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Fresh Fruit Consumption and Major Cardiovascular Disease in China

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Abstract

Background—In Western populations, a higher level of fruit consumption has been associated with a lower risk of cardiovascular disease, but little is known about such associations in China, where the consumption level is low and rates of stroke are high.

Methods—Between 2004 and 2008, we recruited 512,891 adults, 30 to 79 years of age, from 10 diverse localities in China. During 3.2 million person-years of follow-up, 5173 deaths from cardiovascular disease, 2551 incident major coronary events (fatal or nonfatal), 14,579 ischemic strokes, and 3523 intracerebral hemorrhages were recorded among the 451,665 participants who did not have a history of cardiovascular disease or antihypertensive treatments at baseline. Cox regression yielded adjusted hazard ratios relating fresh fruit consumption to disease rates.

Results—Overall, 18.0% of participants reported consuming fresh fruit daily. As compared with participants who never or rarely consumed fresh fruit (the “nonconsumption” category), those who ate fresh fruit daily had lower systolic blood pressure (by 4.0 mm Hg) and blood glucose levels (by 0.5 mmol per liter [9.0 mg per deciliter]) (P<0.001 for trend for both comparisons). The adjusted hazard ratios for daily consumption versus nonconsumption were 0.60 (95% confidence interval

*A complete list of the members of the steering committee and collaborative group of the China Kadoorie Biobank is provided in the Supplementary Appendix, available at NEJM.org.

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[CI], 0.54 to 0.67) for cardiovascular death, and 0.66 (95% CI, 0.58 to 0.75), 0.75 (95% CI, 0.72 to 0.79), and 0.64 (95% CI, 0.56 to 0.74), respectively, for incident major coronary events, ischemic stroke, and hemorrhagic stroke. There was a strong loglinear dose–response relationship between the incidence of each outcome and the amount of fresh fruit consumed. These associations were similar across the 10 study regions and in subgroups of participants defined by baseline characteristics.

Conclusions—Among Chinese adults, a higher level of fruit consumption was associated with lower blood pressure and blood glucose levels and, largely independent of these and other dietary and nondietary factors, with significantly lower risks of major cardiovascular diseases. (Funded by the Wellcome Trust and others.)

Cardiovascular disease is a leading cause of premature death and disability worldwide and is responsible for more than 17 million deaths annually, with approximately 80% of the disease burden in low- and middle-income countries, such as China.[1] A low level of fruit consumption is a major risk factor for cardiovascular disease, accounting for an estimated 104 million disability-adjusted lifeyears worldwide in 2010,[2] including approximately 30 million in China.[3] However, these estimates were based mainly on findings from Western studies, with little reliable evidence from China and other developing countries, where diet, lifestyle factors, and disease patterns differ substantially from those in Western populations.[3–5] Moreover, most previous studies tended to involve a combination of fresh and processed fruit (frozen, dried, or canned fruit or fruit juice), with limited data specifically on fresh fruit, which is usually consumed raw as a snack in China. Furthermore, the associations of fruit intake with stroke subtypes, especially hemorrhagic stroke, are less well established than the association with ischemic heart disease,[3,6,7] underscoring the importance of performing studies in China, where rates of stroke (particularly hemorrhagic stroke) are high. We examined the association of fresh fruit consumption with risks of major cardiovascular events in China, where fresh fruit consumption is low, although fresh vegetable consumption is high.[8]

Methods

Study Design and Oversight

The China Kadoorie Biobank Study is a nationwide, prospective cohort study involving 10 diverse localities (regions) in China, which is jointly coordinated by the University of Oxford and the Chinese Academy of Medical Sciences. The study design and methods have been reported previously.[9,10] Approval of the study was obtained from ethics committees or institutional review boards at the University of Oxford, the Chinese Center for Disease Control and Prevention (China CDC), the Chinese Academy of Medical Sciences, and all participating regions. The funders had no role in study design, data collection and analysis, preparation of the manuscript, or the decision to submit it for publication.

Baseline Survey

We selected 10 regional study sites (5 urban and 5 rural) in order to cover a wide range of risk exposures and disease patterns, taking into account the accuracy and completeness of death and disease registries for each region and the local capability to gather the necessary study data. Between June 2004 and July 2008, all nondisabled, permanent residents of each region who were 35 to 74 years of age were invited to participate in the study. Of the total of approximately 1.8 million eligible adults in these regions, almost 1 in 3 (33% in rural areas and 27% in urban areas) responded. Overall, 512,891 persons were recruited, including a few who were just outside the targeted age range, and all provided written informed consent.

