Southern Dietary Pattern is Associated with Hazard of Acute Coronary Heart Disease in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study

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Abstract

Background—The association of overall diet, as characterized by dietary patterns, with risk of incident acute coronary heart disease (CHD) has not been studied extensively in samples including sociodemographic and regional diversity.

Methods and Results—We used data from 17,418 participants in Reasons for Geographic and Racial Differences in Stroke (REGARDS), a national, population-based, longitudinal study of white and black adults aged 45 years, enrolled from 2003-2007. We derived dietary patterns with factor analysis, and used Cox proportional hazards regression to examine hazard of incident acute CHD events – nonfatal myocardial infarction and acute CHD death – associated with quartiles of consumption of each pattern, adjusted for various levels of covariates. Five primary dietary patterns emerged: Convenience, Plant-based, Sweets, Southern, and Alcohol and Salad. A total of 536 acute CHD events occurred over a median (IQR) 5.8 (2.1) years of follow-up. After adjustment for sociodemographics, lifestyle factors, and energy intake, highest consumers of the Southern pattern (characterized by added fats, fried food, eggs, organ and processed meats, and sugar-sweetened beverages) experienced a 56% higher hazard of acute CHD (comparing quartile 4 to quartile 1: HR = 1.56; 95% CI: 1.17, 2.08; *P* for trend across quartiles = 0.003). Adding anthropometric and medical history variables to the model attenuated the association somewhat (HR = 1.37; 95% CI: 1.01, 1.85; *P* = 0.036).

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Conclusions—A dietary pattern characteristic of the southern US was associated with greater hazard of CHD in this sample of white and black adults in diverse regions of the US.

Keywords

coronary disease; diet; epidemiology; follow-up studies; nutrition

Although coronary heart disease (CHD) mortality decreased 36% in the US between 1999-2001 and 2008-2010, CHD still was responsible for 1 of every 6 deaths in the US in 2010 – nearly 380,000 in total[1]. Documented risk factors for CHD include dyslipidemia, diabetes mellitus, hypertension, overweight/obesity, cigarette smoking, and physical inactivity[2]. Observational and intervention studies provide evidence that diet also influences the development of CHD, likely through its effects on several of these key risk factors[3].

While individual foods and nutrients (e.g., red meat and saturated fat) have been studied extensively in relation to CHD risk[4], the relationship between overall diet and CHD risk may be more informative because foods typically are eaten in combination, not in isolation[5]. Empirically deriving dietary patterns *a posteriori* with cluster or factor analysis has facilitated investigations into the role overall diet may play in the etiology of chronic diseases[6,7]. Factor analysis, a data-driven exploratory method, assesses eating patterns in specified groups without preconceived judgments about which foods commonly are consumed together. Factor analysis has been used in previous studies to derive dietary patterns which subsequently were related to CHD risk[8-16]. However, studies examining associations among *a posteriori*-derived dietary patterns and CHD risk in a large US population sample including sociodemographic and regional diversity are lacking.

Reasons for Geographic and Racial Differences in Stroke (REGARDS) is a large cohort study designed to identify factors which increase the risk of stroke in blacks and persons residing in the southern US[17]. REGARDS includes a regionally and socioeconomically diverse population sample, with approximately equal numbers of men and women and a high proportion of black participants. REGARDS included a comprehensive assessment of diet, sociodemographic factors, and anthropometric measures at the baseline examination. Dietary patterns previously have been derived in the REGARDS cohort and related to incidence of stroke and mortality from end-stage renal disease[18,19]. The ongoing REGARDS-Myocardial Infarction (REGARDS-MI) study includes rigorous ascertainment of acute CHD outcomes. We tested the hypothesis that dietary patterns derived empirically using factor analysis were associated with hazard of incident acute CHD in REGARDS participants free of CHD at baseline.

Methods

Study Population

Details on the design and methods of REGARDS have been published[17]. Briefly, REGARDS is a national, population-based, longitudinal cohort of 30,239 community-dwelling black and white women and men aged 45 years or older, recruited from 2003-2007 via mail and telephone using commercially available lists of US residents. REGARDS used

the same lists to contact potential participants as the Behavioral Risk Factor Surveillance System (BRFSS), and the demographics of REGARDS mirror those of BRFSS. The telephone response (those answering the phone) was 33% and cooperation (those answering the phone who agreed to participate) was 49%, similar to that of other cohort studies[20,21]. For this analysis, we included only those without a history of CHD (n=24,297). The sampling scheme included 30% of participants from the stroke belt (North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana), 20% from the stroke buckle (the coastal plain of North Carolina, South Carolina, and Georgia), and 50% from elsewhere in the continental US. The baseline cohort was 42% black and 55% women.

Criteria for inclusion in the sample included having a name, telephone number, and address in the commercially available nationwide database from which the sample was selected, and age 45 years. Exclusion criteria included race other than white or black, active treatment for cancer, chronic medical conditions precluding long-term participation, cognitive impairment, current or impending residence in a nursing home, or inability to communicate in English. An initial telephone interview was used to survey participants and establish eligibility. Following verbal consent, demographic information and medical history (including risk factor evaluation) was collected by computer assisted telephone interviewing. Race was self-classified by participants using the following options defined by the investigators: white, black or African American, Asian, Native Hawaiian or other Pacific Islander, and American Indian or Alaska Native. Race was assessed in REGARDS because blacks have the highest disparity in stroke mortality compared to other race/ethnic groups. An in-home examination then was conducted to perform various physical measurements, medication inventory, phlebotomy, and urine collection among those eligible. Written informed consent was obtained from all participants, and the study was approved by the institutional review boards at all participating institutions.

