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Correlates of a southern diet pattern in a national cohort study of blacks and whites: the REGARDS study

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Abstract

Background: The Southern dietary pattern, derived within the REasons for Geographic And Racial Differences in Stroke (REGARDS) cohort, is characterized by high consumption of added fats, fried food, organ meats, processed meats, and sugar-sweetened beverages, and is associated with increased risk of several chronic diseases. The aim of the present study was to identify characteristics of individuals with high adherence to this dietary pattern.

Design: We analyzed data from REGARDS, a national cohort of 30,239 black and white adults 45 years of age living in the US. Dietary data were collected using the Block 98 Food Frequency Questionnaire (FFQ). Multivariable linear regression was used to calculate standardized beta coefficients across all covariates for the entire sample and stratified by race and region.

Results: We included 16,781 participants with complete dietary data. Among these, 34.6% were black, 45.6% male, 55.2% resided in stroke belt region, and the average age was 65 years. Black race was the factor with the largest magnitude of association to the Southern dietary pattern ($\beta = 0.76$ SD, $p < 0.0001$). Large differences in Southern dietary pattern adherence were observed between black participants and white participants in the stroke belt and non-belt (stroke belt $\beta = 0.75$ SD, non-belt $\beta = 0.77$ SD).

Conclusion: There was a high consumption of the Southern dietary pattern in the US black population, regardless of other factors, underlying our previous findings showing the substantial contribution of this dietary pattern to racial disparities in incident hypertension and stroke.

Introduction

The “Southern” dietary pattern is a dietary pattern derived from factor analysis within the REasons for Geographic And Racial Disparities in Stroke (REGARDS) cohort. This dietary pattern is characterized by high consumption of added fats, fried food, eggs and egg dishes, organ meats, processed meats, and sugar-sweetened beverages (1). Prior studies have shown that increased adherence to the Southern dietary pattern is associated with a higher risk of incident stroke (2), coronary heart disease (3), sepsis (4), end stage renal disease and chronic kidney disease (5), cancer mortality (6), and cognitive impairment (7). Furthermore, this

Dietary Assessment

The Block 98 Food Frequency Questionnaire (FFQ) was included as part of the baseline self-administered questionnaires that were left with participants. The Block 98 FFQ was developed by Block Dietary Data Systems (Berkeley, CA, USA), distributed by NutritionQuest and validated in populations similar to REGARDS (20, 21). The questionnaire includes more than 150 multiple-choice questions based on 107 food items and can be completed in about 30–40 minutes. Participants were asked to recall usual dietary intake from the past year and mail the completed form along with the other questionnaires to the REGARDS coordinating center.

Dietary Pattern Derivation

As previously reported, usable FFQ data from the baseline FFQ were available for 21,636 participants (1). A total of 56 food groups were constructed based on culinary use and nutrient similarity as in similar studies (22). For example, beverages containing only some juice, such as Hi-C, were grouped with sugar-sweetened beverages based on nutritional content. Similarly, other foods, including fried potatoes, fish, and chicken, were separated into a different group because of nutritional content and likely differences in culinary use across race and geographically defined populations. Other items, such as “Chinese food,” were left in stand-alone groups due to their uniqueness. Principal component analysis (PCA) was used to derive dietary patterns. An eigenvalue cutpoint of approximately 1.5 was employed, based on scree plots and interpretability of the derived factors. A five-factor solution was selected to provide optimal congruence across region, sex, and race. Final factor loadings were derived using factor analysis with orthogonal rotation. Patterns were empirically named based on foods that loaded highly in each factor by consensus of the investigators. One of the patterns identified was the “Southern pattern,” named because of high loadings in added fats, fried food, eggs and egg dishes, organ meats, processed meats, and sugar-sweetened beverages, foods sometimes associated with a traditional diet consumed in the Southeastern US (Table 1). Other patterns comprised the “convenience pattern,” “plant-based pattern,” “sweets/fats pattern,” and “salads and alcohol pattern.” As noted above, the Southern dietary pattern subsequently was found to be associated with higher risk of an array of health outcomes and a substantial potential contributor to black-white disparities, and as such is the focus of this report.