At the local study clinics, trained health workers administered a laptop-based questionnaire on sociodemographic characteristics, smoking and alcohol consumption, diet, physical activity, and medical history; measured height, weight, waist circumference, and blood pressure; and performed spot random blood glucose testing using the SureStep Plus System (Johnson & Johnson). Blood pressure was measured at least twice with the use of an automated digital blood-pressure monitor (model UA-779, A&D Medical) after at least 5 minutes of rest in a seated position; the mean of two satisfactory measurements was used for analyses.[11,12]

Dietary data covered 12 major food groups: rice, wheat products, other staple foods, meat, poultry, fish, eggs, dairy products, fresh vegetables, preserved vegetables, fresh fruit, and soybean products. Respondents were asked about the frequency of habitual consumption during the previous 12 months and chose among five categories of frequency (daily, 4 to 6 days per week, 1 to 3 days per week, monthly, or never or rarely [the reference category]). In a subsample of 926 participants, the survey questionnaire was repeated within a year after the baseline assessment (mean interval, 5.4 months) in order to assess the reproducibility of the responses.

Resurveys

After completion of the baseline survey, we randomly selected 5 to 6% of the original participants for two resurveys, using procedures similar to those at baseline. The first resurvey took place from July through October 2008, with 19,788 participants resurveyed, and the second was conducted from August 2013 through September 2014, with just over 25,000 participants resurveyed. In addition to questions about the frequency of consumption, the second resurvey questionnaire asked about the amount consumed for each food group, which was used as a proxy measure to estimate the average consumption at baseline for each of the five frequency categories (see the Supplementary Appendix, available with the full text of this article at NEJM.org).

Follow-up and Outcome Measures

The vital status of each participant was determined periodically through the Disease Surveillance Points (DSP) system of the China CDC.[13] The DSP vital-status data sets were checked annually against local residential records and health insurance records and were confirmed with street committees or village administrators. In addition, information about major diseases and episodes of hospitalization was collected through linkages with disease registries (for cancer, cardiovascular disease, and diabetes) and national health insurance claims databases. The Chinese National Health Insurance scheme provides electronic linkage to all hospitalization data.

Fatal and nonfatal events were documented according to the *International Classification of Diseases, 10th Revision* (ICD-10), by coders who were unaware of the baseline characteristics of the study participants.10 The four main outcome measures that were examined were cardiovascular death (ICD-10 codes I00 to I25, I27 to I88, and I95 to I99) and the incidence of major coronary events (fatal ischemic heart disease [codes I20 to I25] plus nonfatal myocardial infarction [code I21]), hemorrhagic stroke (code I61), and ischemic stroke (code I63). Other ischemic heart disease (i.e., ischemic heart disease not meeting the criteria for a major coronary event) and other cerebrovascular diseases (ICD-10 codes I60, I62, and I64 to I69) were analyzed separately. For analyses of incident disease, only the first cardiovascular event was counted.

Statistical Analysis

For the current study, we excluded persons who had a history of cardiovascular disease (23,132 persons) or antihypertensive treatment (48,174 persons) at baseline. Baseline characteristics of the remaining 451,665 participants were described as means and standard deviations or percentages in each category of fruit consumption, with adjustment for age, sex, and region as appropriate, by means of either multiple linear regression (for continuous outcomes) or logistic regression (for binary outcomes). The marginal mean values and 95% confidence intervals for body-mass index (BMI), waist circumference, blood pressure, and blood glucose according to frequency of fruit consumption were estimated separately for men and women with the use of multiple linear regression models adjusted for baseline covariates.

Cox regression was used to calculate hazard ratios and 95% confidence intervals for relative risks in relation to fruit consumption, with adjustment for baseline covariates and with stratification according to age at risk (in 5-year intervals), sex, and region. For analyses involving more than two exposure categories, the floatingabsolute- risk method was used, which provides the variance of the logarithm of the hazard ratio (i.e., to compute a confidence interval for the hazard ratio) for each category (including the reference category) to facilitate comparisons among the different exposure categories.14 Conventional (unfloated) analyses were also performed so that the results of the two methods could be compared. We calculated the hazard ratio for cardiovascular death with nondaily fruit consumption as compared with daily consumption in order to estimate the population-attributable fraction, using the formula $Pe(HR - 1) \div [Pe(HR - 1) + 1]$,15 where Pe is the prevalence of nondaily consumption of fresh fruit in the Chinese population, and HR is the hazard ratio. Additional information about the statistical analyses is provided in the Supplementary Appendix.

Results

Patterns of Fresh Fruit Consumption

Among the 451,665 participants included in the study, the mean age was 50.5 years (range, 30 to 79); 58.8% of the participants were women, and 42.5% were from urban areas (Table 1). Overall, 18.0% of participants reported consumption of fresh fruit on a daily basis, 9.4% reported consumption 4 to 6 days per week, and 6.3% reported no or rare consumption (also referred to as nonconsumption). The proportion of participants with regular fruit consumption (i.e., 4 to 6 days per week or more) was inversely associated with age among rural participants and urban women (Fig. S1 and S2 in the Supplementary Appendix). Among urban men, however, the association was U-shaped, with men who were 50 to 55 years of age (preretirement age in China) reporting the lowest consumption. There was no south-tonorth gradient in fruit consumption, with two urban areas (Qingdao and Harbin) having the highest consumption and two rural areas (Henan and Hunan) having the lowest consumption (Fig. S3 in the Supplementary Appendix). The Spearman correlation coefficient of 0.55 between responses a few months apart indicated moderate reliability of the measure of fruit-consumption frequency (Table S2 in the Supplementary Appendix).