Dietary Assessment

Diet was assessed with the Block 98 food frequency questionnaire (FFQ), a validated semi-quantitative FFQ that assessed usual dietary intake of 110 food items (NutritionQuest, Berkeley, CA)[22,23]. For each line item on the FFQ, participants were asked how often, on average, they consumed the food (or group of foods) during the previous year. Participants selected from nine possible frequencies ranging from "never" to "every day." For each item on the FFQ, the quantity of the food consumed also was recorded. For unitary items (i.e., eggs or slices of bacon), the usual number consumed each time the food was eaten was queried (1, 2, 3, or 4). For non-unitary foods, a photo was provided to participants to aid in estimating usual portions for foods served on plates (1/4, 1/2, 1, or 2 cups) and three different usual portions for foods served in bowls (1/2, 1, or 2 cups). The FFQ included adjustment questions (e.g., inquiring about the type of milk consumed – low-fat, non-fat, etc.).

The FFQ was self-administered by participants after the in-home visit and mailed to the REGARDS Operations Center, where they were checked for completeness and scanned. Scanned FFQ files were forwarded to NutritionQuest for processing and analysis. Amounts

of each food on the FFQ consumed by a participant were calculated by multiplying the frequency of consumption of that food by the usual amount consumed.

Food Groups

The methods for constructing food groups and deriving dietary patterns in REGARDS have been described elsewhere[24]. Briefly, we constructed food groups using the original 110 individual food variables on the FFQ, based on culinary use and nutrient similarities, as well as a review of previous studies. When an item could be considered for multiple categories, we considered the nutritional content and/or cooking method of the item as well as the use of the item. For example, one line item was "beverages containing some juice like Hi-C." We grouped this item with sugar-sweetened beverages due to nutritional content (i.e., added sugar). We created separate groups to differentiate more and less healthy alternatives for similar foods, such as low-fat and high-fat dairy. When we considered potatoes, fish, and chicken, we separated the fried items from the non-fried items due to the higher fat content of fried foods and expected differences of use across populations. Some items, such as "Chinese food," were left as stand-alone food groups due to the uniqueness of the items. Additionally, we created multiple categories of vegetables (cruciferous, dark yellow, green leafy, tomato, and other) to preserve regional variability in vegetable intake. Finally, we kept coffee and tea in separate groups as the two often are consumed in different manners across the US. Initially, this resulted in 58 food groups, but evaluation of communality and zero values identified two groups for elimination: the diet shakes/meal replacement variable was excluded, and breakfast/power bars were moved into the sweet breakfast foods group. This resulted in 56 final food groups on which dietary patterns were based.

Dietary Patterns

We used split sample replication to 1) derive the dietary patterns using exploratory factor analysis, and 2) test the patterns using confirmatory factor analysis[25]. We conducted three separate analyses: by sex (male/female), race (black/white), and region (southeastern US stroke belt/non-belt), and coefficients of congruence were determined for each stratification pair. The coefficient of congruence is used in multivariate statistics to test the similarity of factors across groups (in this case sex, race, and region)[24,26]. The final number of factors retained was chosen based on the eigenvalue (scree plot) and the solution providing the optimal congruence across sex, race, and region. As congruence between sex, race, and region was high, we calculated final factor loadings using factor analysis with varimax rotation of five factors on the full sample (Table 1). For simplicity, we are presenting only those factors with loadings greater than 0.15, in agreement with previous studies[5,6]; however, all food groups were used in calculating the final score, regardless of loading. We named patterns based on the factor loadings that contributed most highly to each pattern. Factor 1 loaded heavily on mixed dishes, pasta dishes, pizza, Mexican food, and Chinese food and was designated the "Convenience" pattern. Factor 2 had high factor loadings for vegetables, fruits, fruit juice, cereal, beans, fish, poultry, and yogurt and was named the "Plant-based" pattern. Factor 3 loaded on added sugars, desserts, chocolate, candy, and sweetened breakfast foods and was named the "Sweets" pattern. Factor 4 loaded heavily on added fats, fried food, eggs and egg dishes, organ meats, processed meats, and sugar-sweetened beverages. This diet reflected a culinary pattern observed in the southeastern US

and was named the "Southern" pattern. Factor 5 loaded highly on beer, wine, liquor, green leafy vegetables, tomatoes, and salad dressing. Accordingly, we named it the "Alcohol and Salad" pattern.

Outcome Ascertainment

We defined incident acute CHD as nonfatal MI or acute CHD death in participants free of CHD at baseline. Incident cases of CHD were captured by participant report and adjudicated by physician adjudicators with appropriate expertise. Participants were contacted by telephone every six months to assess vital status. If a suspected heart event was reported, medical records were pursued. MIs were adjudicated based on the presence of signs or symptoms suggestive of ischemia; diagnostic cardiac enzymes (rising and/or falling pattern in cardiac troponin or creatine phosphokinase-MB isoenzyme concentrations over six or more hours with a peak concentration greater than twice the upper limit of normal); and electrocardiogram changes consistent with ischemia or MI, guided by the Minnesota Code and classified as evolving diagnostic, positive, nonspecific, or not consistent with ischemia[27]. In the case where a participant died outside of the hospital, interviews with family members or other proxies, proximal hospitalizations, baseline medical history, death certificates, and the National Death Index were used to identify CHD as the underlying cause of death.

