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Impact of Diet on Mortality From Stroke: Results From the U.S. Multiethnic Cohort Study

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Abstract

Objectives—Stroke is the fourth leading cause of death in the United States and stroke mortality rates vary by ethnicity. The purpose of this study was to examine the associations between food group consumption and risk of death from stroke among 5 ethnic groups in the United States.

Methods—The Multiethnic Cohort includes >215,000 participants, the majority of whom are African American, Native Hawaiian, Japanese American, Latino, and Caucasian men and women recruited by mail survey in Hawaii and Los Angeles in 1993–1996. Deaths from stroke were identified by linkage to the state death files and the U.S. National Death Index. Diet was assessed using a validated food frequency questionnaire. Associations were examined using multivariable Cox proportional hazards models, stratified by ethnicity and gender.

Results—A total of 860 deaths from stroke were identified among the cohort participants. Vegetable intake was associated with a significant reduction in risk for fatal stroke among African American women (relative risk [RR] = 0.60; 95% CI: 0.36–0.99). Among Japanese American women only, high fruit intake was significantly associated with a risk reduction for stroke mortality (RR = 0.43; 95% confidence interval [CI]: 0.22–0.85), whereas meat intake increased risk (RR = 2.36; 95% CI: 1.31–4.26). Among men, a significant reduction in stroke mortality was observed among Native Hawaiians (RR = 0.26; 95% CI: 0.07–0.95). After pooling the data for the ethnic groups, the findings support an elevated risk for high meat intake among women overall (RR = 1.56; 95% CI: 1.12–2.16); no significant effects of dietary intake on risk for fatal stroke were observed among men.

Conclusions—Although some variations were observed for the associations between diet and stroke mortality among ethnic groups, the findings suggest that these differences are not substantial and may be due to dietary intake of specific food subgroups. Additional investigations including dietary subgroups and nutrients sources are needed to clarify these findings.

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Keywords

stroke mortality; food groups; ethnicity; Multiethnic Cohort Study

INTRODUCTION

Cerebrovascular disease (stroke) was the fourth leading cause of death in the United States in 2008 and accounted for 134,148 deaths that year [1]. Disparities in mortality from stroke (both hemorrhagic and ischemic) have been shown to exist among different ethnic groups in the United States [2]. In 2008, the age-adjusted death rates (per 100,000 population) among males was 63.4 for African Americans, 39.2 for Caucasians, 34.0 for Asians, and 33.1 for Hispanics [1]. Women tend to have lower stroke mortality rates compared to men, but these ethnic differences are still apparent (54.4 for African Americans, 39.0 for Caucasians, 28.9 for Hispanics, and 32.1 for Asians) [1].

A substantial body of evidence has shown that diet is related to risk of stroke. A protective effect of fruits, vegetables, and whole grain products against cardiovascular diseases [3,4], including stroke [5,6], has been observed in many large prospective studies. However, most previous studies examining associations between diet and stroke were conducted in primarily Caucasian populations, and the literature on ethnic minorities is limited. Previous work has also demonstrated ethnic differences in dietary consumption of specific food groups [7,8]. The United States Department of Agriculture (USDA) and the American Heart Association developed general population dietary guidelines for consumption of the 5 food groups (vegetables, fruit, meat and meat alternatives, grains, and dairy) to improve overall health and reduce the risk of chronic disease [9]. The proportion of the U.S. population from minority ethnic backgrounds is increasing [10] and, therefore, the need for additional health data on how risk factors and rates of disease vary by ethnicity is evident [11].

The objective of this study was to determine the association between intake of the 5 makhor USDA food groups and the risk of death from stroke among f5 ethnic groups in the Multiethnic Cohort (MEC).

METHODS

Study population

The MEC was established in Hawaii and Los Angeles between 1993 and 1996 [12]. More than 215,000 men and women aged 45 to 75 years at baseline and representing 5 main ethnic groups (African American, Native Hawaiian, Japanese American, Latino, and Caucasian) were mailed a self-administered questionnaire. The response rates were highest for Japanese Americans (46% for men and 51% for women) and lowest for Latinos (19% for men and 21% for women). However, the MEC was shown to include a representative population sample as evidenced by a comparison of educational levels and marital status with census data [12]. All participants filled out a mailed questionnaire, including a quantitative food frequency questionnaire (QFFQ). History of medical conditions was determined by asking the following question: “Has your doctor ever told you that you had any of the following conditions?” with choices for specific diseases and conditions, including stroke.

