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Race and Region Are Associated with Nutrient Intakes among Black and White Men in the United States[1,2]

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Abstract

Stroke mortality rates and prevalence of several chronic diseases are higher in Southern populations and blacks in the US. This study examined the relationships of race (black, white) and region (Stroke Belt, Stroke Buckle, other) with selected nutrient intakes among black and white American men (n = 9229). The Block 98 FFQ assessed dietary intakes and multivariable linear regression analysis was used to examine whether race and region were associated with intakes of fiber, saturated fat, *trans* fat, sodium, potassium, magnesium, calcium, and cholesterol. Race and region were significant predictors of most nutrient intakes. Black men consumed 1.00% lower energy from saturated fat compared with white men [multivariable-adjusted β: 1.00% (95% CI = −0.88, −1.13)]. A significant interaction between race and region was detected for *trans* fat ($P < 0.0001$), where intake was significantly lower among black men compared with white men only in the Stroke Belt [multivariable-adjusted β: −0.21 (95% CI = −0.11, −0.31)]. Among black men, intakes of sodium, potassium, magnesium, and calcium were lower, whereas cholesterol was higher, compared with white men ($P < 0.05$ for all). Comparing regions, men in the Stroke Buckle had the lowest intakes of fiber, potassium, magnesium, and calcium compared with those in the Stroke Belt and other regions; men in both the Stroke Buckle and Stroke Belt had higher intakes of cholesterol compared with those in other regions ($P < 0.005$ for all). Given these observed differences in dietary intakes, more research is needed to understand if and how they play a role in the health disparities and chronic disease risks observed among racial groups and regions in the US. J. Nutr. 141: 296–303, 2011.

Introduction

The risk of stroke morbidity and mortality has been shown to vary according to several key demographic factors, including sex, geographic region, and race. For example, men aged 55–64 y have a 25% increased incidence of stroke compared with women of the same age (1). An increased likelihood of stroke has also been reported for those living in the Stroke Belt (residents of 11 southeastern states in the US) compared with residence in other regions of the US [(sex- and age-adjusted OR = 1.25; (95% CI = 1.19, 1.31)] (2). Higher stroke mortality rates have been documented for black men compared with black women and white men and women (3) and among blacks living in southern states compared with nonsouthern states (4). The average black: white stroke mortality ratio for men ages 55–64 y living in the southern states was 3.24 compared with 2.67 for those living in the nonsouthern states (4).

A potential contributor to variations in stroke risk by region and race may be dietary differences, which have been shown to vary by race and region in the US. Diet quality differs in blacks compared with whites (5,6) and among individuals living in the South compared with other regions in the US (7). Few studies have examined whether dietary intakes differ by race and region, and only one of which we are aware considered both in the same study. Champagne et al. (8) reported lower intakes of several disease-related nutrients such as dietary fiber, calcium, magnesium, and potassium among 1751 Delta black and Delta white adults compared with a national sample of U.S. black and white adults; lower intakes of these nutrients were also observed for Delta black adults compared with Delta white adults. This study, however, did not jointly consider the effects of both race and region or whether the 2 interacted. Also, examining dietary intakes for men and women separately may be important for understanding racial and regional differences in dietary intakes given that men generally have less healthy overall dietary patterns compared with women (9–11).

Our objective was to examine dietary intakes of men currently enrolled in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study and determine whether

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there were racial and regional differences in intakes among black and white men living in the Stroke Belt (noncoastal regions of North Carolina, South Carolina, and Georgia, as well as Alabama, Arkansas, Georgia, Louisiana, Mississippi, and Tennessee) and Stroke Buckle (coastal plain regions of North Carolina, South Carolina, and Georgia) compared with those living elsewhere in the US. An additional goal was to examine whether race and region were significant predictors of selected nutrient intakes and whether the 2 would interact. We hypothesized that significant differences would be observed across different subgroups of men. Examining associations and interactions among race, region, and dietary intakes specifically among men may help to identify dietary risk factors for stroke and other chronic diseases and inform dietary recommendations and public health nutrition interventions for high-risk populations such as black men living in the South.

Materials and Methods

*Study population.*This study used baseline data from the REGARDS cohort, a national longitudinal study that took place between 2003 and 2007 and included ~30,000 black and white individuals aged 45 y and older. Details on the design, methods, and objectives for the REGARDS study are described elsewhere (12). Briefly, within each region, individuals were recruited via mail and telephone using commercially available lists of residents. The cohort oversampled individuals in the Stroke Belt (20%) and Stroke Buckle (30%); 50% came from the other 48 contiguous United States. Informed consent was obtained from all participants and methods for the parent study were reviewed and approved by the Institutional Review Board at the University of Alabama at Birmingham. The Boston University School of Medicine and Boston Medical Center also approved the protocol for this ancillary study.

This study included only men who had completed a FFQ (n = 10,834), which was ~79.8% of the total sample of men in the main study. Of these, we excluded individuals who left >15% of food items blank (n = 592) and individuals with implausible values for dietary intake (<3347 kJ/d or >20,920 kJ/d, n = 683). After all exclusions, 9559 men were available for the analysis.

Exposure and covariate assessment. Details on the methods used in the original data collection for the REGARDS study are provided elsewhere (12). In brief, demographic information and medical history were obtained via computer-assisted telephone interview (CATI). Additional demographic and risk factor characteristics and dietary intakes were collected via self-administered questionnaires, including the Block FFQ (see below); participants were sent information on how to complete the questionnaires, which were mailed back to the study center at the University of Alabama at Birmingham.

Race and region were our primary exposure variables. Race was determined via self-report on the CATI, in which participants self-identified themselves as non-Hispanic black or white. Region was determined using geocoding methods and was defined as follows: Stroke Buckle (costal plain region of NC, SC, and GA), Stroke Belt (remainder of NC, SC and GA, plus AL, MS, TN, AR, and LA), and other (the remaining states in the contiguous US).

