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Title
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Permalink
https://escholarship.org/uc/item/3kh5f73s

Journal
British Journal Of Nutrition, 111(2)

ISSN
0007-1145

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Publication Date
2014-01-28

DOI
10.1017/s0007114513002328

Peer reviewed

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Author Manuscript
Br J Nutr. Author manuscript; available in PMC 2014 March 09.

Published in final edited form as:
Br J Nutr. 2014 January 28; 111(2): 353–362. doi:10.1017/S0007114513002328.

Fruit and Vegetable Intake and Risk of Coronary Heart Disease: Results from Prospective Cohort Studies of Chinese Adults in Shanghai

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Abstract

Protective associations of fruit and vegetables against coronary heart disease (CHD) have been suggested in many epidemiological studies among Western populations. However, prospective data are lacking for Asian populations. We examined the associations of fruit and vegetable intake with incidence of CHD among 67,211 women (40–70 years) and 55,474 men (40–74 years) living in Shanghai, China. Food intake was assessed using validated food-frequency questionnaires through in-person interviews. Coronary events (nonfatal myocardial infarction or fatal CHD) were identified by biennial home visits and further confirmed by medical records review. During a mean follow-up of 9.8 and 5.4 years, 148 events in women and 217 events in men were documented and verified, respectively. After adjustment for potential confounders, women in the highest quartile of total fruit and vegetable intake (median: 814 g/d) had a hazard ratio (HR) for CHD of 0.62 (95% CI 0.38, 1.02) (*P* for trend=0.04) compared with those in the lowest quartile (median: 274 g/d). This association was primarily driven by fruits (the HR for the highest *vs.* the lowest intake in women: 0.62; 95% CI, 0.37, 1.03). The strength of the association was attenuated after further controlling for history of diabetes or hypertension. For men, no significant association was found for fruit and vegetable intake when analyzed either in combination or individually. Our findings suggest that a high consumption of fruits may reduce the risk of CHD in Chinese women.

Keywords

Fruit; Vegetable; Coronary heart disease; Prospective study

Introduction

Fruit and vegetables have been widely considered as essential components of a healthy diet and their protective effects against coronary heart disease (CHD) have been evaluated in

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CONFLICTS OF INTEREST.
The authors have no conflicts of interest to declare.

AUTHORSHIP.
Drs X. Zhang, Y. Gao, G. Yang, W. Zheng, Y. Xiang, and X. Shu designed research; Drs X. Zhang, Y. Gao, H. Li, G. Yang, W. Zheng, Y. Xiang, and X. Shu contributed to study implementation and data collection; Drs. D. Yu and J. Huang conducted statistical analysis and drafted the manuscript. All authors contributed to the revision of the manuscript, read and approved the final manuscript.

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many epidemiological studies[1]. In a recent meta-analysis of prospective studies, daily consumption of more than 5 portions (about 400 g) of fruit and vegetables was related to a 17% lower risk of CHD when compared with consumption of less than 3 portions[2]. In an earlier meta-analysis, a 4% decrease in risk of CHD was found to be associated with each portion increase in fruit and vegetable intake[3]. However, substantial heterogeneities across studies were found in both reports, especially with regard to the association of vegetable intake with CHD. One possible explanation is that the types of fruit and vegetables commonly consumed and the processing methods used vary across study populations. Some specific groups of fruit and vegetables might have more benefits than others[4; 5]. The nutrient contents may differ in cooked *vs.* raw vegetables[6]. Furthermore, other dietary as well as lifestyle factors, such as saturated fat intake and smoking, which are correlated with fruit and vegetable intake, may modify the associations of fruit and vegetables with CHD[4; 7; 8].

To date, most studies evaluating the association between fruit and vegetable intake and CHD risk have been conducted in the US and Europe[2; 9]. It remains unclear whether fruit and vegetable consumption is associated with CHD risk in Asian populations who generally have different dietary patterns and cooking practices from Western populations. We investigated the association of fruit and vegetable consumption with risk of CHD in two prospective cohorts of middle-aged and older Chinese men and women.

Subjects and methods

Included in this analysis were participants from the Shanghai Women's Health Study (SWHS) and the Shanghai Men's Health Study (SMHS), two population-based prospective studies. The designs and methods have been described previously[10; 11]. In brief, 74,941 women aged 40–70 years were recruited from 1996 to 2000 and 61,482 men aged 40–74 years were recruited from 2002 to 2006 in urban communities in Shanghai, China. Participation rates were 92.7% and 74.1%, respectively. In both studies, in-person interviews were conducted by trained staff using structured questionnaires to collect information on socio-demographics, diet and lifestyle habits, physical activities, and medical history. Anthropometric measurements, including height and weight, were also taken at baseline. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Institute Review Board of all institutes involved. Written informed consent was obtained from all participants.

Dietary assessment

Food intakes were assessed by semi-quantitative food-frequency questionnaire (FFQ) in each cohort. Participant was asked, on average, how often she or he had consumed a specific food or food group during the preceding year, and then how many she or he had consumed in grams per unit of time. Frequencies and amounts were converted into daily intake of each food. Total energy and nutrient intakes were calculated according to the Chinese Food Composition Tables 2002[12].

