Associations of key diet-quality indexes with mortality in the Multiethnic Cohort: the Dietary Patterns Methods Project[1–5]

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ABSTRACT

Background: Healthy dietary patterns have been linked positively with health and longevity. However, prospective studies in diverse populations in the United States addressing dietary patterns and mortality are limited.

Objective: We assessed the ability of the following 4 diet-quality indexes [the Healthy Eating Index-2010 (HEI-2010), the Alternative HEI-2010 (AHEI-2010), the alternate Mediterranean diet score (aMED), and the Dietary Approaches to Stop Hypertension (DASH)] to predict the reduction in risk of mortality from all causes, cardiovascular disease (CVD), and cancer.

Design: White, African American, Native Hawaiian, Japanese American, and Latino adults (n = 215,782) from the Multiethnic Cohort completed a quantitative food-frequency questionnaire. Scores for each dietary index were computed and divided into quintiles for men and women. Mortality was documented over 13–18 y of follow-up. HRs and 95% CIs were computed by using adjusted Cox models.

Results: High HEI-2010, AHEI-2010, aMED, and DASH scores were all inversely associated with risk of mortality from all causes, CVD, and cancer in both men and women (P-trend < 0.0001 for all models). For men, the HEI-2010 was consistently associated with a reduction in risk of mortality for all causes (HR: 0.75; 95% CI: 0.71, 0.79), CVD (HR: 0.74; 95% CI: 0.69, 0.81), and cancer (HR: 0.76; 95% CI: 0.70, 0.83) when lowest and highest quintiles were compared. In women, the AHEI and aMED showed large reductions for all-cause mortality (HR: 0.78; 95% CI: 0.74, 0.82), the AHEI showed large reductions for CVD (HR: 0.76; 95% CI: 0.69, 0.83), and the aMED showed large reductions for cancer (HR: 0.84; 95% CI: 0.76, 0. 92).

Conclusion: These results, in a US multiethnic population, suggest that consuming a dietary pattern that achieves a high diet-quality index score is associated with lower risk of mortality from all causes, CVD, and cancer in adult men and women. *Am J Clin Nutr* 2015;101:587–97.

Keywords dietary indexes, epidemiology, multiethnic, risk factors, survival

INTRODUCTION

Traditionally, the assessment of a diet's relation to disease risk focused on the influence of individual or small groups of nutrients and foods. Within the past decade, the examination of dietary intake has broadened to include dietary patterns to capture the complexity of foods and beverages consumed and, as a result, better assess the diet-disease relation (1). Dietary patterns reflect real-world dietary practices and the numerous and multifaceted combinations with which foods can be consumed (1, 2). Analyses that take into account dietary patterns hold promise for better translating research to food-based dietary guidelines.

Several indexes were developed by using a hypothesis-oriented methodology (a priori approach that uses available scientific evidence) and applied to populations to better evaluate the role of diet in cardiovascular disease (CVD)[6] (3), cancer (4, 5), other diseases, and biomarkers (6, 7). The Dietary Patterns Methods Project (DPMP) was initiated by the National Cancer Institute (8) in an effort to establish a common methodology for the application of dietary indexes and, in so doing, strengthen the scientific evidence relating dietary patterns to mortality (9, 10). A review of the literature led to the selection of 4 dietary indexes to examine within the Multiethnic Cohort (MEC), the NIH-AARP Diet and Health Study (9), and the Women's Health Initiative Observational study (10).

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[3] Supplemental Tables 1–10 and Supplemental Figure 1 are available from the "Supplemental data" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

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[6] Abbreviations used: AHEI-2010, Alternate Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension; DPMP, Dietary Patterns Methods Project; HEI-2010, Healthy Eating Index-2010; MEC, Multiethnic Cohort; MPED, MyPyramid Equivalents Database; QFFQ, quantitative food-frequency questionnaire; Qx1, baseline questionnaire; SSB, sugar-sweetened beverage.

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The Healthy Eating Index (HEI) takes a global approach to assess diet quality that includes nearly all foods in the calculation of the total score (11–13). The Alternative Healthy Eating Index (AHEI) and alternate Mediterranean diet score (aMED) (14, 15) tailor their score calculations on the basis of whether foods were shown to increase or decrease chronic disease outcomes and survival (15–19). Last, the Dietary Approaches to Stop Hypertension (DASH) index (20, 21) was developed to reflect adherence to a particular dietary pattern shown in randomized trials to reduce blood pressure (22–24).

The application of these dietary indexes in a multiethnic population is of particular importance because of the racially and ethnically diverse population of the United States as well as health disparities in groups (25). Previous work in the MEC indicated that there are similarities and differences across ethnic groups in commonly consumed foods (26), adherence to dietary recommendations (15, 27), and patterns derived by using an exploratory factor analysis (28). The Multi-Ethnic Study of Atherosclerosis examined the intake of specific nutrients on the basis of the DASH in its members and showed significant ethnic differences in all nutrients except saturated fat (29).

Few studies have examined mortality outcomes and adherence to dietary indexes in a multiethnic population. Findings from such research have important implications on the development of dietary guidelines that are applicable to the entire US population. To this end, we examined the association between dietary patterns as defined by the 4 diet-quality index scores identified by the DPMP and mortality from all causes, CVD, and cancer in the MEC.

METHODS

Study population

The MEC is a prospective cohort study that recruited a multiethnic population to investigate the association of lifestyle and genetic factors with the incidence of cancer and other diseases. The study's design and implementation have been described previously (30). Briefly, >215,000 men and women aged 45–75 y at recruitment and living in Hawaii or the Los Angeles area were enrolled between 1993 and 1996. To obtain a multiethnic sample of whites, African Americans, Native Hawaiians, Japanese Americans, and Latinos, driver's license files, voter registration lists, and Medicare files were used to identify potential participants. At cohort entry, participants completed a self-administered, 26-page baseline questionnaire (Qx1). The information from the Qx1 included demographics, anthropometric measures, personal and family medical history, reproductive and menstrual history (women), mammogram and Papanicolau test screening practices (women), occupational history, food intake, and physical activity. The institutional review boards at the University of Hawaii and the University of Southern California approved the study protocol.

Dietary assessment and calculation of dietary indexes

The Qx1 included a 182-item quantitative food-frequency questionnaire (QFFQ), which was described in detail elsewhere (30–32). Usual intake over the past 12 mo was assessed by using 8 categories that ranged from never or hardly ever to "≥2 times/d or 9 categories that ranged from never or hardly ever to ≥4 times/d for some beverage items. Quantities of foods were assessed by using 3 portion sizes specific to each food item, which were shown as representative images. The QFFQ was validated and calibrated in each ethnic-sex group by using data from 1606 participants and 3 randomly scheduled 24-dietary recalls (31). The MEC QFFQ has several unique attributes, including the presence of ethnic-specific foods, reliance on a food composition table specific to the MEC, and use of a large recipe database (33).