Sociodemographic covariates were assessed from both the CATI and mail-in questionnaires and categorized as follows: age (y), income (< $25,000, $25,000 to <$50,000, $50,000 to <$75,000, and ≥$75,000), education (<high school, high school graduate, some college, college degree or higher), marital status (single, married, divorced, widow, other), smoking status (current, never, former), multivitamin supplement use (% yes), television watching (0 h/wk, 1–6 h/wk, 1 h/d, 2–3 h/d, >3 h/d), and physical activity (0/wk, 1–3/wk, ≥4/wk). Physical activity was assessed through questionnaire as the self-reported number of times per week an individual participated in intense activity. Anthropometric and physical measurements, including height, weight, waist circumference, blood pressure, blood and urine samples, and electrocardiogram, were collected during an in-home examination by a trained technician. An inventory of current medications was also completed. Presence of medical conditions was determined following standard assays, as described elsewhere (12), and included diabetes (fasting plasma glucose > 6.99 mmol/L, nonfasting glucose ≥ 11.1 mmol/L, or use of diabetes medication), hypertension (systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or use of antihypertensive medications), and hypercholesterolemia (total cholesterol ≥ 6.216 mmol/L, LDL cholesterol ≥ 4.144 mmol/L, HDL cholesterol ≤ 1.036 mmol/L, or use of lipid-lowering medications). BMI was calculated from measured weight and height data (kg/m^2).

Dietary assessment. Dietary intakes were assessed using the 1998 Block Dietary Questionnaire (Block 98) self-administered FFQ (13), which is a semiquantitative FFQ that measures usual dietary intakes. For each item on the FFQ, a common serving size of the food or beverage is specified (e.g., 1/2 cup carrots, 2 slices of bacon) and participants are asked how often, on average, they consumed this amount during the previous year. Individuals selected from 9 possible frequencies ranging from "never or less than once per month" to "1 (or 2) or more times per day" and selected an appropriate portion size. Portion size for unitary items such as eggs was queried as "1, 2, or 3" (where 1 is the smallest egg) and the number consumed each time was also reported. For nonunitary foods, a photo was provided to participants to aid in estimating 4 different portions. For each food, a gram amount was then assigned based on the gram weight of the volume for the selected portion size model.

FFQ were completed by participants at home and mailed to the study center, where they were checked for completeness and scanned. Scanned FFQ files were then sent to NutritionQuest for processing. Nutrients were calculated using the Block nutrient database, which was developed from the USDA Nutrient Database for Standard Reference (14) and other sources (e.g. manufacturers' data). The amount of each food consumed was calculated by multiplying the reported frequency by the portion size for each food item. The total amount of a contributing nutrient from each food was then derived by multiplying the amount consumed by the amount of nutrient in the given FFQ line item (from the Block nutrient database). Nutrients were then summed over all FFQ items to provide estimates for total daily nutrient intakes from foods and beverages; intakes from dietary supplements were not included (personal communication, Torin Block, NutritionQuest).

There were significant differences between those who did and did not complete an FFQ. For example, those completing an FFQ were somewhat older (65.7 ± 9.1 vs. 64.8 ± 9.6 y) and had a slightly lower BMI (28.4 ± 4.9 vs. 29.0 ± 5.3 kg/m^2) compared with those not completing an FFQ. Also, compared with FFQ nonparticipants, a higher proportion of FFQ completers were college educated (43 vs. 32%; P < 0.0001) and a lower proportion had less than a high school education (9 vs. 18%; P < 0.0001), and a higher proportion of FFQ completers had an income ≥ $75,000/y (25 vs. 19%) and a lower proportion had an income ≤ $25,000 (19 vs. 31%) (data not shown).

*Statistical analyses.*For all descriptive analyses, we stratified our sample by region and by race within region a priori, as our study objective was to examine differences across these subgroups. We then calculated sample means and frequencies for sociodemographic variables, anthropometric variables, and macro- and micronutrient intakes. For sociodemographic and anthropometric variables, chi-square analyses were used for categorical variables and t tests and multifactor ANOVA were used for continuous variables to test for differences in racial subgroups within region as well as differences between regions. Macronutrients and micronutrients were adjusted for total energy using the nutrient residual approach (15); macronutrients were also treated as percent energy. As dietary data are not normally distributed, we calculated medians and IQR for nutrients and tested for significant differences between races within region using the Wilcoxon two-sample test. We tested for significant differences across the 3 regions using the Kruskal-Wallis test.

We performed linear regression analyses to examine whether race and region (our primary exposure variables) were associated with nutrient intakes of fiber (g), saturated fat (percent energy), *trans* fat (percent energy), sodium (mg), potassium (mg), magnesium (mg), calcium (mg), and dietary cholesterol (mg). Separate sets of models were developed for each outcome and we began by examining univariate associations with race and region. Then, for each nutrient outcome, we created 2 multivariable-adjusted models. The first model was multivariable adjusted for age, total energy, BMI, multivitamin use, income, education, marital status, smoking status, alcohol use, physical activity, television viewing, and diagnoses of disease (hypertension, hypercholesterolemia, and diabetes). Dummy variables were used to include individuals with missing covariate information. The second model checked for effect modification by adding interaction terms for race and region (race * region) to the multivariable-adjusted model. We performed stratified analyses by race and region for any interaction terms with P-values < 0.05.

To test for potential multicollinearity, we performed a chi-square analysis of race and region and conducted diagnostic statistics to examine associations between the independent variables in our multivariable models. There were significant differences in races across regions (P < 0.0001). Among white men, 35% lived in the Stroke Belt, 20% in the Stroke Buckle, and 45% in other regions; for black men, 32% lived in the Stroke Belt, 17% in the Stroke Buckle, and 51% in other regions. In our multivariable models, values for tolerance tests were ≥ 0.34, indicating collinearity was not present in our models (data not shown).

α was set at $P < 0.05$ for all analyses and all hypothesis tests were 2-tailed. Statistical analyses were performed using the SAS for Windows, version 9.2 (16).

