Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study[1–3]

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ABSTRACT

Background: Epidemiologic studies report inconsistent findings on the association of fruit and vegetable intake with the risk of cardiovascular disease.

Objective: The objective was to examine the relation between fruit and vegetable intake and the risk of cardiovascular disease.

Design: We studied 9608 adults aged 25–74 y participating in the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study and free of cardiovascular disease at the time of their baseline examination between 1971 and 1975. Fruit and vegetable intake at baseline was measured with a food-frequency questionnaire. The incidence of and mortality from cardiovascular disease were obtained from medical records and death certificates.

Results: Over an average of 19 y, 888 strokes (218 fatal), 1786 ischemic heart disease events (639 fatal), 1145 cardiovascular disease deaths, and 2530 all-cause deaths were documented. Consuming fruit and vegetables ≥3 times/d compared with <1 time/d was associated with a 27% lower stroke incidence [relative risk (RR): 0.73; 95% CI: 0.57, 0.95; *P* for trend = 0.01), a 42% lower stroke mortality (0.58; 0.33, 1.02; *P* for trend = 0.05), a 24% lower ischemic heart disease mortality (0.76; 0.56, 1.03; *P* for trend = 0.07), a 27% lower cardiovascular disease mortality (0.73; 0.58, 0.92; *P* for trend = 0.008), and a 15% lower all-cause mortality (0.85; 0.72, 1.00; *P* for trend = 0.02) after adjustment for established cardiovascular disease risk factors.

Conclusion: We showed an inverse association of fruit and vegetable intake with the risk of cardiovascular disease and all-cause mortality in the general US population. *Am J Clin Nutr* 2002;76:93–9.

KEY WORDS Fruit, vegetables, ischemic heart disease, cerebrovascular disorders, mortality, cohort studies, NHANES I, National Health and Nutrition Examination Survey, cardiovascular disease

INTRODUCTION

Observational epidemiologic studies have suggested that dietary nutrients such as potassium, antioxidants, and folic acid—abundant in fruit and vegetables—are associated with a lower incidence of and mortality from cardiovascular disease (1–3). The few prospective cohort studies that have examined the relation of fruit and vegetable intake with cardiovascular disease have reported inconsistent findings

See corresponding editorial on page 1.

(4, 5). A review identified 6 cohort studies that examined the association of fruit and vegetable intake (rather than nutrient intakes) with the risk of cardiovascular disease (4). Most of these studies reported no association or a nonsignificant inverse association between fruit and vegetable intake and the risk of cardiovascular disease.

National and international recommendations aimed at increasing fruit and vegetable intake further support the need to evaluate the relation between intake of these foods and cardiovascular disease (6, 7). Nutritional recommendations are easier to understand and follow when phrased in terms of foods rather than nutrients. We took advantage of the large sample size and prolonged follow-up experience of participants in the National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (NHEFS) to examine the association between fruit and vegetable intake and the risk of subsequent cardiovascular disease.

SUBJECTS AND METHODS

Study population

The NHEFS is an ongoing prospective cohort study of participants in the first National Health and Nutrition Examination Survey (NHANES I) aged 25–74 y at the time of their baseline examination between 1971 and 1975. Of the 14 407 persons followed in the NHEFS, we excluded 1020 who self-reported a history of heart attack, heart failure, or stroke at baseline; 327 persons who had used medication for heart disease during the preceding 6 mo; 2853 NHANES I Augmentation Survey participants who were not administered a dietary assessment (8); and

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214 who lacked information on fruit and vegetable intake. Among the remaining participants, 385 (3.9%) were lost to follow-up, leaving 9608 participants who contributed 159 304 person-years of follow-up.

Measurements

Baseline data collection included a medical history, a standardized medical examination, a dietary assessment, laboratory tests, and anthropometric measurements (8, 9). Blood pressure, body weight, and height were obtained with the use of standard protocols. The baseline questionnaire on medical history included questions about selected health conditions and medications used for those conditions during the preceding 6 mo. Data on education level, physical activity, and alcohol consumption were obtained by interviewer-administered questionnaires. Baseline information on smoking status was obtained in 6913 NHANES I participants. For the remaining study participants, information on smoking status at baseline was derived from responses to questions on lifetime smoking history at follow-up interviews in 1982 through 1984 or later.