MEC food-composition tables were used to create the major food groups and subgroups that make up The Pyramid Servings Database, subsequently called the MyPyramid Equivalents Database (MPED) (32). The MPED is a standardized food-grouping system developed by the USDA that disaggregates most foods into their ingredients and allocates each ingredient to 1 of 32 food groups (34). MPED groups and subgroups were used to construct each dietary index. Amounts of foods reported were converted from portions to cup equivalents or ounce equivalents, which are units of measure used in the MPED. These equivalents can be converted to metric units as follows: 1 oz = 28.3 g and 1 cup = 225 mL.

An overview of the dietary index components and scoring is presented in **Table 1**. Some line items in the QFFQ combined or omitted foods, which required modifications to some components. Table 1 footnotes provide the foods used to calculate components in these situations.

The Healthy Eating Index-2010 (HEI-2010) reflects the 2010 Dietary Guidelines for Americans (35) with higher scores reflecting better adherence to federal dietary guidelines (12). The HEI-2010 updated the components used in the HEI-2005 (11). All components except the fatty acids ratio were calculated as per 1000 kcal, and 5, 10, or 20 points were assigned to optimal intakes. Refined grains, sodium, and empty calories were reverse scored (Table 1).

The Alternate Healthy Eating Index-2010 (AHEI-2010) was developed to identify dietary patterns consistently associated with lower risk of chronic disease in clinical and epidemiologic investigations (16). This index built on aspects of the original Healthy Eating Index (13), the original Alternate Healthy Eating Index (19), and a comprehensive review of relevant literature since the establishment of the first Alternate Healthy Eating Index. Table 1 presents the criteria used to assign an individual's diet the maximum 10 points for each component. Red and processed meat, sugar-sweetened beverages (SSBs), and sodium were reverse coded so that lower intakes provided the maximum points. Within the criteria for the lowest decile of sodium intake, mean intake in the MEC was 1335 mg/d in men and 1080 mg/d in women.

The aMED, as developed by Fung et al. (14), was an adaptation of the Mediterranean diet score developed by Trichopoulou et al. (17, 36) and acknowledged eating behaviors consistently associated with lower risks of chronic disease in studies. In men in the MEC, median intakes of aMED components were as follows: vegetables, 1.66 cup equivalents; fruit, 1.53 cup equivalents; nuts, 0.45 oz equivalents; legumes, 0.09 oz equivalents; fish, 0.63 oz equivalents; whole grains, 1.23 cup equivalents; MUFA:SFA ratio, 1.22; and red and processed meat, 2.04 oz equivalents. in women, median intakes of aMED components were as follows: vegetables, 1.71 cup equivalents; fruit, 1.81 cup

TABLE 1

Components and optimal quantities for scoring standards for each component of HEI-2010, AHEI-2010, aMED, and DASH scores by using standardized cup and ounce equivalents from the MPED[1]

	Dietary quality indexes, scoring, and criteria			
	HEI-2010[2]	AHEI-2010	aMED	DASH
Component	100 points total (12 components: 5–20 points each)	110 points total (11 components: 10 points each)	9 points total (9 components: 1 point each)	8–40 points total (8 components: 1–5 points each)
Vegetables	Total vegetables: 1.1 cup equivalents (5 points); greens and beans: ≥0.2 cup equivalents (5 points)	Excluding potatoes: ≥2.5 cup equivalents	Excluding potatoes: greater than or equal to median cup equivalents	Excluding potatoes: highest quintile
Fruit	Total fruit: ≥0.8 cup equivalents (5 points); whole fruit: ≥0.4 cup equivalents (5 points)	Whole fruit: ≥2 cup equivalents	Total fruit: greater than or equal to median cup equivalents	Total fruit: highest quintile
Nuts		Nuts and legumes: ≥1 oz equivalents	Greater than or equal to median ounce equivalents	Nuts, seeds, and legumes: highest quintile
Legumes			Greater than or equal to median cup equivalents	
Fish	Seafood and plant proteins: ≥0.8 oz equivalents (5 points)		Greater than or equal to median ounce equivalents	
Whole grains[3]	≥1.5 oz equivalents (10 points)	Women: 5 oz equivalents, men: 6 oz equivalents	Greater than or equal to median ounce equivalents	Highest quintile
Total protein foods	≥2.5 oz equivalents (5 points)			
Dairy	≥1.3 cup equivalents[4] (10 points)			Low-fat dairy[5]: highest quintile
Oils/fats	PUFA + MUFA:SFA ratio: >2.5 (10 points)	*trans* Fat: ≤0.5%; EPA + DHA: 250 mg; PUFA: ≥10%	MUFA:SFA ratio: > median	
Alcohol		Women: 0.5–1.5 drinks, men: 0.5–2.0 drinks[6]	Women: 5–15 g/d, men: 10–25 g/d	
Red and processed meat[7]		0 oz equivalents	Less than median ounce equivalents	Lowest quintile
Refined grains[7]	≤1.8 oz equivalents (10 points)			
Empty calories[7]	Energy (kcal) from solid fat, added sugars, alcohol: ≤19% of kilocalories (20 points)			
SSBs and fruit juice[7]		0 g[8]		Lowest quintile[9]
Sodium[7]	≤1.1 g (10 points)	Lowest decile (mg)		Lowest quintile

[1]Scoring standards are expressed as cup and ounce equivalents from the MPED whereby 1 oz = 28.3 g and 1 cup = 225 mL. AHEI-2010, Alternative Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; DASH, Dietary Approaches to Stop Hypertension; HEI-2010, Healthy Eating Index-2010; MPED, MyPyramid Equivalents Database; SSB, sugar-sweetened beverage.

[2]Density approach used. All amounts except the fatty acid ratio are per 1000 kcal.

[3]Does not include popcorn, wheat germ, or wheat bran.

[4]Foods included in this definition are whole milk, other cheese (American, cheddar, or cream cheese), and cottage cheese.

[5]Foods included in this definition are cottage cheese; low-fat cheese; low-fat/1% or 2% milk; nonfat/skim milk or butter milk; yogurt; and ice milk, frozen yogurt, and sherbet.

[6]Moderate drinkers (amounts in table) received maximum points, nondrinkers received 2.5 points, and heavy drinkers (more than amounts in table) received progressively lower points.

