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Dietary Patterns, Abdominal Visceral Adipose Tissue and Cardiometabolic Risk Factors in African Americans: the Jackson Heart Study

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Abstract

Dietary behavior is an important lifestyle factor to impact an individual's risk of developing cardiovascular disease (CVD). However, the influence of specific dietary factors on CVD risk for African Americans remains unclear. We conducted a cross-sectional study of 1775 participants from Jackson Heart Study (JHS) Exam 2 (between 2006 and 2009) who were free of hypertension, diabetes and CVD at the baseline (between 2001 and 2004). Dietary intakes were documented using a validated food-frequency questionnaire (FFQ) and dietary patterns were generated by factor analysis. Three major dietary patterns were identified: a "southern", a "fast food" and a "prudent" pattern. After adjustment for age, sex, smoking and alcohol status, education level and

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The authors declared no conflict of interest.

Author Contributions:
Dr. Liu had full access to all of the data in the study and takes responsibility for integrity of the data and accuracy of data analysis.
Study Concept and Design: Drs. Liu, Fox, Talegawkar, Tucker and Taylor.
Acquisition of data: Dr. Liu.
Analysis and Interpretation of data: Drs. Liu, Fox, Hickson, Talegawkar and Taylor.
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physical activity, high “southern” pattern score was associated with an increased odds ratio (OR) for high abdominal visceral adipose tissue (VAT) (OR:1.80, 95%CI:1.1–3.0, *p=0.02*), hypertension (OR:1.42, 95%CI:1.1–1.9, *p=0.02*), diabetes (OR:2.03, 95%CI:1.1–3.9, *p=0.03*) and metabolic syndrome (OR:2.16, 95%CI:1.3–3.6, *p=0.004*). Similar associations were also observed in the “fast food” pattern (*p ranges 0.03–0.0001*). The “prudent” pattern was significantly associated, in a protective direction, with hypertension (OR 0.69, 95%CI 0.5–0.9, *p=0.02*). In conclusion, dietary patterns, especially the “southern” pattern, identified from a regional specific FFQ in this Deep South African Americans, are correlated with abdominal VAT and cardiometabolic risk factors.

Keywords

Jackson Heart Study; dietary patterns; cardiometabolic risk factors

Introduction

African Americans, compared to other ethnic groups, have been shown to have similar risk for cardiovascular disease (CVD) but greater cardiovascular mortality (1). Our recent studies demonstrated higher CVD risk in African Americans from the Jackson Heart Study (JHS), with higher prevalence of obesity, diabetes and hypertension than that in European Americans from the Framingham Heart Study (FHS) (2,3). Although the underlying explanations for ethnic disparities remains poorly understood, they may be associated with a greater clustering of risk factors in African Americans, including lower socioeconomic status (4,5), lower physical activity (6) and genetic factors (7). These variations may also implicate environmental factors and/or modifiable lifestyle habits as important determinants of CVD risk. Numerous studies have shown that dietary behavior is an important lifestyle factor impacting risk of developing CVD (8–10). However, the influence of specific dietary factors on CVD risk for African Americans remains unsolved, particularly because the dietary behaviors and patterns differ across geographical areas and ethnic groups (11). Furthermore, associations of diet with CVD risk have been rarely examined in population-based studies with an adequate sample size of African Americans. Thus, the objective of this report is to describe dietary patterns, derived from principal component analysis (PCA), and to determine whether these dietary patterns can impact cardiometabolic abnormalities in African Americans of the JHS cohort from the Deep South metropolitan area of Jackson, Mississippi.

Methods

Study Sample

The JHS recruited 5301 African Americans from the Jackson, MS metropolitan area between September 2000 and March 2004 and comprises 5301 participants between the ages of 21–94 years (12). The cohort composed of four components: 1) approximately 31% of the cohort members were participants from the Atherosclerosis Risk in Communities (ARIC) study recruited to the JHS; 2) 30% were representative community volunteers who met census-derived age, sex and socioeconomic status eligibility criteria from the Jackson, MS metropolitan area; 3) 17% were randomly ascertained from the Jackson, Mississippi; 4) 22% were in the JHS family study. The sampling frame for the family study was participants in any one of the ARIC, random or volunteer samples whose family size met eligibility requirements as detailed previously (12). For the present study, study sample consisted of JHS participants, who underwent extensive dietary assessment interviews and multi-detector computed tomography scan. The study excluded participants with the presence of CVD, hypertension or diabetes (n=3361) and those without dietary assessments (n=165). Thus, the final sample size for this analysis is 1775.