The dietary assessment included a 3-mo food-frequency questionnaire about the participants' usual consumption of food groups in 13 major categories, including 3 items referring to fruit and vegetable intake. The primary item used in this investigation asked participants how often "fruits and vegetables of all kinds fresh, canned, frozen, cooked, or raw, and juices" were usually consumed in the past 3 mo, excluding periods of illness or dieting. Frequency of consumption of fruit and vegetables was coded into categories ranging from never to 8 times/d. Information on portion size was not collected. Frequency of consumption of meat and poultry and of fish and shellfish were also obtained from the food-frequency questionnaire. Preceding the food-frequency questionnaire, a single 24-h dietary recall was collected by trained personnel using a standardized protocol and food-portion models. Interviewers coded the dietary-recall questionnaires using nutrient information from the US Department of Agriculture *Handbook No. 8* (10) or other resources. Total energy intakes were calculated for each participant by the National Center for Health Statistics. Details of the data collection procedures at baseline were described elsewhere (8, 9).

Follow-up procedures

Follow-up data were collected in 1982–1984, 1986, 1987, and 1992 (11). Incident cardiovascular disease was based on documentation of an event that met prespecified study criteria and occurred during the period between the baseline examination and the last follow-up interview. Mortality from cardiovascular disease was based on information from death certificates. The validity of study outcome data from both sources was documented previously (12).

Incident stroke was based on a death certificate report in which the underlying cause of death was recorded as an International Classification of Diseases, ninth revision (ICD-9; 13), code of 430–438, or on a hospital or nursing home stay in which the participant had a discharge diagnosis with the above codes. Incident ischemic heart disease was defined in the same manner as ICD-9 codes 410–414. Cause-specific mortality was identified on the basis of the underlying cause of death with the use of the above-mentioned ICD-9 codes for stroke and ischemic heart disease and ICD-9 codes 390–459 to define cardiovascular disease.

Statistical analysis

To corroborate the fruit and vegetable intake data from the 3-mo food-frequency questionnaire, we used Spearman rank-order correlation analysis to compare the data with data from the 24-h dietary recall. Fruit and vegetable intake was grouped into 4 categories by intake (<1 time/d, 1 time/d, 2 times/d, and ≥3 times/d) to identify discrete levels of consumption and to provide a sufficient number of participants at risk in each category. For each baseline characteristic, the mean or percentage of study participants was calculated by category of fruit and vegetable intake. The statistical significance of differences was examined by using analysis of variance (continuous variables) and the chi-square test (categorical variables). The cumulative incidence of and mortality from cardiovascular disease by category of fruit and vegetable intake were calculated by using the Kaplan-Meier method (14), and differences in cumulative rates were examined by the log-rank test for trend (15). Cox proportional hazards regression models were used to explore the relation between categories of fruit and vegetable intake and the risk of cardiovascular disease (16). The multivariate models were adjusted for physical activity (3 categories), education level (completed or did not complete high school), regular alcohol consumption (4 categories), current cigarette smoking at baseline (yes or no), vitamin supplement use (yes or no), total energy intake (continuously), sex, race, and diabetic status (yes or no). Age was used as the time scale in all time-to-event analyses (17), and all analyses were stratified by birth cohort to control for calendar period and cohort effects (17). Estimation methods taking into account sample clustering and stratification of the NHANES I were used (17, 18). Data from the small number of participants who had reached 85 y of age were censored.

RESULTS

The baseline characteristics of the study participants by category of fruit and vegetable intake are presented in **Table 1**. Compared with participants who had lower fruit and vegetable intakes, those with higher intakes tended to be white and female. The mean (±SD) serving size of fruit and vegetables consumed in this cohort calculated from the 24-h dietary recall was 106.2 ± 89.9 g/d. A Spearman rank-order correlation coefficient of 0.50 was obtained for the comparison of fruit and vegetable intake derived from the food-frequency questionnaires and 24-h dietary recalls.

Over 159 304 person-years of follow-up between 1971 and 1992, 888 stroke events (218 fatal), 1786 ischemic heart disease events (639 fatal), 1145 cardiovascular disease deaths, and 2530 deaths from all causes were documented. The cumulative mortality from stroke, ischemic heart disease, cardiovascular disease, and all causes by category of fruit and vegetable intake is shown in **Figure 1**. The cumulative mortality from stroke at age 85 y by increasing category of fruit and vegetable intake was 14.5%, 9.8%, 8.8%, and 6.1% (P for trend < 0.001). The corresponding cumulative mortality from ischemic heart disease was 32.0%, 25.4%, 23.6%, and 21.5% (P for trend < 0.001); from cardiovascular disease was 51.2%, 42.1%, 38.8%, and 32.7% (P for trend < 0.001); and from all causes was 79.3%, 69.1%, 64.0%, and 60.4% (P for trend < 0.001). The cumulative incidence of stroke at age 85 y from the lowest to the highest frequency of fruit and vegetable intake was 42.8%, 37.8%, 34.1%,