Risk Factors of Interest

Risk factors were based on baseline measurements and classified as in prior REGARDS studies (2–5, 7, 19, 23). Self-reported variables were age (continuous, in years), race (black/white), sex (male/female), region of residence (stroke belt and stroke buckle vs. non-belt/buckle), income (< \$75K/year vs. > \$75K/year), current smoker (yes vs. no), and education (high school graduate or less vs. some college or more). Physical activity, also self-reported, was assessed as the number of times per week participants engaged in exercise enough to work up a sweat (none vs. some). Height, weight, waist circumference, and blood pressure were measured during the in-home visit by a trained examiner. BMI was calculated as weight in kilograms divided by height in meters squared, (kg/m^2). Hypertension was defined as a systolic blood pressure ≥ 140 mmHg and/or a diastolic blood pressure ≥ 90 mmHg,

or a self-report of a prior diagnosis of hypertension or current use of anti-hypertensive medications. Diabetes was defined as a fasting blood glucose concentration of ≥ 126 mg/dL, or a non-fasting blood glucose concentration of ≥ 200 mg/dL, or a self-reported use of insulin or oral anti-glycemic agents. Geographical covariates were census tract level and determined with United States Department of Agriculture (USDA) data. These data included living in a food desert (yes vs. no), neighborhood disadvantage (yes vs. no), and residence in rural or urban areas (rural vs. urban). These data were then linked to participant residence via geocoding, methods described elsewhere (24, 25).

Statistical Analyses

The outcome of interest was a participant's adherence to the Southern dietary pattern, as quantified by the loading score from the factor analysis. The score was a continuous scale, with a range of -4.5 to 8.2 (mean = -0.001 , SD = 1.0), with higher scores indicating greater adherence to the dietary pattern. Chi-square and ANOVA tests were used to assess unadjusted means of demographic characteristics by quartile of Southern dietary pattern score. Multivariable linear regression was used to calculate standardized beta coefficients across all covariates for the entire sample, and then stratified by race and region (stroke belt/stroke buckle vs. non-belt/buckle). The standardization of the estimated regression coefficients was to allow an easy comparison of the differences in the strength of the associations across the different predictor variables. Specifically, differences in Southern diet score are expressed as the number of standard deviation difference associated with the factor; hence, between groups for dichotomous variables and per standard deviation for continuous variables (age, BMI, and waist circumference). Unadjusted and fully adjusted coefficients were calculated to compare the impact of adding additional covariates to the model. Covariates included in the final model were chosen because they have previously been shown to be associated with other dietary patterns (16, 18, 26–28). Multicollinearity was not a problem and variance inflation factor (VIF) was checked for all variables. In order to account for multiple testing, a p-value of < 0.01 was considered statistically significant. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Of the 30,239 participants, 56 had data anomalies (incomplete or unusable forms, other than the FFQ, due to being damaged), 8,547 (28%) had missing dietary data or implausible energy intakes, and 4,855 (16%) were missing risk factors of interest, leaving an analytical sample of 16,781 participants (Figure 1). Among these participants, 34.6% were black, 45.6% male, 55.2% resided in stroke belt region, and the average age was 65 years. Supplemental Table 1 provides demographic characteristics of included and excluded participants. Briefly, those excluded were more likely to be black, have a high school education or below, have an income of less than \$75K/year, live in a food desert, and reside in a disadvantaged neighborhood.

Stratification of daily intake for food groups making up the Southern dietary pattern allowed for observation of racial differences in dietary intake (Table 1, Supplemental Table 2). Black participants in the highest quartiles of Southern pattern adherence consumed higher

amounts of fried foods, organ meats, and sugar-sweetened beverages compared with white participants. Fried food intake in black participants in the fourth quartile was close to double the intake in white participants (60 g/day vs 36 g/day, respectively). Consumption of organ meats (liver, gizzard, neckbones, and chitlins) for black participants in the fourth quartile was triple the intake of white participants (7.1 g/day vs 2.9 g/day, respectively). Sugar-sweetened beverage intake among black participants in the highest quartile of Southern dietary pattern adherence was 145.6 g/day and 12.4 g/day for white participants. White participants in the highest quartile of Southern dietary pattern adherence reported higher consumption of high-fat milk and red meat. High-fat milk intake for white participants was 265 g/day (approximately 1 cup) and 160 g/day for black participants (approximately 0.68 cups). White participants in the highest quartile of adherence consumed almost double the amount of red meat compared to black participants (80 g/day vs 48 g/day, respectively).