Results

Significant differences between regions were observed across all demographic and lifestyle characteristics ($P < 0.05$ for all) (**Table 1**). Within all regions, black men were younger than white men ($P < 0.001$ for all), with an age difference between regions ($P < 0.001$). A significantly smaller proportion of black men within each region had an annual income ≥ $75,000/y and had a college degree or higher ($P < 0.001$ for all) and differences between regions were also observed ($P < 0.001$). The percentage of black men who viewed television > 3 h/d was almost double compared with white men within each region ($P < 0.001$). A greater proportion of black men within each region reported being a current smoker compared with white men ($P < 0.001$). Within all regions, a smaller proportion of black men were currently married compared with white men ($P < 0.001$ for all); a significant difference was observed across regions ($P < 0.001$).

Small weight differences between black men and white men were observed within each region, with no significant difference in waist circumference either within or between regions (P-within = 0.25 and P-between = 0.08) (**Table 2**). Within each region, white men had a higher prevalence of overweight and more black men were obese ($P < 0.001$), but there were no significant differences in proportions across regions. More black men had diabetes compared with white men ($P < 0.001$).

Compared with white men, black men within each region consumed a higher percentage of energy from carbohydrate and a lower percentage of energy from total fat; intakes of fiber and alcohol were also lower for black men ($P < 0.05$ for all) (**Table 3**). Black men consumed a lower percentage of energy from *trans* fat compared with white men in the Stroke Belt ($P < 0.001$) but not in the Stroke Buckle (P = 0.54). White men had a higher median intake of total energy in the Stroke Belt and other regions only ($P < 0.05$); total energy intake did not differ across regions (P = 0.26). Black men consumed lower median intakes of riboflavin, niacin, vitamin B-12, α-tocopherol, vitamin D, calcium, potassium, magnesium, sodium, and iron compared with white men within each region ($P < 0.05$ for all) (**Table 4**). Black men consumed more vitamin C than white men in the Stroke Belt and Buckle ($P < 0.001$), but intakes in the other regions did not differ (P = 0.76). Significant differences in median intakes of vitamin A, riboflavin, niacin, vitamin B-12, α-tocopherol, β-carotene, vitamin C, calcium, magnesium, potassium, iron, and cholesterol were observed across regions ($P < 0.05$ for all).

In multivariable analyses, race and region were significant predictors of most nutrient intakes (**Table 5**). Significant interactions between race and region were detected for *trans* fat only (P-interaction < 0.0001); thus, this analysis was stratified by region to obtain the independent effects of race within region. Compared with white men, blacks consumed 1.00% lower energy from saturated fat [multivariable-adjusted β: 1.00% (95% CI: −0.88, −1.13)], and intakes were also lower in the Stroke Buckle [multivariable-adjusted β: −0.22 (95% CI = −0.08, −0.35)] and Stroke Belt [multivariable-adjusted β: −0.20 (95% CI: −0.08, −0.31)] compared with the other regions (P < 0.005 for all). Intake of *trans* fat was significantly lower among black men only in the Stroke Belt [multivariable-adjusted β: −0.21 (95% CI = −0.11, −0.31)]. Sodium, potassium, magnesium, and calcium intakes were all lower among black men compared with white men ($P < 0.0001$ for all), whereas cholesterol intakes were higher. Race was not significantly associated with fiber intakes (P = 0.36). Comparing regions, the lowest intakes of fiber, potassium, magnesium, and calcium were among men living in the Stroke Buckle, and men living in both the Stroke Buckle and Stroke Belt had higher intakes of cholesterol ($P < 0.005$ for all).

Discussion

Coupled with a higher risk of many chronic diseases among blacks in the South (17,18), our study was undertaken to explore whether diet might be part of the geographic and racial variation. In particular, this study aimed to examine the effects of race and region on dietary intakes among black and white men living in the Stroke Belt, Stroke Buckle, and other regions in the US. Race was a significant predictor of dietary intakes with lower intakes of all nutrients except fiber for black men compared with white men after adjustment for many potential confounders. In multivariable-adjusted models, the Stroke Belt and Buckle were associated with lower intakes of fiber, saturated fat, sodium (Stroke Belt only), potassium, magnesium (Stroke Buckle only), and calcium compared with other regions. Black race and the Stroke Belt/Buckle regions were associated with higher cholesterol intakes. The effects of region were generally more pronounced for the Stroke Buckle than the Belt and the effect of region on nutrient intake was modified by race for *trans* fat intakes only.

Saturated fat intake, an important risk factor for many chronic diseases, was 1.00% lower for black compared with white men. Effects for region were 0.22% lower for the Stroke Buckle and 0.20% lower for the Belt compared with the other regions, similar to our findings in women (P. K. Newby, S. E. Noel, R. Grant, S. Judd, J. M. Shikany, and J. Ard, unpublished data). Although the effects of region are quite small and likely of limited clinical importance, the finding of 1% lower intakes among blacks compared with whites is an important difference given the AHA guideline to limit saturated fat intake to no more than 7% of total energy intake (19). A recent study based on data from the NHANES from 1971 to 2002 reported lower intakes of total energy from saturated fat in 30,413 black men aged 25–74 y (5). The authors note that although blacks consumed lower intakes of saturated fat and higher intakes of vitamin C, similar to our results, lower intakes of several nutrients and foods such as calcium, potassium, and vegetables may be related to the higher chronic disease risk in black men. Similar results were also observed for 1751 adults living in the Lower Mississippi Delta, where lower saturated fat intakes were reported in Delta blacks

TABLE 1 Sample characteristics of 9559 men, stratified by race and geographic region[1]