Statistical Analysis

Of the participants free from CHD at baseline (n=24,297), we excluded those who were missing FFQ data altogether, had more than 15% missing data on the FFQ, or had implausible reported energy intakes (<800 or >5000 kcal/d in men and <500 or >4500 kcal/d in women). This resulted in a final sample of 17,418 (71.7% of the sample free of CHD at baseline). We grouped consumption of the five dietary patterns into quartiles, with quartile 1 representing the lowest consumption of each pattern and quartile 4 representing the highest consumption of the pattern. We calculated descriptive statistics (including proportions and measures of central tendency) for demographic, socioeconomic, lifestyle, anthropometric, medical history, and nutrient variables at the baseline assessment according to these quartiles using the chi-square test (for proportions) and analysis of variance (for continuous variables). We used Cox proportional hazards regression to examine the hazard of incident acute CHD associated with consumption of each of the five dietary patterns, using the lowest quartile of consumption (quartile 1) as the referent quartile throughout. Years since study entry was the time metric, with participants censored at the date of incident CHD, date of withdrawal from the study, date of death, or December 31, 2013, whichever came first. We examined Schoenfeld residuals and confirmed that proportional hazards assumptions were met. We built models sequentially by first adding demographic variables (age, sex, race, age-race interaction) (model 1); model 1 plus socioeconomic factors (education, household income) and region (model 2); model 2 plus total energy intake (model 3); model 3 plus lifestyle factors (smoking, physical activity) (model 4); and model 4 plus anthropometric measures (body mass index (BMI), waist circumference) and medical history (hypertension, dyslipidemia, diabetes) (model 5). We performed analyses using SAS statistical software, version 9.3 (SAS Institute, Cary, NC).

Results

The 17,418 REGARDS participants included in this analysis included 59% who were women, 35% who were black, and 56% who were residents of the stroke belt. Demographic, socioeconomic, lifestyle, anthropometric, and medical history characteristics by quartile of consumption of each dietary pattern are provided in Table 2. Compared to participants with a lower consumption of the Southern dietary pattern, participants with a higher consumption of the Southern pattern were less likely to be older than 65 years and more likely to be male, black, a non-high school graduate with an annual household income of <$20,000, and a resident of the stroke belt. Greater consumption of the Southern pattern also was associated with a higher likelihood of smoking, a lower likelihood of being physically active, and higher mean BMI and waist circumference compared to lower consumption. Finally, greater consumption of the Southern pattern was associated with a higher prevalence of hypertension, dyslipidemia, and diabetes.

Dietary variables by quartile of consumption of each dietary pattern are provided in Table 3. In general, higher consumption of each of the five patterns was associated with higher total energy intake. This also was the case for total fat intake (as % of total energy), except for the Plant-based pattern, where greater consumption was associated with lower total fat intake. Higher consumption of the Southern pattern was associated with lower intakes of dietary fiber, vegetables, and fruits, while higher consumption of the Plant-based pattern was associated with higher intakes of dietary fiber, vegetables, fruits, and whole grains.

A total of 536 cases of acute CHD were adjudicated over a median (IQR) 5.8 (2.1) years of follow-up. After adjustment for age, sex, race, education, household income, region, energy, smoking, and physical activity, participants with the highest consumption of the Southern pattern experienced a 56% higher hazard of acute CHD (comparing quartile 4 to quartile 1: HR = 1.56; 95% CI: 1.17, 2.08; *P* for trend across quartiles = 0.003) (Table 4). Adding BMI, waist circumference, and history of hypertension, dyslipidemia, and diabetes to the model attenuated the association somewhat, but a significant association remained (HR = 1.37; 95% CI: 1.01, 1.85; *P* for trend = 0.036). No other dietary pattern was associated with the hazard of acute CHD in multivariable models adjusted beyond age, sex, and race. A Kaplan-Meier plot demonstrates a lower probability of acute CHD-free survival in the quartile of highest consumption of the Southern pattern compared to the other dietary patterns (Figure).

Discussion

A dietary pattern labeled as Southern, characterized by added fats, fried food, eggs, organ meats, processed meats, and sugar-sweetened beverages, was positively associated with hazard of incident acute CHD in this population-based sample of black and white adults in the US. The other main dietary patterns derived in the REGARDS cohort were not associated with CHD hazard. The lack of an association with the Plant-based pattern was notable, based on the beneficial health effects of the food groups that loaded heavily in this pattern[28,29].

Associations of factor analysis-derived dietary patterns have been investigated in diverse populations worldwide, with varying results. In agreement with the positive association of the Southern pattern with hazard of acute CHD in the REGARDS cohort, higher consumption of a pattern characterized by fried foods, eggs, and meat (similar to the Southern pattern) was associated with a greater risk of acute MI in 52 countries in the INTERHEART study[11] and INTERHEART China study[14]. The US Health Professionals Follow-up Study (HPFS) and Nurses' Health Study (NHS) identified "Western" patterns, characterized by high loading of red meat, processed meat, refined grains, French fries, high-fat dairy products, and sweets (combining various aspects of our Southern and Sweets patterns). In both of these studies, consumption of the Western pattern was positively associated with CHD risk[8,9]. However, a dietary pattern loading heavily on French fries, fast foods, and sugar-sweetened beverages was not associated with CHD risk in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Netherlands cohort[16].

It is noteworthy that no association was seen with hazard of CHD for the Plant-based pattern in REGARDS participants, in contrast to the results of some, but not all, previous studies. A plant-based diet was inversely associated with CHD risk in the Spanish cohort of the EPIC study (EPIC-Spain)[12]. Higher consumption of fruit and vegetable patterns also was associated with a lower risk of acute MI in the INTERHEART study[11] and INTERHEART China study[14]. A vegetable pattern was associated with a significantly reduced risk of CHD in women, although not in men, in the Japan Collaborative Cohort Study[15], and a high fruits and vegetables pattern was associated with a decreased risk of coronary deaths and non-fatal MI in the Whitehall II study in England[30]. The HPFS and NHS identified "prudent" patterns, characterized by high loading of fruits, vegetables, legumes, whole grains, fish, and poultry (similar to our Plant-based pattern), that were inversely associated with CHD risk in both cohorts[8,9]. However, in agreement with our results, a vegetable pattern was not associated with risk of acute MI in Costa Rica[10]. In addition, a prudent pattern characterized by fruits and vegetables, along with wholemeal cereals, was not associated with CHD risk in a Danish cohort[13].