[7]Components were reverse scored such that higher intake was associated with a lower score.

[8]Foods included in this definition are orange or grapefruit juice, other fruit juices or fruit drinks, and regular sodas.

[9]Foods included in this definition are other fruit juices or fruit drinks and regular sodas.

equivalents; nuts, 0.34 oz equivalents; legumes, 0.07 oz equivalents; fish, 0.47 oz equivalents; whole grains, 1.32 cup equivalents; MUFA:SFA ratio, 1.20; and red and processed meat, 1.32 oz equivalents.

The DASH index, as specified by Fung et al. (20), includes 8 components that are specified in the DASH diet (20, 37). For this DASH index, scoring is based on quintiles with the lowest intake [quintile one (quintile 1)] receiving one point and quintile 5 receiving 5 points. Red and processed meat, SSBs, and sodium were reverse coded so that quintile 1 received 5 points and quintile 5 received one point. In men in the MEC, mean intakes in quintile 5 were as follows: vegetables, 4.16 cup equivalents; fruit, 5.06 cup equivalents; nuts, seeds and legumes, 2.57 oz equivalents; whole grains, 4.23 cup equivalents; and low-fat dairy, 2.89 cup equivalents. In quintile 1, mean intakes were as follows: red and processed meat, 0.61 oz equivalents; SSBs, 0.49 g; and sodium, 1,699 mg. In women in the MEC, mean intakes in quintile 5 were as follows: vegetables, 4.38 cup equivalents; fruit, 5.62 cup equivalents; nuts, seeds and legumes, 2.03 oz equivalents; whole grains, 4.11 cup equivalents; and low-fat dairy, 2.82 cup equivalents. In quintile 1, mean intakes were as follows: red and processed meats, 0.38 oz equivalents; SSBs, 0 g; and sodium, 1378 mg.

Case ascertainment

Deaths were identified by using state death files and the National Death Index. Deaths from CVD were identified and classified as International Classification of Diseases, Ninth Revision codes 390–448 or International Classification of Diseases, Tenth Revision codes I00–I78 and G45 (38, 39). Cancer deaths were identified by using International Classification of Diseases, Ninth Revision codes 140–208 or International Classification of Diseases, Tenth Revision codes C00–C97 (38, 39). All-cause mortality included CVD and cancer deaths as well as deaths from other causes, including accidents and suicides. All death files were current as of 31 December 2011 for participants in Hawaii and 31 October 2010 for Los Angeles participants. Participants with no recorded deaths as of these respective dates were censored.

Statistical analysis

Analyses were limited to 70,170 men and 86,634 women who identified with 1 of 5 main MEC ethnic groups (white, African American, Japanese American, Native Hawaiian, and Latino) (excluding n = 13,992), had valid dietary assessment information (excluding n = 8263); and had no previous history of cancer, heart attack, or stroke at baseline (excluding n = 36,723). The association of risk of all-cause, CVD, and cancer mortality with the 4 dietary indexes was modeled through Cox regression by using years since study entry as the time metric. For CVD and cancer models, study participants who died of other causes were considered censored at the time of death. The following covariates were included in the models: age and energy intake as continuous variables, history of diabetes (yes or no), ethnicity (as indicator variables), moderate-to-vigorous physical activity ($<$2.5 or $\geq$2.5 h/wk), smoking (current smoker, past smoker, or never smoked), education ($<$12, 12, 13–15, or $\geq$16 y) as a proxy of socioeconomic status, marital status (married or not married), and hormone-replacement therapy [yes or no (women only)]. BMI (in kg/m^2) was categorized as $<$25, 25–29.9, or $\geq$30 by using self-reported height and weight. All models were fit with and without adjustment for categorized BMI. The HEI-2010 and DASH do not have a unique component for alcohol; therefore, models that involved the HEI-2010 and DASH were further adjusted for alcohol intake as a continuous variable. All variables included as continuous measures had no missing values. Education, marital status, smoking, BMI, and physical activity had missing values; thus, each of these variables was modeled with a missing value category. Missing values ranged from $<$1% to 2.3% of the total sample. Separate models were fit for men and women with all ethnic groups combined as well as stratified by ethnicity. The stratification by ethnicity was necessitated by the ethnicity-dietary index interaction analysis, which yielded significant estimates for the cross-product terms.

HRs and 95% CIs were calculated for dietary index scores divided into quintiles and represented by 4 indicator variables by using the lowest quintile as a reference category. Wald's chi-square statistic was used to evaluate the linear trend on the basis of the median dietary score within each quintile. The proportional hazard assumption for Cox models was verified by plotting scaled Schoenfeld's residuals against the time to the event (40). All descriptive analyses were conducted with IBM SPSS Statistics version 21 software (IBM Corp.), and all analytic analyses were conducted with SAS version 9.3 software (SAS Institute Inc.). All P values were 2-sided, and $P < 0.05$ was defined as statistically significant.

RESULTS

Participant characteristics

A total of 34,430 mortality cases were documented (18,263 men and 16,167 women) over 13–18 y of follow-up (**Table 2**). Of these cases, 11,919 deaths were from CVD (6408 men and 5511 women), and 10,883 deaths were from cancer (5853 men and 5030 women). Across the indexes, men and women in quintile 5 (best adherence) had better lifestyle profiles than those of subjects in quintile 1 (e.g., lower BMI, more hours per week of physical activity, and fewer smokers). Men and women in quintile 5 reported higher energy intakes than in quintile 1 except for the HEI-2010. A higher proportion of white men and women were in quintile 5 than quintile 1 for all indexes. In contrast, for Latino men and women, a higher proportion distributed to quintile 1 than quintile 5 across indexes. Both Japanese American men and women had higher percentages in quintile 5 than quintile 1 for all but one index (DASH). In the case of the remaining ethnic groups, men and women within each ethnic group shared the same index with regards to a higher proportion in quintile 5 than quintile 1 (i.e., African American, HEI-2010; Native Hawaiian, aMED). African American women also had a higher proportion in quintile 5 than quintile 1 for the aMED. For each index, a higher percentage of individuals in quintile 5 than quintile 1 had a history of diabetes. A higher percentage of women in quintile 5 than in quintile 1 reported having used hormone-replacement therapy (Table 2).

Main findings

Sex-stratified results

All indexes showed a high correlation with each other for both sexes (**Table 3**). The highest correlations were observed between the HEI-2010 and DASH (0.72 in men and 0.70 in women; $P <$ 0.0001) and the HEI-2010 and AHEI-2010 (0.70 in men; $P <$ 0.0001). The lowest correlations were seen between the HEI-2010 and aMED in both men and women (0.58 and 0.53, respectively; $P <$ 0.0001).