Sample characteristics	Stroke Buckle			Stroke Belt			Other (non-stroke buckle or belt)			*P*-value between regions
	Black	White	*P*-value	Black	White	*P*-value	Black	White	*P*-value	
n	418	1438		793	2456		1265	3189		
Age, *y*	62.2 ± 9.2	65.9 ± 9.1	<0.001	63.2 ± 8.8	66.1 ± 8.8	<0.001	65.4 ± 8.9	66.8 ± 9.4	<0.001	<0.001
Multivitamin use, *%*	32.8	44.0	<0.001	35.4	46.7	<0.001	38.7	49.0	<0.001	0.002
Income, *%*			<0.001			<0.001			<0.001	<0.001
<$25,000	27.5	14.1		30.8	15.4		27.3	12.5		
$25,000 to <$50,000	34.5	32.0		32.9	34.8		34.5	31.9		
$50,000 to <$75,000	15.8	21.2		13.2	18.2		14.3	18.6		
≥$75,000	12.9	24.2		13.5	22.8		15.3	28.1		
Education, *%*			<0.001			<0.001			<0.001	<0.001
<High school	16.8	8.3		17.8	6.9		14.5	4.4		
High school graduate	29.0	21.0		25.4	23.7		28.4	19.2		
Some college	29.0	26.2		24.7	24.9		28.7	23.4		
College degree or higher	25.4	44.4		32.2	44.5		28.4	53.1		
Marital status, *%*			<0.001			<0.001			<0.001	<0.001
Single	6.2	2.2		5.7	2.4		7.8	4.1		
Married	66.8	85.7		70.4	86.0		65.2	83.1		
Divorced	12.9	5.6		13.6	5.3		13.8	5.6		
Widowed	7.7	5.9		7.7	5.9		8.9	6.7		
Other	6.5	0.6		2.7	0.4		4.2	0.7		
Smoking, *%*			<0.001			<0.001			<0.001	<0.001
Current	18.0	12.2		22.3	11.8		19.7	9.6		
Never	34.4	30.8		32.4	35.2		30.7	39.1		
Former	47.6	57.0		45.4	53.0		49.6	51.3		
Physical activity, *%*			0.006			0.08			<0.001	0.01
0 times/wk	28.7	24.1		27.6	25.1		31.3	26.5		
1–3 times/wk	39.5	35.6		38.1	36.2		39.4	36.7		
4 or more times/wk	31.8	40.4		34.4	38.7		29.3	36.8		
Television viewing, *%*			<0.001			<0.001			<0.001	0.003
0 h/wk	0.5	1.0		0.5	0.5		0.2	1.0		
1–6 h/wk	14.0	10.8		13.7	9.8		10.6	11.7		
1 h/d	3.5	7.8		4.3	8.1		4.8	10.4		
2–3 h/d	41.1	58.9		37.9	58.2		45.4	55.8		
>3 h/d	40.9	21.6		43.6	23.4		39.1	21.1		

[1] Values are means ± SD or percentages. Differences within (black vs. white) and between (Stroke Buckle vs. Stroke Belt vs. other) regions were examined using *t* tests for continuous variables (age) and chi-square for categorical variables.

compared with Delta whites (24.5 vs. 26.7 g; $P = 0.008$) (8). In that study, no significant differences in cholesterol intakes were observed between Delta blacks and whites or between Delta blacks and U.S. blacks (based on an external comparison group from the Continuing Survey of Food Intakes by Individuals 1994–1996, 1998). Our results, however, indicate higher consumption

TABLE 2 Anthropometric characteristics and health indicators of 9559 men, stratified by race and geographic region[1]

Anthropometric characteristic and health indicators	Stroke Buckle			Stroke Belt			Other (non-stroke buckle or belt)			*P*-value between regions
	Black	White	*P*-value	Black	White	*P*-value	Black	White	*P*-value	
n	418	1438		793	2456		1265	3189		
Weight, *kg*	93.0 ± 20	90.3 ± 17	0.01	92.3 ± 22	89.6 ± 17	0.002	90.6 ± 19	88.8 ± 17	0.004	0.003
Height, *cm*	177 ± 7.6	178 ± 7.3	0.17	178 ± 7.3	178 ± 8.1	0.66	178 ± 16	177 ± 7.3	0.49	0.23
Waist, *cm*	99.5 ± 14.7	100 ± 12.2	0.31	100 ± 15.2	101 ± 13.7	0.34	99.6 ± 13.8	99.9 ± 13.2	0.53	0.08
BMI, kg/m^2	29.4 ± 5.4	28.5 ± 4.8	0.001	28.9 ± 5.7	28.2 ± 4.6	0.003	28.7 ± 5.1	28.1 ± 4.8	0.003	0.009
BMI weight group, *%*			<0.001			<0.001			<0.001	0.24
Overweight	40.2	46.5		38.3	46.3		41.3	45.9		
Obese	39.0	30.9		36.9	29.2		35.5	28.4		
Hypertension, *%*	66.0	53.3	<0.001	67.6	54.2	<0.001	66.5	48.3	<0.001	0.002
Diabetes, *%*	33.8	18.9	<0.001	27.4	18.7	<0.001	28.2	14.7	<0.001	0.002
Dyslipidemia, *%*	64.9	72.8	0.002	60.2	71.0	<0.001	60.6	68.7	<0.001	0.002

[1] Values are means ± SD or percentages. Differences within (black vs. white) and between regions (Stroke Buckle vs. Stroke Belt vs. other) were examined using *t* tests and a multi-factor ANOVA for continuous variables and chi-square for categorical variables.