Baseline characteristics of participants by quartile of Southern diet score are shown in Table 2. Those least adherent to the Southern dietary pattern appear in the first quartile, while those most adherent in the fourth quartile. The following characteristics were associated with greater adherence to the Southern diet pattern: black race, male sex, residence in stroke belt region, lower education level, lower income, current smoker, residence in a food desert, living in a disadvantaged neighborhood, physical inactivity, higher BMI, higher waist circumference, history of hypertension, and history of diabetes ($p < .0001$). Residence in a rural region was the only covariate not associated with Southern diet score ($p = 0.23$).

Linear regression results are shown in Table 3. With the exception of residence in a rural region ($p = 0.08$), all factors were significant ($p < 0.0001$) in each unadjusted model. After fully adjusting each model for all other risk factors, residence in a rural region became significant ($p = 0.0009$) and all other covariates, except for living in a food desert ($p = 0.037$), remained significant. The magnitude of the association with adherence to the Southern dietary pattern was highest for race ($\beta = 0.76$ SD, $p < 0.0001$), followed by gender ($\beta = 0.4$ SD, $p < 0.0001$), and smoking status ($\beta = 0.3$ SD, $p < 0.0001$).

As the focus of REGARDS is on racial and geographic disparities, the data were stratified by both race and region (Table 3). For both black and white participants, male sex, residence in the stroke belt, being a current smoker, living in a disadvantaged neighborhood, reporting no physical activity, and having a greater waist circumference were all associated with greater adherence to the Southern dietary pattern. Of these, gender had the highest magnitude of association with Southern dietary pattern adherence ($\beta = 0.46$ SD, $p < 0.0001$ and $\beta = 0.36$ SD, $p < 0.0001$, for black participants and white participants, respectively). Having more than a high school education level and an income greater than \$75K were both associated with being less adherent to the Southern dietary pattern for both black and white participants, with education level having the stronger magnitude of association ($\beta = -0.23$ SD, $p < 0.0001$ and $\beta = -0.19$ SD, $p < 0.0001$, for black participants and white participants, respectively). For black participants only, older age was significantly associated with being less adherent to the Southern dietary pattern. Residence in a rural region and higher BMI were only associated with greater pattern adherence in white participants. Additionally, for white participants only, history of hypertension and history of diabetes were both associated with greater adherence to the Southern dietary pattern.

In both the stroke belt region and elsewhere, black race, male sex, being a current smoker, living in a disadvantaged neighborhood, reporting no physical activity, and greater waist circumference were all associated with greater adherence to the Southern dietary pattern. Having greater than a high school education level and an income greater than \$75K were associated with less adherence to the dietary pattern in both regions. Only in the stroke belt region, older age was associated with less adherence to the Southern dietary pattern and residence in a rural region, higher BMI, and history of hypertension were associated with greater pattern adherence. History of diabetes and living in a food desert were not associated with Southern diet pattern adherence in either the stroke belt or non-belt region.

Discussion

In this study, characteristics of individuals with a higher intake of the Southern dietary pattern were identified. Despite the diet being referred to as the “Southern Diet”, the single factor with the largest separation of diet adherence was race. Further, the high intake of the diet by the black population was relatively consistent in both stroke belt and non-stroke belt regions. This substantial racial difference in the diet is a major contributor to the previously reported mediation of the black-white difference in stroke risk (2) and risk of incident hypertension (8). Adherence to this dietary pattern was also higher for men, those with a lower education and income level, those who reside in a food desert and/or disadvantaged neighborhood, current smokers, those who are physically inactive, and those with higher BMI and waist circumference.