The validity and reproducibility of the questionnaires used in both cohorts have been evaluated and shown to be fairly high. Compared with 24 bi-weekly 24-hour dietary recalls, the FFQ used in the SWHS covered 86% of commonly consumed foods in the study population; the correlation coefficients between the estimates from the dietary recalls and FFQ were 0.55 for total fruit intake and 0.41 for total vegetable intake[13]. Similarly, the FFQ used in the SMHS covered 89% of recorded foods and the correlation coefficients of dietary intake estimates derived between FFQ and average of 12 24-hour dietary recalls were 0.72 for total fruit intake and 0.42 for total vegetable intake [14].

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Total fruit and vegetable intake was estimated by summing intakes of all fruit and vegetable items. Fruit items listed on FFQs in both SMHS and SWHS included apple, pear, citrus fruit, banana, watermelon, peach, grape, and other fruits (e.g. strawberry and cantaloupe). There were 33 vegetable items in the SWHS FFQ, including cruciferous vegetables (bok choy, cabbage, napa cabbage, cauliflower, and white turnip), allium (garlic and garlic shoots, garlic bulb, onions, green onions, and Chinese chives), legumes (fresh peas, fresh soybeans, broad beans, Chinese long beans, green beans, and snow peas), and other vegetables (e.g. celery, eggplant, cucumber, mushroom, tomato, sweet potato, bean sprouts, etc.). An expanded version of the SWHS FFQ was used in the SMHS, with addition of four cruciferous vegetable items: garland chrysanthemum, shepherd's purse, clover, and amaranth. Potatoes and dried beans were not included as vegetables due to their starchy content as suggested by the World Health Organization (WHO)[(15)].

Outcome ascertainment

Both cohorts were actively followed by in-person home visits, which took place every 2–3 years, and annual linkage to vital statistics records. The overall follow-up rate was 96% for both cohorts. Very few cohort members moved out of the study area and these participants were treated as censored observations, using date of last contact as censoring date. Our primary end point was incident CHD, comprising nonfatal myocardial infarction (MI) and fatal CHD. Self-reported diagnosis of MI was further confirmed by reviewing participant's medical records by physicians who were unaware of their exposure status. Cases of MI were defined according to WHO criteria: symptoms plus either diagnostic electrocardiographic changes or elevated levels of cardiac enzymes[(16)].

In both cohorts, almost all participants (99.9%) were successfully followed for their vital status. Death due to CHD was determined by medical records review whenever possible and death certificates with CHD listed as underlying cause of death (the International Classification of Diseases, 9th Revision, ICD-9 codes 410–414). In both SWHS and SMHS, follow-up time was calculated from the date of baseline interview to the date of incident CHD, death, loss of follow-up, or December 31, 2009, whichever came first.

Statistical analysis

We excluded from the current study 7,618 women and 5,804 men who reported a history of CHD, stroke or cancer at baseline (a history of cancer was an exclusion criterion for enrollment in the SMHS). We further excluded individuals with extreme energy intake (<2,092 or >14,644 kJ/d for women [n=112] and <3,347 or >17,573 kJ/d for men [n=204]). A total of 67,211 women and 55,474 men were included in current analysis.

Analyses were performed separately for each cohort in consideration of differences between the two cohorts in baseline characteristics of participants, time period of recruitment, and duration of follow-up. Dietary intakes were adjusted for total energy using residual method to control for confounding by total energy intake and reduce extraneous variations[(17)]. Pearson partial correlation coefficients between total fruit and vegetable intake and related nutrients were calculated with adjustment for age, sex and energy intake. Participants were then classified by quartiles of energy-adjusted intakes of total fruit and vegetables. Baseline characteristics were compared using Chi-squared test for categorical variables or linear regression for continuous variables. Hazard ratio (HR) and 95% confidence interval (CI) were estimated by Cox proportional hazards regression models using age as timescale and stratified by birth cohort (5-year interval). In the SWHS, multivariate model was adjusted for baseline age (continues), body mass index (BMI, kg/m^2, continues), family income (4 categories), education level (4 categories), smoking (since very few women ever smoked, dichotomous variable never/ever was used), alcohol drinking (never or ever, few women

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ever drank), physical activity level (quartiles of metabolic equivalents [MET] score, h/week)[18], use of aspirin, vitamin E supplement, multivitamin supplement, menopausal status and hormone therapy (yes or no), total energy intake (kJ/d, continues) and energy-adjusted intakes of red meat and fish/shellfish (g/d, continues). In additional analyses, we further controlled for prior diagnoses of diabetes, hypertension, or dyslipidemia and nutrients intake (fiber, vitamin C, potassium, or magnesium). Similar covariates were included in multivariate analyses of SMHS cohort with refined categories for smoking (never, past, or current: 1–9, 10–19, ≥20 cigarettes/d) and alcohol drinking (never, past, or current: <2, ≥2 drinks/d). *P* value for trend was assessed by treating median value of each quartile as a continuous variable.