TABLE 3 Daily intakes of energy and macronutrients among 9,559 men, stratified by race and geographic region[1]

Energy and macronutrients[2]	Stroke buckle			Stroke belt			Other (non-stroke buckle or belt)			*P*-value between regions[4]
	Black	White	*P*-value[3]	Black	White	*P*-value[3]	Black	White	*P*-value[3]	
n	418	1438		793	2456		1265	3189		
Energy, *kJ*	6830 (4233)	7357 (3577)	0.13	7040 (4193)	7441 (3899)	0.02	6963 (4214)	7404 (3462)	<0.001	0.26
Carbohydrate, *g*	210 (132)	202 (107)	0.07	213 (128)	207 (114)	0.16	203 (125)	204 (103)	0.81	0.08
Carbohydrate, *% energy*	50.0 (12.1)	46.7 (11.2)	<0.001	49.5 (12.6)	47.1 (11.3)	<0.001	48.9 (12.0)	46.6 (11.9)	<0.001	0.11
Protein, *g*	56.4 (40.2)	62.2 (35.2)	<0.001	55.9 (39.2)	63.7 (37.4)	<0.001	57.1 (34.6)	64.9 (34.0)	<0.001	0.03
Protein, *% energy*	13.7 (3.9)	14.3 (3.9)	<0.001	13.6 (3.7)	14.4 (3.6)	<0.001	13.8 (4.0)	14.8 (3.7)	<0.001	<0.001
Total fat, *g*	64.0 (48.9)	73.1 (43.7)	0.003	65.6 (46.1)	73.6 (49.1)	<0.001	66.0 (46.8)	73.1 (42.1)	<0.001	0.28
Total fat, *% energy*	35.8 (9.7)	37.8 (9.9)	<0.001	36.2 (9.4)	37.9 (9.7)	<0.001	36.4 (10.0)	37.7 (9.7)	<0.001	0.12
Saturated	10.2 (3.0)	10.8 (3.3)	<0.001	10.4 (2.9)	10.8 (3.2)	<0.001	10.3 (3.1)	10.9 (3.6)	<0.001	0.59
trans	2.9 (1.7)	3.0 (1.5)	0.54	2.9 (1.7)	3.0 (1.6)	<0.001	2.8 (1.6)	2.7 (1.4)	<0.001	<0.001
Monounsaturated	13.7 (4.1)	14.5 (4.2)	<0.001	13.4 (4.0)	14.2 (4.2)	<0.001	13.7 (4.2)	14.4 (4.1)	<0.001	0.09
Polyunsaturated	8.6 (3.4)	9.4 (3.8)	<0.001	9.0 (3.7)	9.5 (3.9)	<0.001	9.0 (3.6)	8.9 (3.5)	0.06	<0.001
Fiber, *g*	12.6 (9.6)	15.0 (9.6)	<0.001	13.5 (10.2)	15.3 (10.3)	<0.001	13.9 (10.5)	15.8 (10.0)	<0.001	<0.001
Alcohol, *% energy*	0.2 (2.0)	0.5 (5.9)	<0.001	0.3 (3.1)	0.4 (4.7)	0.02	0.4 (4.2)	1.2 (6.4)	<0.001	<0.001

[1] Values are medians (IQR).
[2] Macronutrients are adjusted for total energy intake using the nutrient residual model.
[3] *P*-values comparing differences in median intakes between races within region (i.e. black vs. white) were calculated using the Wilcoxon two-sample test.
[4] Global *P*-values comparing differences in median intakes across regions (i.e., Stroke Buckle vs. Stroke Belt vs. other) were calculated using the Kruskal-Wallis test.

of cholesterol for blacks and for both blacks and whites living in the Stroke Belt and Buckle compared with those in the other regions of the US.

A significant interaction between race and region was detected for *trans* fat intake, which was lower among black men only in the Stroke Belt. Although the point estimate is small [multivariable-adjusted β: −0.21 (95% CI = −0.11, −0.31)], the finding may have public health importance given the recommendation by the AHA to consume <1% of daily energy from *trans* fats for the prevention of cardiovascular disease and its risk factors (19). It is unclear why there is an effect only for the Stroke Belt and not the Buckle given that the effects are present and stronger for many of the other nutrients in the Stroke Buckle. Further investigation is needed to understand and confirm this finding.

A scientific statement from the AHA on Dietary Approaches to Prevent and Treat Hypertension found persuasive evidence supporting the relationship between higher intakes of sodium and lower intakes of potassium on elevated blood pressure, with limited or equivocal evidence for the relationship with lower intakes of calcium and magnesium intakes (20). There is also moderate to strong evidence that higher intakes of several nutrients such as potassium, magnesium, and calcium are associated with prevention of stroke in men and women (21).

TABLE 4 Daily intakes of micronutrients among 9559 men, stratified by race and geographic region[1]

Intakes of micronutrients[2]	Stroke Buckle			Stroke Belt			Other (non-stroke buckle or belt)			*P*-value between regions[4]
	Black	White	*P*-value[3]	Black	White	*P*-value[3]	Black	White	*P*-value[3]	
n	418	1438		793	2456		1265	3189		
Vitamin A, *IU*	6508 (6120)	7117 (5722)	0.05	6661 (5781)	7116 (5957)	0.03	6903 (6329)	7739 (6076)	<0.001	<0.001
Thiamin, *mg*	1.3 (0.8)	1.3 (0.7)	0.67	1.3 (0.8)	1.3 (0.7)	0.06	1.2 (0.8)	1.3 (0.7)	<0.001	0.18
Riboflavin, *mg*	1.4 (0.9)	1.5 (0.8)	<0.001	1.4 (0.8)	1.6 (0.9)	<0.001	1.4 (0.9)	1.6 (0.8)	<0.001	0.002
Niacin, *mg*	16.7 (13.0)	19.1 (10.7)	<0.001	16.7 (11.9)	19.1 (11.5)	<0.001	16.7 (11.6)	19.9 (10.9)	<0.001	0.03
Folate, *μg*	331 (211)	334 (195)	0.36	314 (213)	340 (193)	0.001	314 (194)	339 (190)	<0.001	0.95
Vitamin B-12, *μg*	3.3 (2.6)	3.8 (2.7)	<0.001	3.1 (2.6)	3.8 (2.7)	<0.001	3.1 (2.5)	3.7 (2.5)	<0.001	0.002
α-Tocopherol, *μg*	7.7 (5.6)	9.1 (5.7)	<0.001	8.3 (5.9)	9.2 (6.3)	<0.001	8.4 (6.1)	9.5 (5.7)	<0.001	0.02
β-Carotene, *μg*	2561 (2581)	2503 (2553)	0.82	2437 (2454)	2511 (2413)	0.52	2596 (2682)	2655 (2522)	0.43	<0.001
Vitamin C, *mg*	105 (107)	84.4 (81.1)	<0.001	95.8 (101)	85.4 (77.8)	<0.001	97.8 (91.2)	99.6 (85.9)	0.76	<0.001
Vitamin D, *IU*	109 (106)	127 (111)	<0.001	107 (105)	131 (133)	<0.001	108 (118)	132 (132)	<0.001	0.17
Calcium, *mg*	523 (376)	621 (411)	<0.001	559 (405)	666 (455)	<0.001	532 (391)	676 (447)	<0.001	<0.001
Magnesium, *mg*	232 (140)	275 (133)	<0.001	238 (149)	282 (157)	<0.001	241 (156)	289 (144)	<0.001	<0.001
Potassium, *mg*	2218 (1379)	2647 (1242)	<0.001	2306 (1453)	2706 (1393)	<0.001	2308 (1408)	2838 (1371)	<0.001	<0.001
Iron, *mg*	11.7 (7.6)	12.7 (7.0)	<0.001	11.2 (6.9)	12.8 (7.5)	<0.001	11.3 (7.4)	13.1 (7.5)	<0.001	0.04
Sodium, *mg*	2149 (1478)	2321 (1286)	0.02	2170 (1476)	2370 (1304)	<0.001	2190 (1466)	2368 (1258)	<0.001	0.53
Cholesterol, *mg*	239 (216)	207 (159)	0.004	222 (200)	215 (159)	0.06	210 (174)	202 (142)	0.02	<0.001