There are several potential mechanisms through which greater consumption of the Southern dietary pattern was associated with increased hazard of CHD in this study. This pattern loaded heavily on processed meats and sugar-sweetened beverages. A systematic review and meta-analysis of observational studies and randomized trials provided evidence that processed meat consumption was associated with a higher incidence of CHD, which the authors speculated was due not only to their high sodium content, but also to their high nitrate preservative content, which (along with their byproducts) have been shown experimentally to promote atherosclerosis and vascular dysfunction[31]. A meta-analysis of prospective studies showed that sugar-sweetened beverage consumption was positively associated with the risk of CHD, with the effect attributed not only to increased BMI, but also to increased glycemic load, resulting in insulin resistance, β-cell dysfunction, and inflammation, setting the stage for atherosclerosis[32]. However, evidence linking some of the other foods on which the Southern pattern loaded heavily to increased risk of CHD is lacking. For example, while the Southern pattern loaded heavily on added fats, previous studies indicate that while the type of added fats appears to be related to CHD risk, the amount of added fats does not[33]. In addition, consumption of fried foods in the EPIC-Spain

cohort was not associated with risk of CHD, although the type of oil, the degree of thermal degradation of the oil, and the type of food likely affect the production of atherosclerotic *trans* fatty acids during the frying process and, therefore, should be characterized[34]. Finally, results from the HPFS and NHS, along with a subsequent epidemiologic review and a meta-analysis of prospective cohort studies, showed that higher consumption of eggs (up to one egg per day) was not associated with increased risk of CHD in men or women[35-37].

This study included both strengths and weaknesses that should be noted. Strengths of this study include the large population-based sample, the sociodemographic and regional diversity of the sample (including the large proportion of black participants), the comprehensive assessment of diet, and derivation of dietary patterns using a rigorous method – factor analysis. To our knowledge, this is the first time that data-derived dietary pattern methods have been applied to a population with a large proportion of participants from the stroke belt and buckle regions of the US.

Dietary patterns may be defined *a priori* by assessing degree of adherence to indices of healthy diets such as the Healthy Eating Index[38]. The advantage of such indices is that they are based on dietary recommendations or guidelines from official bodies based on current nutrition knowledge on what constitutes a healthy diet, most of which is generated from empirical research. In addition, using a standard index across multiple studies allows for consistency in how a healthy diet is assessed, and there may be a nascent trend toward scientific consensus on the guidelines underlying these indices. The primary advantage of factor analysis is that the resulting patterns are not defined *a priori* nor are they based on the authors' opinions on what defines a healthy or other dietary patterns; rather, statistical methods are used to derive patterns *a posteriori* based on the actual dietary data collected in the population of interest. However, a potential limitation of factor analysis is that subjectivity can come into play during the factor analysis process in such areas as collapsing primary dietary data, grouping the data, deciding on the number of patterns that should remain in the final solution, and even in the naming of the patterns. Resulting decisions made by investigators affect not only the number, but also the type of dietary patterns derived and reported[6,39]. It is possible that this subjectivity could have resulted in some of the variation of the published results noted above.

It should be noted that the Block 98 FFQ has yet to be validated in the REGARDS population. Measurement error is a potential limitation in any study relying on recall of dietary intake, as with an FFQ. It is possible that inaccuracies in reporting dietary intake may have resulted in misclassification. However, this would tend to bias results toward the null, potentially reducing the magnitude of the associations between dietary patterns and acute CHD observed in this analysis. Unfortunately, correction for potential measurement error was not possible. It is possible that selection bias may have resulted from using commercially available lists for recruitment, as not all persons have listed telephone numbers and/or a mailing address. We were missing dietary data on 28.3% of participants free of CHD at baseline. Those missing dietary data were more likely to have lower income and to have not graduated from high school. However, we had adequate numbers of individuals in those categories to provide assurance that this did not bias the results of the study; of those with dietary data, 1553 were not high school graduates and 2635 had an

annual income less than $20,000. Finally, the results may not be generalizable to groups other than whites and blacks in the US.

In summary, a Southern dietary pattern, characterized by added fats, fried food, eggs and egg dishes, organ meats, processed meats, and sugar-sweetened beverages, was associated with a greater hazard of incident acute CHD in this sociodemographically and regionally diverse sample of white and black adults. Despite its high loading of putative "heart healthy" foods (including fruits, vegetables, fish, and beans), a Plant-based pattern was not associated with hazard of CHD in this sample.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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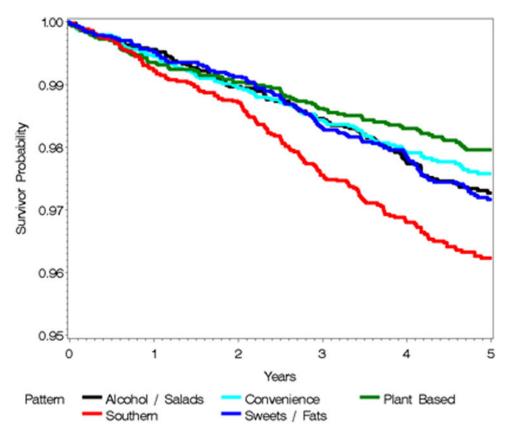
Figure 1.
Probability of acute coronary heart disease-free survival in the quartile of highest consumption of the various dietary patterns.