The following participants were excluded: people not belonging to one of the 5 main ethnic groups (n=13 994), participants with missing smoking information (n=6743), with extreme diets based on energy and macronutrient intakes as well as daily food group servings (n=12 346 those with implausible or missing anthropometric information (n = 3251), and those with a history of stroke (n = 4609). This resulted in a study population of 78,844 men and 96,044 women. The study protocol was approved by the institutional review boards of the University of Hawaii and University of Southern California and all participants provided informed consent.

Dietary assessment

The QFFQ was developed from 3-day measured dietary records from 60 participants of each ethnic-sex group [12]. Ethnic-specific foods were included in the QFFQ irrespective of their contribution to the diet. The QFFQ inquired about the amount of food consumed based on a choice of three portion sizes specific to each food item, which were also shown in representative photographs. The usual intake frequency was based on 8 categories, ranging from ‘Never or hardly ever’ to ‘2 or more times a day’. The QFFQ was validated and calibrated using 3 randomly collected 24-hour dietary recalls in each ethnic–gender group in a total of 1606 subjects [13]. Average correlation coefficients for all nutrients ranged from 0.26 in African American women to 0.57 in Caucasian men, whereas for nutrient densities, average correlations ranged from 0.57 to 0.74 across ethnic–gender groups.

A food composition table specific for the MEC, including a large recipe database and many unique foods consumed by the multiethnic population, was developed to analyze the QFFQ data [12,14]. All mixed dishes were broken down into their component ingredients and the food group servings were computed by summing up the servings across the appropriate food items for each individual [7,8,14]. The food groups and servings were based on the USDA dietary guidelines and included vegetables (dark green, deep yellow, potato, starchy, tomato, other vegetables), fruit (citrus, melons and berries, other fruits), meat and meat alternatives (all meat, fish and poultry, organ meat, frankfurter/sausage/lunch meats, poultry, egg, nuts, dry beans and peas), grains (whole grain, non-whole grain), and dairy products (milk, yogurt, cheese) [9]. Fruits and vegetables contributed to 70%–75% of vitamin C intake among the different ethnic–gender groups; vegetables were major contributors to vitamin A intake (carrots alone contributed 17%–35% among the different ethnic–gender groups); grains were significant contributors of thiamin (39%–46%), riboflavin (23%–29%), niacin (27%–36%), and vitamin B6 (23%–28%); dairy products contributed significantly to calcium (20%–47%) and vitamin D (30%–50%; Sharma, S, 2012, unpublished data); meat, fish, and poultry dishes were significant sources of protein (approximately 30%) and vitamin B12 (>30% for most ethnic–gender groups) [15,16], and fish was also a major source of vitamin D (13%–36%; Sharma, S, 2012, unpublished data).

Case ascertainment

For this study, the MEC was linked to data from state death files and the National Death Index through December 31, 2001. Deaths from stroke were identified and classified as International Classification of Diseases, Ninth Revision (ICD-9) codes 430–438 or ICD-10 codes I60–I64, I67, and I69 [17,18]. Follow up ended at the earliest of the following events: death or December 31, 2001 (i.e., censor date).

Statistical analysis

The association between food group intake and risk of fatal stroke and hypertensive disease was estimated as relative risks (RR) and 95% confidence intervals (95% CI) using Cox proportional hazards regression models. Exposure to food group consumption was analysed based on tertiles for the entire cohort or gender-specific tertiles, as appropriate. Separate models for men and women are presented and were adjusted for the following potential confounders: ethnicity when appropriate (as a stratum variable), time on study (≤2, 3–5, and >5 years, as a strata variable), history of diabetes (yes–no), body mass index (≤18.5, 18.6–24.9, 25.0–29.9 and ≥30) and alcohol intake (yes–no) as categorical variables; and years of education, energy intake (logarithmically transformed due to the skewed distribution), and physical activity (average hours of moderate or vigorous physical activity per day) as continuous variables. Evaluating complex smoking models revealed that a model with categorical indicator variables for current and former smokers and pack-years as a continuous variable was appropriate. Due to their high correlations, the different food groups were mutually adjusted for each other. In addition, we included history of hormone replacement therapy in the models for women. Tests based on Schoenfeld residuals showed no evidence that proportional hazard assumptions were violated. Trend variables, which were assigned the median of the appropriate tertile values, were used to assess dose–response relationships. All statistical analyses were performed using SAS statistical software, version 9.1 (SAS Institute, Inc., Cary, NC).

Potential variations in the effects of diet on stroke mortality were examined using ethnic–gender-stratified models, considering direction of point estimates, extent of confidence interval overlap, dose–response effects, as well as the plausibility of nonuniform effects based on supporting literature [19].