All-cause mortality

Higher scores on the HEI-2010, AHEI-2010, aMED, and DASH were all inversely associated with risk of mortality from all causes in both men and women (P-trend $<$ 0.0001) as shown in **Table 4**. For men, a large reduction in risk was seen for the HEI-2010 with a quintile 1:quintile 5 HR of 0.75 (95% CI: 0.71,

TABLE 2
Descriptive characteristics of participants (*n* = 156,804) on the basis of lowest and highest quintiles of dietary index scores in men and women in the Multiethnic Cohort[1]

	HEI-2010		AHEI-2010		aMED		DASH	
	Quintile 1	Quintile 5	Quintile 1	Quintile 5	Quintile 1	Quintile 5	Quintile 1	Quintile 5
Men (*n* = 70,170)								
Index scores, range	13.4–55.9	74.8–99.9	26.9–55.3	71.8–99.4	0–2	5–9	9–20	28–39
n	14,034	14,034	14,034	14,033	14,127	17,071	16,614	10,961
Mortality, *n* cases	3896	3619	3630	3545	3978	4181	4115	2897
CVD	1320	1304	1236	1229	1377	1472	1380	1061
Cancer	1344	1093	1230	1135	1267	1336	1444	831
Age at time of questionnaire, y	57.3 ± 8.6[2]	61.0 ± 8.6	57.2 ± 8.6	60.6 ± 8.8	58.5 ± 8.8	59.6 ± 8.8	56.6 ± 8.4	61.3 ± 8.7
Age at time of death, y	73.1 ± 9.1	77.6 ± 8.4	73.0 ± 9.3	77.5 ± 8.7	74.4 ± 9.0	76.4 ± 9.1	73.0 ± 9.4	77.8 ± 8.3
Ethnicity, percentage of row								
White (*n* = 17,330)	17.0	26.9	20.4	23.0	19.2	26.6	15.2	23.3
African American (*n* = 9014)	18.6	25.3	23.1	15.8	23.5	22.7	25.4	13.4
Native Hawaiian (*n* = 4992)	22.0	18.4	19.4	19.5	18.5	27.6	33.6	10.3
Japanese American (*n* = 21,239)	18.6	19.0	15.8	26.0	18.0	26.4	31.4	12.3
Latino (*n* = 17,595)	24.9	12.1	23.3	12.1	22.4	19.5	19.0	14.8
BMI, kg/m^2	26.7 ± 4.4	26.1 ± 3.9	26.9 ± 4.3	26.0 ± 3.9	26.8 ± 4.2	26.4 ± 4.2	26.8 ± 4.3	25.9 ± 3.8
Energy intake, kcal	2558 ± 1230	2258 ± 961	2341 ± 1108	2515 ± 1031	1808 ± 778	3105 ± 1244	2189 ± 924	2672 ± 1152
Physical activity,[3] h/wk	1.2 ± 1.6	1.5 ± 1.5	1.2 ± 1.6	1.5 ± 1.5	1.1 ± 1.4	1.6 ± 1.6	1.3 ± 1.5	1.6 ± 1.6
History of diabetes, percentage with diabetes	7.4	13.4	7.1	13.0	9.8	11.2	7.1	14.0
Smoking, percentage who never smoked	23.2	38.2	26.4	34.2	27.6	34.4	24.1	39.2
Education, percentage who graduated from college	22.0	38.8	24.1	37.6	26.7	34.4	24.6	38.3
Marital status, percentage married	73.0	75.6	73.5	77.4	73.9	77.0	74.4	76.4
Women (*n* = 86,634)								
Index scores, range	21.2–60.3	79.0–100	28.0–56.8	72.4–100.7	0–2	5–9	9–20	28–39
n	17,326	17,327	17,327	17,326	18,397	20,459	19,456	13,826
Mortality, *n* cases	3170	3459	3184	3175	3587	3787	3447	2641
CVD	1021	1198	1082	1081	1197	1321	1163	914
Cancer	1031	1054	1028	958	1107	1152	1146	784
Age-questionnaire, y	56.6 ± 8.6	61.5 ± 8.5	56.9 ± 8.7	60.8 ± 8.7	57.9 ± 8.9	60.1 ± 8.8	56.4 ± 8.6	61.4 ± 8.5
Age-death, y	73.4 ± 9.6	78.4 ± 8.3	73.9 ± 9.4	78.2 ± 8.7	75.1 ± 9.2	77.3 ± 8.9	73.4 ± 9.6	78.6 ± 8.3
Ethnicity, percentage of row								
White (*n* = 20,653)	17.2	23.9	20.6	21.6	22.3	23.2	14.5	22.2
African American (*n* = 16,072)	17.0	26.0	22.6	17.3	22.2	24.0	26.2	13.1
Native Hawaiian (*n* = 6368)	23.2	17.7	20.7	20.2	18.8	28.5	31.2	11.4
Japanese American (*n* = 24,785)	17.5	20.3	14.4	27.5	18.6	26.1	26.4	13.8
Latina (*n* = 18,756)	27.8	11.0	24.3	10.6	23.5	18.8	19.8	15.9
BMI, kg/m^2	27.1 ± 6.2	25.5 ± 5.2	27.2 ± 6.1	25.3 ± 5.3	26.7 ± 5.8	26.0 ± 5.5	27.0 ± 6.0	25.3 ± 5.1
Energy intake, kcal	2072 ± 1079	1870 ± 817	1762 ± 894	2136 ± 872	1390 ± 578	2616 ± 1098	1674 ± 728	2270 ± 979
Physical activity,[3] h/wk	1.0 ± 1.2	1.3 ± 1.3	1.0 ± 1.2	1.3 ± 1.3	0.9 ± 1.2	1.3 ± 1.3	0.9 ± 1.2	1.3 ± 1.3
History of diabetes, percentage with diabetes	7.6	10.4	7.1	11.1	8.8	9.5	7.6	10.7
Smoking, percentage who never smoked	49.1	59.5	51.2	57.6	52.2	58.9	49.9	60.3
Education, percentage who graduated from college	18.0	31.4	20.4	30.3	21.1	28.2	19.7	31.8
Marital status, percentage married	57.7	58.5	57.2	61.7	58.3	59.9	60.0	57.3
HRT, percentage who used	37.7	53.1	39.7	51.0	41.9	49.2	38.2	52.5

[1]AHEI-2010, Alternative Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension; HEI-2010, Healthy Eating Index-2010; HRT, hormone replacement therapy.
[2]Mean ± SD (all such values).
[3]Represents moderate to vigorous physical activity.

