≥2/d	478/11,011	0.90 (0.78, 1.03)	
Black Tea			0.0003
None	1189/23,829	1.00	
Any to <1/d	312/9278	0.84 (0.74, 0.96)	
1/d	87/2924	0.68 (0.54, 0.84)	
≥2/d	30/864	0.66 (0.46, 0.96)	
Alcohol[2]			—
None	1437/31,600	1.00	
Light to moderate[2]	160/4801	0.84 (0.71, 1.00)	
Heavy[2]	21/524	0.89 (0.58, 1.38)	
Respiratory disease			
Coffee			0.0009
None	179/7387	1.00	
Any to <1/d	72/4387	0.75 (0.57, 0.99)	
1/d	262/14,140	0.76 (0.62, 0.92)	
≥2/d	178/11,011	0.66 (0.53, 0.82)	
Black Tea			0.04
None	496/23,829	1.00	
Any to <1/d	132/9278	0.87 (0.72, 1.06)	
1/d	53/2924	0.93 (0.69, 1.24)	
≥2/d	10/864	0.47 (0.25, 0.89)	
Alcohol[2]			—
HR (95% CI)			
None	626/31,600	1.00	
Light to moderate[2]	55/4801	0.62 (0.47, 0.83)	
Heavy[2]	10/524	0.92 (0.49, 1.72)	

[1] Model includes all beverages simultaneously (coffee, black tea, alcohol, soft drinks, juice, and green tea) and is adjusted for age, sex, dialect, education, year of interview, moderate and vigorous activity, sleep, BMI, hypertension (except for cancer), nonbeverage vegetable-fruit-soy–rich dietary pattern score, and energy intake. Definition of outcomes: cancer, ICD-9 codes 140–239; cardiovascular disease, ICD-9 codes 394–459; respiratory disease (e.g., influenza, pneumonia, and chronic obstructive pulmonary disease), ICD-9 codes 480–488 and 490–96. ICD-9, International Classification of Diseases, version 9.
[2] Light to moderate alcohol consumption is defined as >0 to ≤7 drinks/wk for women and >0 to ≤14 drinks/wk for men. Heavy alcohol consumption is defined as >7 drinks/wk for women and >14 drinks/wk for men.

associations for the different beverages materially differed upon exclusion of deaths within 3 y or 5 y of follow-up time.

Discussion

The relation between beverage intake and mortality in the SCHS was modified by smoking status for coffee, black tea, and alcohol. Higher intakes of coffee and black tea were strongly and inversely associated with all-cause mortality in never-smokers. These associations were driven by the respiratory and CVD cause-specific categories. In ever-smokers there was no association between coffee and black tea intake and mortality. Additionally, Chinese Singaporeans who reported light-moderate alcohol intake had a reduced risk of all-cause mortality relative to their peers who reported no alcohol intake regardless of smoking status. This association was driven by the CVD and respiratory cause-specific categories as well. Heavy alcohol intake was strongly associated with all-cause and cancer mortality in participants with a history of smoking, but no other section of the population. Lastly, there was no overall association (either in smokers or non-smokers) between green tea and mortality, or between soft drinks or juice (sugar-sweetened beverages) and mortality except for an unexpected suggestively inverse association between higher soft drink intake and respiratory mortality.

The results of this study expand the evidence related to coffee and mortality. In Western populations, higher coffee intake was inversely associated with all-cause mortality, mainly driven by CVD and inflammatory or respiratory causes in some studies (5–8, 32), suggestively inverse in men in another study (7), and not associated with mortality in 2 others (9, 10). Two studies included Eastern (Japanese) populations, with one finding a suggestive U or J shape, with a protective association with CVD mortality in weekly to 2 cups/d and a positive association with an intake of >2 cups/d (33). The other study found no association between coffee and mortality in men and an inverse trend between higher coffee intake and all-cause mortality in women driven by the CVD mortality endpoint (34). For context, the SCHS includes a novel population with routine coffee consumption, and the results in never-smokers showed a strong inverse association between higher coffee intake and all-cause mortality, a suggestive inverse association with CVD mortality,

TABLE 7 HRs and 95% CIs of all-cause and cause-specific mortality according to coffee, black tea, and alcohol intake in Chinese men and women for ever smokers, Singapore Chinese Health Study[1]