Participants who consumed fresh fruit more frequently (as compared with those who consumed it less frequently) were more likely to be women and to live in urban areas, were younger, had a higher level of education and higher household income, and were less likely to smoke or drink alcohol regularly and more likely to consume dairy products and meat, but they had similar levels of consumption of preserved and fresh vegetables (Table 1). Our participants had an overall mean BMI (the weight in kilograms divided by the square of the height in meters) of 23.5 and overall mean systolic blood pressure of 128.8 mm Hg. As compared with participants who never or rarely consumed fresh fruit, the BMI of daily consumers was 0.5 points higher, the waist circumference 0.9 cm larger, the blood pressure 4.0 mm Hg systolic lower and 1.4 mm Hg diastolic lower, and the blood glucose level 0.5 mmol per liter (9.0 mg per deciliter) lower (Fig. 1). These associations were largely unchanged after additional adjustment for potential confounders or mediators, except for systolic blood pressure, for which the association was attenuated by about one fifth (to 3.3 mm Hg in men and to 2.2 mm Hg in women).

Association of Fruit Consumption with Cardiovascular Outcomes

During 3.2 million person-years of follow-up, there were 5173 cardiovascular deaths, 2551 major coronary events (plus 16,563 other ischemic heart disease events), 14,579 ischemic strokes, and 3523 hemorrhagic strokes (plus 11,054 other cerebrovascular disease events) recorded. The risks of these major cardiovascular events were strongly and inversely associated with the level of fruit consumption ($P<0.001$ for trend, for all comparisons) (Fig. 2 and Table 2). As compared with nonconsumption, the adjusted hazard ratios for daily consumption were 0.60 (95% confidence interval [CI], 0.54 to 0.67) for cardiovascular death, 0.66 (95% CI, 0.58 to 0.75) for major coronary events, 0.75 (95% CI, 0.72 to 0.79) for ischemic stroke, and 0.64 (95% CI, 0.56 to 0.74) for hemorrhagic stroke. After correction for regression dilution bias, the associations were approximately log-linear; the hazard ratios for one daily portion of fruit were 0.63 (95% CI, 0.56 to 0.72), 0.70 (95% CI, 0.60 to 0.83), 0.80 (95% CI, 0.75 to 0.85), and 0.69 (95% CI, 0.59 to 0.81), respectively. The level of fruit consumption was also significantly and inversely associated with risks of other ischemic heart disease and other cerebrovascular diseases, although the associations were less strong (Table 2, and Fig. S4 in the Supplementary Appendix).

With the exception of ischemic stroke and other cerebrovascular diseases, the associations between the level of fruit consumption and the risk of major cardiovascular events did not

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appear to be modified by baseline characteristics such as sex, age, region, or season of enrollment (Fig. 3, and Fig. S5 through S8 in the Supplementary Appendix). For ischemic stroke, the association appeared to be somewhat greater among men, participants from urban areas, those who drank alcohol regularly, those with higher educational levels, and those with higher blood glucose levels (Fig. S5 in the Supplementary Appendix). None of the associations or interactions were materially attenuated by additional adjustment for BMI, waist circumference, systolic blood pressure, and blood glucose level (Fig. S9 in the Supplementary Appendix).

In our study, approximately 95% of participants reported daily consumption of fresh vegetables. Additional adjustment for consumption of fresh vegetables and other dietary variables did not alter the risk estimates for fresh fruit consumption (Table S3 in the Supplementary Appendix). Likewise, the exclusion of the first 2 years of follow-up in order to further reduce the effect of reverse causality did not materially change the observed associations (data not shown).

Population-Attributable Fraction of Low Fruit Consumption

The hazard ratio for cardiovascular death with nondaily versus daily fruit consumption was 1.30 (95% CI, 1.17 to 1.46). In our second resurvey, about 65% of the participants reported nondaily fruit consumption (Table S4 in the Supplementary Appendix), which was in line with the proportion in the most recent China Health and Nutrition Survey, conducted in 2011.[16] We performed an exploratory analysis to estimate the effect of fruit consumption on cardiovascular death under the assumption that there is a causal association. On the basis of this assumption, our data suggest that 16% (95% CI, 10 to 23) of deaths from cardiovascular causes could be attributed to low fruit consumption. Applying this proportion to national data on cardiovascular mortality[17] suggests that about 560,000 (95% CI, 350,000 to 800,000) deaths from cardiovascular causes each year, including about 200,000 before 70 years of age, could be prevented if daily consumption of fresh fruit were universal in China. However, it is difficult to establish causality reliably in observational studies of dietary factors that have such moderate relative risks and potential for confounding.