RESULTS

A total of 860 deaths from stroke (434 men and 426 women) and 353 deaths from hypertensive disease (188 men and 165 women) were identified in the MEC during the 8 years of follow-up. The average length of follow-up time was 7.5 years (SD = 1.1). The demographics of stroke mortality cases compared to the entire cohort are presented in Table 1. Mean daily intake of energy as well as mean daily servings of the 5 food groups were similar between cases and the total cohort. Among both men and women, fatal stroke cases had a higher proportion of current smokers and individuals with ≤10 years of education, as well as a higher prevalence of diabetes and hypertension compared to all participants. In addition, compared to the total number of women in the cohort, a lower proportion of the women were married.

Among men (Table 2), there was a statistically significant increase in risk of stroke mortality among the Japanese Americans with vegetable intake in the second tertile (RR = 1.60; 95% CI: 1.01–2.53) and reduced risk among Native Hawaiians with meat intake in the second tertile (RR = 0.26; 95% CI: 0.07–0.95). There was no statistical evidence that dietary intake impacted risk of stroke among men in any other ethnic group. Although results reached statistical significance for 2 associations among the men, there was no strong evidence of effect modification observed between the ethnic groups (based on confidence intervals); thus, pooled data for men are also presented in Table 2. After pooling the data, there was no statistically significant evidence of an association between dietary intake for any food group and risk of stroke mortality among men.

Results for women are presented in Table 3. African American women with vegetable intake in the highest tertile had a statistically significant reduction in risk for stroke mortality (RR = 0.60; 95% CI: 0.36–0.99), as did Japanese American women with high fruit intake (RR = 0.43; 95% CI: 0.22–0.85). High meat intake was associated with an elevated risk of death from stroke among Japanese American women. This association was apparent at both levels of meat intake above the baseline, although the findings reached statistical significance only for meat intake in the second tertile (RR = 2.36; 95% CI: 1.31–4.26 for the second tertile of meat intake; RR = 2.19; 95% CI: 0.94–5.09 for the third tertile). The point estimates for associations between meat intake and stroke mortality among Caucasian, African American, and Latino women (point estimates RR = 1.59, 1.28, and 1.24, respectively) also suggested that high meat intake may elevate risk, although these results were not statistically significant. No significant associations or trends were observed for associations between grain or dairy intake among women in any ethnic group. Similar to the men's group, there was considerable overlap of confidence intervals across the ethnic group strata for all food groups; thus, pooled results are also included women. After pooling, point estimates were indicative of an inverse association between higher vegetable and dairy intake and risk of fatal stroke among women, but these results were not statistically significant. There was a significant elevated risk of stroke mortality among women with meat intake in the highest tertile (RR = 1.56; 95% CI: 1.12–2.16), as well as a significant trend association (p = 0.01) for increased risk.

The associations between dietary intake and risk for stroke mortality for the total cohort population and by ethnicity (without gender stratification) are presented in Table 4. Statistically significant associations were observed only among the Native Hawaiians, where protective associations were found among those with vegetable intake in the second tertile (RR = 0.40; 95% CI: 0.17–0.96) and meat intake in the third tertile (RR = 0.26; 95% CI: 0.10–0.72). No significant associations between dietary intake and food group consumption were observed when data were pooled for the total cohort population.

DISCUSSION

This study examined the association between dietary intake from the 5 major USDA food groups and risk of death from stroke among 5 ethnic populations in the United States. The findings for the ethnic–gender-stratified analyses suggest the possibility that higher intake of vegetables may have a greater benefit in African American women, whereas higher intake of fruit is beneficial among Japanese American women. A recent meta-analysis of cohort studies reported an inverse association between fruit and vegetable intake and the risk of stroke, suggesting a possible protective effect [20]. These effects could be due to the high content of antioxidants, folate, potassium, and fiber in many fruits and vegetables. Dietary potassium has been shown to decrease platelet aggregation and arterial thrombosis and is therefore associated with a reduced risk of occlusive stroke [21,22]. Lee et al. found that potassium intake was inversely related to risk of fatal thromboembolic stroke among Japanese American men [23]. There is strong evidence that high fiber intake inhibits the development of atherosclerosis or thrombosis and thus supports the protective effect on risk of ischemic stroke [24]. In the present study, however, beneficial effects of vegetables and fruit on fatal stroke were most apparent in women among specific ethnic groups only. This observation, and the lack of evidence among other groups, may be due to the specific types of fruit and vegetables consumed by these ethnic groups.