We also evaluated the HR of CHD associated with each portion increment in daily intake of fruit and vegetables, with a portion defined as 80 g as suggested by the WHO and previous studies[15; 19]. In addition, we applied restricted cubic spline regression with 5 knots (10th, 25th, 50th, 75th, and 90th percentiles) to explore the dose-response relationships and potential optimal intakes[20].

In addition, we examined the HRs of CHD associated with specific types of fruits and vegetables, including apples and pears, bananas, citrus fruit, watermelon, other fruits, cruciferous vegetables, allium, legumes and other vegetables. Stratified analysis was applied by obese status, physical activity level, smoking, and history of hypertension and diabetes. Sensitivity analysis was carried out by excluding the first 2 year of follow-up. Proportional hazard assumption was tested by the Schoenfeld residuals and no significant violation was found. All statistics were performed using SAS software (version 9.3; SAS Institute Inc., Cary, NC, USA) with 2-sided *P* value <0.05 considered statistically significant.

Results

The median intakes (interquartile ranges) of total fruit and vegetables were 502 (360, 673) g/d in the SWHS and 440 (315, 590) g/d in the SMHS. Generally, women consumed more fruit but slightly less vegetables than men (fruit median intake: 235 *vs.* 125 g/d; vegetable median intake: 250 *vs.* 295 g/d). In both studies, persons who consumed more fruit and vegetables had higher income and education, were less likely to smoke, and more likely to use aspirin or vitamin supplements (Table 1). They also had greater levels of physical activity, BMI and fish/shellfish intake. The prevalence of diabetes and hypertension decreased across increasing quartiles of total fruit and vegetable intake in women but not in men. Intakes of several nutrients are highly correlated with total fruit and vegetable intake; partial Pearson correlation coefficients were 0.81 for dietary fiber, 0.92 for vitamin C, 0.88 for potassium, and 0.74 for magnesium.

During an average follow-up of 9.8 year, 148 self-reported cases of CHD among women were confirmed by medical records review. After adjustment for potential confounding factors, including socio-demographic status, lifestyles, BMI, as well as total energy and red meat and fish intake, women in the highest quartile of total fruit and vegetables intake had a HR (95% CI) of 0.62 (0.38, 1.02) for CHD (*P* for trend=0.04) compared with those in the lowest quartile (Table 2). The corresponding HRs (95% CIs) were 0.62 (0.37, 1.03) for fruit intake and 0.94 (0.59, 1.50) for vegetable intake. When we further controlled for prior history of diabetes, hypertension or dyslipidemia, these inverse associations were attenuated with HR (95% CI) = 0.67 (95% CI 0.41, 1.10) (*P* for trend=0.09) comparing the extreme quartiles of total fruit and vegetable intake. Additional adjustment for dietary potassium or magnesium, but not fiber or vitamin C, also attenuated the inverse association (data not shown in Table).

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In the SMHS, 217 cases were verified after a mean follow-up of 5.4 year. No statistically significant association with CHD risk was found for fruit and vegetables when analyzed either together or separately (Table 2).

To compare with results from previous studies, we estimated standard portions of intake with one portion defined as 80 g. Each portion increment of total fruit and vegetables intake was associated with a 6% reduction of incident CHD among women (HR [95% CI] = 0.94 [0.89, 1.00], *P*=0.05; Table 2). The spline dose-response curves also suggested that for women, the HR for CHD decreased with each portion increment in total fruit and vegetable intake (Fig. 1A). Compared with consumption of 3 portions/d, the inverse association appears to be evident only when intake level reached at least 8 portions/d (HR [95% CI] = 0.69 [0.45, 1.06]). For men, the lowest HR for CHD occurred at approximately 6 portions per day (Fig. 1B).

Tables 3 and 4 show HRs of CHD associated with major types of fruits and vegetables consumed in women and men, respectively. A higher banana intake was significantly associated with lower risk of CHD in women, with a HR comparing extreme quartiles of 0.48 (95% CI, 0.30, 0.78) (*P* for trend=0.006). Although other types of fruit also showed inverse associations with CHD, none of these associations reached statistical significance. Similar to total vegetables, no significant association was found for specific types of vegetables evaluated in either women or men.

In stratified analyses, the inverse association between total fruit and vegetable intake and CHD seemed stronger in overweight and physical inactive women. The HRs (95% CIs) for per portion (80 g) increment were 0.93 (0.86, 1.00) and 0.98 (0.88, 1.09) in women with BMI ≥24 *vs.* <24 kg/m^2 and 0.92 (0.84, 1.02) and 0.96 (0.89, 1.04) for physical inactive *vs.* active women. However, none of the interactions were significant. For men, no difference in the association by BMI or physical activity was observed. In both men and women, no effect modification by smoking or history of hypertension or diabetes was found. Sensitivity analyses showed no material changes in the results when the first 2 years of follow-up in both cohorts were omitted.