Discussion

In our study involving more than 450,000 men and women in China without prior cardiovascular disease or antihypertensive treatment, higher fresh fruit consumption was associated with significantly lower levels of blood pressure and blood glucose. Largely independent of blood pressure, blood glucose levels, and other dietary and nondietary factors, higher fruit consumption was also associated with significantly lower risks of cardiovascular disease, including cardiovascular death, major coronary events, hemorrhagic stroke, and ischemic stroke. These associations were consistent across 10 regions and in various subgroups of participants defined by various baseline characteristics. If these associations are largely causal, the potential health gain from increased consumption of fresh fruit in China would be substantial.

Several large prospective studies of mostly Western populations have assessed the association of fruit consumption with cardiovascular disease.[18–25] Most of them showed an inverse association, but the magnitude of the benefit varied considerably, and the association was typically weaker than that observed in the current study. For example, in a recent meta-analysis of six studies involving nearly 680,000 participants and 10,000 cardiovascular deaths, each additional serving (80 g) of fruit per day was associated with a 5% (95% CI, 0 to 9) lower risk of cardiovascular death, which is not good evidence of a real protective effect.19 Only one previous prospective study in China has shown an association between fresh fruit consumption and cardiovascular risk. In that study, involving approximately 130,000 adults from Shanghai and approximately 1600 cardiovascular deaths during follow-up, the risk of cardiovascular death among people in the highest quintile of fruit consumption was about 30% lower than among those in the lowest quintile,26 but no overall association with the incidence of major coronary events was observed, perhaps in part because of the small number of such events (365).27 Information on the association between fruit consumption and stroke subtypes is limited, 18 especially for hemorrhagic stroke, which is relatively uncommon in Western populations. In our study, which involved more than 3500 hemorrhagic strokes, we found that higher consumption of fresh fruit was associated with a significantly lower risk of hemorrhagic stroke, largely independent of blood pressure.

The association between the level of fruit consumption and cardiovascular risk in our study (a 40% lower risk of cardiovascular death and a 34% lower risk of major coronary events among participants who consumed fresh fruit daily as compared with those who never or rarely consumed fresh fruit) was much stronger than the associations observed in previous studies. Several factors may account for this difference. First, unlike many previous studies, our study focused on fresh fruit, which is universally consumed raw in China, perhaps maximizing its potential benefits.23,28 Moreover, the average level of fruit consumption in the Chinese population is very low,8 and there is evidence that the association of fruit consumption with disease risks may be particularly strong at the low end of the range of intake (i.e., fewer than two servings per day).19 In addition, our analyses excluded not only persons with a history of cardiovascular disease but also those receiving antihypertensive treatment, thereby reducing confounding by medication use. Our analysis also takes into account regression dilution bias,29,30 whereas previously, few large, prospective studies have dealt with this important issue.20

Our study has several limitations. First, we did not collect information on processed fruit because its consumption is extremely low in China. Second, we were unable to properly examine the association of fresh vegetables with cardiovascular risk because daily consumption is almost universal in our study population. Third, fruit consumption at baseline was assessed with the use of a simple qualitative food-frequency questionnaire, and information on mean consumption amounts was estimated indirectly on the basis of data from resurveys (under the assumption that there were no large changes between the baseline survey and the second resurvey). Fourth, we did not collect information about types of fruit consumed, which is likely to vary greatly according to season and region (although the most commonly consumed fruits in China are apples, citrus fruit, and pears). Fifth, our study was not exactly nationally representative, and the questionnaire used has not been validated against another dietary measure. Finally, and perhaps most important, fruit consumption in our study was closely correlated with socioeconomic status, which in turn has been closely

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associated with health status and the risk of cardiovascular disease.31 Although we adjusted carefully for several variables related to socioeconomic status (i.e., region, educational level, and income) and analyses stratified according to these variables showed consistent findings, residual confounding by socioeconomic status is still possible.

Our study does not permit reliable inference of causality, but the observed inverse association between fruit consumption and cardiovascular risk could be causal,32,33 given that fruit is a rich source of potassium, dietary fiber, folate, antioxidants, and various bioactive phytochemicals, each of which has potential cardioprotective effects,34 and contains little sodium and fat and few calories. The association may be mediated through conventional cardiovascular risk factors such as hypertension, diabetes, and overweight.35 However, in our relatively lean study population (mean BMI, 23.5), fruit intake was associated with higher, instead of lower, adiposity, perhaps through improved nutrition, since a stronger positive association was observed among those with a lower BMI, and adjustment for blood pressure and blood glucose levels attenuated the association only slightly, suggesting the involvement of other mechanisms.36