A significant reduction in risk for stroke mortality was observed among Native Hawaiian men with higher meat intake levels. Conversely, the risk for stroke mortality was relatively high among Japanese American women with higher meat intake compared to other ethnic groups. However, point estimates for the association between meat intake and stroke mortality were elevated among all other ethnic groups of women with the exception of Native Hawaiians, and stratum-specific results indicated that presentation of pooled results would be appropriate. Previous studies have also reported a positive association between meat intake and risk of stroke [25,26], possibly due to the high content of fat and cholesterol. The differential impact of meat subgroups on disease risk has also been demonstrated. For example, fish consumption has been associated with a lower risk of stroke [27,28], whereas chicken [28] and processed red meat [29] have been shown to increase this risk, which may explain the observations in this study. Examining the effect of each of these food subgroups on risk of fatal stroke by gender and ethnicity could provide additional insight but was beyond the scope of the present analysis.

No statistically significant associations were observed between dairy intake and risk of fatal stroke for any of the models examined in the current analyses. This finding is in contrast with 2 cohort studies in Japan and a recent meta-analysis that reported a protective association between dairy products and risk for stroke [30–32]. The analyses presented in this study were based on tertiles, but it is of interest that a statistically significant protective association (approximately a 30% risk reduction) between higher levels of dairy intake and stroke mortality was observed among women when quartiles of dairy intake were examined (data not shown), rather than tertiles. A protective effect of dairy products on risk of stroke is plausible given the role that calcium, potassium, and magnesium play in reducing platelet aggregation and insulin resistance and in improving the metabolism of lipids in the blood [30,32,33].

There was no significant effect of grain intake observed in our study. Previous studies found that whole grain intake was significantly associated with a reduced risk of stroke and hypertension, while refined grains were identified as risk factors [6, 34, 35]. These contradictory findings for grain subgroups might explain the null effect of total grain in our study.

Some variation was observed for the effects of diet on risk of stroke mortality among the ethnic–gender groups, as previously discussed, but the extent of variation in the estimates (i.e., based on confidence intervals) suggested that the effects of diet on risk for stroke mortality may not be dissimilar. Thus, pooled results were also presented for each gender group. No significant associations were observed among men, but a significantly elevated risk for stroke mortality was observed for women with high dietary intake of meat. Although this association was observed only among women, specific meat products, processed meats in particular, have been shown to increase risk for stroke among both genders [29,36]. It is possible that the differences in associations between men and women observed in our study may reflect differences in types and quantities of specific foods consumed and/or food preparation methods. Synergistic and antagonistic interactions of nutrients within the entire diet may result in different observed associations between single food groups and risk of fatal stroke in men and women. Thus, future studies examining nutrients associated with fatal stroke in multiethnic groups are necessary.

Pooled results for the entire population and by ethnicity, without gender stratification, were also examined. Among the ethnic groups, significant preventive associations were observed among Native Hawaiians with higher intake of vegetables and meat. Baseline data from the MEC have shown that fish intake, a possible preventive factor against stroke [27,28] as discussed previously, was at least 6% higher among the Native Hawaiians than in any other ethnic group and may explain these observations. A preventive effect for vegetable intake is also plausible based on previous research, but given the limited number of cases among the Hawaiian group, and lack of an expected dose–response relationship, the current results should be interpreted with caution. No significant findings were observed data for the whole cohort were pooled. These results for the whole cohort have been included for the interested reader, but given the variation in associations between meat intake and stroke mortality observed among men versus women, the gender-specific findings may be more relevant. Further, it is plausible that undetermined biochemical differences between the sexes, such as percentage body fat, serum cholesterol level, blood glucose, hormonal effects, and insulin resistance, could play a crucial role in atherosclerosis [37], and gender differences in associations between diet and stroke mortality have been reported previously [38]. Thus, it is important that gender-specific results be considered in evaluations of dietary risk factors for stroke.

Previous studies on risk of morbidity and mortality from stroke have primarily been conducted among Caucasian populations and, thus, the present study is among the first to examine differences in dietary risk factors of fatal stroke disease among ethnic minority groups in the United States. This study employed a very large, stratified random sample of persons of ethnic groups that comprise an increasing proportion of the U.S. population [10]. The large sample size and information on a wide range of covariates allowed us to adjust the analyses for a variety of potential confounders. Another strength of this study was the use of standardized food group servings, which facilitated direct comparisons of food intake across all ethnic–gender groups. Furthermore, all dietary data were analyzed using the same food composition tables, included ethnic-specific foods, and the dietary data were collected using a common QFFQ, which allowed for meaningful comparison of results across ethnicities.