Previously, education and income have been associated with diet intake and quality, with higher-income households and those with greater education being more likely to adhere to higher-quality diets (those with greater servings of fresh fruits and vegetables and less energy from solid fats, alcoholic beverages, and added sugars) (14, 15, 27). Higher-quality diets also have higher costs, with income being a consistent predictor of diet intake (29, 30). Several of the foods comprising the Southern dietary pattern are high in energy from solid fats and added sugars, and the pattern is low in fresh fruits and vegetables. Our results are consistent with these findings, in that low education and low income were associated with greater adherence to the Southern dietary pattern.

Similarly, residence in a food desert or disadvantaged neighborhood are both environmental factors that directly affect the cost and availability of foods to an individual, thereby influencing dietary patterns followed (28, 30). Disadvantaged or lower income neighborhoods often have less access to diverse food selections and residence in these areas has been associated with decreased intake of fruits, vegetables, and fish and increased intake of less healthy meats such as processed meats (30, 31). Fresh foods can often take more time to prepare and those living in disadvantaged neighborhoods often work many jobs. This presents a complex issue of availability, affordability, and time. Consequently, this can contribute to diets low in fruits and vegetables and high in energy from processed foods and saturated fat (30), which is consistent with the foods found within the Southern dietary pattern.

We observed large differences in Southern dietary pattern adherence between black participants and white participants (stroke belt = 0.75 SD, non-belt = 0.77 SD). In contrast, the differences between the stroke belt and non-stroke belt were smaller regardless of race (black participants = 0.24 SD, white participants = 0.21 SD). As such, the differences between black participants and white participants (regardless of region) dominates the differences between regions (regardless of race). This suggests that black participants in the stroke belt are just as likely to adhere to this dietary pattern as black participants in the non-stroke belt. It also suggests that residents of the stroke belt consume more of the Southern dietary pattern regardless of race. The racial differences in daily intake of several of the foods prominent in the Southern dietary pattern reinforce this observation.

Large, but similar, differences in Southern dietary pattern adherence were observed between males and females for both race and region. The difference in adherence between males and females was larger among black participants than white participants (black participants = 0.46 SD, white participants = 0.36 SD). Additionally, the difference was larger for participants in the stroke belt compared to participants in the non-belt (stroke belt = 0.44 SD, non-belt = 0.34 SD).

One of the greatest strengths of this research is that the study was conducted in a large sample of geographically dispersed adults, with detailed measurement of covariates using standardized methods. Additionally, oversampling of black participants and residents from the southeastern United States allowed a unique opportunity to investigate sociodemographic and geographical predictors of a Southern diet pattern. However, limitations must also be considered. The study relied on FFQ data, increasing the chances for error in individual dietary reporting. Those who did not return the FFQ or had implausible data were more likely to be black, which could bias the results. Furthermore, although several covariates were adjusted for, other confounding variables from unmeasured health and lifestyle factors linked with diet cannot be excluded. Finally, as a cross-sectional study, causality cannot be inferred.