In conclusion, our evaluation of the relationship between fresh fruit consumption and cardiovascular disease in China showed that the level of fruit consumption was inversely associated with blood pressure and blood glucose levels. Largely independent of blood pressure, blood glucose levels, and other dietary and nondietary factors, higher fruit consumption was associated with a significantly lower risk of major cardiovascular events.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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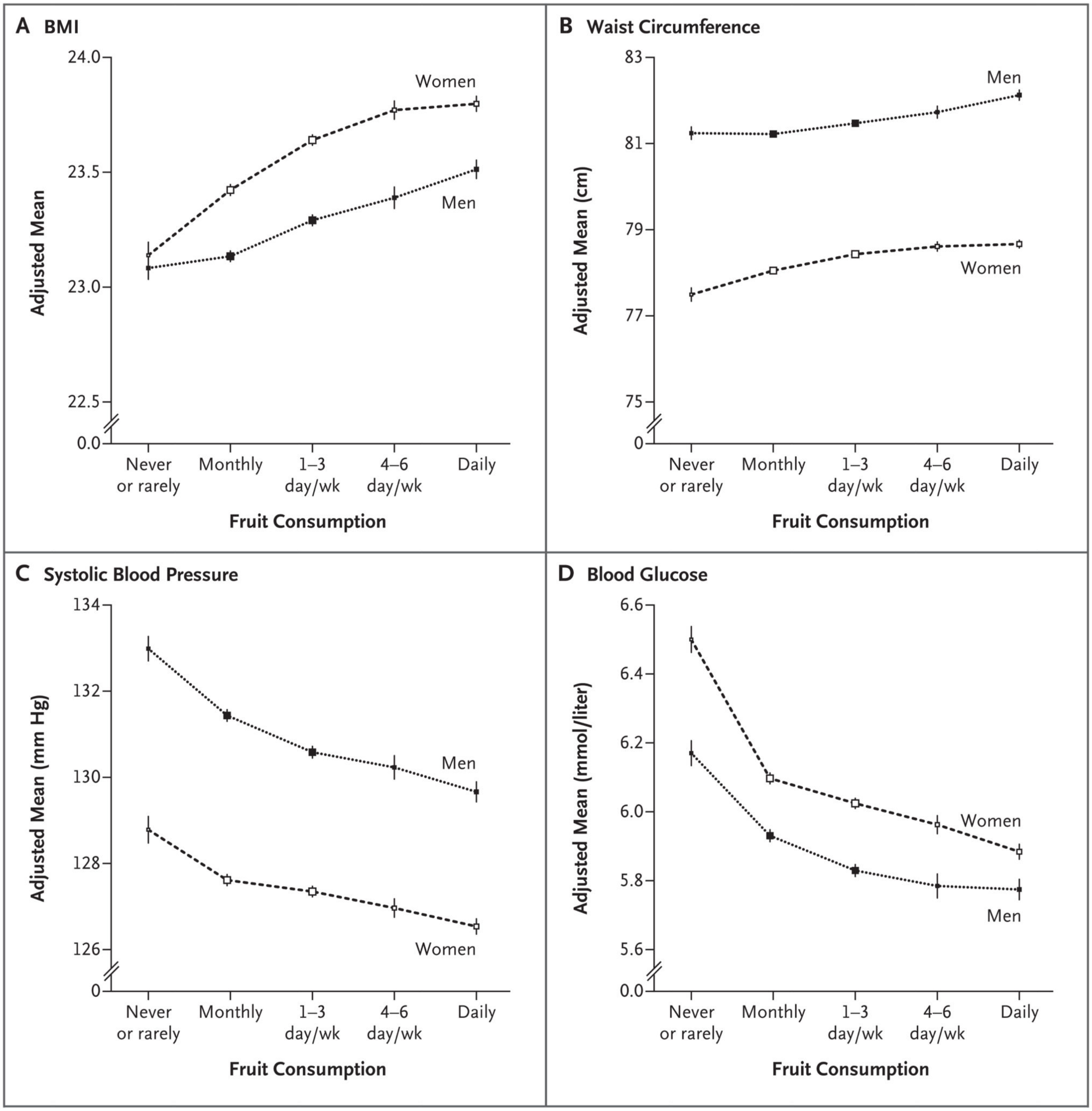

Figure 1. Adjusted Mean Body-Mass Index (BMI), Waist Circumference, Blood Pressure, and Blood Glucose According to the Frequency of Fresh Fruit Consumption.

Mean values for BMI (Panel A) and waist circumference (Panel B) were adjusted for age (10 categories), area of China (10 regions), educational level (4 categories), annual household income (4 categories), smoking status (4 categories, with the category of "Never" subdivided into "Never" and "Occasional"), alcohol intake (4 categories, with the category of "Never" subdivided into "Never" and "Occasional"), physical activity (continuous variable), survey season (4 categories), and consumption of meat (3 categories), dairy products (3 categories), and preserved vegetables (5 categories). Mean values for systolic blood pressure (Panel C) and random blood glucose measurements (Panel D) were adjusted for the listed variables plus BMI and waist circumference. Blood glucose values were missing for 7503 study participants. To convert the values for glucose to milligrams per deciliter, divide by 0.05551. Vertical lines indicate 95% confidence intervals. P<0.001 for trend, for all comparisons.