The QFFQ in this study was carefully developed to obtain portion sizes and to include commonly consumed and unique ethnic food items [13,14].

Limitations that should also be noted include potential inaccuracies in the dietary data. The QFFQ was subject to recall bias, and over reporting of the dietary data was also a concern. Although the QFFQ used in the MEC was validated and was shown to capture total intake relatively well [13,14], additional methods such as food diaries and biomarkers may have been useful to validate capture of specific food groups [39]. Misclassification bias may also be a concern, because up to 20% of ischemic stroke cases may be misclassified [40], and several factors may influence the accuracy of ICD coding for stroke [41]. Considering that several previous studies have found the effects of diet on ischemic versus hemorrhagic stroke [42–45] to be similar, the concerns regarding misclassification, and the relatively small number of stroke cases observed in this study, the current analyses did not differentiate outcomes of ischemic versus hemorrhagic stroke. Future studies using methods such as review of medical records may be useful to improve the accuracy of stroke outcome measures. As previously mentioned, differences in dietary intake of food subgroups could also have resulted in the failure to detect significant associations between the 5 food groups and stroke mortality. For example, previous MEC studies have reported ethnic variation in mean daily intake of red meat among males (49 g/day among Japanese Americans to 73 g/day among Latinos), and fish and rice intake is considerably higher among Japanese Americans and Native Hawaiians of both genders compared to other ethnic groups [12]. Specific nutrient food sources can also vary; among most ethnic groups in the MEC, women had higher percentages of dairy products contributing to saturated fat intake, whereas red meat was a greater contributor among men [15]. However, food sources for some nutrients, such as vitamin D and calcium (Sharma, S, 2012, unpublished data), and B vitamins [16] are very similar across ethnic–gender groups. Future work focused on analyses of specific subgroups would be useful to clarify the observed associations among the different ethnic and gender groups.

Conclusions

Some variation was observed in the associations between diet and risk of fatal stroke among the different ethnic groups in this study. Additional research in this area is needed to investigate the role of dietary subgroups, nutrients, and other components of foods in explaining potential ethnic differences in stroke mortality and would be useful to confirm whether differences in risk of stroke mortality do exist between ethnic groups and/or genders. As the proportion of minority ethnic groups in the U.S. population increases, there is a need to continue to assess the associations between dietary factors and disease risk among different ethnic groups to target appropriate interventions.

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Table 1

Characteristics of cases of death from stroke and the total cohort

Characteristics	Men				Women			
	Cases (n=434)		Total participants (n=78 844)		Cases (n=426)		Total participants (n=96 044)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age at cohort entry (years)	66.6	7.1	65.7	7.6	66.4	7.4	59.3	8.8
Energy intake (kcal)	2141	1009	2301	974	1806	850	1887	840
% energy from fat	30.1	7.5	30.2	7.1	30.2	7.2	29.7	7.1
% energy from saturated fat	8.9	2.8	8.9	2.7	9.0	2.6	8.7	2.6
% energy from alcohol	3.8	8.2	4.1	7.4	1.7	5.4	1.6	4.6
% energy from carbohydrate	51.3	9.9	51.1	9.1	52.9	9.5	53.6	8.9
Food group intake (servings/day)								
Vegetables	4.3	2.7	4.5	2.8	4.2	2.6	4.6	2.9
Fruit	3.2	2.5	3.0	2.6	3.4	2.6	3.5	2.9
Meat	5.7	3.6	6.2	3.8	4.8	3.1	4.8	3.1
Dairy	1.2	1.0	1.2	1.0	1.2	1.0	1.2	1.0
Grain	7.8	3.9	8.4	3.8	6.4	3.3	7.0	3.5
Moderate or vigorous activity (hours/day)	1.1	1.4	1.3	1.5	0.9	1.1	1.1	1.2
Smoking (pack-years)	17.4	17.9	13.7	16.4	10.5	15.5	6.5	12.0
	Percent (%)							
Ethnicity								
Caucasian	17		26		21		25	
African American	25		13		36		19	
Native Hawaiian	4		7		6		7	
Japanese American	31		31		18		28	
Latino	23		23		19		21	
Body Mass Index (kg/m^2)								
≤ 18.5	1		1		5		3	
18.6 – 24.9	49		42		41		47	

Characteristics	Men		Women	
	Cases (n=434)	Total participants (n=78 844)	Cases (n=426)	Total participants (n=96 044)
25.0 – 29.9	34	43	30	31
≥ 30	16	14	24	19
Smoking status				
Never smoker	27	31	45	57
Past smoker	51	51	33	29
Current smoker	22	18	22	14
Alcohol consumers	51	63	30	39
Medical history				
History of Diabetes	26	12	24	10
History of Hypertension	60	39	62	37
Education				
Graduated college	18	30	15	25
Grade 11/12 - some college	57	54	60	58
≤10yrs education	25	16	25	17
Currently Married	74	77	47	59