Discussion

In these two prospective cohorts of middle-aged and older Chinese adults, we evaluated the association between fruit and vegetable intake and risk of CHD. We found that, in women, each 80 g/d increase in total fruit and vegetable consumption was associated with a 6% decrease in CHD incidence; this inverse association was primarily driven by fruit intake. In men, the link between fruit or vegetable intake and reduced risk of CHD was less evident.

The cardioprotective effect of fruit and vegetables might be mediated through several established CVD risk factors, such as hypertension, hypercholesterolemia and diabetes[1]. This is suggested by the findings from our and previous studies that the inverse associations between fruit and vegetable intake and CHD were attenuated when history of hypertension or diabetes was controlled for [21]. Randomized controlled trials have shown that increased consumption of fruit and vegetables significantly reduced blood pressure[22; 23], perhaps due to the high potassium and magnesium contents in fruit and vegetables. Also, the high levels of fiber[24], plant phytosterols[25], and vitamins[26], contained in fruit and vegetables may reduce blood cholesterol, oxidative stress, and inflammation. In our populations, intakes of potassium, magnesium, dietary fiber, and vitamin C are highly correlated with total fruit and vegetable intake. Additional adjustment for potassium or magnesium largely diminished the inverse association of total fruit and vegetable intake with CHD observed in our study. It is plausible that the high potassium and magnesium contents in bananas might partially explain

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our finding of an inverse association between banana intake and CHD in women and a recent report of an inverse association of banana intake with blood pressure in Asian adults[27].

The association of fruit and vegetable with risk of CHD observed in the SWHS is consistent with previous results in both direction and magnitude. Most prospective studies so far have been conducted among Western populations. In the Women's Health Study of 39,127 middle-aged US female health professionals, the relative risks of MI across extreme quintiles were 0.62 (0.37, 1.04) for total fruit and vegetables and 0.57 (0.34, 0.98) for all fruits[21]. Similar to ours, after additional adjustment for CHD risk factors, including history of diabetes, hypertension or high cholesterol, the inverse associations became statistically non-significant. In the Nurses' Health Study, Joshipura *et al.* found that 1 serving/d increase in fruit and vegetable intake was associated with a 4% decreased risk for CHD[28]. Data from Asian populations are limited. In the Japan Public Health Center-based Prospective Study, consumption of fruit, but not vegetables, was inversely associated with incidence of cardiovascular disease (CVD, including MI and stroke)[29]. While in another Japanese cohort, higher intake of fruit and vegetables was associated with lower risk of death from CVD only in Japanese women but not in men[30].

As indicated in our study and some previous studies, the inverse association with CHD was less consistent for vegetable intake compared to fruit intake[2; 3]. For example, total vegetable intake was not associated with incidence of MI among US male physicians[31] or Italian women[32]; although leafy vegetables and olive oil showed significant inverse associations in later study. While in Finnish male smokers[33] and in Japanese women but not in men[30], higher vegetable intake was associated with lower risk of nonfatal MI or CHD death. The heterogeneity might come from differences in commonly consumed vegetables and other dietary factors and variation in traditional cooking methods across nations. In general, Chinese people, particularly the older generation like participants in the present study, prefer cooked vegetables rather than raw vegetables, and the most commonly used cooking methods are stir-frying and boiling. Such methods of processing vegetables may lead to loss of water-soluble, heat-sensitive and oxygen-labile nutrients[34]. In addition, salt was typically added during home cooking and this may offset the benefits of vegetables [35]. Fruits are typically eaten raw in the study population and fruit juice consumption is likely to be negligible[27]. The association of vegetable intake with CHD might also be modified by other dietary factors. Some studies have suggested that the cardioprotective effect of vegetable was more pronounced when combined with a diet low in carbohydrates[8] or high in fats[7; 36]. However, the traditional Chinese diet is featured by a high-carbohydrate and low-fat composition. In our study population, carbohydrate, total fat and saturated fat respectively accounted for 68%, 15% and 4.5% of total energy, compared with approximately 45%, 35% and 10% of total energy in a US population[37]. Vegetable intake is relatively high in our population (median: 3.5 portions/d *vs.* <2 portions/d in US and North Europe[9; 38]; the median for the lowest quartile in our study was ~2 portions/d). The overall high consumption, the limited consumption variability and relatively low incidence of CHD might have contributed to the less consistent association between vegetable intake and CHD in our study[39].