TABLE 3
Pearson's correlation coefficients of total summary dietary index scores for men (n = 70,170) and women (n = 86,634) in the Multiethnic Cohort[1]

	HEI-2010		AHEI-2010		aMED		DASH	
	Men	Women	Men	Women	Men	Women	Men	Women
HEI-2010	1.00	1.00	0.70	0.67	0.58	0.53	0.72	0.70
AHEI-2010			1.00	1.00	0.66	0.67	0.67	0.68
aMED					1.00	1.00	0.62	0.62
DASH							1.00	1.00

[1]All coefficients were significant, $P < 0.0001$. AHEI-2010, Alternative Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; DASH, Dietary Approaches to Stop Hypertension; HEI-2010, Healthy Eating Index-2010.

0.79). Large reductions in risk for women were observed for the AHEI-2010 and aMED, which were each associated with an equal reduction in risk between quintile 1:quintile 5 HR of 0.78 (95% CI: 0.74, 0.82).

CVD mortality

Higher scores for all indexes were also inversely associated with risk of mortality from CVD (P-trend < 0.0001) for both men and women (Table 4). The HEI-2010 showed a large impact on risk reduction for men with a quintile 1:quintile 5 HR of 0.74 (95% CI: 0.69, 0.81). In women, a reduction in risk was observed for the AHEI-2010 quintile 1:quintile 5 with an HR of 0.76 (95% CI: 0.69, 0.83).

Cancer mortality

All indexes were inversely associated with risk of mortality from cancer in both men and women (P-trend < 0.0001) as shown in Table 4. For men, the HEI-2010 showed an inverse association with a quintile 1:quintile 5 HR of 0.76 (95% CI: 0.70, 0.83) and a consistent reduction for each quintile. For women, a large reduction in risk was observed for the aMED with a quintile 1:quintile 5 HR of 0.84 (95% CI: 0.76, 0.92) as well as a significant reduction in risk of multiple quintiles of the other 3 indexes.

Sex-stratified mortality summary

Supplemental Figure 1 shows the contrast between quintile 1:quintile 5 for each mortality outcome within each dietary index by sex and highlights the similarity across indexes in associations with risk of all-cause mortality for both men and women. P values for quintile 1:quintile 5 comparisons within each index were <0.003 for all models when BMI was included as a covariate and were ≤0.001 without BMI as a covariate (data not shown).

Sex- and ethnicity-stratified results

All-cause mortality

Table 5 presents a summary of analyses stratified by sex and ethnicity as the HR for quintile 1 compared with quintile 5. These results are presented in full in **Supplemental Tables 1–10**. When all-cause mortality data were stratified by both sex and ethnicity, a protective effect was still seen for the indexes in all groups except Native Hawaiians, in whom associations were NS.

Across indexes, large reductions in risk were observed most often for white men. The HEI-2010 showed large reductions in risk in men for most ethnic groups especially for African American, Japanese American, and white men. The DASH showed a similarly large reduction in risk for African American men (HR: 0.69; 95% CI: 0.61, 0.79), whereas the aMED showed a reduction in risk for Latino men (HR: 0.79; 95% CI: 0.71, 0.88) (Table 5).

For women, the indexes again showed large reductions in risk most often for white women; however, large reductions in risk were seen across a number of indexes for different ethnic groups (Table 5). For white women, a large risk reduction was shown with the HEI-2010 (HR: 0.67; 95% CI: 0.60, 0.75); for Japanese American women, a large risk reduction was shown with the aMED (HR: 0.79; 95% CI: 0.71, 0.88); and for African American and Latina women, a large risk reduction was shown with the DASH (HR: 0.68; 95% CI: 0.61, 0.76) and (HR: 0.84; 95% CI: 0.74, 0.96), respectively.

CVD mortality

As with all-cause mortality, large reductions in CVD mortality were observed most often for white men across indexes. Large reductions in CVD mortality were seen with the HEI-2010 in African Americans (HR: 0.70; 95% CI: 0.59, 0.83), Japanese Americans (HR: 0.69; 95% CI: 0.59, 0.81), and whites (HR: 0.63; 95% CI: 0.53, 0.75) (Table 5). In women, larger reductions in risk were seen across indexes for white and Japanese American women. The DASH was associated with a large reduction in risk in African American women (HR: 0.65; 95% CI: 0.54, 0.77) and white women (HR: 0.63; 95% CI: 0.51, 0.78), and in Japanese American women, this reduction was seen with the AHEI-2010 (HR: 0.61; 95% CI: 0.50, 0.74). For Native Hawaiian and Latino men and women, none of the indexes reached significance.

Cancer mortality

For cancer mortality risk in men, stronger inverse associations with most indexes were observed for African American men. The HEI-2010 exhibited solid reductions in risk in men of all ethnicities except Native Hawaiians (Table 5). The HEI-2010 showed a strong association in white and Japanese American men [HR: 0.75 (95% CI: 0.63, 0.89) and 0.79 (95% CI: 0.67, 0.93), respectively]. The DASH showed a large overall inverse association (HR: 0.69; 95% CI: 0.55, 0.86) for African American men as well as Latino men (HR: 0.72; 95% CI: 0.58, 0.89). In women, most indexes showed large reductions in cancer mortality for Latinas. A large reduction in cancer mortality was shown with the aMED for African American women (HR: 0.79; 95% CI: 0.65, 0.96) and Latina women (HR: 0.70; 95% CI: 0.55, 0.89), and a large reduction in cancer mortality was shown with the HEI-2010 and AHEI-2010 for white women (0.75; 95% CI: 0.62, 0.90 and 0.75; 95% CI: 0.63, 0.91, respectively). No significant association was observed with any index and cancer mortality for Native Hawaiian men and women or Japanese American women.