Table 2

Food group intake (servings per day) and risk of death from stroke among men and women*

	Men	Women
Cases / Non-cases	434 / 78 410	426 / 95 618
Vegetables		
Q1 (0–2.3)	1.00	1.00
Q2 (2.4–3.4)	0.80 (0.59–1.08)	1.02 (0.75–1.37)
Q3 (3.5–4.6)	1.00 (0.74–1.36)	1.04 (0.76–1.42)
Q4 (4.7–6.6)	1.00 (0.72–1.40)	0.91 (0.65–1.23)
Q5 (>6.6)	1.01 (0.70–1.47)	0.79 (0.53–1.17)
p for trend	*0.57*	*0.15*
Fruit		
Q1 (0–1.0)	1.00	1.00
Q2 (1.0–1.9)	0.98 (0.71–1.33)	0.89 (0.65–1.23)
Q3 (2.0– 3.0)	0.92 (0.67–1.27)	0.96 (0.70–1.31)
Q4 (3.1– 4.8)	1.15 (0.84–1.59)	0.93 (0.67–1.29)
Q5 (>4.8)	1.11 (0.79–1.57)	0.83 (0.57–1.20)
p for trend	*0.32*	*0.39*
Meat		
Q1 (0– 2.5)	1.00	1.00
Q2 (2.6–3.7)	0.86 (0.65–1.14)	0.92 (0.67–1.26)
Q3 (3.8–5.1)	0.76 (0.55–1.05)	1.01 (0.72–1.41)
Q4 (5.2–7.3)	0.84 (0.59–1.19)	1.26 (0.89–1.79)
Q5 (>7.3)	0.87 (0.57–1.34)	1.06 (0.69–1.65)
p for trend	*0.71*	*0.52*
Grain		
Q1 (0–5.1)	1.00	1.00
Q2 (5.2–7.0)	1.11 (0.82–1.49)	0.84 (0.62–1.15)
Q3 (7.1–9.0)	1.01 (0.71–1.43)	0.86 (0.60–1.22)
Q4 (9.1–12.0)	1.08 (0.73–1.61)	1.03 (0.70–1.53)
Q5 (>12.0)	1.25 (0.78–2.00)	0.81 (0.49–1.34)
p for trend	*0.40*	*0.69*
Dairy		
Q1 (0–0.4)	1.00	1.00
Q2 (0.5–0.8)	0.94 (0.70–1.27)	0.73 (0.54–0.99)
Q3 (0.9–1.2)	0.96 (0.70–1.31)	0.75 (0.55–1.02)
Q4 (1.3–1.9)	1.18 (0.86–1.63)	0.65 (0.46–0.92)
Q5 (>1.9)	0.98 (0.67–1.43)	0.73 (0.51–1.06)
p for trend	*0.79*	*0.24*

*Adjusted for ethnicity, time on study, years of education, energy intake, smoking, body mass index, physical activity, history of diabetes, and alcohol intake. The models for women were additionally adjusted for history of hormone replacement therapy.

Table 3

Food group intake (servings per day) and risk of death from stroke among men by ethnic group*