As with most nutritional epidemiological studies, dietary assessment error is the main concern for current study. Compared to fruit intake, assessment of vegetable intake is more challenging because of the large variety of vegetables and the difficulty in estimating portions. As indicated in our validation studies, vegetable intake was assessed less accurately than fruit intake[13; 14], and this may further explain the less consistent results that we found for vegetables. A Japanese cohort study also suggested that men might report their intake less accurately than women[30]. In addition to measurement error, the relatively short

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follow-up time in men's cohort could also reduce our ability to detect significant associations. Because of the shorter follow-up, changes in diets due to the presence of risk factors or subclinical diseases (reverse causation bias) might have greater influence on the results in men than in women. Another concern of the study is residual confounding, despite that we have extensively controlled for potential confounders, including socioeconomic status, BMI, physical activity, smoking, and other established risk factors of CHD. Fruit and vegetable intake is in general associated with a healthy lifestyle and likely to be included as part of a healthy diet. We adjusted for several important lifestyle and dietary variables in multivariable analyses and conducted analyses stratified by smoking, physical activity, and BMI to further evaluate the independent association between fruit and vegetable intake and CHD and potential effect modifications. We found no evidence of significant effect modifications. Nevertheless, we cannot exclude the possibility of residual confounding or effect modifications by other unmeasured covariates. Finally, our participants were recruited from urban Shanghai, the most developed region in China, so the results may not be entirely generalizable to Chinese people living in other areas or other countries around the world. Nevertheless, to our knowledge, this is the first report on the associations of fruit and vegetable intake with risk of CHD among Chinese with a population-based prospective design and medical record-confirmed cases.

In conclusion, our results suggest that higher intake of fruits, may be associated with lower risk of incident CHD in Chinese adults, particularly women.

Acknowledgments

FINANCIAL SUPPORT.

This work was supported by research grants R01HL079123, R37CA070867 and R01CA082729 from the US National Institutes of Health. Jie Huang was a former trainee of the Vanderbilt-Shanghai Chronic Disease Research Program supported by a grant from the Fogarty International Center (D43TW008313). US National Institutes of Health had no role in the design, analysis or writing of this article.

Abbreviation

MI	myocardial infarction
SWHS	Shanghai Women's Health Study
SMHS	Shanghai Men's Health Study

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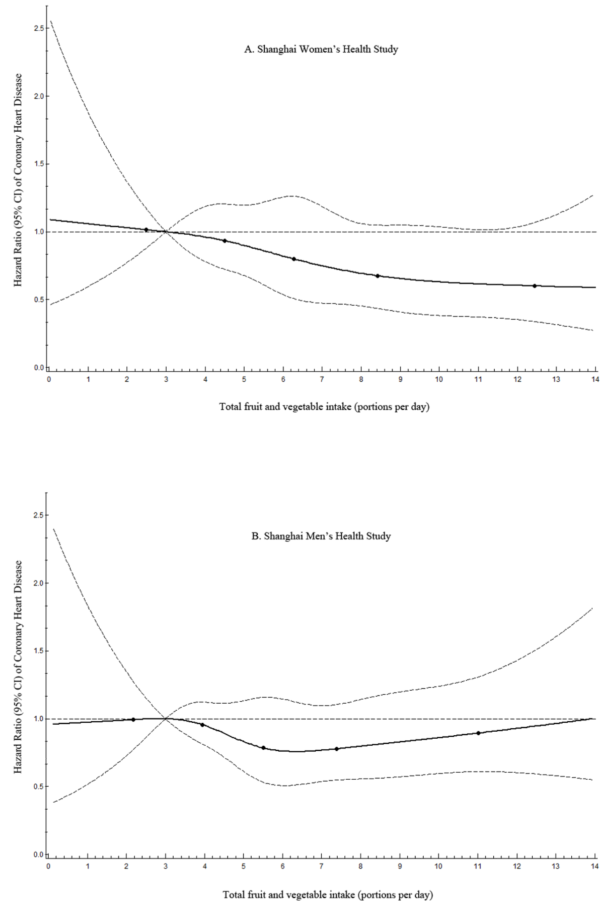

Figure 1.

Dose-response relationship between total fruit and vegetable intake and risk of coronary heart disease by restricted cubic spline analysis in Chinese women (A) and men (B) (— hazard ratio, ---- 95% CI, reference = 3 portions/d).

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Table 1

Baseline characteristics of participants by quartiles of total fruit and vegetable intake*

	Quartile			
Characteristics	**Q1 (low)**	**Q2**	**Q3**	**Q4**
Shanghai Women's Health Study (n = 67,211)				
Intake range, g/d	< 360	360–502	502–673	> 673
Age, years	53.9	51.9	51.1	50.2
High income†, %	12.9	17.0	19.6	21.6
High education‡, %	9.6	13.6	15.4	15.5
Ever smoking, %	4.4	2.4	1.9	1.9
Drinking alcohol, %	2.3	2.1	2.1	2.4
Postmenopausal, %	54.4	45.8	43.0	39.2
Hormone therapy, %	1.3	1.9	2.2	2.5
Aspirin use, %	1.1	1.2	1.4	1.7
Vitamin E supplement, %	7.3	10.0	11.3	13.3
Multivitamin supplement, %	4.6	6.7	7.7	8.7
Baseline diabetes, %	5.8	3.4	2.8	2.1
Baseline hypertension, %	21.4	20.0	19.3	19.5
BMI, kg/m^2	23.9	23.8	23.8	24.0
Physical activity, MET-h/week	104.5	106.2	106.8	110.4
Dietary intake*				
Total energy, kJ/d	6983	7100	7088	6945
Red meat, g/d	48	51	49	47
Fish and shellfish, g/d	36	46	53	62
Dietary fiber, g/d	8	10	11	14
Vitamin C, mg/d	47	72	95	141
Potassium, mg/d	1289	1578	1813	2243
Magnesium, mg/d	233	256	275	310
Shanghai Men's Health Study (n = 55,474)				
Intake range, g/d	< 316	316–440	440–590	> 590
Age, years	54.4	54.4	54.5	54.5
High income†, %	6.3	8.6	10.6	14.0
High education‡, %	15.7	21.0	25.4	30.0
Smoking, %				
Never	21.5	27.9	32.5	36.6
Past	8.3	9.2	9.9	10.5
Current	70.2	62.9	57.6	52.9
Drinking alcohol, %				
Never	63.2	66.6	67.3	67.7
Past	4.2	3.8	3.6	3.6
Current	32.6	29.6	29.1	28.7