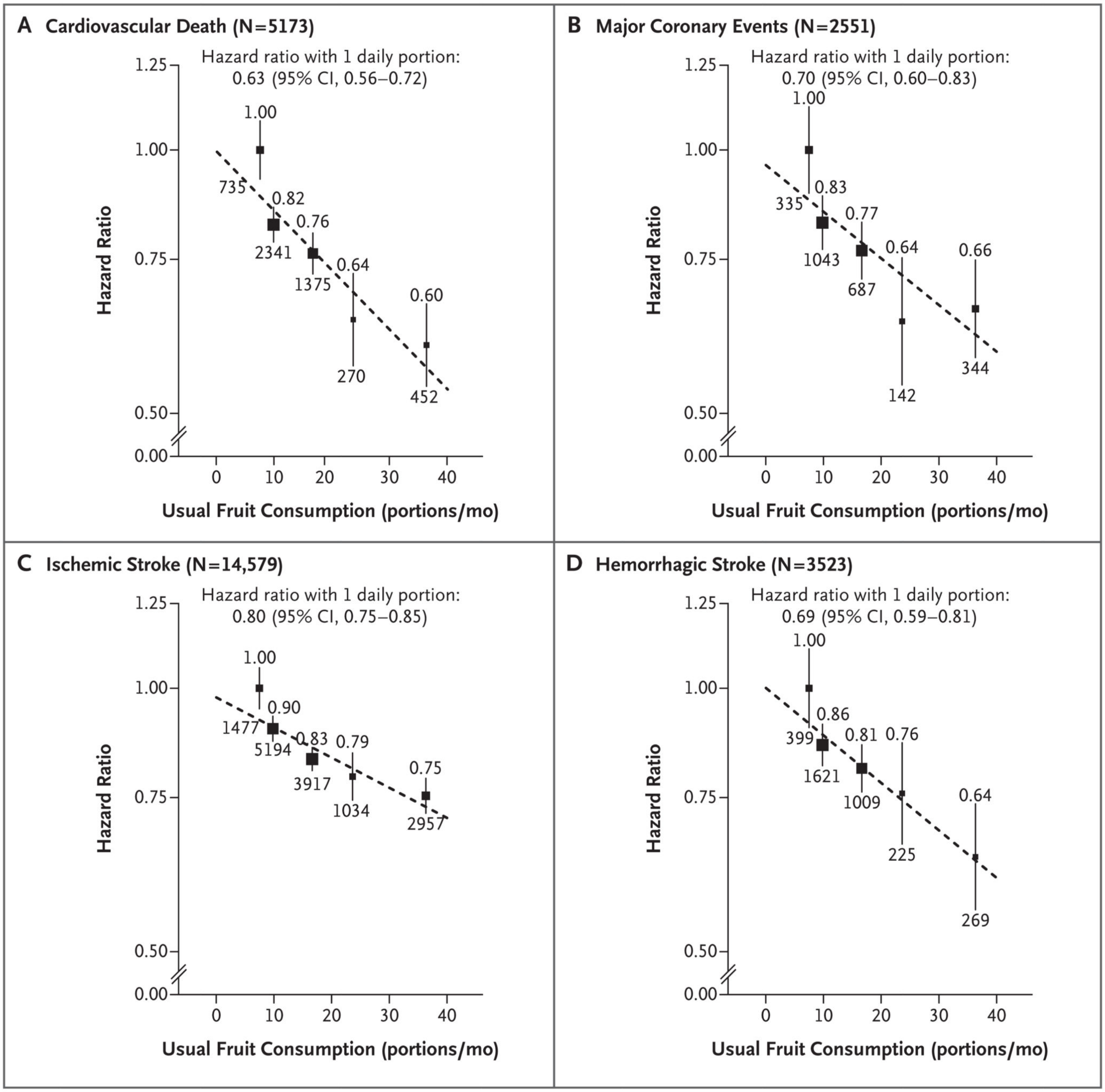

Figure 2. Adjusted Hazard Ratios for Major Cardiovascular Events According to the Level of Fresh Fruit Consumption.

Analyses were adjusted for educational level, income, alcohol intake, smoking status, physical activity, survey season, and consumption of dairy products, meat, and preserved vegetables and were stratified according to age at risk, sex, and region. The black boxes represent hazard ratios, with the size inversely proportional to the variance of the logarithm of the hazard ratio, and the vertical lines represent 95% confidence intervals. The numbers above the vertical lines are point estimates for hazard ratios, and the numbers below the lines are numbers of events.