[1] Values are medians (IQR).
[2] Nutrients are adjusted for total energy intake using the nutrient residual model; intakes are from foods only.
[3] *P*-values comparing differences in median intakes between races within region (i.e. black vs. white) were calculated using the Wilcoxon two-sample test.
[4] Global *P*-values comparing differences in median intakes across regions (i.e. Stroke Buckle vs. Stroke Belt vs. other) were calculated using the Kruskal-Wallis test.

TABLE 5 Multivariable linear regression analyses showing associations among race, region, and daily nutrient intakes among 9559 men[1]

	Effects of race and region on nutrient intakes		
Nutrient outcome	β (SE)	95% CI	*P*-value
Fiber, *g*			
Black	−0.15 (0.16)	(−0.47, 0.17)	0.36
Stroke Buckle	−0.64 (0.18)	(−0.29, −0.99)	0.0004
Stroke Belt	−0.37 (0.15)	(−0.08, −0.66)	0.01
Saturated fat, *% energy*			
Black	−1.00 (0.06)	(−0.88, −1.13)	<0.0001
Stroke Buckle	−0.22 (0.07)	(−0.08, −0.35)	0.002
Stroke Belt	−0.20 (0.06)	(−0.08, −0.31)	0.0008
Trans fat, *% energy*[2]			
Stroke Buckle: Black	−0.12 (0.07)	(−0.26, 0.02)	0.10
Stroke Belt: Black	−0.21 (0.05)	(−0.11, −0.31)	<0.0001
Other	0.02 (0.04)	(−0.05, 0.10)	0.57
Sodium, *mg*			
Black	−70.4 (12.2)	(−46.5, −94.4)	<0.0001
Stroke Buckle	−25.2 (13.5)	(−51.6, 1.22)	0.06
Stroke Belt	−36.9 (11.3)	(−14.8, −58.9)	0.001
Potassium, *g*			
Black	−245 (15.9)	(−214, −277)	<0.0001
Stroke Buckle	−127 (17.5)	(−92.9, −162)	<0.0001
Stroke Belt	−87.6 (14.6)	(−59.0, −116)	<0.0001
Magnesium, *mg*			
Black	−21.0 (1.8)	(−17.5, −24.6)	<0.0001
Stroke Buckle	−8.10 (2.0)	(−4.18, −12.0)	<0.0001
Stroke Belt	−2.78 (1.7)	(−6.05, 0.50)	0.10
Calcium, *mg*			
Black	−96.3 (7.0)	(−82.7, −110)	<0.0001
Stroke Buckle	−45.7 (7.7)	(−30.7, −60.7)	<0.0001
Stroke Belt	−12.7 (6.4)	(−0.17, −25.3)	0.04
Cholesterol, *mg*			
Black	9.09 (2.7)	(3.88, 14.3)	0.0006
Stroke Buckle	12.4 (2.9)	(6.64, 18.1)	<0.0001
Stroke Belt	10.2 (2.4)	(5.43, 15.0)	<0.0001

[1] For unstratified analyses, the reference group for race is white and the reference group for region is "other." All models are adjusted for the following covariates: age, total energy, BMI, multivitamin use, income, education, marital status, smoking status, alcohol use, physical activity, television viewing, and diagnoses of disease (hypertension, hypercholesterolemia, and diabetes). Results are stratified for analyses where a significant interaction was detected ($P < 0.05$).

[2] A significant interaction between race and region was detected for trans fat ($P < 0.0001$). This analysis was stratified by region and β-coefficients represent effects for blacks within each region (referent: white).

Our study found lower intakes of potassium, magnesium, and calcium for black men compared with white men. Intakes of these nutrients were also lower in the Stroke Belt and Buckle compared with other regions. Champagne et al. (8) reported results similar to our own, with lower intakes of calcium, magnesium, and potassium among blacks compared with whites in the Lower Mississippi Delta and among those in the Delta region compared with a national sample of U.S. black and white adults. Another cross-sectional study of 17,752 participants from NHANES III reported higher intakes of poly- and monounsaturated fat and cholesterol and lower intakes of fiber, potassium, calcium, phosphorus, magnesium, copper, and iron for participants in the South compared with other regions in the US (7). This study, which did not examine the effects of race, also found that those living in the South had higher systolic and diastolic blood pressure and the highest sodium intakes compared with other regions. Our results were similar to this nationally representative sample except for sodium, which was lower among those living in the Stroke Belt and Stroke Buckle. However, the FFQ has been found to underestimate sodium intake compared with multiple dietary records and urinary nitrogen (22). Although significant, most differences are small.