TABLE 1
Baseline characteristics of 9608 participants in the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study by frequency of fruit and vegetable intake

	Frequency of fruit and vegetable intake				
Variable	<1 time/d (n = 1094)	1 time/d (n = 3106)	2 times/d (n = 3536)	≥3 times/d (n = 1872)	P^1
Age (y)	51.2 ± 15.8[2]	47.6 ± 15.5	49.3 ± 15.5	49.7 ± 15.5	0.14
Men (%)	50.1	40.0	37.6	30.1	<0.001
Whites (%)	69.9	81.2	88.0	90.2	<0.001
Blood pressure (mm Hg)					
Systolic	139.4 ± 26.4	134.2 ± 24.5	133.3 ± 23.3	132.0 ± 22.6	<0.001
Diastolic	85.7 ± 14.4	83.4 ± 13.1	82.8 ± 12.7	81.9 ± 12.2	<0.001
Hypertension (%)[3]	34.6	26.9	25.9	25.4	<0.001
Serum total cholesterol					
(mmol/L)	5.66 ± 1.20	5.64 ± 1.26	5.75 ± 1.27	5.75 ± 1.29	0.01
(mg/dL)	218.7 ± 46.4	217.6 ± 48.8	222.0 ± 49.2	222.1 ± 49.8	0.01
Hypercholesterolemia (%)[4]	29.5	29.4	32.6	32.6	0.02
Diabetes (%)	3.6	3.4	3.8	5.7	0.006
BMI (kg/m^2)	25.9 ± 5.5	25.8 ± 5.3	25.6 ± 5.1	25.3 ± 4.7	0.001
Low recreational physical activity (%)	56.8	48.1	43.5	40.4	<0.001
Less than a high school education (%)	73.9	53.3	39.1	31.6	<0.001
Current cigarette smoking (%)	41.6	40.3	32.9	26.2	<0.001
Regular alcohol consumption (%)	22.8	23.1	25.3	22.5	0.05
Vitamin supplement use (%)[5]	21.0	28.8	35.5	41.0	<0.001
Sodium intake (mg/d)	1834 ± 1223	2065 ± 1342	2106 ± 1342	2062 ± 1311	<0.001
Dietary fiber (g/d)	11.4 ± 13.1	12.1 ± 11.5	12.9 ± 10.3	14.5 ± 11.9	<0.001
Fruit and vegetable intake (g/24 h)	242 ± 341	263 ± 217	372 ± 258	520 ± 347	<0.001
Saturated fat intake (g/d)	25.0 ± 18.6	26.7 ± 17.8	27.2 ± 18.1	25.8 ± 16.5	0.19
Total energy intake (kJ/d)	6805 ± 3586	7348 ± 3662	7578 ± 3549	7549 ± 3423	<0.001

[1] ANOVA for continuous variables and chi-square test for categorical variables.
[2] $\bar{x}$ ± SD.
[3] Defined as a systolic blood pressure ≥160 mm Hg, a diastolic blood pressure ≥95 mm Hg, or both or the use of antihypertensive medication.
[4] Defined as a serum cholesterol concentration ≥6.2 mmol/L (≥240 mg/dL).
[5] Defined as the regular or irregular consumption of any supplement.

and 25.5% (P for trend < 0.001); the corresponding mortality from ischemic heart disease was 62.4%, 59.7%, 54.4%, and 54.3% (P for trend < 0.001) (**Figure 2**).

The relative risks (RRs) and 95% CIs for cardiovascular diseases according to frequency of fruit and vegetable intake are presented in **Table 2**. After adjustment for age, race, sex, history of diabetes, physical activity, education level, regular alcohol consumption, current smoking, vitamin supplement use, and total energy intake, intake of fruit and vegetables ≥3 times/d compared with <1 time/d was associated with a 27% lower incidence of stroke (RR: 0.73; 95% CI: 0.57, 0.95; P for trend = 0.01), a 42% lower mortality from stroke (0.58; 0.33, 1.02; P for trend = 0.05), a 24% lower mortality from ischemic heart disease (0.76; 0.56, 1.03; P for trend = 0.07), a 27% lower mortality from cardiovascular disease (0.73; 0.58, 0.92; P for trend = 0.008), and a 15% lower mortality from all causes (0.85; 0.72, 1.00; P for trend = 0.02).