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	Quartile			
Characteristics	**Q1 (low)**	**Q2**	**Q3**	**Q4**
Aspirin use, %	2.4	3.3	4.0	5.5
Vitamin E supplement, %	2.3	3.5	4.3	6.0
Multivitamin supplement, %	5.0	6.7	7.9	10.0
Baseline diabetes, %	5.3	5.4	5.1	5.5
Baseline hypertension, %	24.3	25.7	26.1	28.3
BMI, kg/m^2	23.3	23.6	23.7	24.0
Physical activity, MET-h/week	56.0	58.2	60.3	62.7
Dietary intake*				
Total energy, kJ/d	8033	8109	8067	7954
Red meat, g/d	61	62	62	60
Fish and shellfish, g/d	38	47	54	64
Dietary fiber, g/d	9	10	12	15
Vitamin C, mg/d	50	78	101	150
Potassium, mg/d	1430	1723	1965	2422
Magnesium, mg/d	271	298	321	363

*Intake values were energy-adjusted using residual method. Data were mean or percentage. *P* values were all <0.005 (except for drinking *P*=0.14 in women, and age *P*=0.71, diabetes *P*=0.36 in men).

†High income was defined as family income ≥30,000 Yuan per year for women or personal income ≥2,000 Yuan per month for men.

‡High education was defined as professional or college education or more.

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Table 2

Hazard ratio (95% CI) of incident coronary heart disease by fruit and vegetable intake

	Quartile				*P* for trend	Per 80g/d increase	
	Q1	Q2	Q3	Q4		HR (95% CI)	*P*
Shanghai Women's Health Study							
Total fruit and vegetable							
Median intake, g/d*	274	432	581	814			
No. of cases	60	35	29	24			
Model 1†	1	0.74 (0.48, 1.12)	0.68 (0.43, 1.07)	0.62 (0.38, 1.02)	0.04	0.94 (0.89, 1.00)	0.05
Model 2‡	1	0.77 (0.50, 1.18)	0.71 (0.45, 1.13)	0.67 (0.41, 1.10)	0.09	0.95 (0.90, 1.01)	0.12
All fruits							
Median intake, g/d*	83	188	287	449			
No. of cases	57	37	33	21			
Model 1†	1	0.87 (0.57, 1.33)	0.87 (0.56, 1.36)	0.62 (0.37, 1.03)	0.08	0.88 (0.80, 0.97)	0.009
Model 2‡	1	1.01 (0.66, 1.55)	1.06 (0.68, 1.67)	0.77 (0.45, 1.31)	0.42	0.93 (0.84, 1.02)	0.11
All vegetables							
Median intake, g/d*	137	213	292	429			
No. of cases	43	43	29	33			
Model 1†	1	1.18 (0.77, 1.81)	0.84 (0.52, 1.35)	0.94 (0.58, 1.50)	0.52	0.99 (0.90, 1.08)	0.76
Model 2‡	1	1.15 (0.75, 1.76)	0.77 (0.48, 1.25)	0.83 (0.52, 1.33)	0.24	0.96 (0.87, 1.05)	0.37
Shanghai Men's Health Study							
Total fruit and vegetable							
Median intake, g/d*	242	379	507	722			
No. of cases	65	51	47	54			
Model 1†	1	0.80 (0.55, 1.16)	0.75 (0.51, 1.10)	0.85 (0.58, 1.25)	0.45	0.99 (0.94, 1.04)	0.75
Model 2‡	1	0.80 (0.55, 1.16)	0.76 (0.51, 1.11)	0.86 (0.59, 1.26)	0.49	0.99 (0.94, 1.05)	0.80
All fruits							
Median intake, g/d*	23	90	162	285			
No. of cases	57	57	51	52			

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	Quartile				*P* for trend	Per 80g/d increase	
	Q1	**Q2**	**Q3**	**Q4**		**HR (95% CI)**	***P***
Model 1†	1	0.95 (0.66, 1.39)	0.85 (0.57, 1.25)	0.86 (0.57, 1.28)	0.40	0.94 (0.85, 1.03)	0.20
Model 2‡	1	1.01 (0.69, 1.47)	0.93 (0.62, 1.38)	0.96 (0.63, 1.44)	0.77	0.96 (0.88, 1.06)	0.44
All vegetables							
Median intake, g/d*	160	253	344	502			
No. of cases	61	55	40	61			
Model 1†	1	0.96 (0.67, 1.39)	0.69 (0.46, 1.04)	1.07 (0.74, 1.55)	0.84	1.02 (0.96, 1.09)	0.53
Model 2‡	1	0.95 (0.65, 1.37)	0.68 (0.45, 1.01)	1.02 (0.71, 1.48)	0.96	1.01 (0.95, 1.08)	0.73

* Intake values were energy-adjusted using residual method.