In conclusion, in this national US sample, we demonstrated that the characteristic associated with strongest adherence to the Southern dietary pattern was black race compared to white race, and this was consistent regardless of residential region and other factors. Racial differences were observed in daily intake of foods making up the Southern diet pattern, with black participants consuming greater amounts of fried foods, organ meats, and sugar-sweetened beverages compared to white participants. These findings reinforce the role of race in dietary pattern adherence and underscore the need for nutrition interventions in predominantly black communities. Future research should focus on the development and delivery of nutrition interventions and understanding of barriers to healthy eating in these communities, and the impact of these interventions on the development of chronic diseases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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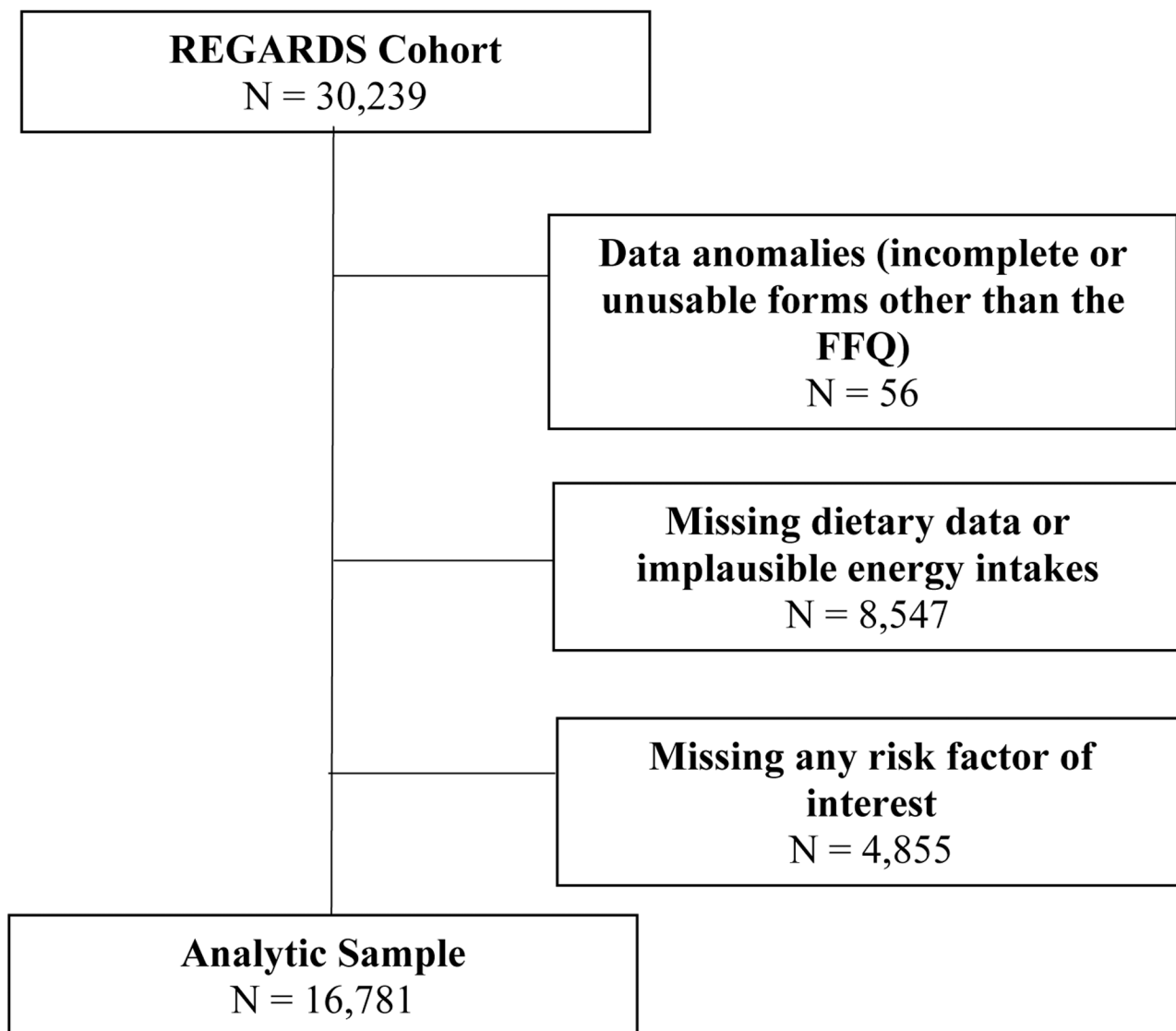


Figure 1.
Participant Selection

TABLE 1.

Final factors loadings and 75th percentile of daily grams/day of food groups making up the Southern dietary pattern (showing only those with absolute value > 0.20 for simplicity).