The RRs of cardiovascular disease for participants who consumed fruit and vegetables ≥3 times/d compared with those who consumed them <1 time/d—in models individually adjusted for other dietary variables, serum cholesterol, blood pressure, or body mass index—are shown in **Table 3**. Adjustment for the frequency of consumption of meat and fish minimally changed the point estimates and at the same time widened the 95% CIs such that the RR was significant only for stroke incidence. After adjustment for serum cholesterol, the RR of mortality from ischemic heart disease was further away from the null and was significant. When adjusted for systolic blood pressure, the RRs of most outcomes diminished and the RRs of mortality from stroke were no longer significant. Adjustment for body mass index produced little change in the RRs and 95% CIs. The results of models adjusted simultaneously for total serum cholesterol, systolic blood pressure, and body mass index were similar to those adjusted for systolic blood pressure alone.

The inverse associations between frequency of fruit and vegetable intake and incidence of and mortality from stroke, ischemic heart disease, and cardiovascular disease were generally consistent across strata of age and sex, and no significant interactions were detected even though the associations differed somewhat by race (**Table 4**). Risk estimates were not significantly different across strata of smoking status, diabetic status, vitamin use, and physical activity (data not shown).

DISCUSSION

This study shows a strong inverse association between fruit and vegetable intake and the risk of subsequent cardiovascular disease. These findings have important clinical and public health implications. Increased fruit and vegetable intakes have been recommended to prevent morbidity and mortality from cardiovascular disease (6, 7). Our findings provide additional evidence to support this recommendation.

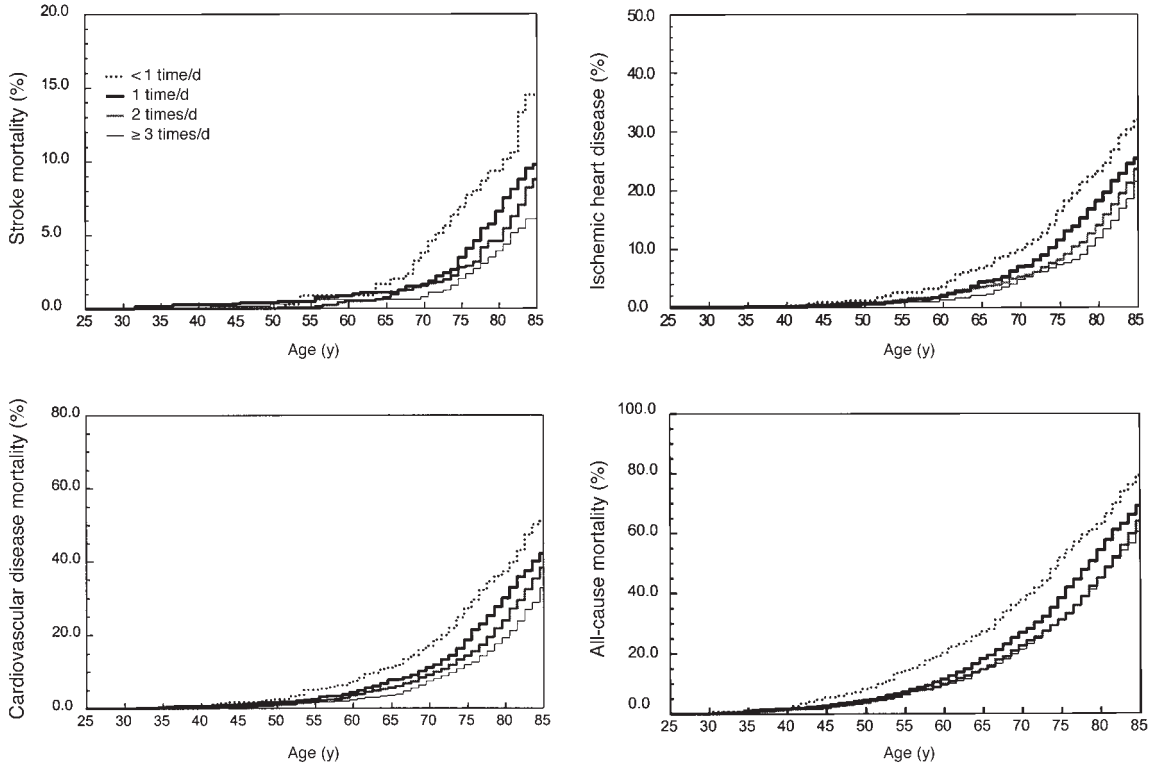

FIGURE 1. Age-adjusted cumulative mortality from stroke, ischemic heart disease, cardiovascular disease, and all causes according to frequency of fruit and vegetable intake in 9608 participants in the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (*P* for trend < 0.0001 for all outcomes, log-rank test).