† Model was stratified by birth cohort (5-year intervals) and adjusted for baseline age, BMI, income, education, smoking, alcohol drinking, physical activity, use of aspirin, vitamin E and multivitamin supplements, (in women only: menopause and hormone replacement therapy), total energy and intakes of red meat and fish/shellfish.

‡ Further adjusted for history of diabetes, hypertension or dyslipidemia.

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Table 3

Hazard ratio (95% CI) of incident coronary heart disease by types of fruits and vegetables in the Shanghai Women's Health Study

	Quartile				*P* for trend
	Q1	**Q2**	**Q3**	**Q4**	
Types of fruits					
Apples and pears					
Median intake, g/d*	10.1	41.9	78.6	138.6	
No. of cases	58	33	28	29	
Model 1†	1	0.77 (0.50, 1.18)	0.67 (0.42, 1.07)	0.77 (0.49, 1.24)	0.23
Model 2‡	1	0.83 (0.53, 1.28)	0.76 (0.48, 1.21)	0.92 (0.57, 1.48)	0.65
Bananas					
Median intake, g/d*	0.2	3.3	11.3	37.9	
No. of cases	59	36	29	24	
Model 1†	1	0.75 (0.49, 1.14)	0.63 (0.40, 0.99)	0.48 (0.30, 0.78)	0.006
Model 2‡	1	0.93 (0.60, 1.44)	0.79 (0.49, 1.26)	0.60 (0.37, 1.00)	0.045
Citrus fruit					
Median intake, g/d*	1.5	11.0	22.4	46.8	
No. of cases	60	26	29	33	
Model 1†	1	0.58 (0.36, 0.92)	0.65 (0.41, 1.02)	0.74 (0.48, 1.15)	0.30
Model 2‡	1	0.66 (0.41, 1.05)	0.75 (0.48, 1.19)	0.88 (0.56, 1.38)	0.77
Watermelon					
Median intake, g/d*	23.2	72.5	124.5	212.1	
No. of cases	54	45	28	21	
Model 1†	1	1.04 (0.70, 1.56)	0.74 (0.46, 1.17)	0.57 (0.34, 0.96)	0.02
Model 2‡	1	1.24 (0.82, 1.87)	0.90 (0.56, 1.44)	0.71 (0.42, 1.20)	0.13
Other fruits					
Median intake, g/d*	1.5	12.2	32.0	86.6	
No. of cases	58	38	25	27	
Model 1†	1	0.93 (0.61, 1.41)	0.68 (0.42, 1.10)	0.80 (0.50, 1.29)	0.33

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	Quartile				P for trend
	Q1	Q2	Q3	Q4	
Model 2‡	1	1.03 (0.68, 1.58)	0.77 (0.48, 1.26)	0.94 (0.58, 1.51)	0.67
Types of vegetables					
Cruciferous vegetables					
Median intake, g/d*	32.9	65.6	98.4	155.9	
No. of cases	41	34	35	38	
Model 1†	1	0.87 (0.55, 1.37)	0.92 (0.58, 1.44)	0.88 (0.56, 1.38)	0.66
Model 2‡	1	0.86 (0.55, 1.36)	0.90 (0.57, 1.42)	0.80 (0.51, 1.26)	0.38
Allium					
Median intake, g/d*	1.9	4.2	7.2	15.0	
No. of cases	37	32	36	43	
Model 1†	1	0.93 (0.58, 1.50)	1.09 (0.69, 1.74)	1.30 (0.83, 2.04)	0.15
Model 2‡	1	0.92 (0.57, 1.49)	1.09 (0.69, 1.73)	1.27 (0.81, 1.99)	0.18
Legumes					
Median intake, g/d*	8.5	17.7	28.5	50.7	
No. of cases	45	32	37	34	
Model 1†	1	0.83 (0.52, 1.30)	0.90 (0.58, 1.39)	0.72 (0.46, 1.13)	0.19
Model 2‡	1	0.80 (0.51, 1.26)	0.88 (0.56, 1.36)	0.69 (0.44, 1.09)	0.15
Other vegetables					
Median intake, g/d*	59.6	104.3	153.5	244.0	
No. of cases	49	30	38	31	
Model 1†	1	0.81 (0.51, 1.29)	1.12 (0.73, 1.74)	0.97 (0.61, 1.56)	0.84
Model 2‡	1	0.80 (0.50, 1.26)	1.06 (0.69, 1.65)	0.86 (0.54, 1.38)	0.75

* Intake values were energy-adjusted using residual method.