Food Group	Factor loading	75 th percentile Daily Serving Size of Food Item (g/day)							
		Q1 (lowest adherence)		Q2		Q3		Q4 (highest adherence)	
		Black	White	Black	White	Black	White	Black	White
Added fats	0.38	8.2	12.6	9.6	15.0	12.7	19.7	21.8	30.9
Bread	0.37	23.8	31.8	26.8	38.9	37.1	55.1	74.0	89.6
Cereal – high fiber	-0.25	16.8	17.4	8.6	6.7	4.7	4.7	4.3	4.2
Eggs and egg dishes	0.42	11.5	14.3	14.3	21.7	21.7	28.6	43.3	50.0
Fried food	0.56	15.6	8.8	16.7	13.3	25.5	19.5	60.0	36.3
Fried potatoes	0.16	5.0	5.0	5.0	9.3	5.0	9.3	10.5	18.6
Milk – high-fat	0.24	14.9	4.0	50.5	109.2	107.1	192.0	159.1	265.1
Milk – low-fat	-0.42	252.1	346.0	0.0	74.6	0.0	0.0	0.0	0.0
Organ meat	0.47	2.3	1.2	2.4	1.2	2.9	1.8	7.1	2.9
Processed meats	0.45	10.6	13.5	12.1	17.4	17.9	23.6	37.5	41.1
Red meat	0.26	18.8	36.5	19.3	41.6	27.8	54.4	48.1	80.1
Refined grains	0.20	26.1	27.4	21.3	26.0	26.9	28.0	42.7	40.3
Shell fish	0.23	4.2	4.9	3.5	6.2	4.3	8.4	8.4	12.4
Soda	0.24	55.4	51.4	102.9	156.0	156.0	205.7	312.0	360.0
Sugar-sweetened beverages	0.37	8.3	4.1	16.5	4.1	38.5	4.1	145.6	12.4
Vegetable – green-leafy	-0.22	103.7	102.6	63.1	63.1	41.1	60.1	39.6	53.5
Yogurt	-0.25	53.1	35.0	17.5	9.4	4.7	4.7	4.1	2.0

TABLE 2.

Baseline characteristics by Quartile (Q) of Southern Diet Score in the REasons for Geographical and Racial Differences in Stroke (REGARDS) Study.

Characteristic, mean or frequency (%)	Q1 n (%) (lowest adherence) N=5349	Q2 n (%) N=5349	Q3 n (%) N=5350	Q4 n (%) (highest adherence) N=5349	P-value
Range of Southern Diet Score	-4.42, -0.61	-0.61, -0.10	-0.10, 0.48	0.48, 8.25	---
Age (years), mean	65 (9)	65 (9)	65 (9)	64 (9)	<0.0001
Black	425 (7.3)	1047 (18.0)	1775 (30.6)	2563 (44.1)	<0.0001
Male	1623 (21.2)	1713 (22.4)	1985 (25.9)	2337 (30.5)	<0.0001
Stroke belt region	1999 (21.6)	2246 (24.2)	2412 (26.0)	1585 (21.1)	<0.0001
HS grad and below	971 (17.1)	1240 (21.8)	1535 (27.0)	1940 (34.1)	<0.0001
Income <\$75K/year	2995 (22.2)	3293 (24.4)	3523 (26.1)	3711 (27.4)	<0.0001
Current smoker	353 (15.0)	471 (20.1)	636 (27.1)	887 (37.8)	<0.0001
Living in food desert	390 (15.3)	499 (19.6)	718 (28.2)	940 (36.9)	<0.0001
Neighborhood disadvantage	1278 (15.5)	1791 (21.8)	2332 (28.3)	2834 (34.4)	<0.0001
Rural	507 (25.3)	532 (26.6)	488 (24.4)	474 (23.7)	0.232
Reporting no physical activity	1137 (21.2)	1351 (25.2)	1404 (26.2)	1472 (27.4)	<0.0001
BMI (kg/m ²)	27.7 (5.5)	28.8 (5.9)	29.4 (6.0)	30.6 (6.7)	<0.0001
Waist circumference (cm)					
Male	97.7 (13.3)	99.4 (12.4)	100.1 (12.7)	101.6 (14.0)	<0.0001
Female	87.4 (14.8)	90.8 (15.3)	93.5 (15.6)	98.2 (16.4)	
History of hypertension	2131 (20.3)	2509 (23.9)	2834 (27.0)	3016 (28.8)	<0.0001
History of diabetes	608 (16.2)	836 (22.3)	1021 (27.2)	1283 (34.2)	<0.0001

BMI indicates body mass index; and HS, high school.