Mortality and beverage	Deaths, *n*/total *n*	HR (95% CI)	*P*-trend
All cause			
Coffee			0.32
None	710/1,984	1.00	
Any to <1/d	374/1306	0.90 (0.79, 1.02)	
1/d	1599/4809	0.98 (0.89, 1.07)	
≥2/d	2351/7560	1.00 (0.91, 1.09)	
Black Tea			0.22
None	3261/9604	1.00	
Any to <1/d	1146/3908		
1/d	427/1425	1.03 (0.93, 1.14)	
≥2/d	200/722	0.90 (0.78, 1.05)	
Alcohol[2]			—
None	3519/10,443	1.00	
Light to moderate[2]	1099/4135	0.91 (0.85, 0.98)	
Heavy[2]	416/1081	1.56 (1.40, 1.74)	
Cancer			
Coffee			0.08
None	265/1984	1.00	
Any to <1/d	136/1306	0.87 (0.71, 1.08)	
1/d	627/4809	1.01 (0.87, 1.17)	
≥2/d	992/7560	1.09 (0.94, 1.25)	
Black Tea			0.56
None	1309/9604	1.00	
Any to <1/d	470/3908	0.99 (0.89, 1.11)	
1/d	158/1425	0.94 (0.79, 1.11)	
≥2/d	83/722	0.95 (0.76, 1.19)	
Alcohol[2]			—
None	1329/10,443	1.00	
Light to moderate[2]	482/4135	1.04 (0.93, 1.16)	
Heavy[2]	209/1081	2.01 (1.72, 2.34)	
Cardiovascular disease			
Coffee			0.55
None	228/1984	1.00	
Any to <1/d	111/1306	0.84 (0.66, 1.05)	
1/d	463/4809	0.91 (0.77, 1.07)	
≥2/d	677/7560	0.95 (0.81, 1.11)	
Black Tea			0.87
None	949/9604	1.00	
Any to <1/d	330/3908	0.96 (0.84, 1.09)	
1/d	139/1425	1.14 (0.95, 1.36)	
≥2/d	61/722	0.92 (0.70, 1.20)	
Alcohol[2]			—
None	1078/10,443	1.00	
Light to moderate[2]	308/4135	0.85 (0.75, 0.97)	
Heavy[2]	93/1081	1.16 (0.95, 1.36)	
Respiratory disease			
Coffee			0.46
None	126/1984	1.00	
Any to <1/d	74/1306	0.99 (0.74, 1.32)	
1/d	294/4809	0.99 (0.80, 1.23)	
≥2/d	451/7560	1.06 (0.86, 1.30)	
Black Tea			0.07
None	638/9604	1.00	
Any to <1/d	209/3908	0.95 (0.81, 1.11)	
1/d	69/1425	0.92 (0.72, 1.18)	
≥2/d	29/722	0.72 (0.49, 1.06)	
Respiratory disease			
Alcohol[2]			—
None	704/10,443	1.00	
Light to moderate[2]	186/4135	0.79 (0.67, 0.93)	
Heavy[2]	55/1081	1.20 (0.91, 1.59)	

[1] Model includes all beverages simultaneously (coffee, black tea, alcohol, soft drinks, juice, and green tea) and is adjusted for age, sex, dialect, education, year of interview, moderate and vigorous activity, sleep, BMI, hypertension (except for cancer), nonbeverage vegetable-fruit-soy–rich dietary pattern score, and energy intake. Definition of outcomes: cancer, ICD-9 codes 140–239; cardiovascular disease, ICD-9 codes 394–459; respiratory disease (e.g., influenza, pneumonia, and chronic obstructive pulmonary disease), ICD-9 codes 480–488 and 490–96. ICD-9, International Classification of Diseases, version 9.

[2] Light to moderate alcohol consumption is defined as >0 to ≤7 drinks/wk for women and >0 to ≤14 drinks/wk for men. Heavy alcohol consumption is defined as >7 drinks/wk for women and >14 drinks/wk for men.

and an especially strong association with respiratory-related mortality, similar to the Iowa Women's Health Study (6). The association with cancer mortality was null in the SCHS, similar to each of the aforementioned studies. The SCHS results differ from the majority of research in that the significant findings were limited to never-smokers, which was also found in only one other study of men (7).

Limited studies have examined the association between tea intake and mortality; thus, the data from the SCHS participants and their varied tea consumption is an important contribution to the topic. In a Dutch population, relative to an intake of <1 cup/d, 1–6 cups/d of black tea was inversely associated with risk of CHD mortality during follow up, but not all-cause mortality (9). Two other studies observed an inverse association between black tea and mortality, mainly driven by CVD (32, 35), whereas another was null (10). Higher green tea intake was inversely associated with CVD mortality in women in 2 studies of Japanese populations (33, 36). The associations were null (33) or suggestively inverse in men (36), and there was no association with cancer mortality (36). The results from the SCHS differ with respect to tea types in that there was no association between green tea and mortality, and the inverse association with black tea was limited to never-smokers. Of note, the analytic approach in this study differed, with a more comprehensive adjustment for overall dietary intake (overall dietary pattern) and other beverages, as well as other lifestyle covariates relative to the related studies. Additionally, this analysis also excluded those with a history of chronic disease.