† Model was stratified by birth cohort (5-year intervals) and adjusted for baseline age, BMI, income, education, smoking, alcohol drinking, physical activity, use of aspirin, vitamin E and multivitamin supplements, (in women only: menopause and hormone replacement therapy), total energy and intakes of red meat and fish/shellfish.

‡ Further adjusted for history of diabetes, hypertension or dyslipidemia.

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Table 4

Hazard ratio (95% CI) of incident coronary heart disease by types of fruits and vegetables in the Shanghai Men's Health Study

	Quartile				***P* for trend**
	Q1	**Q2**	**Q3**	**Q4**	
Types of fruits					
Apples and pears					
Median intake, g/d*	0.01	11.1	31.5	78.8	
No. of cases	61	50	58	48	
Model 1†	1	0.81 (0.55, 1.18)	0.91 (0.63, 1.32)	0.70 (0.47, 1.05)	0.14
Model 2‡	1	0.84 (0.57, 1.24)	0.96 (0.66, 1.40)	0.75 (0.50, 1.13)	0.24
Bananas					
Median intake, g/d*	0	1.6	4.9	17.3	
No. of cases	64	45	49	59	
Model 1†	1	0.73 (0.50, 1.08)	0.76 (0.53, 1.11)	0.85 (0.59, 1.23)	0.86
Model 2‡	1	0.83 (0.55, 1.24)	0.87 (0.59, 1.30)	0.97 (0.66, 1.43)	0.74
Citrus fruit					
Median intake, g/d*	0	3.5	10.0	27.3	
No. of cases	65	48	55	49	
Model 1†	1	0.74 (0.51, 1.07)	0.83 (0.57, 1.20)	0.69 (0.47, 1.02)	0.15
Model 2‡	1	0.77 (0.53, 1.13)	0.88 (0.60, 1.27)	0.74 (0.50, 1.09)	0.24
Watermelon					
Median intake, g/d*	4.7	37.1	81.3	167.5	
No. of cases	67	48	45	57	
Model 1†	1	0.71 (0.48, 1.03)	0.66 (0.45, 0.97)	0.86 (0.60, 1.25)	0.69
Model 2‡	1	0.75 (0.52, 1.10)	0.73 (0.49, 1.07)	0.96 (0.66, 1.41)	0.85
Other fruits					
Median intake, g/d*	0	5.8	13.3	33.1	
No. of cases	76	43	50	48	
Model 1†	1	0.57 (0.39, 0.83)	0.66 (0.46, 0.95)	0.63 (0.43, 0.92)	0.09

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	Quartile				*P* for trend
	Q1	Q2	Q3	Q4	
Model 2[‡]	1	0.59 (0.40, 0.86)	0.69 (0.48, 0.99)	0.65 (0.44, 0.95)	0.11
Types of vegetables					
Cruciferous vegetables					
Median intake, g/d[*]	39.5	76.3	115.5	186.4	
No. of cases	51	57	48	61	
Model 1[†]	1	1.14 (0.78, 1.67)	0.96 (0.64, 1.43)	1.17 (0.80, 1.70)	0.55
Model 2[‡]	1	1.12 (0.76, 1.63)	0.94 (0.63, 1.40)	1.13 (0.78, 1.65)	0.66
Allium					
Median intake, g/d[*]	4.7	9.2	15.1	28.5	
No. of cases	64	46	53	54	
Model 1[†]	1	0.74 (0.51, 1.08)	0.86 (0.60, 1.25)	0.89 (0.61, 1.29)	0.86
Model 2[‡]	1	0.74 (0.50, 1.08)	0.85 (0.59, 1.23)	0.86 (0.60, 1.25)	0.75
Legumes					
Median intake, g/d[*]	10.8	22.8	35.8	62.8	
No. of cases	61	45	58	53	
Model 1[†]	1	0.76 (0.52, 1.13)	0.99 (0.69, 1.42)	0.92 (0.63, 1.34)	0.99
Model 2[‡]	1	0.78 (0.53, 1.15)	1.00 (0.70, 1.44)	0.94 (0.65, 1.37)	0.92
Other vegetables					
Median intake, g/d[*]	68.3	118.0	170.0	270.2	
No. of cases	68	50	40	59	
Model 1[†]	1	0.79 (0.55, 1.14)	0.65 (0.44, 0.97)	0.96 (0.67, 1.39)	0.95
Model 2[‡]	1	0.79 (0.54, 1.14)	0.63 (0.42, 0.94)	0.91 (0.63, 1.31)	0.70

[*] Intake values were energy-adjusted using residual method.

[†] Model was stratified by birth cohort (5-year intervals) and adjusted for baseline age, BMI, income, education, smoking, alcohol drinking, physical activity, use of aspirin, vitamin E and multivitamin supplements, (in women only: menopause and hormone replacement therapy), total energy and intakes of red meat and fish/shellfish.

[‡] Further adjusted for history of diabetes, hypertension or dyslipidemia.