TABLE 3.

Results from linear regression models investigating factors associated with a Southern dietary pattern.

Factors	Unadjusted			Fully adjusted for all other factors															
	Overall			Blacks (n=5,810)				Whites (n=10,971)				Stroke Belt (n=9,267)				Non-Belt (n=7,514)			
	Beta	P	Overall (n=16,781)	Beta	P	Beta	P	Beta	P	Beta	P	Beta	P	Beta	P	Beta	P		
Age (per 1 SD of 9.0 years)	-0.043	<.0001	-0.026	0.001	-0.072	<.0001	0.001	0.87	-0.041	<.0001	0.001	0.87	-0.041	<.0001	-0.007	0.55			
Black participants	0.839	<.0001	0.758	<.0001	---	---	---	---	---	---	---	---	0.754	<.0001	0.765	<.0001			
Males	0.244	<.0001	0.395	<.0001	0.456	<.0001	0.357	<.0001	0.440	<.0001	0.340	<.0001	0.440	<.0001	0.340	<.0001			
Region stroke-belt vs everywhere else	0.217	<.0001	0.224	<.0001	0.240	<.0001	0.214	<.0001	---	---	---	---	---	---	---	---			
Education less than HS vs greater than HS	-0.397	<.0001	-0.206	<.0001	-0.231	<.0001	-0.186	<.0001	-0.218	<.0001	-0.188	<.0001	-0.197	<.0001	-0.130	<.0001			
Income <75K vs >75K	-0.413	<.0001	-0.165	<.0001	-0.215	<.0001	-0.140	<.0001	-0.197	<.0001	-0.130	<.0001	-0.197	<.0001	-0.130	<.0001			
Current smoker	0.418	<.0001	0.298	<.0001	0.273	<.0001	0.306	<.0001	0.308	<.0001	0.283	<.0001	0.308	<.0001	0.283	<.0001			
Living in a food desert	0.382	<.0001	0.039	0.037	0.025	0.42	0.053	0.038	0.038	0.13	0.040	0.20	0.038	0.13	0.040	0.20			
Neighborhood disadvantage	0.548	<.0001	0.162	<.0001	0.162	<.0001	0.161	<.0001	0.191	<.0001	0.120	<.0001	0.191	<.0001	0.120	<.0001			
Rural	-0.041	0.08	0.069	0.0009	-0.001	0.99	0.085	<.0001	0.071	0.005	0.047	0.24	0.071	0.005	0.047	0.24			
Reporting no physical activity	0.138	<.0001	0.068	<.0001	0.078	0.004	0.059	0.0003	0.065	0.0001	0.074	0.0004	0.065	0.0001	0.074	0.0004			
BMI (per SD of 6.1 kg/m ²)	0.169	<.0001	0.005	0.011	-0.002	0.66	0.010	<.0001	0.006	0.02	0.003	0.27	0.006	0.02	0.003	0.27			
Waist circumference (per SD of 15.3 cm)	0.174	<.0001	0.005	<.0001	0.007	<.0001	0.004	<.0001	0.005	<.0001	0.006	<.0001	0.005	<.0001	0.006	<.0001			
History of hypertension	0.271	<.0001	0.034	0.017	0.016	0.58	0.038	0.014	0.042	0.03	0.022	0.28	0.042	0.03	0.022	0.28			
History of diabetes	0.312	<.0001	0.025	0.143	-0.040	0.18	0.077	0.0003	0.014	0.54	0.041	0.11	0.014	0.54	0.041	0.11			

As the Southern diet score is a standardized factor (mean of 0.0, standard deviation of 1.0), beta coefficients can be interpreted as the number of standard deviation difference associated with the factor (i.e., between groups for dichotomous predictors and per standard deviation for continuous predictors). SD indicates standard deviation; BMI, body mass index; and HS, high school. Fully adjusted model adjusts for all other variables.