TABLE 4
HRs (95% CIs) for all-cause, cardiovascular disease, and cancer mortality according to quintiles of dietary index scores in men (n = 70,170) and women (n = 86,634) in the Multiethnic Cohort[1]

Quintile (range of scores)	*n*	Any deaths, *n*	Person-years of follow-up	All-cause mortality,[2] HR (95% CI)	CVD deaths, *n*	CVD mortality,[2] HR (95% CI)	Cancer deaths, *n*	Cancer mortality,[2] HR (95% CI)
Men								
HEI-2010[3]								
1 (13.4–55.9)	14,034	3896	210,583	1.00	1320	1.00	1344	1.00
2 (56.0–62.5)	14,034	3535	214,023	0.89 (0.85, 0.93)	1210	0.87 (0.80, 0.94)	1125	0.87 (0.80, 0.95)
3 (62.6–68.1)	14,035	3633	214,105	0.85 (0.81, 0.89)	1263	0.83 (0.77, 0.90)	1169	0.87 (0.81, 0.95)
4 (68.2–74.8)	14,033	3580	215,135	0.82 (0.78, 0.86)	1311	0.84 (0.77, 0.91)	1122	0.84 (0.77, 0.91)
5 (74.9–99.9)	14,034	3619	217,158	0.75 (0.71, 0.79)	1304	0.74 (0.69, 0.81)	1093	0.76 (0.70, 0.83)
AHEI-2010[4]								
1 (26.9–55.3)	14,034	3630	213,093	1.00	1236	1.00	1230	1.00
2 (55.4–61.1)	14,034	3675	212,963	0.92 (0.88, 0.96)	1327	0.96 (0.89, 1.04)	1151	0.90 (0.83, 0.97)
3 (61.2–66.0)	14,034	3664	213,486	0.90 (0.86, 0.94)	1262	0.89 (0.82, 0.96)	1143	0.89 (0.82, 0.97)
4 (66.1–71.8)	14,035	3749	213,802	0.88 (0.84, 0.93)	1354	0.92 (0.85, 0.99)	1194	0.91 (0.84, 0.99)
5 (71.9–99.4)	14,033	3545	217,659	0.78 (0.74, 0.82)	1229	0.79 (0.73, 0.86)	1135	0.83 (0.76, 0.90)
aMED[4]								
1 (0–2)	14,127	3978	211,954	1.00	1377	1.00	1267	1.00
2 (3)	12,595	3344	190,659	0.92 (0.88, 0.97)	1202	0.97 (0.89, 1.04)	1053	0.92 (0.88, 1.00)
3 (4)	13,775	3549	210,244	0.86 (0.82, 0.90)	1238	0.87 (0.81, 0.95)	1165	0.92 (0.85, 0.99)
4 (5)	12,602	3211	193,258	0.83 (0.79, 0.87)	1119	0.84 (0.77, 0.91)	1032	0.88 (0.81, 0.96)
5 (6–9)	17,071	4181	264,888	0.76 (0.73, 0.80)	1472	0.79 (0.72, 0.86)	1336	0.81 (0.75, 0.89)
DASH[3]								
1 (9–20)	16,614	4115	255,887	1.00	1380	1.00	1444	1.00
2 (21–23)	16,166	4288	244,915	0.95 (0.91, 1.00)	1480	0.95 (0.88, 1.02)	1396	0.95 (0.88, 1.02)
3 (24–25)	11,659	3084	177,220	0.91 (0.87, 0.96)	1119	0.94 (0.87, 1.02)	955	0.89 (0.82, 0.97)
4 (26–28)	14,770	3879	224,833	0.86 (0.82, 0.90)	1368	0.86 (0.79, 0.93)	1227	0.88 (0.81, 0.95)
5 (29–39)	10,961	2897	168,148	0.81 (0.77, 0.85)	1061	0.83 (0.76, 0.91)	831	0.78 (0.71, 0.85)
Women								
HEI-2010[3]								
1 (21.2–60.3)	17,326	3170	272,901	1.00	1021	1.00	1031	1.00
2 (60.4–67.1)	17,328	3107	274,129	0.91 (0.86, 0.95)	1054	0.91 (0.84, 1.00)	990	0.96 (0.88, 1.05)
3 (67.2–72.9)	17,326	3267	274,271	0.90 (0.86, 0.95)	1142	0.92 (0.85, 1.00)	995	0.95 (0.87, 1.04)
4 (73.0–79.0)	17,327	3164	276,333	0.80 (0.76, 0.84)	1096	0.79 (0.73, 0.87)	960	0.86 (0.79, 0.95)
5 (79.1–100)	17,327	3459	276,173	0.79 (0.75, 0.83)	1198	0.77 (0.71, 0.84)	1054	0.89 (0.81, 0.98)
AHEI-2010[4]								
1 (28.0–56.8)	17,327	3184	273,508	1.00	1082	1.00	1028	1.00
2 (56.9–62.3)	17,327	3259	272,656	0.94 (0.90, 0.99)	1091	0.90 (0.83, 0.98)	1035	0.99 (0.91, 1.08)
3 (62.4–67.0)	17,326	3275	274,067	0.88 (0.84, 0.93)	1147	0.87 (0.80, 0.95)	956	0.88 (0.81, 0.97)
4 (67.1–72.4)	17,328	3274	275,393	0.85 (0.81, 0.90)	1110	0.82 (0.75, 0.90)	1053	0.96 (0.88, 1.05)
5 (72.5–100.7)	17,326	3175	278,184	0.78 (0.74, 0.82)	1081	0.76 (0.69, 0.83)	958	0.85 (0.77, 0.93)
aMED[4]								
1 (0–2)	18,397	3587	288,780	1.00	1197	1.00	1107	1.00
2 (3)	15,684	2958	247,761	0.90 (0.86, 0.94)	1017	0.91 (0.84, 0.99)	939	0.96 (0.88, 1.05)
3 (4)	16,516	2946	262,985	0.83 (0.79, 0.87)	1025	0.85 (0.78, 0.93)	886	0.85 (0.77, 0.93)
4 (5)	15,578	2889	247,505	0.84 (0.79, 0.88)	951	0.82 (0.75, 0.90)	946	0.95 (0.86, 1.04)
5 (6–9)	20,459	3787	326,776	0.78 (0.74, 0.82)	1321	0.81 (0.74, 0.89)	1152	0.84 (0.76, 0.92)
DASH[3]								
1 (9–20)	19,456	3447	309,482	1.00	1163	1.00	1146	1.00
2 (21–23)	19,720	3672	312,314	0.92 (0.88, 0.97)	1259	0.91 (0.84, 0.98)	1128	0.93 (0.86, 1.02)
3 (24–25)	14,691	2805	232,319	0.89 (0.84, 0.94)	958	0.86 (0.79, 0.94)	866	0.94 (0.85, 1.03)
4 (26–28)	18,941	3602	299,959	0.83 (0.79, 0.87)	1217	0.78 (0.72, 0.85)	1106	0.90 (0.82, 0.98)
5 (29–39)	13,826	2641	219,732	0.80 (0.75, 0.84)	914	0.78 (0.71, 0.85)	784	0.86 (0.78, 0.95)

[1]AHEI-2010, Alternative Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension; HEI-2010, Healthy Eating Index-2010.