The association between alcohol intake and mortality in the SCHS aligns with the large body of literature demonstrating an inverse association between light to moderate alcohol intake and mortality, mainly due to CVD and respiratory/inflammatory causes (11, 12). Alternatively, heavy intake was only associated with mortality in ever-smokers in the cohort, which has not been uniformly reported but aligns with data from Japanese populations (12).

Lastly, there was no significant association between sugar-sweetened beverages (soft drinks and juice) and mortality in the present study. There is a caveat to the SCHS results, because there was a suggestive inverse association between higher soft drink intake and respiratory mortality. Because diet is linked to overall respiratory function, pneumonia, and chronic obstructive pulmonary disease (37, 38), we hypothesized that these mortality outcomes may be relevant to our cause-specific analysis,

TABLE 8 HRs and 95% CIs of all-cause and cause-specific mortality according to soft drink, juice, and green tea intake in Chinese men and women, Singapore Chinese Health Study[1]

Mortality and beverage	Deaths, *n*/total *n*	HR (95% CI)	*P*-trend
All cause			
Soft drinks			0.11
None	8058/39,064	1.00	
Monthly	820/5320	0.93 (0.87, 1.01)	
1/wk	387/2783	0.94 (0.84,1.04)	
2–6/wk	515/3685	0.96 (0.87, 1.05)	
≥1/d	248/1732	0.92 (0.81, 1.04)	
Juice			0.91
None	8783/43,438	1.00	
Monthly	674/5150	0.90 (0.84, 0.98)	
1/wk	289/2047	1.10 (0.97,1.24)	
≥2/wk	283/1949	1.01 (0.90, 1.14)	
Green tea			0.98
None	6217/31,241	1.00	
Any to <1/d	2528/15,019	0.96 (0.91, 1.01)	
1/d	613/3344	0.95 (0.87,1.03)	
≥2/d	671/2980	1.00 (0.93, 1.09)	
Cancer			
Soft drinks			0.06
None	3086/39,064	1.00	
Monthly	355/5320	1.01 (0.91, 1.13)	
1/wk	162/2783	0.96 (0.81, 1.12)	
2–6/wk	202/3685	0.91 (0.78, 1.05)	
≥1/d	97/1732	0.85 (0.69, 1.05)	
Juice			0.63
None	3399/43,438	1.00	
Monthly	271/5150	0.88 (0.77, 0.99)	
1/wk	120/2047	1.08 (0.90, 1.30)	
≥2/wk	112/1949	0.98 (0.81, 1.19)	
Green tea			0.48
None	2375/31,241	1.00	
Any to <1/d	1023/15,019	1.00 (0.92, 1.08)	
1/d	232/3344	0.95 (0.83, 1.09)	
≥2/d	271/2980	1.10 (0.97, 1.25)	
Cardiovascular disease			
Soft drinks			0.54
None	2466/39,064	1.00	
Monthly	249/5320	0.96 (0.84, 1.09)	
1/wk	131/2783	1.08 (0.91, 1.30)	
2–6/wk	170/3685	1.08 (0.92, 1.27)	
≥1/d	81/1732	1.03 (0.83, 1.30)	
Juice			0.22
None	2711/43,438	1.00	
Monthly	197/5150	0.88 (0.76, 1.02)	
1/wk	94/2047	1.19 (0.96, 1.46)	
≥2/wk	95/1949	1.16 (0.94, 1.43)	
Green tea			0.52
None	1907/31241	1.00	
Any to <1/d	779/15,019	0.95 (0.88, 1.04)	
1/d	205/3344	1.01 (0.87, 1.17)	
≥2/d	206/2980	0.97 (0.83, 1.12)	
Respiratory disease			
Soft drinks			0.03
None	1388/39,064	1.00	
Monthly	101/5320	0.72 (0.58, 0.88)	
1/wk	53/2783	0.85 (0.64, 1.12)	
2–6/wk	63/3685	0.77 (0.60, 1.00)	
≥1/d	31/1732	0.77 (0.54, 1.10)	
Juice			0.35
None	1465/43,438	1.00	
Monthly	102/5150	0.98 (0.80, 1.20)	
1/wk	33/2047	0.93 (0.65, 1.31)	
≥2/wk	36/1949	0.88 (0.63, 1.23)	
Green tea			0.18
None	1059/31,241	1.00	
Any to <1/d	379/15,019	0.91 (0.81, 1.03)	
1/d	87/3344	0.81 (0.65, 1.02)	
≥2/d	111/2980	0.98 (0.80, 1.20)	