With respect to dietary differences between blacks and whites, Diaz et al. (23) reported lower intakes of cholesterol, fiber, sodium, and potassium for overweight (BMI ≥ 25 kg/m^2) blacks compared with overweight whites based on 24-h recalls from NHANES 1999–2000. In that study, blacks had a higher likelihood of having elevated systolic blood pressure; however, no dietary factors were associated with systolic blood pressure. Another study that examined trends in dietary intakes from 1971 to 2002 using NHANES data found that blacks reported consuming lower amounts of saturated fat, potassium, and calcium relative to whites (5). The lower intakes of calcium and potassium in blacks may be partially due to lower dairy intakes among this population (5). Results based on national data (NHANES 1999–2000 and Continuing Survey of Food Intakes by Individuals 1994–1996, 1998) indicate that black men typically consumed fewer servings of dairy and had lower intakes of calcium, magnesium, and phosphorus (6). Black men reported consuming less milk and more fruit drinks/ades (i.e., drinks made from water, sugar, and fruit juice) than white men across most age categories (6–39 y and ≥60 y) in a national study on beverage consumption (24). Ford et al. (25) reported that men consumed more magnesium than women across all ethnic groups, although black men consumed less magnesium than white men (median intake: 237 vs. 326 mg/d, respectively). In that study, the 2 main dietary sources of magnesium were vegetables and dairy products, both of which were consumed less frequently by blacks compared with whites (5,6). In future analyses, we plan to examine the dietary patterns of this population as a complementary approach to understanding the regional and racial differences in individual nutrient intakes and to further investigate relationships between diet and disease.

As seen with our report among women (P. K. Newby, S. E. Noel, R. Grant, S. Judd, J. M. Shikany, and J. Ard, unpublished data), stronger effects for race (adjusted for region and other factors) compared with region were seen for most analyses. Cushman et al. (26) also reported larger effects for race than region in a study of risk factors for stroke in the REGARDS population. Nonetheless, regional differences in disease risk within race are still observed. In one study, black adults living in the Stroke Belt had a higher likelihood of diabetes compared with those living in the other states [multivariable-adjusted OR: 1.13 (95% CI = 1.02, 1.26)] and black adults living in the Stroke Buckle had an even higher likelihood compared with those in the remaining states after adjusting for demographic variables [multivariable-adjusted OR: 1.45 (95% CI = 1.26, 1.66)] (18). Higher rates of stroke mortality and an increased risk of chronic disease have been noted for the Stroke Buckle in 2 other studies (18,27). Geographic disparities between the Stroke Belt and Buckle with the remaining US may be due in part to lifestyle differences such as diet and physical activity. In our study, the effect of region on nutrient intakes was, for the most part, greater for the Stroke Buckle compared with the Belt. For example, potassium intake was 127.22 and 87.61 g/d lower among men in the Stroke Buckle and Belt compared with other regions, respectively, a difference that may help explain the increased stroke risk in this region; more studies are needed to further investigate this hypothesis.

This study has several strengths, including a large sample size, the inclusion of a large number of black men, and information for individuals living in unique regions with known health disparities (i.e. the Stroke Belt and Stroke Buckle). Several studies have examined the effects of race, region, or sex on dietary intakes in separate analyses, but few have looked at the effects of race and region in combination with diet and none specifically tested for effect modification. Our study examined interactions between race and region on dietary intakes in a large population of men while adjusting for many potential confounders, thus isolating the independent effects of race and region on dietary intakes while testing for synergies. However, the analyses in this study were cross-sectional, because our aim was to describe dietary intakes at baseline. While a cross-sectional study has well-known limitations, our goal was to examine potential interactions between race and region on dietary intakes before moving to more complex longitudinal analyses. Further, our key exposure variables, race and region, do not vary over time; thus, there is no possibility of reverse causality despite the cross-sectional design.

It should be noted that dietary data were collected using an older instrument (Block 98 FFQ), but at the time of this study's inception (mid-1990s) it was one of the main tools used to collect data on racially diverse populations, such as in this study. Although designed for the general U.S. population, the Block 98 FFQ specifically included foods contributing to diets among U.S. blacks (personal communication, Torin Block, NutritionQuest, Berkeley, CA). Yet, it remains possible that the Block FFQ did not sufficiently discriminate between dietary intakes among blacks and whites both within and between regions in the US, potentially resulting in misclassification and attenuation of true differences in dietary intakes. Unfortunately, a validation study of the Block FFQ to better understand its performance among REGARDS participants was not performed, so it was not possible to quantify dietary reporting errors and correct our estimates. Nonetheless, dietary reporting errors are generally random and attenuate results (15), so our findings may underestimate true differences in dietary intakes by race and region. Although the FFQ designed by Tucker et al. (28) specifically to measure dietary intakes in black Southern populations may be a more appropriate tool due to its inclusion of more culturally specific foods, this instrument did not exist at the time the REGARDS study began. As well, an older version of the nutrient database was used to remain consistent with other studies using this FFQ. The nutrient estimates provided in the descriptive tables should be interpreted with caution, because FFQ are not designed to provide precise estimates of absolute intakes. Further, while many of our results are significant and consistent with studies discussed herein, other results presented in this study achieve significance due to our large sample size, but such differences are not necessarily clinically significant. Finally, we observed effect modification by race and region for *trans* fat intakes only and more research is needed to reproduce this result, because interaction effects can be spurious and difficult to replicate (15).