[2]P-trend < 0.0001 for all models within the dietary index.

[3]Adjusted for age, BMI, diabetes, energy, ethnicity, education, marital status, smoking, physical activity, hormone replacement therapy, and alcohol.

[4]Adjusted for age, BMI, diabetes, energy, ethnicity, education, marital status, smoking, physical activity, and hormone replacement therapy.

TABLE 5

HRs (95% CIs) for all-cause, cardiovascular disease, and cancer mortality stratified by sex and ethnicity comparing the first quintile (reference, lowest adherence group) to the fifth quintile (highest adherence group) for the 4 dietary index scores in 156,804 participants in the Multiethnic Cohort[1]

	All-cause mortality					CVD mortality					Cancer mortality				
	White	AA	NH	JA	Latino	White	AA	NH	JA	Latino	White	AA	NH	JA	Latino
Men (n = 70,170)															
HEI-2010[2]	0.65	0.69	0.91	0.74	0.88	0.63	0.70	0.83	0.69	1.01	0.75	0.71	0.86	0.79	0.76
	(0.59, 0.72)	(0.62, 0.77)	(0.76, 1.07)	(0.68, 0.81)	(0.79, 0.98)	(0.53, 0.75)	(0.59, 0.83)	(0.63, 1.08)	(0.59, 0.81)	(0.84, 1.21)	(0.63, 0.89)	(0.59, 0.87)	(0.63, 1.16)	(0.67, 0.93)	(0.62, 0.93)
AHEI-2010[3]	0.69	0.75	1.00	0.82	0.80	0.68	0.75	1.09	0.79	0.87	0.78	0.80	1.00	0.88	0.81
	(0.62, 0.76)	(0.67, 0.85)	(0.84, 1.20)	(0.74, 0.90)	(0.71, 0.89)	(0.57, 0.81)	(0.62, 0.90)	(0.81, 1.45)	(0.67, 0.93)	(0.72, 1.05)	(0.66, 0.92)	(0.66, 0.98)	(0.73, 1.37)	(0.75, 1.03)	(0.66, 0.99)
aMED[3]	0.68	0.74	0.91	0.79	0.79	0.70	0.75	0.82	0.80	0.90	0.77	0.74	1.04	0.91	0.75
	(0.61, 0.75)	(0.66, 0.84)	(0.76, 1.09)	(0.72, 0.87)	(0.71, 0.88)	(0.59, 0.84)	(0.62, 0.90)	(0.61, 1.09)	(0.68, 0.94)	(0.75, 1.08)	(0.64, 0.92)	(0.60, 0.91)	(0.74, 1.45)	(0.77, 1.07)	(0.61, 0.91)
DASH[2]	0.71	0.69	1.03	0.83	0.93	0.71	0.73	0.97	0.81	1.12	0.75	0.69	1.12	0.83	0.72
	(0.64, 0.79)	(0.61, 0.79)	(0.85, 1.25)	(0.75, 0.91)	(0.83, 1.04)	(0.58, 0.86)	(0.60, 0.89)	(0.71, 1.32)	(0.69, 0.95)	(0.93, 1.36)	(0.62, 0.91)	(0.55, 0.86)	(0.79, 1.58)	(0.70, 0.98)	(0.58, 0.89)
Women (n = 86,634)															
HEI-2010[2]	0.67	0.71	0.98	0.90	0.92	0.65	0.72	0.88	0.85	0.96	0.75	0.91	1.16	1.11	0.74
	(0.60, 0.75)	(0.64, 0.78)	(0.82, 1.16)	(0.80, 1.00)	(0.81, 1.05)	(0.54, 0.80)	(0.61, 0.84)	(0.64, 1.20)	(0.70,1.04)	(0.77, 1.19)	(0.62, 0.90)	(0.76, 1.09)	(0.85, 1.58)	(0.91, 1.35)	(0.58, 0.95)
AHEI-2010[3]	0.70	0.72	0.94	0.80	0.87	0.73	0.71	1.00	0.61	0.94	0.75	0.83	0.84	1.03	0.88
	(0.63, 0.78)	(0.65, 0.79)	(0.78, 1.12)	(0.71, 0.90)	(0.76, 1.00)	(0.60, 0.89)	(0.61, 0.83)	(0.72, 1.39)	(0.50, 0.74)	(0.74, 1.18)	(0.63, 0.91)	(0.69, 1.00)	(0.61, 1.15)	(0.83, 1.26)	(0.69, 1.13)
aMED[3]	0.72	0.74	0.91	0.79	0.85	0.77	0.82	1.00	0.72	0.89	0.80	0.79	1.00	1.02	0.70
	(0.65, 0.81)	(0.67, 0.82)	(0.75, 1.09)	(0.71, 0.88)	(0.74, 0.97)	(0.62, 0.95)	(0.70, 0.97)	(0.72, 1.39)	(0.59, 0.87)	(0.71, 1.11)	(0.66, 0.97)	(0.65, 0.96)	(0.71, 1.41)	(0.83, 1.24)	(0.55, 0.89)
DASH[2]	0.70	0.68	0.93	0.91	0.84	0.63	0.65	1.12	0.87	0.91	0.78	0.87	0.79	1.02	0.76
	(0.62, 0.79)	(0.61, 0.76)	(0.76, 1.12)	(0.82, 1.02)	(0.74, 0.96)	(0.51, 0.78)	(0.54, 0.77)	(0.80, 1.56)	(0.72, 1.05)	(0.73, 1.14)	(0.63, 0.97)	(0.71, 1.06)	(0.55, 1.13)	(0.84, 1.23)	(0.60, 0.96)

[1]AA, African American; AHEI-2010, Alternative Healthy Eating Index-2010; aMED, alternate Mediterranean diet score; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension; HEI-2010, Healthy Eating Index-2010; JA, Japanese American; NH, Native Hawaiian.

[2]Adjusted for age, BMI, diabetes, energy, education, marital status, smoking, physical activity, hormone replacement therapy, and alcohol.

[3]Adjusted for age, body mass index, diabetes, energy, education, marital status, smoking, physical activity, and hormone replacement therapy.

DISCUSSION

To our knowledge, this is the first study to examine 4 hypothesis-driven dietary indexes in a large prospective cohort of men and women representing several major ethnic groups. Each index offered a reduction in mortality risk for men and women. In individuals whose diets scored the highest on any one of the indexes, men had 17–26% lower risk of mortality from all causes, CVD, or cancer, and women experienced an 11–24% reduction in risk. The influence of diet quality, regardless of how it was measured, was considerable.