The data on fruit and vegetable intake from the food-frequency questionnaire showed very good agreement with the data from the 24-h dietary recall. The Spearman rank-order correlation coefficient of 0.5 obtained in our study compares favorably with the value of 0.31 obtained for vegetables by Ocke et al (19) and of 0.48 obtained for vegetables by Bohlscheid-Thomas et al (20). Food-frequency questionnaires provide a better measure of usual food intake than does a single 24-h dietary recall. In our study, the comparison of the mean fruit and vegetable intake reported on the 24-h dietary recall with that reported on the food-frequency questionnaire suggested that persons reporting an intake < 1 time/d may have underestimated their usual intake. It is possible that such measurement error would shift our RR estimates toward the null value; however, fruit and vegetable intake may be biased toward the overall mean when estimated by frequency categories.

Recent prospective studies report an inverse association between fruit and vegetable intake and the risk of ischemic stroke and ischemic heart disease (21–25). In a study of 832 men from Framingham, MA, Gillman et al (21) found that an increase of 3 servings/d of fruit and vegetables was associated with an RR of 0.75 (95% CI: 0.55, 1.03) for ischemic stroke. In the Nurses' Health Study and the Health Professionals Follow-up Study, persons in the highest quintile of fruit and vegetable intake (median: 5.1 servings/d among men and 5.8 servings/d among women) had an RR of stroke of 0.69 (95% CI: 0.52, 0.92) and of ischemic heart disease of 0.80 (95% CI: 0.69, 0.93) compared with the lowest quintile (22, 23). Our study extends these findings in several ways. First, our study was conducted in a representative sample of the US population; therefore, the results are broadly applicable. In contrast, most previous studies were conducted in popula-

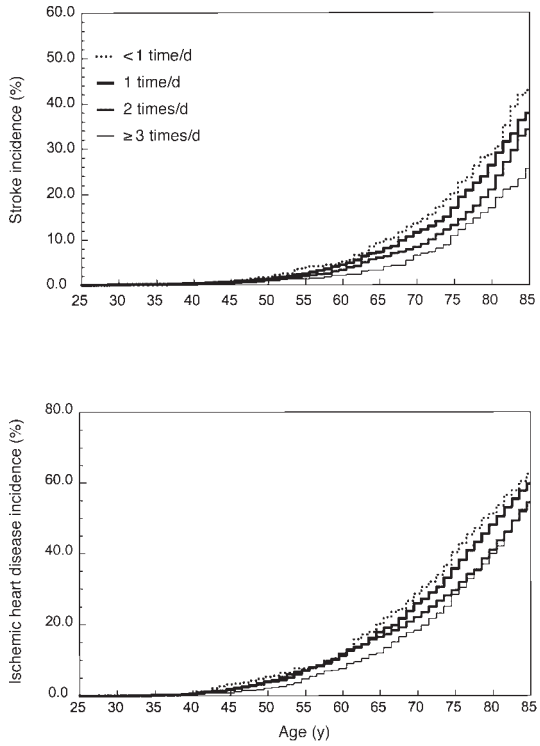

FIGURE 2. Age-adjusted cumulative incidence of stroke and ischemic heart disease according to frequency of fruit and vegetable intake in 9608 participants in the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (*P* for trend < 0.0001 for all outcomes, log-rank test).