[1] Model includes all beverages simultaneously (coffee, black tea, alcohol, soft drinks, juice, and green tea) and is adjusted for age, sex, dialect, education, year of interview, smoking, moderate and vigorous activity, sleep, BMI, hypertension (except for cancer), nonbeverage vegetable-fruit-soy–rich dietary pattern score, and energy intake. Definition of outcomes: cancer, ICD-9 codes 140–239; cardiovascular disease, ICD-9 codes 394–459; respiratory disease (e.g., influenza, pneumonia, and chronic obstructive pulmonary disease), ICD-9 codes 480–488 and 490–96. ICD-9, International Classification of Diseases, version 9.

especially because diet in the SCHS has been linked to nonmalignant respiratory symptoms and the aforementioned finding related to coffee intake in the Iowa Women's Health Study (6, 39). Yet these soft drink–respiratory mortality results were counter to our hypothesis and cautiously interpreted given the nonsignificance of the estimates for the individual intake categories representing greater-than-monthly intake and unclear biological plausibility. Surprisingly, there is only one other study that has reported on sugar-sweetened beverages and mortality, and the results of that study were also null (10). These null findings were not expected, given previous reports from the SCHS and other cohorts on the link between these beverages and morbidity outcomes (13, 15). Of note, our analytic approach for this study relative to these aforementioned studies did differ in that we comprehensively adjusted for overall nonbeverage dietary intake in the form of a dietary pattern score rather than individual foods and nutrients in addition to all other beverages.

The findings that the association between coffee and black tea and mortality were null in smokers is plausible given the pleiotropic effects smoking and dietary intake have on the biological system (40, 41). Furthermore, the powerful carcinogenic effects of smoking (26, 40) likely explain the heightened association between heavy alcohol intake and cancer and all-cause mortality in ever-smokers. Broadly, smoking alters the metabolism, creating dysfunction in cellular activity and a procarcinogenesis state (40). This state would plausibly create an environment in which a beverage habit such as heavy alcohol consumption may have a stronger carcinogenic effect because of the limited ability of the biological system to adapt and maintain homeostasis in the presence of the excess metabolic perturbations generated by smoking (21). The same concept applies to the limitation from smoking of a potentially beneficial adaptation (18, 20, 40). The literature on the bioactive components of coffee and teas and their potential health benefits is well documented (3, 42, 43), as is the research on alcohol intake and health (44). Sugar-sweetened beverages are a beverage category devoid of any nutritional benefits, and they are associated with morbid cardiometabolic outcomes and cancers (13–15, 45). However, unlike the consistency displayed in the literature investigating incidence of disease states and mortality in coffee, teas, and alcohol, there is essentially no record that sugar-sweetened

beverages have been examined with mortality beyond this current study and the other cited study, which had substantial limitations (10). However, we interpret our juice findings cautiously and note that the actual juice consumed and its nutritional composition are variable and not directly measured in our study.

Strengths of the current study include the large Chinese population with a unique diet and beverage intake pattern, ample events, and follow-up time. Another particular strength was the use of an FFQ that was specifically developed and validated in this population. Others include the high participant response rate, detailed collection of data through face-to-face interviews, thorough assessment of potential lifestyle and demographic confounders, very low level of loss of participants to follow-up, and nearly complete mortality assessment with objectively obtained records on time and cause of death. Limitations include the dietary measurement error, although this would most likely result in nondifferential misclassification with respect to mortality and a likely underestimation of risk. Further, despite the fact that the serving size of the nonalcoholic beverages was defined, the heterogeneity of the actual serving size and varying participant interpretation of this size are certainly feasible, which may also result in misclassification. The self-report of other lifestyle-related data may also result in some misclassification and residual confounding in our models. Repeated assessment of beverage intake and other lifestyle factors would have allowed us to examine change in respect to mortality.

This study highlights how beverages associate with longevity independent of the diet pattern and how smoking is an important consideration when examining diet, given the overlapping influence on biological pathways. We observed that a higher intake of beverages rich in bioactive components (coffee and black tea) are associated with a greater probability of increased longevity in nonsmokers, whereas light to moderate alcohol intake may be beneficial for longevity regardless of smoking and heavy alcohol consumption may be particularly problematic in smokers. Alternatively, green tea is rich in perceived beneficial components and sugar-sweetened beverages are devoid of healthfulness, and neither was associated with longevity. These results highlight how beverage habits, one of the most habitual dietary intake behaviors, associate with mortality and thus have public health implications.

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