Table 1

Final Factor Loadings Derived from 17,418 Participants in the REGARDS Cohort (Only Factor Loadings with an Absolute Value >0.15 Are Shown)

Food Group	Dietary Patterns				
	Convenience	Plant-based	Sweets	Southern	Alcohol and Salads
Beans	0.36	0.38			
Beer		-0.16			0.23
Bread			0.47	0.37	
Bread – whole grain		0.30	0.18		
Butter			0.17		0.32
Candy			0.40		
Cereal		0.38			-0.20
Cereal – high-fiber		0.24		-0.25	
Chinese food	0.44				
Chocolate			0.46		
Coffee			0.22	-0.16	0.30
Condiments	0.25		0.31		0.29
Desserts	0.20		0.53		-0.17
Dairy – high-fat	0.18		0.37		0.21
Dairy – low-fat		0.20		-0.19	
Eggs and egg dishes				0.42	0.29
Fats – added			0.40	0.38	0.25
Fish	0.27	0.38			0.21
Fried food	0.24			0.56	
Fruit juice – 100%		0.25		0.17	-0.17
Fruits		0.58			
Grains – refined	0.31	0.17	0.20	0.20	
Liquor					0.31
Margarine			0.37		
Meat – organ	0.17			0.47	
Meat – processed	0.25		0.26	0.45	0.22

| | **Dietary Patterns** | | | | |
Food Group	Convenience	Plant-based	Sweets	Southern	Alcohol and Salads
Meat – red	0.45		0.18	0.26	0.26
Mexican food	0.48				
Milk alternatives		0.18			
Milk – high-fat			0.18	0.24	
Milk – low-fat		0.16		-0.42	
Mixed dishes with meat	0.61				
Pasta dishes	0.59		0.17		
Pizza	0.45	-0.18	0.20		
Potatoes	0.36		0.26		
Potatoes – fried	0.37		0.28	0.16	
Poultry	0.29	0.31			
Salad dressing/sauces		0.30			0.55
Salty snacks	0.32		0.30		
Seeds, nuts		0.26	0.19		0.19
Shell fish	0.28			0.23	0.24
Soda		-0.23		0.24	
Soup	0.44	0.32			
Sugar – miscellaneous			0.54	0.19	
Sugar-sweetened beverages				0.37	-0.15
Sweet breakfast foods	0.19		0.39		
Tea			0.31		
Vegetable mixed dishes	0.35	0.31			-0.25
Vegetables – cruciferous		0.59			
Vegetables – dark yellow		0.41			-0.17
Vegetables – green leafy	0.16	0.49		-0.22	0.48
Vegetables – other		0.48			
Vegetables – tomato		0.32			0.27
Water		0.32			
Wine					0.36
Yogurt		0.31		-0.25	

Table 2

Characteristics of Participants (n=17,418) Based on Quartiles of Consumption of the Five Dietary Patterns among the 17,418 Participants in the REGARDS Cohort.

Dietary Pattern	Characteristic	Quartile 1 (Lowest Consumption), % or Mean ± SD	Quartile 2, % or Mean ± SD	Quartile 3, % or Mean ± SD	Quartile 4 (Highest Consumption), % or Mean ± SD	P Value*
Convenience	Age >65 y	57.0	49.0	44.0	34.1	<0.001
	Male	30.9	35.8	44.1	51.9	<0.001
	Black	47.0	38.8	28.9	23.8	<0.001
	Did not graduate from high school	27.5	25.3	23.9	23.2	<0.001
	Household income <$20,000/y	19.6	15.6	12.5	11.9	<0.001
	Resident of stroke belt†	56.2	57.6	56.0	55.2	<0.001
	Current smoker	13.1	13.3	12.6	14.4	<0.001
	Physically active‡	31.8	28.7	30.2	28.8	<0.001
	Body mass index (kg/m²)	28.9 ± 6.2	27.9 ± 6.0	27.8 ± 6.1	28.5 ± 6.2	<0.001
	Waist circumference (cm)	92.7 ± 15.4	92.7 ± 15.3	94.0 ± 15.3	96.5 ± 15.5	<0.001
	Hypertension§	59.6	56.2	51.2	48.7	<0.001
	Dyslipidemia‖	52.3	52.5	53.8	55.9	0.004
	Diabetes#	18.6	17.3	14.1	14.6	<0.001
Plant-based	Age >65 y	36.0	46.8	50.8	50.4	<0.001
	Male	50.3	41.8	37.0	33.6	<0.001
	Black	28.5	35.7	35.8	38.5	<0.001
	Did not graduate from high school	29.5	25.0	24.7	20.7	<0.001
	Household income <$20,000/y	14.8	15.2	15.0	14.6	<0.001
	Resident of stroke belt	56.2	57.6	56.0	55.2	0.43
	Current smoker	23.1	13.3	9.7	7.3	<0.001
	Physically active	25.3	28.1	29.8	36.3	<0.001
	Body mass index (kg/m²)	28.2 ± 6.1	28.2 ± 6.1	28.0 ± 6.2	27.8 ± 6.2	0.038
	Waist circumference (cm)	95.3 ± 15.2	94.0 ± 15.6	94.0 ± 15.4	92.1 ± 15.4	<0.001
	Hypertension	51.1	55.0	55.4	54.2	<0.001
	Dyslipidemia	55.9	53.4	54.3	51.0	<0.001