TABLE 2
Relative risks (RRs) (and 95% CIs) of cardiovascular disease and total mortality for 9608 participants in the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study by frequency of fruit and vegetable intake

	Frequency of fruit and vegetable intake				
Variable	<1 time/d (n = 1094)	1 time/d (n = 3106)	2 times/d (n = 3536)	≥3 times/d (n = 1872)	P for trend[1]
Stroke incidence					
Number of events	134	291	329	134	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.93 (0.75, 1.14)	0.80 (0.65, 0.99)	0.61 (0.48, 0.79)	<0.001
Multivariate model[2]	1.00	1.04 (0.86, 1.26)	0.93 (0.76, 1.13)	0.73, (0.57, 0.95)	0.01
Stroke mortality					
Number of events	42	68	77	31	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.75 (0.55, 1.01)	0.67 (0.48, 0.93)	0.52 (0.33, 0.81)	0.004
Multivariate model[2]	1.00	0.83 (0.56, 1.22)	0.74 (0.48, 1.12)	0.58 (0.33, 1.02)	0.05
Ischemic heart disease incidence					
Number of events	239	568	643	336	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.97 (0.83, 1.13)	0.84 (0.73, 0.95)	0.85 (0.72, 1.02)	0.02
Multivariate model[2]	1.00	1.07 (0.91, 1.27)	0.97 (0.83, 1.14)	1.01 (0.84, 1.21)	0.8
Ischemic heart disease mortality					
Number of events	105	196	231	107	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.81 (0.63, 1.04)	0.72 (0.57, 0.91)	0.66 (0.49, 0.90)	0.007
Multivariate model[2]	1.00	0.89 (0.68, 1.17)	0.84 (0.65, 1.09)	0.76 (0.56, 1.03)	0.07
Cardiovascular disease mortality					
Number of events	193	360	413	179	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.83 (0.69, 1.01)	0.74 (0.62, 0.87)	0.63 (0.51, 0.79)	<0.001
Multivariate model[2]	1.00	0.91 (0.75, 1.10)	0.84 (0.70, 0.99)	0.73 (0.58, 0.92)	0.008
Noncardiovascular disease mortality					
Number of events	223	427	469	266	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.81 (0.65, 1.02)	0.71 (0.60, 0.83)	0.80 (0.66, 0.96)	0.004
Multivariate model[2]	1.00	0.86 (0.67, 1.10)	0.81 (0.66, 0.98)	0.95 (0.76, 1.18)	0.5
All-cause mortality					
Number of events	416	787	882	445	
RR (95% CI)					
Adjusted for age, race, sex, and energy	1.00	0.82 (0.70, 0.97)	0.72 (0.64, 0.81)	0.72 (0.62, 0.84)	<0.001
Multivariate model[2]	1.00	0.88 (0.74, 1.06)	0.82 (0.71, 0.94)	0.85 (0.72, 1.00)	0.02

[1] Log-rank test.
[2] Adjusted for age, sex, race, history of diabetes, physical activity (3 categories), education level (completed or did not complete high school), regular alcohol consumption (4 categories), current cigarette smoking at baseline (yes or no), vitamin supplement use (yes or no), and total energy intake (continuous); n = 9156.

tions that probably had food habits different from those of the general population. For instance, the median intake of fruit and vegetables in the Health Professionals Follow-up Study and the Nurses' Health Study was well above the national and international recommendation of 5 servings/d (6, 7, 22, 23). Differences in the dietary assessment methods used in these studies may also have contributed to the differences in measured intakes of fruit and vegetables. In addition, our study examined the relation between fruit and vegetable intake and stroke incidence and mortality, ischemic heart disease incidence and mortality, cardiovascular disease mortality, noncardiovascular disease mortality, and all-cause mortality rather than the incidence of stroke or ischemic heart disease alone.

In the current study, fruit and vegetable intake was significantly associated with lower mortality from ischemic heart disease; however, the same was not true for the incidence of ischemic heart disease. One possibility for this finding is that mortality as an endpoint may be more accurately assessed than is incidence. The cases identified by this method are by definition the most severe and tend to be more homogeneous than those identified by self-report or proxy, either alone or in combination with hospital discharge data and death certificate information. In the NHEFS cohort, it was shown that the use of cases identified from death certificate information alone produces higher estimates of RRs and wider 95% CIs (12). Another possibility is that fruit and vegetable intake may reduce the case-fatality rate after a myocardial infarction, thus resulting in stronger associations with mortality than with incidence. Such a relation may not exist with stroke. In addition, our findings suggest that the protective association of fruit and vegetable intake with cardiovascular disease may be related to blood pressure. This fact could explain why previous studies found a strong association between fruit and vegetable intake and the risk of stroke. A multicenter clinical trial with a heterogeneous population showed that a diet rich in fruit, vegetables, and low-fat dairy products reduces blood pressure (26). Our results are consistent with this finding and