Dietary Assessment and dietary Patterns

As part of the standard dietary data collection, usual dietary intake was assessed for all participants with a short food frequency questionnaire (FFQ) developed from a long questionnaire previously designed for the USDA Delta Nutrition Intervention Research Initiative (Delta-NIRI) (13). This Delta NIRI FFQ was specifically designed for a southern United States population to capture the regional eating patterns and the regional foods such as ham hocks, chitterling, grits, etc, with specified serving sizes that were described using natural portions or standard weight and volume measures of servings commonly consumed, based on 24 hour recall data in the Delta region. Due to limitations in time for the questionnaire, a shorter version of the Delta NIRI questionnaire was created for the JHS, reducing the number of food items from 283 to 158 by collapsing similar food items into categories (14). Average daily energy intakes of food items and total energy intake were calculated with software at Nutrition coordinating Center (University of Minnesota, Minneapolis, MN) and developed for the survey instrument (15). In order to minimize within-person variation in consumption of individual foods, the 158 food items were aggregated into 31 predefined food groups based on their energy contributions. Individual food items were preserved if they constituted distinct items on their own (i.e., chicken, corn products, butter, soup, coffee and tea) or if they were thought to represent particular dietary habits (Table 1).

For the reproducibility and validity of the short Delta NIRI JHS FFQ used for the entire cohort, a subset of participants (n=499) was selected from the whole JHS cohort (n=5301) for the Diet and Physical Activity sub-Study (DPASS) (15,16). Participants included for DPASS were matched on age, sex, socioeconomic status and physical activities (15). The original, long FFQ and 24-hour diet recalls were administrated for participants during their initial clinic visit, followed by four 24-hour dietary recalls scheduled a month apart from a month after the initial clinic visit, and the quality control checks were performed on both the short and the long FFQ (16). For most nutrients analyzed, both short and the long FFQ are reasonably valid for assessment of dietary intake of adult African Americans in the South (16).

Risk Factors and Covariate Assessment

Risk factors and covariates were measured at Exam 2 (2005 – 2008) (17). Body mass index (BMI) was defined as weight (in kilograms) divided by the square of height (in meters). Two measures of waist circumference (WC) (at the level of the umbilicus, in the upright position) were averaged to determine WC for each participant. Fasting blood samples were collected according to standardized procedures and the assessment of plasma glucose and lipids were processed at the Central Laboratory (University of Minnesota) as previously described. Sitting blood pressure was measured twice at 5-minutes intervals and the average of two measurements was used for analysis.

Participants were considered to have hypertension if they were taking antihypertensive medications and/or if their systolic pressure was ≥ 140 mm Hg or diastolic pressure ≥ 90 mm Hg. Impaired fasting glucose was defined as fasting plasma glucose of 100–125 mg/dl among those not treated for diabetes. Diabetes was defined as a fasting plasma glucose level ≥ 126 mg/dl or treatment with insulin or hypoglycemic agents. High triglycerides level were defined as fasting plasma triglyceride level ≥ 150 mg/dl and low HDL-C level was defined as fasting plasma HDL-C level < 40 mg/dl in men and < 50 in women. Participants were considered current smokers if they had smoked, used chewing tobacco or nicotine gum, or were wearing a nicotine patch at the time of interview. Daily alcohol consumption were assessed by the validated food frequency questionnaires and collected during the face-to-face encounters by trained interviewers (16). Physical activity was assessed using the JHS Physical Activity Cohort survey (JPAC) (18). Obesity was defined by BMI of at least 30 kg/m^2 and modified National cholesterol Education Program Adult Treatment Panel III criteria were used to define the metabolic syndrome (19).

Multi-Detector CT Scan Protocol for Measuring Abdominal Adipose tissue (VAT) and Liver Fat

Abdominal adipose tissues (VAT) was measured at Exam 2 (2005 – 2008) and the research CT protocol has been reported previously (17). Briefly, the CT images included scout images, one ECG gated series of the entire heart, and a series through the lower abdomen detected by computed tomography system equipped with cardiac gating (GE Healthcare Lightspeed 16 Pro, Milwaukee, Wisconsin). The abdominal muscular wall was first manually traced and 24 contiguous 2-mm thick imaging slices covering the lower abdomen from L3 to S1 were used to measure VAT by semiautomatic segmentation technique. The abdominal fat volumes were the sum of VAT voxels over 24 slices. Volume Analysis software (Advantage Windows, GE Healthcare, Waukesha, WI) was used to segment and characterize each individual voxel as a tissue attenuation of fat using a threshold range −190 to −30 Hounsfield units. Participants were excluded from the CT scan Exam if: 1) body weight was greater than 350 lbs (~160 kg); 2) pregnant or unknown pregnancy status; 3) female participant < 40 years of age; 4) Male participant < 35 years of age.

The CT diagnosis of fatty liver can be made by measuring CT attenuation in Hounsfield Units (HU), which have been shown to be inversely correlated with the fatty filtration of the liver seen on liver biopsy (20). A more recent study demonstrates that a simple measurement of liver attenuation on unenhanced CT scans is the best method of predicting pathologic fat content in the liver (21). Thus, measurement of liver attenuation in HU (LA) was performed in multi-detector CT scans of the abdomen at the level of the $T_{12} – L_1$ intervertebral space and was used to estimate liver fat. The LA was determined by calculating the mean HU of three regions of interest (ROI) in the parenchyma of the right lobe of the liver (20). In this study, high VAT or high liver fat were defined by 90^{th} percentile of VAT or 10^{th} percentile of LA (low LA = high liver fat) generated from the healthy participants. These participants were free of abnormal conditions including CVD, diabetes, hypertension and dyslipidemia at the time when CT Exam were conducted.