Dietary Pattern	Characteristic	Quartile 1 (Lowest Consumption), % or Mean ± SD	Quartile 2, % or Mean ± SD	Quartile 3, % or Mean ± SD	Quartile 4 (Highest Consumption), % or Mean ± SD	P Value*
Sweets	Diabetes	13.9	16.6	16.9	17.2	<0.001
	Age >65 y	43.8	48.5	47.4	44.3	<0.001
	Male	35.0	37.5	44.1	46.0	<0.001
	Black	46.1	34.5	29.0	28.8	<0.001
	Did not graduate from high school	23.7	23.5	24.5	28.2	<0.001
	Household income <$20,000/y	15.1	13.9	14.1	16.5	<0.001
	Resident of stroke belt	53.3	55.0	56.5	60.2	<0.001
	Current smoker	12.0	11.5	13.1	16.8	<0.001
	Physically active	32.0	29.5	29.7	28.3	<0.001
	Body mass index (kg/m^2)	28.3 ± 6.2	28.1 ± 5.9	27.8 ± 6.1	28.1 ± 6.3	0.19
	Waist circumference (cm)	94.0 ± 15.7	94.0 ± 14.9	94.0 ± 15.4	94.6 ± 15.7	<0.001
	Hypertension	57.0	54.4	53.1	51.2	<0.001
	Dyslipidemia	51.3	54.3	54.1	54.8	<0.001
	Diabetes	18.6	17.8	15.1	13.1	<0.001
Southern	Age >65 y	45.9	47.4	48.2	42.4	<0.001
	Male	33.6	34.9	42.3	52.0	<0.001
	Black	9.5	24.8	43.0	61.4	<0.001
	Did not graduate from high school	19.5	22.6	27.2	30.6	<0.001
	Household income <$20,000/y	8.0	11.6	16.9	23.2	<0.001
	Resident of stroke belt	48.8	53.6	58.7	64.0	<0.001
	Current smoker	8.2	10.6	14.2	20.5	<0.001
	Physically active	32.9	28.3	28.3	29.9	<0.001
	Body mass index (kg/m^2)	26.6 ± 5.3	27.6 ± 5.8	28.4 ± 6.2	29.6 ± 6.7	<0.001
	Waist circumference (cm)	88.9 ± 14.5	91.4 ± 14.9	95.3 ± 14.7	99.1 ± 15.8	<0.001
	Hypertension	41.9	51.3	58.4	64.1	<0.001
	Dyslipidemia	50.6	54.9	53.4	55.6	<0.001
	Diabetes	8.7	13.5	18.2	24.2	<0.001
Alcohol and Salads	Age >65 y	52.5	47.2	45.0	39.4	<0.001
	Male	33.1	36.6	44.1	48.9	<0.001
	Black	52.0	39.4	27.5	19.7	<0.001

Dietary Pattern	Characteristic	Quartile 1 (Lowest Consumption), % or Mean ± SD	Quartile 2, % or Mean ± SD	Quartile 3, % or Mean ± SD	Quartile 4 (Highest Consumption), % or Mean ± SD	P Value*
	Did not graduate from high school	28.8	27.6	23.5	20.0	<0.001
	Household income <$20,000/y	24.8	16.1	11.5	7.4	<0.001
	Resident of stroke belt	58.9	59.3	55.8	51.0	<0.001
	Current smoker	11.2	13.4	14.2	14.6	<0.001
	Physically active	27.8	28.4	29.8	33.4	<0.001
	Body mass index (kg/m²)	28.1 ± 6.4	28.1 ± 6.2	28.9 ± 5.9	28.9 ± 6.0	0.030
	Waist circumference (cm)	94.3 ± 15.3	94.7 ± 15.2	94.7 ± 15.4	94.3 ± 15.8	0.006
	Hypertension	60.1	54.9	51.7	49.0	<0.001
	Dyslipidemia	55.4	54.3	53.4	51.5	0.004
	Diabetes	18.3	17.4	15.7	13.2	<0.001

SD indicates standard deviation.

*
Chi-square test (for proportions) and analysis of variance (for continuous variables).

†
Stroke belt consists of North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana.

‡
Physically active defined as four or more days of exercise (enough to work up a sweat) per week.

§
Hypertension defined as systolic blood pressure 140 mm Hg and/or diastolic blood pressure 90 mm Hg or self-reported current use of medication to control blood pressure.

‖
Dyslipidemia defined as total cholesterol 6.22 mmol/L (240 mg/dL) and/or low-density lipoprotein cholesterol 4.14 mmol/L (160 mg/dL) and/or high-density lipoprotein cholesterol 1.04 mmol/L (40 mg/dL) or self-reported current use of medication to control cholesterol.

#
Diabetes defined as fasting glucose 6.99 mmol/L (126 mg/dL) and/or non-fasting glucose 11.10 mmol/L (200 mg/dL) or self-reported current use of medication to control blood sugar.

Table 3

Intake of Energy, Selected Nutrients, and Food Groups Based on Quartiles of Consumption of the Five Dietary Patterns among the 17,418 Participants in the REGARDS Cohort.