TABLE 3
Relative risks (RRs) (and 95% CIs) of cardiovascular disease, noncardiovascular disease, and all-cause mortality in participants in the first National Health and Nutrition Examination Follow-up Study who consumed fruit and vegetables ≥3 times/d compared with <1 time/d, adjusted for dietary variables, serum total cholesterol, blood pressure, and BMI

	Cox proportional hazards model					
Variable	Multivariate[1]	Additionally adjusted for dietary variables[2]	Additionally adjusted for serum total cholesterol	Additionally adjusted for blood pressure	Additionally adjusted for BMI	Additionally adjusted for BMI, cholesterol, and blood pressure
Stroke incidence	0.73 (0.57, 0.95)[3]	0.75 (0.58, 0.97)[3]	0.73 (0.57, 0.93)[3]	0.77 (0.60, 0.99)[3]	0.73 (0.57, 0.94)[3]	0.77 (0.60, 0.99)[3]
Stroke mortality	0.58 (0.33, 1.02)[3]	0.63 (0.37, 1.08)	0.57 (0.33, 0.99)[3]	0.62 (0.35, 1.07)	0.58 (0.33, 1.01)	0.61 (0.35, 1.07)
Ischemic heart disease incidence	1.01 (0.84, 1.21)	1.03 (0.86, 1.22)	0.98 (0.81, 1.19)	1.05 (0.88, 1.26)	1.00 (0.83, 1.20)	1.03 (0.85, 1.25)
Ischemic heart disease mortality	0.76 (0.56, 1.03)	0.78 (0.57, 1.06)	0.74 (0.55, 0.99)[3]	0.81 (0.61, 1.08)	0.76 (0.56, 1.02)	0.80 (0.60, 1.06)
Cardiovascular disease mortality	0.73 (0.58, 0.92)[4]	0.75 (0.60, 0.94)[3]	0.72 (0.57, 0.90)[4]	0.79 (0.62, 0.99)[3]	0.73 (0.58, 0.92)[3]	0.78 (0.62, 0.98)[3]
Noncardiovascular disease mortality	0.95 (0.76, 1.18)	0.94 (0.76, 1.17)	0.96 (0.77, 1.19)	0.97 (0.78, 1.19)	0.95 (0.77, 1.18)	0.98 (0.79, 1.21)
All-cause mortality	0.85 (0.72, 1.00)	0.86 (0.73, 1.01)	0.85 (0.72, 1.00)	0.89 (0.76, 1.04)	0.85 (0.73, 1.00)	0.89 (0.76, 1.04)

[1] Adjusted for age, sex, race, history of diabetes, physical activity (3 categories), education level (completed or did not complete high school), regular alcohol consumption (4 categories), current cigarette smoking at baseline (yes or no), vitamin supplement use (yes or no), and total energy intake (continuous).
[2] The dietary variables included the frequency of meat and poultry and fish and shellfish intakes.
[3] P for trend < 0.05.
[4] P for trend < 0.01.

support the role of a diet rich in fruit and vegetables as a possible approach for preventing cardiovascular disease.

Another study, conducted by van't Veer et al (27), attempted to quantify the public health benefit of increased fruit and vegetable intake as a means to prevent cardiovascular disease. They performed a meta-analysis using results from 14 observational epidemiologic studies of cardiovascular disease (3 case-control and 11 prospective studies) published through 1998 to calculate the pooled relative risk and the preventable proportion of cardiovascular disease deaths. In that study, an increase in fruit and vegetable intake of 150 g/d was associated with a 16% lower mortality from cardiovascular disease.

TABLE 4
Relative risks (RRs) (and 95% CIs) of cardiovascular disease, noncardiovascular disease, and all-cause mortality in participants in the first National Health and Nutrition Examination Follow-up Study who consumed fruit and vegetables ≥3 times/d compared with <1 time/d, according to selected characteristics[1]