	Caucasian	African American	Japanese American	Latino
Cases / Non-cases	74 / 20 615	106 / 10 323	136 / 23 978	100 / 18 177
Vegetables				
Q1 (0–2.6)	1.00	1.00	1.00	1.00
Q2 (2.7–4.0)	0.86 (0.47–1.59)	0.87 (0.51–1.49)	1.48 (0.84–2.61)	0.78 (0.43–1.40)
Q3 (4.1–6.0)	0.97 (0.50–1.87)	1.28 (0.72–2.27)	2.04 (1.16–3.61)	0.92 (0.50–1.69)
Q4 (>6.0)	0.75 (0.32–1.74)	0.65 (0.29–1.47)	1.53 (0.80–2.94)	0.90 (0.44–1.83)
p for trend	*0.57*	*0.49*	*0.39*	*0.94*
Fruit				
Q1 (0–1.3)	1.00	1.00	1.00	1.00
Q2 (1.4–2.4)	0.79 (0.39–1.57)	0.94 (0.56–1.59)	0.78 (0.45–1.38)	1.12 (0.61–2.06)
Q3 (2.5–4.2)	1.24 (0.64–2.39)	1.16 (0.68–2.00)	1.24 (0.74–2.08)	1.16 (0.62–2.18)
Q4 (>4.2)	1.49 (0.72–3.11)	0.66 (0.34–1.29)	1.31 (0.75–2.31)	1.12 (0.58–2.16)
p for trend	*0.14*	*0.26*	*0.14*	*0.81*
Meat				
Q1 (0–3.6)	1.00	1.00	1.00	1.00
Q2 (3.7–5.4)	0.86 (0.47–1.57)	0.98 (0.57–1.68)	0.74 (0.45–1.21)	0.82 (0.44–1.54)
Q3 (5.5–8.0)	1.13 (0.56–2.30)	0.82 (0.42–1.58)	0.97 (0.58–1.65)	1.15 (0.61–2.19)
Q4 (>8.0)	0.73 (0.23–2.25)	0.87 (0.40–1.93)	0.85 (0.43–1.71)	0.85 (0.38–1.90)
p for trend	*0.76*	*0.71*	*0.89*	*0.76*
Grains				
Q1 (0–5.6)	1.00	1.00	1.00	1.00
Q2 (5.7–7.9)	1.27 (0.72–2.26)	0.98 (0.54–1.79)	0.76 (0.42–1.37)	0.98 (0.54–1.78)
Q3 (8.0–11.1)	0.62 (0.25–1.52)	1.68 (0.84–3.36)	0.78 (0.42–1.46)	0.80 (0.39–1.66)
Q4 (>11.1)	0.89 (0.27–2.91)	2.10 (0.88–5.02)	0.54 (0.25–1.16)	1.26 (0.54–2.95)
p for trend	*0.58*	*0.06*	*0.12*	*0.54*
Dairy				
Q1 (0–0.5)	1.00	1.00	1.00	1.00
Q2 (0.6–1.0)	0.86 (0.42–1.75)	1.39 (0.82–2.34)	0.90 (0.58–1.40)	0.84 (0.38–1.82)
Q3 (1.1–1.7)	0.84 (0.41–1.71)	1.20 (0.66–2.19)	1.26 (0.80–1.96)	1.47 (0.72–3.02)
Q4 (>1.7)	0.81 (0.37–1.76)	0.96 (0.45–2.05)	0.88 (0.43–1.79)	1.33 (0.60–2.93)
p for trend	*0.67*	*0.68*	*0.85*	*0.33*

*Adjusted for time on study, years of education, energy intake, smoking, body mass index, physical activity, history of diabetes, and alcohol intake.

Table 4

Food group intake (servings per day) and risk of death from stroke among women by ethnic group*

	Caucasian	African American	Japanese American	Latino
Cases / Non-cases	92 / 24 114	152 / 18 082	76 / 27 137	80 / 19 473
Vegetables				
Q1 (0–2.6)	1.00	1.00	1.00	1.00
Q2 (2.7–4.0)	0.49 (0.27–0.90)	0.90 (0.59–1.38)	1.45 (0.74–2.85)	1.51 (0.76–3.01)
Q3 (4.1–6.0)	0.51 (0.27–0.97)	0.52 (0.30–0.89)	1.32 (0.63–2.76)	1.69 (0.82–3.51)
Q4 (>6.0)	0.77 (0.40–1.50)	0.58 (0.31–1.04)	0.85 (0.33–2.15)	1.28 (0.54–3.03)
p for trend	*0.65*	*0.04*	*0.47*	*0.80*
Fruit				
Q1 (0–1.5)	1.00	1.00	1.00	1.00
Q2 (1.6–2.8)	0.78 (0.43–1.40)	0.88 (0.55–1.41)	0.64 (0.33–1.22)	1.72 (0.82–3.62)
Q3 (2.9–4.9)	1.01 (0.56–1.80)	1.02 (0.63–1.64)	0.63 (0.33–1.21)	1.57 (0.72–3.43)
Q4 (>4.9)	0.63 (0.30–1.33)	0.81 (0.47–1.41)	0.37 (0.16–0.83)	2.07 (0.92–4.64)
p for trend	*0.34*	*0.53*	*0.03*	*0.15*
Meat				
Q1 (0–2.8)	1.00	1.00	1.00	1.00
Q2 (2.9–4.2)	1.05 (0.61–1.81)	0.84 (0.50–1.41)	2.03 (1.05–3.92)	0.98 (0.45–2.12)
Q3 (4.3–6.3)	0.97 (0.50–1.88)	1.03 (0.60–1.76)	2.28 (1.05–4.92)	1.60 (0.76–3.37)
Q4 (>6.3)	1.47 (0.64–3.41)	1.17 (0.62–2.20)	1.86 (0.63–5.52)	0.88 (0.34–2.26)
p for trend	*0.43*	*0.41*	*0.32*	*0.68*
Grains				
Q1 (0–4.5)	1.00	1.00	1.00	1.00
Q2 (4.6–6.5)	0.79 (0.45–1.40)	0.80 (0.50–1.27)	1.91 (0.81–4.52)	1.56 (0.75–3.26)
Q3 (6.6–9.1)	0.76 (0.37–1.54)	0.82 (0.47–1.43)	2.33 (0.88–6.17)	1.57 (0.67–3.67)
Q4 (>9.1)	0.73 (0.27–1.97)	0.55 (0.26–1.16)	2.45 (0.71–8.47)	1.40 (0.49–4.05)
p for trend	*0.51*	*0.14*	*0.30*	*0.79*
Dairy				
Q1 (0–0.5)	1.00	1.00	1.00	1.00
Q2 (0.6–1.0)	1.18 (0.59–2.33)	0.84 (0.53–1.34)	0.62 (0.35–1.10)	0.79 (0.37–1.70)
Q3 (1.1–1.7)	1.11 (0.56–2.20)	0.88 (0.54–1.45)	0.39 (0.18–0.82)	0.66 (0.31–1.43)
Q4 (>1.7)	0.83 (0.39–1.78)	0.94 (0.53–1.69)	0.37 (0.13–1.08)	0.70 (0.31–1.62)
p for trend	*0.37*	*0.97*	*0.01*	*0.54*