The high correlations in the indexes suggested some level of agreement; however, none of the indexes were perfectly correlated, which confirmed that each index represented a unique combination of dietary constituents. In general, we showed that all indexes performed well, which suggested the idea of a variety of healthy dietary patterns from which individuals can choose. For many of the indexes, significant gains were made at each quintile, which suggested that small improvements in dietary quality may be beneficial. The most-dramatic results were seen when all contributors to mortality were combined, and the weakest associations were observed for cancer mortality. Chiuve et al. (16) noted that cancer is a heterogeneous endpoint, and diet may play a more-important role in the cause of certain cancers over others. Findings related to all-cause mortality are particularly relevant with regard to public health recommendations. Thus, these results from a multiethnic population offer a unique perspective for targeting US dietary recommendations.

The inverse associations shown between the HEI-2010, AHEI-2010, aMED, and DASH and mortality were consistent with previous studies in which higher-quality dietary patterns were associated with reduced risk of all-cause mortality (17, 18, 41–46), CVD mortality (20, 41, 45), and cancer mortality (43, 45). In this study, the HEI-2010 consistently exhibited quintile 1: quintile 5 risk reductions in men. Both the AHEI-2010 and aMED performed well in women although the performance of the indexes varied when stratified by ethnicity. The original 1995 version of the HEI was not associated with risk of non-trauma-related deaths (47, 48) and did not predict mortality in older adults (49). Adherence to the DASH pattern was previously shown to be associated with reduced risk of fatal coronary heart disease in female nurses (20), which corroborates the results from women in the MEC.

Different versions of the Mediterranean dietary pattern have been used to examine relations with health outcomes (41–44, 50), which has contributed to the confusion in interpreting results across studies. Nonetheless, these versions have consistently been associated with a reduction in risk of all-cause mortality (17, 18, 36, 42–46). The relative Mediterranean diet score was associated with significant reductions in all-cause and CVD mortality in men and women in Spain; however, no relation was shown for cancer mortality (41). This finding was inconsistent with results from the MEC and other DPMP cohorts (9, 10), which showed a reduction in risk of cancer mortality for both men and women. Stronger associations were seen in the MEC with the aMED in Japanese American women and Latino men and all-cause mortality and African American and Latina women and cancer mortality. These results highlight the importance of finding a common definition of a Mediterranean-style diet (51) and the need for additional research in multiethnic populations.

Differences were seen in the performance of the various indexes after stratification by ethnicity. The indexes performed most consistently with white and African American men and, to some extent, white women. Because the indexes assessed in this study were developed by using data primarily from studies in which these sex-ethnic groups were the majority (22, 52–55), our findings affirm previous work on diet and disease in these populations. Although reductions in risk were observed in the other sex-ethnic groups in the MEC, results were less pronounced and less consistent. Future studies that use data from the MEC and other cohorts emphasizing diverse ethnic groups (29) offer the opportunity to explore unique cultural aspects of dietary intake to complement current dietary guidelines.

Despite the large numbers of participants in each ethnic group, sample size may have played a role in the nonsignificant and spurious associations seen in Native Hawaiian, Japanese American, and Latino ethnicity-sex subgroups. Native Hawaiians had the highest prevalence of obesity in the MEC (28) and Hawaii (56) along with the highest cancer mortality (57) and ischemic heart disease rates (58) in the state. Despite nonsignificant results, a higher percentage of Native Hawaiians were in quintile 1 than quintile 5 for most indexes. This finding, coupled with their unique health profile (59, 60), suggests a need for dietary improvement.

For the Latino population, none of the indexes were shown to be significantly associated with mortality from CVD. Latino populations in California, where MEC data were collected, and nationwide have lower rates of ischemic heart disease, heart attack, and stroke than do most major ethnic groups (25, 61). To our knowledge, empirically derived dietary patterns have not been used to explore CVD incidence or mortality in Hispanic members of the Multi-Ethnic Study of Atherosclerosis cohort (62). The opportunity to observe an impact of these dietary indexes may be premature. In Japanese American women, no dietary index was associated with cancer death, which may have been due in part to a stronger correlation between age and eating habits in this population. For all 4 dietary indexes and 5 ethnic groups, we observed a steady increase in the percentage of healthy eaters (those in quintile 5) with older age. This observation was most dramatic in Japanese American women. As such, adjustment for age may have confounded the associations between index scores and cancer mortality.

A limitation of the application of some of these dietary indexes may have been the classification of components by quintiles, deciles, or medians based on the populations under study. The HEI-2010 and the AHEI-2010 primarily use absolute measures for all components. The possibility existed that both aMED and the DASH index scores could have been strengthened by discontinuing the use of moving targets. For comparison over time, this discontinuation will become a necessity. Other limitations included the reduction in sample size after ethnic stratification; thus, we could not rule out the existence of weak positive associations between indexes and risk of mortality. In addition, adjustments for physical activity and smoking were crude, and results may have changed if more elaborate adjustments had been made. The possibility of residual confounding also could not be ruled out because participants in quintile 5 may have had better health habits that we did not assess or better access to health care. Study participants came from Hawaii and California, which may have reflected lifestyles that differ from those in other parts of the United States and, as such, may limit generalizability.

There were several strengths to this study. Dietary intakes from a very large population-based multiethnic population were used to generate systematic dietary patterns. Nearly complete information on a wide range of covariates was available for the entire sample and allowed for adjustment in analyses. The same consequence held true for the availability of the outcome measures. Another strength was the comprehensive QFFQ designed to capture ethnic-specific foods and allowed for relevant comparisons across ethnic groups.

In conclusion, higher scores on the HEI-2010, AHEI-2010, aMED, and DASH were all inversely associated with mortality from all causes, CVD, and cancer in a diverse population of men and women. The HEI-2010, which uniquely emphasizes high intakes for seafood and plant protein as well as total protein foods and a higher ratio of polyunsaturated and monounsaturated fats to saturated fats and low intakes of refined grains and empty calories (solid fats and added sugars), consistently provided large reductions for men. The AHEI-2010 and aMED, which uniquely include both moderate intake of alcohol and low intake of red and processed meats, appeared to provide the greatest reductions in mortality risk of women. Greater adherence to any one of the indexes was associated with lower risk of mortality across diseases indicating potential benefits to the quality of life and longevity for adults across many racial and ethnic groups. These findings reinforce the concept of a healthful diet being important rather than a one-size-fits-all prescriptive diet plan and suggest the need for more research into meaningful ways in which these indexes overlap and differ.

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