	Sex		Age		Race	
Variable	Men (n = 3485)	Women (n = 5671)	<60 y (n = 6312)	≥60 y (n = 2844)	White (n = 7759)	Nonwhite (n = 1397)
Stroke incidence						
RR	0.65[2]	0.75	0.80	0.68[2]	0.72[2]	0.80
(95% CI)	(0.43, 0.99)	(0.53, 1.07)	(0.51, 1.27)	(0.50, 0.93)	(0.55, 0.95)	(0.43, 1.50)
Stroke mortality						
RR	0.77	0.47	0.39	0.65	0.49[2]	1.08
(95% CI)	(0.32, 1.81)	(0.21, 1.02)	(0.10, 1.51)	(0.35, 1.22)	(0.28, 0.85)	(0.33, 3.54)
Ischemic heart disease incidence						
RR	0.97	1.09	0.97	1.02	0.96	1.25
(95% CI)	(0.78, 1.21)	(0.80, 1.49)	(0.72, 1.30)	(0.79, 1.31)	(0.79, 1.18)	(0.91, 1.71)
Ischemic heart disease mortality						
RR	0.68	0.92	0.61	0.81	0.68[2]	1.19
(95% CI)	(0.44, 1.05)	(0.55, 1.52)	(0.36, 1.06)	(0.58, 1.15)	(0.48, 0.97)	(0.66, 2.14)
Cardiovascular disease mortality						
RR	0.64[3]	0.89	0.64[2]	0.76[2]	0.70[3]	0.89
(95% CI)	(0.45, 0.89)	(0.63, 1.28)	(0.43, 0.97)	(0.59, 0.97)	(0.55, 0.90)	(0.52, 1.53)
Noncardiovascular disease mortality						
RR	1.00	0.88	0.88	0.98	0.92	1.02
(95% CI)	(0.78, 1.29)	(0.65, 1.20)	(0.63, 1.22)	(0.76, 1.26)	(0.72, 1.18)	(0.66, 1.59)
All-cause mortality						
RR	0.82	0.89	0.78[2]	0.87	0.82	0.95
(95% CI)	(0.67, 1.02)	(0.68, 1.16)	(0.60, 1.03)	(0.73, 1.05)	(0.68, 0.99)	(0.66, 1.37)

[1] RRs adjusted where appropriate for age, sex, race, diabetic status, physical activity (3 categories), education level (completed or did not complete high school), regular alcohol consumption (4 categories), current cigarette smoking at baseline (yes or no), vitamin supplement use (yes or no), and total energy intake (continuous); n = 9156.
[2] P for trend < 0.05.
[3] P for trend < 0.01.

Our finding of a 27% lower cardiovascular disease mortality with the consumption of fruit and vegetables ≥3 times/d compared with <1 time/d (a difference of 278 g/d), calculated from a 24-h dietary recall, was consistent with the finding of van't Veer et al. Law and Morris (5) conducted a meta-analytic review of 11 cohort studies of fruit and vegetable consumption or a nutrient marker. They found an estimated reduction in the RR of 15% for a contrast between the 90th and 10th percentiles of 6 dietary markers of fruit and vegetable consumption. Although our results are not directly comparable, they are compatible with those of Law and Morris.

Persons consuming fruit and vegetables frequently are likely to have other healthy habits, ie, exercise regularly, do not smoke cigarettes, and have a low dietary intake of cholesterol and saturated fat. In our study population, the dietary intake of saturated fat was not associated with fruit and vegetable intake. In addition, the estimates of risk we present were adjusted for important potential confounders of cardiovascular disease, such as, race, sex, education level, physical activity, cigarette smoking, regular alcohol consumption, and diabetes status. The associations between fruit and vegetable intake and risk of cardiovascular disease were consistent with our main findings in both direction and magnitude across strata of vitamin use, smoking status, and level of recreational activity, all of which are markers of a healthy lifestyle. These findings generally indicate that the association of fruit and vegetable intake with a lower risk of cardiovascular disease and total mortality may not be the result of confounding by other health habits.

Several individual nutrients, including potassium, antioxidants, and folic acid—which are abundant in fruit and vegetables—may contribute to the inverse association of the intake of these foods with the risk of stroke and mortality from cardiovascular disease (1–3, 28). Although each of these nutrients may play a protective role in the prevention of cardiovascular disease, their effect in combination with those of other components in whole foods may have a greater effect. Although every effort was made to isolate the effects of fruit and vegetables alone, the results presented herein may also pertain to a dietary pattern rich in fruit and vegetables. Consequently, the role of foods and dietary patterns and the role of specific nutrients in the prevention of cardiovascular disease should be investigated.

In conclusion, this study indicates that the frequency of fruit and vegetable intake is inversely associated with stroke incidence, stroke mortality, ischemic heart disease mortality, cardiovascular disease mortality, and all-cause mortality in the general US population. Nutrients in whole foods, such as fruit and vegetables, may have additive and synergistic effects not available through dietary supplementation. In addition, this study provides additional evidence for recommendations to increase fruit and vegetable intakes as part of a dietary approach to prevent cardiovascular disease.

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