In conclusion, our study showed that race and region were significant predictors of nutrient intakes in a large study of black and white men in the United States and, for *trans* fat intake, the effect of region was modified by race. Given these observed differences in dietary intakes, more research is needed to understand if and how they play a role in the health disparities and chronic disease risks observed among racial groups and regions in the US. Also, clarifying the effects of race and region on dietary intakes may be helpful in making dietary recommendations and informing interventions for specific population subgroups.

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Literature Cited

1. AHA. Heart disease and stroke statistics: 2009 update. Dallas TAHA; 2009 AHA [cited 2010 Apr 15]. Available from: http://www.americanheart.org/downloadable/heart/1240250946756LS-1982%20Heart%20and%20Stroke%20Update.042009.pdf.
2. Liao Y, Greenlund KJ, Croft JB, Keenan NL, Giles WH. Factors explaining excess stroke prevalence in the US Stroke Belt. Stroke. 2009;40:3336–41.
3. Howard G, Evans GW, Pearce K, Howard VJ, Bell RA, Mayer EJ, Burke GL. Is the stroke belt disappearing? An analysis of racial, temporal, and age effects. Stroke. 1995;26:1153–8.
4. Howard G, Labarthe DR, Hu J, Yoon S, Howard VJ. Regional differences in African Americans' high risk for stroke: the remarkable burden of stroke for Southern African Americans. Ann Epidemiol. 2007;17:689–96.
5. Kant AK, Graubard BI, Kumanyika SK. Trends in black-white differentials in dietary intakes of U.S. adults, 1971–2002. Am J Prev Med. 2007;32:264–72.
6. Fulgoni V III, Nicholls J, Reed A, Buckley R, Kafer K, Huth P, DiRienzo D, Miller GD. Dairy consumption and related nutrient intake in African-American adults and children in the United States: continuing survey of food intakes by individuals 1994–1996, 1998, and the National Health and Nutrition Examination Survey 1999–2000. J Am Diet Assoc. 2007;107:256–64.
7. Hajjar I, Kotchen T. Regional variations of blood pressure in the United States are associated with regional variations in dietary intakes: the NHANES-III data. J Nutr. 2003;133:211–4.
8. Champagne CM, Bogle ML, McGee BB, Yadrick K, Allen HR, Kramer TR, Simpson P, Gossett J, Weber J. Dietary intake in the lower Mississippi delta region: results from the Foods of our Delta Study. J Am Diet Assoc. 2004;104:199–207.
9. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. Am J Clin Nutr. 2003;77:1417–25.
10. Tseng M, DeVellis RF. Fundamental dietary patterns and their correlates among US whites. J Am Diet Assoc. 2001;101:929–32.
11. Williams DE, Prevost AT, Whichelow MJ, Cox BD, Day NE, Wareham NJ. A cross-sectional study of dietary patterns with glucose intolerance and other features of the metabolic syndrome. Br J Nutr. 2000;83: 257–66.
12. Howard VJ, Cushman M, Pulley L, Gomez CR, Go RC, Prineas RJ, Graham A, Moy CS, Howard G. The reasons for geographic and racial differences in stroke study: objectives and design. Neuroepidemiology. 2005;25:135–43.
13. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. Am J Epidemiol. 1986;124:453–69.

14. USDA. Nutrient Database for Standard Reference [Releases 10 and 11]. . Washington, DC: US Government Printing Office; 1993, 1996.
15. Willett WC. Nutritional epidemiology. 2nd ed. New York: Oxford University Press; 1998.
16. The SAS System for Windows. Version 9.2. Cary (NC): SAS; 1999.
17. Obisesan TO, Vargas CM, Gillum RF. Geographic variation in stroke risk in the United States. Region, urbanization, and hypertension in the Third National Health and Nutrition Examination Survey. Stroke. 2000;31:19–25.
18. Voeks JH, McClure LA, Go RC, Prineas RJ, Cushman M, Kissela BM, Roseman JM. Regional differences in diabetes as a possible contributor to the geographic disparity in stroke mortality: the Reasons for Geographic and Racial Differences in Stroke Study. Stroke. 2008;39: 1675–80.
19. Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, Franklin B, Kris-Etherton P, Harris WS, et al. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. Circulation. 2006; 114:82–96.
20. Appel LJ, Brands MW, Daniels SR, Karanja N, Elmer PJ, Sacks FM. Dietary approaches to prevent and treat hypertension: a scientific statement from the American Heart Association. Hypertension. 2006; 47:296–308.
21. Ding EL, Mozaffarian D. Optimal dietary habits for the prevention of stroke. Semin Neurol. 2006;26:11–23.
22. Day N, McKeown N, Wong M, Welch A, Bingham S. Epidemiological assessment of diet: a comparison of a 7-day diary with a food frequency questionnaire using urinary markers of nitrogen, potassium and sodium. Int J Epidemiol. 2001;30:309–17.
23. Diaz VA, Mainous AG III, Koopman RJ, Carek PJ, Geesey ME. Race and diet in the overweight: association with cardiovascular risk in a nationally representative sample. Nutrition. 2005;21:718–25.
24. Storey ML, Forshee RA, Anderson PA. Beverage consumption in the US population. J Am Diet Assoc. 2006;106:1992–2000.
25. Ford ES, Mokdad AH. Dietary magnesium intake in a national sample of US adults. J Nutr. 2003;133:2879–82.
26. Cushman M, Cantrell RA, McClure LA, Howard G, Prineas RJ, Moy CS, Temple EM, Howard VJ. Estimated 10-year stroke risk by region and race in the United States: geographic and racial differences in stroke risk. Ann Neurol. 2008;64:507–13.
27. Howard G, Anderson R, Johnson NJ, Sorlie P, Russell G, Howard VJ. Evaluation of social status as a contributing factor to the stroke belt region of the United States. Stroke. 1997;28:936–40.
28. Tucker KL, Maras J, Champagne C, Connell C, Goolsby S, Weber J, Zaghloul S, Carithers T, Bogle ML. A regional food-frequency questionnaire for the US Mississippi Delta. Public Health Nutr. 2005;8:87–96.