Dietary Pattern	Component	Quartile 1 (Lowest Consumption), Median (IQR)	Quartile 2, Median (IQR)	Quartile 3, Median (IQR)	Quartile 4 (Highest Consumption), Median (IQR)	P Value[*]
Convenience	Energy (kcal/d)	1332 (720)	1340 (671)	1612 (714)	2169 (974)	<0.001
	Fat (% energy)	36.2 (11.9)	37.1 (10.1)	37.6 (9.4)	38.7 (8.5)	<0.001
	Carbohydrate (% energy)	52.0 (13.3)	48.9 (11.7)	47.4 (10.9)	45.3 (10.1)	<0.001
	Protein (% energy)	13.0 (3.7)	14.1 (3.8)	14.8 (3.7)	15.5 (3.7)	<0.001
	Dietary fiber (g/d)	12.4 (8.8)	12.2 (8.4)	14.3 (9.2)	18.9 (10.6)	<0.001
	Vegetables (servings/d)	2.0 (2.2)	2.0 (2.0)	2.5 (2.2)	3.2 (2.7)	<0.001
	Fruit (servings/d)	1.4 (1.4)	1.1 (1.4)	1.1 (1.3)	1.1 (1.2)	<0.001
	Whole grains (servings/d)	3.0 (2.5)	3.0 (2.3)	3.6 (2.4)	4.8 (3.1)	<0.001
Plant-based	Energy (kcal/d)	1430 (873)	1431 (796)	1576 (792)	1901 (923)	<0.001
	Fat (% energy)	38.9 (9.6)	37.9 (9.7)	37.4 (9.6)	35.9 (10.3)	<0.001
	Carbohydrate (% energy)	45.7 (11.7)	47.8 (11.4)	48.5 (11.4)	50.4 (12.0)	<0.001
	Protein (% energy)	13.5 (3.9)	14.0 (3.8)	14.6 (3.8)	15.4 (3.9)	<0.001
	Dietary fiber (g/d)	9.3 (5.9)	11.7 (6.0)	15.6 (6.7)	22.9 (10.1)	<0.001
	Vegetables (servings/d)	1.4 (1.1)	1.9 (1.4)	2.8 (1.9)	4.6 (3.0)	<0.001
	Fruit (servings/d)	0.6 (0.7)	1.0 (0.9)	1.4 (1.1)	2.1 (1.7)	<0.001
	Whole grains (servings/d)	2.9 (2.4)	3.3 (2.4)	3.7 (2.5)	4.5 (3.2)	<0.001
Sweets	Energy (kcal/d)	1173 (642)	1370 (586)	1672 (665)	2227 (939)	<0.001
	Fat (% energy)	34.9 (11.0)	36.6 (9.9)	38.1 (9.5)	39.6 (8.3)	<0.001
	Carbohydrate (% energy)	46.8 (14.6)	48.6 (12.2)	48.5 (11.1)	48.4 (9.8)	<0.001
	Protein (% energy)	15.6 (4.8)	14.9 (3.8)	14.3 (3.4)	13.2 (3.2)	<0.001
	Dietary fiber (g/d)	11.4 (8.6)	13.2 (8.9)	15.1 (9.2)	18.0 (10.5)	<0.001
	Vegetables (servings/d)	2.3 (2.4)	2.2 (2.2)	2.5 (2.2)	2.8 (2.6)	<0.001
	Fruit (servings/d)	1.1 (1.4)	1.2 (1.4)	1.2 (1.4)	1.1 (1.4)	<0.001
	Whole grains (servings/d)	2.3 (1.8)	3.2 (2.0)	4.0 (2.3)	5.2 (3.2)	<0.001
Southern	Energy (kcal/d)	1589 (797)	1373 (747)	1474 (769)	1991 (1057)	<0.001
	Fat (% energy)	35.8 (10.2)	37.4 (9.8)	37.9 (9.6)	38.6 (9.8)	<0.001
	Carbohydrate (% energy)	49.6 (11.0)	48.4 (11.7)	48.0 (11.9)	46.4 (12.1)	<0.001

Dietary Pattern	Component	Quartile 1 (Lowest Consumption), Median (IQR)	Quartile 2, Median (IQR)	Quartile 3, Median (IQR)	Quartile 4 (Highest Consumption), Median (IQR)	P Value*
	Protein (% energy)	15.1 (3.8)	14.2 (3.7)	13.9 (3.9)	14.2 (4.2)	<0.001
	Dietary fiber (g/d)	17.1 (10.8)	13.5 (9.2)	12.6 (8.9)	14.5 (10.1)	<0.001
	Vegetables (servings/d)	2.9 (2.6)	2.3 (2.3)	2.2 (2.1)	2.4 (2.4)	<0.001
	Fruit (servings/d)	1.5 (1.5)	1.2 (1.4)	1.1 (1.2)	1.0 (1.2)	<0.001
	Whole grains (servings/d)	3.7 (2.6)	3.1 (2.4)	3.3 (2.5)	4.3 (3.4)	<0.001
Alcohol and Salads	Energy (kcal/d)	1467 (898)	1426 (772)	1581 (799)	1877 (934)	<0.001
	Fat (% energy)	33.9 (8.8)	36.8 (8.8)	38.9 (9.0)	41.1 (10.5)	<0.001
	Carbohydrate (% energy)	54.1 (10.2)	50.1 (9.6)	46.6 (9.6)	41.1 (10.3)	<0.001
	Protein (% energy)	13.8 (3.9)	14.2 (3.7)	14.5 (3.8)	15.0 (4.2)	<0.001
	Dietary fiber (g/d)	14.1 (11.0)	12.7 (9.0)	14.5 (9.2)	16.2 (10.4)	<0.001
	Vegetables (servings/d)	1.9 (2.0)	2.0 (1.9)	2.5 (2.2)	3.4 (2.8)	<0.001
	Fruit (servings/d)	1.3 (1.3)	1.1 (1.4)	1.2 (1.4)	1.1 (1.5)	<0.001
	Whole grains (servings/d)	3.8 (3.0)	3.4 (2.6)	3.5 (2.5)	3.5 (2.9)	<0.001

IQR indicates interquartile range.

*
Kruskal-Wallis.

Table 4

Hazard of Acute Incident Coronary Heart Disease by Quartile of Consumption of the Various Dietary Patterns.