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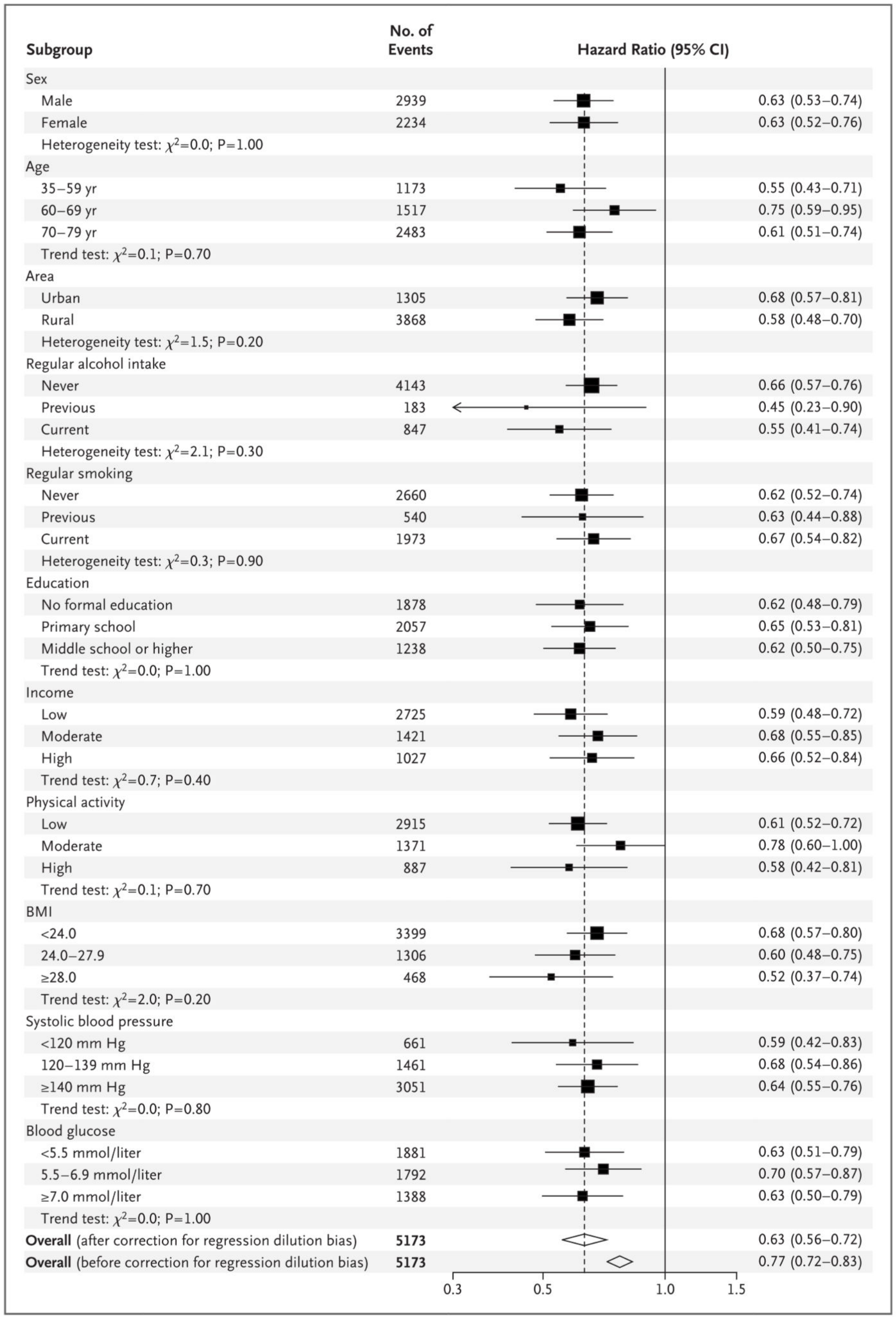

Figure 3. Adjusted Hazard Ratios for Cardiovascular Death with One Daily Portion of Fresh Fruit, According to Baseline Characteristics.

Analyses were adjusted for educational level, income, alcohol intake, smoking status, physical activity, survey season, and consumption of dairy products, meat, and preserved vegetables and were stratified according to age at risk, sex, and region, as appropriate. The black boxes represent hazard ratios, with the size inversely proportional to the variance of the logarithm of the hazard ratio, and the horizontal lines represent 95% confidence intervals. The open diamonds represent the overall hazard ratios and 95% confidence intervals. Chi-square tests (χ^2) were performed to examine either trend (with 1 df) or heterogeneity (with n –1 df, where n represents the number of categories). To convert the values for glucose to milligrams per deciliter, divide by 0.05551.

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Table 1

Baseline Characteristics of the Study Participants According to the Frequency of Fresh Fruit Consumption.*

Characteristic	Consumption of Fresh Fruit					
	Never or Rarely (N = 28,479)	Monthly (N = 156,098)	1–3 Days/Wk (N = 143,183)	4–6 Days/Wk (N = 42,519)	Daily (N = 81,386)	All Participants (N = 451,665)
Age (yr)	53.6±10.4	51.7±10.9	49.8±10.4	48.8±10.4	48.9±11.6	50.5±10.4
Female sex (%)	47.1	55.5	56.5	62.1	71.7	58.8
Urban residence (%)	29.9	21.7	41.5	52.7	83.2	42.5
Educational level (%)						
No formal education	28.7	22.6	17.5	13.9	9.1	18.1
Primary school	34.1	34.8	32.8	29.6	25.6	32.0
Middle or high school	35.3	38.1	46.0	50.5	52.5	44.2
College or university	1.9	4.5	3.7	6.0	12.8	5.7
Household income (%)†						
<10,000 yuan/yr	45.3	36.7	27.7	18.5	15.4	28.8
10,000—19,999 yuan/yr	26.4	28.8	31.3	30.6	25.5	29.0
20,000—34,999 yuan/yr	17.6	24.1	24.4	25.9	27.3	24.5
≥35,000 yuan/yr	10.7	10.4	16.6	25.0	31.8	17.7
Regular smoking (%)						
Never	55.4	63.0	68.8	73.4	74.5	67.4
Previous	4.2	4.6	5.4	5.9	6.4	5.3
Current	40.4	32.4	25.8	20.7	19.1	27.3
Regular alcohol intake (%)						
Never	76.5	81.7	83.9	85.9	85.5	83.2
Previous	1.7	1.3	1.4	1.5	1.6	1.4
Current	21.8	17.0	14.7	12.6	12.9	15.4
Physical activity (MET-hr/day)‡	21.8±12.3	22.4±12.9	22.0±12.2	21.4±12.2	21.0±13.7	21.9±13.9
Regular consumption of foods (%)§						
Fresh vegetables	92.7	90.9	95.9	97.7	98.5	94.6
Preserved vegetables	27.3	21.6	21.6	24.0	23.3	22.5
Meat	38.8	39.1	47.3	58.5	59.6	47.2
Dairy products	6.8	5.5	8.6	15.5	24.7	11.0