*Adjusted for time on study, years of education, energy intake, smoking, body mass index, physical activity, history of diabetes, alcohol intake, and history of hormone replacement therapy.

Table 5

Food group intake (servings per day) and risk of death from hypertensive disease among men and women*

	Men	Women
Cases / Non-cases	188 / 81 082	165 / 98 062
Vegetables		
≤ 2.3	1.00	1.00
2.4 – 3.4	0.89 (0.56–1.42)	1.05 (0.89–1.23)
3.5 – 4.6	1.18 (0.74–1.90)	0.87 (0.73–1.03)
4.7 – 6.6	1.07 (0.63–1.81)	0.82 (0.68–0.99)
≥ 6.7	1.53 (0.88–2.66)	0.86 (0.70–1.06)
p for trend	*0.08*	*0.06*
Fruit		
≤ 1.0	1.00	1.00
1.1 – 1.9	0.76 (0.48–1.22)	0.86 (0.73–1.02)
2.0 – 3.0	0.81 (0.50–1.30)	0.82 (0.69–0.98)
3.1 – 4.8	1.10 (0.69–1.75)	0.93 (0.78–1.10)
≥ 4.9	0.97 (0.58–1.61)	0.92 (0.76–1.11)
p for trend	*0.60*	*0.99*
Meat		
≤ 2.5	1.00	1.00
2.6 – 3.7	1.29 (0.82–2.05)	1.00 (0.84–1.18)
3.8 – 5.1	1.11 (0.67–1.86)	0.95 (0.79–1.14)
5.2 – 7.3	1.27 (0.73–2.21)	1.05 (0.86–1.28)
≥ 7.4	1.19 (0.61–2.31)	1.15 (0.91–1.44)
p for trend	*0.81*	*0.13*
Grain		
≤ 5.1	1.00	1.00
5.2 – 7.0	0.96 (0.62–1.47)	1.00 (0.84–1.18)
7.1 – 9.0	0.75 (0.45–1.26)	1.05 (0.87–1.27)
9.1 – 12.0	0.64 (0.35–1.16)	1.05 (0.85–1.31)
≥ 12.1	0.68 (0.34–1.37)	1.08 (0.83–1.41)
p for trend	*0.20*	*0.51*
Dairy		
≤ 0.4	1.00	1.00
0.5 – 0.8	0.95 (0.59–1.51)	1.04 (0.89–1.23)
0.9 – 1.2	1.28 (0.81–2.02)	0.86 (0.72–1.02)
1.3 – 1.9	0.66 (0.38–1.14)	0.91 (0.76–1.10)
≥ 2.0	0.83 (0.47–1.48)	0.84 (0.69–1.03)
p for trend	*0.28*	*0.06*

[*] Adjusted for ethnicity, time on study, years of education, energy intake (logarithmically transformed), smoking, body mass index, physical activity (average hours of moderate or vigorous physical activity per day), history of diabetes, and alcohol intake. The models for women were additionally adjusted for history of hormone replacement therapy.