Dietary Pattern	Model	Quartile 1 (Lowest Consumption), HR (95% CI)	Quartile 2, HR (95% CI)	Quartile 3, HR (95% CI)	Quartile 4 (Highest Consumption), HR (95% CI)	P Value for Trend
Convenience		n = 4344 (142[*])	n = 4356 (132)	n = 4373 (136)	n = 4345 (126)	
		58.7[†]	54.8	55.7	51.9	0.36
	1[‡]	1(referent)	0.99 (0.78, 1.26)	0.99 (0.78, 1.26)	0.98 (0.76, 1.26)	0.88
	2[§]	1(referent)	1.02 (0.81, 1.30)	1.04 (0.82, 1.33)	1.05 (0.81, 1.35)	0.69
	3[‖]	1(referent)	1.02 (0.81, 1.30)	1.02 (0.80, 1.31)	0.98 (0.75, 1.30)	0.95
	4[#]	1(referent)	1.02 (0.80, 1.29)	1.03 (0.81, 1.32)	0.99 (0.75, 1.31)	0.99
	5[**]	1(referent)	1.04 (0.81, 1.33)	1.05 (0.82, 1.36)	0.95 (0.71, 1.27)	0.85
Plant-based		n = 4351 (140)	n = 4355 (146)	n = 4359 (136)	n = 4353 (114)	
		57.3	60.4	56.2	47.1	0.11
	1	1(referent)	0.97 (0.77, 1.23)	0.92 (0.73, 1.18)	0.79 (0.62, 1.02)	0.07
	2	1(referent)	1.00 (0.79, 1.27)	0.97 (0.76, 1.23)	0.87 (0.67, 1.12)	0.25
	3	1(referent)	0.99 (0.78, 1.26)	0.94 (0.73, 1.20)	0.80 (0.61, 1.05)	0.11
	4	1(referent)	1.08 (0.85, 1.37)	1.06 (0.82, 1.36)	0.95 (0.72, 1.26)	0.75
	5	1(referent)	1.07 (0.84, 1.38)	1.06 (0.82, 1.37)	1.02 (0.76, 1.36)	0.91
Sweets		n = 4349 (103)	n = 4357 (137)	n = 4355 (146)	n = 4357 (150)	
		42.2	56.9	60.2	61.8	0.004
	1	1(referent)	1.26 (0.97, 1.63)	1.28 (1.00, 1.66)	1.35 (1.04, 1.74)	0.031
	2	1(referent)	1.24 (0.96, 1.61)	1.22 (0.94, 1.57)	1.22 (0.95, 1.58)	0.19
	3	1(referent)	1.24 (0.95, 1.60)	1.19 (0.91, 1.55)	1.16 (0.86, 1.56)	0.40
	4	1(referent)	1.22 (0.94, 1.59)	1.18 (0.91, 1.54)	1.14 (0.84, 1.54)	0.47
	5	1(referent)	1.24 (0.95, 1.62)	1.28 (0.98, 1.69)	1.18 (0.86, 1.62)	0.27
Southern		n = 4370 (92)	n = 4362 (110)	n = 4346 (138)	n = 4340 (196)	
		38.5	45.6	56.5	79.8	<0.001
	1	1(referent)	1.17 (0.88, 1.54)	1.37 (1.05, 1.80)	2.00 (1.53, 2.61)	<0.001
	2	1(referent)	1.13 (0.86, 1.50)	1.23 (0.93, 1.62)	1.65 (1.25, 2.18)	<0.001
	3	1(referent)	1.13 (0.85, 1.50)	1.23 (0.93, 1.62)	1.66 (1.24, 2.20)	<0.001
	4	1(referent)	1.09 (0.82, 1.45)	1.15 (0.88, 1.52)	1.56 (1.17, 2.08)	0.003

Dietary Pattern	Model	Quartile 1 (Lowest Consumption), HR (95% CI)	Quartile 2, HR (95% CI)	Quartile 3, HR (95% CI)	Quartile 4 (Highest Consumption), HR (95% CI)	P Value for Trend
	5	1(referent)	1.04 (0.78, 1.40)	1.09 (0.82, 1.46)	1.37 (1.01, 1.85)	0.036
Alcohol and Salads		n = 4338 (140)	n = 4354 (131)	n = 4368 (131)	n = 4358 (134)	
		57.2	54.1	54.1	55.6	0.82
	1	1(referent)	0.99 (0.78, 1.26)	0.97 (0.76, 1.24)	1.03 (0.80, 1.32)	0.86
	2	1(referent)	1.01 (0.79, 1.28)	1.04 (0.81, 1.33)	1.17 (0.91, 1.51)	0.22
	3	1(referent)	1.01 (0.79, 1.28)	1.03 (0.81, 1.32)	1.15 (0.89, 1.49)	0.31
	4	1(referent)	0.99 (0.78, 1.26)	0.99 (0.77, 1.26)	1.09 (0.84, 1.42)	0.57
	5	1(referent)	0.95 (0.74, 1.22)	0.98 (0.76, 1.27)	1.00 (0.76, 1.32)	0.95

CI indicates confidence interval; and HR, hazard ratio.

* Number of events.

† Crude coronary heart disease incidence rate per 10,000 person-years.

‡ Model 1 adjusts for age, sex, race, and age-race interaction.

§ Model 2 adjusts for factors in model 1 plus education, household income, and region.

‖ Model 3 adjusts for factors in model 2 plus total energy intake.

Model 4 adjusts for factors in model 3 plus smoking and physical activity.

** Model 5 adjusts for factors in model 4 plus body mass index, waist circumference, and history of hypertension, dyslipidemia, and diabetes.