* Plus–minus values are means ±SD. Data were adjusted for age, sex, and region when appropriate.

† At the exchange rate as of March 2016, 1 yuan is approximately equal to 0.15 U.S. dollars.

‡ MET denotes metabolic equivalent.

§ Data shown are for daily consumption of fresh vegetables and for consumption on most days (at least 4 days per week) for other foods.

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Table 2

Incidence Rates and Adjusted Hazard Ratios for Major Cardiovascular Events According to Fresh Fruit Consumption.*

Event	Consumption of Fresh Fruit				
	Never or Rarely	**Monthly**	**1–3 Days/Wk**	**4–6 Days/Wk**	**Daily**
Death from cardiovascular causes					
No. of events	735	2341	1375	270	452
Incidence rate (no./1000 person-yr)	3.68	2.10	1.34	0.88	0.78
Hazard ratio	1.00	0.82	0.76	0.64	0.60
95% CI, with floating absolute risk	0.93–1.08	0.78–0.86	0.72–0.80	0.57–0.72	0.54–0.67
95% CI, without floating absolute risk	—	0.75–0.90	0.69–0.84	0.55–0.74	0.52–0.69
Major coronary events					
No. of events	335	1043	687	142	344
Incidence rate (no./1000 person–yr)	1.68	0.94	0.67	0.46	0.59
Hazard ratio	1.00	0.83	0.77	0.64	0.66
95% CI, with floating absolute risk	0.89–1.12	0.77–0.89	0.71–0.83	0.54–0.75	0.58–0.75
95% CI, without floating absolute risk	—	0.73–0.94	0.67–0.88	0.52–0.78	0.55–0.78
Ischemic stroke					
No. of events	1477	5194	3917	1034	2957
Incidence rate (no./1000 person–yr)	7.58	4.75	3.88	3.42	5.17
Hazard ratio	1.00	0.90	0.83	0.79	0.75
95% CI, with floating absolute risk	0.95–1.06	0.87–0.93	0.81–0.86	0.74–0.84	0.72–0.79
95% CI, without floating absolute risk	—	0.85–0.95	0.79–0.88	0.73–0.86	0.70–0.81
Hemorrhagic stroke					
No. of events	399	1621	1009	225	269
Incidence rate (no./1000 person-yr)	2.05	1.48	1.00	0.74	0.47
Hazard ratio	1.00	0.86	0.81	0.76	0.64
95% CI, with floating absolute risk	0.90–1.11	0.82–0.91	0.76–0.86	0.66–0.87	0.56–0.74
95% CI, without floating absolute risk	—	0.77–0.97	0.72–0.92	0.64–0.90	0.54–0.76
Other ischemic heart disease					
No. of events	1190	5694	4573	1421	3685
Incidence rate (no./1000 person-yr)	6.07	5.21	4.53	4.71	6.47
Hazard ratio	1.00	0.96	0.90	0.92	0.88
95% CI, with floating absolute risk	0.94–1.06	0.93–0.99	0.88–0.93	0.88–0.97	0.85–0.92
95% CI, without floating absolute risk	—	0.90–1.02	0.85–0.97	0.85–1.00	0.82–0.95
Other cerebrovascular disease					
No. of events	717	4013	3309	894	2121
Incidence rate (no./1000 person-yr)	3.70	3.70	3.30	2.97	3.73
Hazard ratio	1.00	1.02	0.96	0.82	0.88
95% CI, with floating absolute risk	0.93–1.08	0.98–1.06	0.93–0.99	0.86–0.98	0.84–0.93
95% CI, without floating absolute risk	—	0.94–1.11	0.88–1.05	0.83–1.02	0.80–0.97

*Hazard ratios were adjusted for educational level, income, alcohol consumption, smoking status, physical activity, survey season, and consumption of dairy products, meat, and preserved vegetables and were stratified according to age at risk, sex, and region. The floating-absolute-risk method provides the variance of the logarithm of the hazard ratio for each category (including the reference category) to facilitate comparisons among the different exposure categories.14

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