The study protocol was approved by the institutional review board of the participating institutions: the University of Mississippi Medical Center, Jackson State University and Tugaloo College. All participants provided informed consent.

Statistical Analysis

To identify major dietary patterns based on the 31 food groups, principal component analysis (PCA) was performed (22). Selected factors were rotated by an orthogonal transformation, which maintains uncorrelated factors and achieves a simple structure with greater interpretability. To determine the number of factors to be retained, the criteria of an eigenvalue > 1, the scree plot and interpretability of the factors were considered (22). The factor score for each pattern was constructed by summing observed energy intakes of the component food groups weighted by their factor loadings (23), and each participants received a factor score for each identified dietary pattern. The dietary patterns were interpreted and named based on high or low factor loadings of the food group relative to the population mean intake and to relative ranking of all food groups included in the PCA (Table 2).

LA and triglycerides were normalized by logarithmic transformation. Dietary factor scores were divided into tertiles. Descriptive statistics (means, SE and percentage) by tertiles of each dietary pattern were calculated for demographic/lifestyle/nutrient intakes of study participants. The generalized linear or logistic regression models were constructed with cardiometabolic risk factors as the independent variable and measures of dietary pattern as the dependent variable. Odds ratios and 95% confidence intervals from logistic regression models were calculated to ascertain the associations of dietary patterns with cardiometabolic risk factors after adjustment for age, sex, smoking and alcohol status, education and physical activities. All computations were performed by SAS software version 9.2 (SAS Institute Inc., Cary, North Carolina).

Results

Study Sample Characteristics by Dietary Patterns

Three major dietary patterns were identified in this study: the “southern”, the “fast food” and the “prudent” dietary pattern (Table 1). The “Southern” dietary pattern was principally characterized by high consumption of traditional rural southern US foods, such as beans & legumes, corn products, fried fish & chicken, margarine & butter, rice & pasta, and low consumption of wine, liquor and salty snacks. The “Fast Food” pattern was characterized by high consumption of sugar & candy juice, fast food and salty snacks, and the “Prudent” pattern was characterized by high intakes of fruits & vegetables, cold & hot cereals, nuts & seeds and low intakes of white bread and sweets. Compared with participants with lower “southern” dietary pattern scores, those with higher scores had significantly higher intakes of total energy, fat, total cholesterol and protein, but lower intake of dietary fibers (*All* $p <$

0.0001 for trend) (Table 3). Participants with higher "southern" pattern scores had adverse risk factor profiles, including larger WC, more VAT, elevated diastolic blood pressure, lower HDL-C and greater likelihood of metabolic syndrome (*p range 0.007–0.0001 for trend*). Similar trends were observed for the "fast food" pattern, with the exception of VAT. However, no significance was found between "prudent" pattern scores and any cardiometabolic risk factor (Table 4).

Multivariate-Adjusted Association of Dietary Patterns with Cardiometabolic Risk Factors

Odds ratio (OR) for associations of dietary patterns with cardiometabolic risk factors were computed in multivariable models (Table 5). After adjustment for age, sex, energy intake, smoking and alcohol status, education level and physical activity, higher "southern" pattern scores were significantly associated with increased OR for high VAT, hypertension, diabetes and metabolic syndrome (*p ranges 0.02–0.0005*). Similar significant associations were observed with higher "fast food" pattern scores for hypertension, diabetes, metabolic syndrome, and low HDL-C (*p ranges 0.03–0.0001*). However, no significant associations were found between the "prudent" pattern scores and most cardiometabolic risk factors; with the exception of hypertension and high liver fat, which was inversely associated with the "prudent" pattern (OR 0.75, 95%CI 0.6–0.9 in Tertile 2, *p=0.049* and OR 0.69, 95%CI 0.5–0.9 in Tertile 3, *p=0.02*).

Discussion

Principal Findings

Using the Delta NIRI JHS FFQ that was specifically designed for the southern United States population to capture the regional food behaviors and eating habits, three dietary patterns, the "southern", the "fast food" and the "prudent", were identified in this cohort of African American adults. Both the "southern" and "fast food" dietary patterns were correlated with abdominal VAT and most of cardiometabolic risk factors. In contrast, the "prudent" pattern was significantly associated, in a protective direction, with liver fat and hypertension.

In the Context of the Current Literature

Identification of the "southern", the "fast food" and the "prudent" patterns in this study sample is consistent with findings of our previous study (24) and others (8,10,11,15,25–27), and with anthropological and historical accounts of traditional African American eating habits in the southern United States (11). The "fast food" and the "prudent" patterns identified in our study are characterized by high-fat, high-cholesterol, high-refined carbohydrate foods or with high-fruits, high-vegetables and high-fibers foods, respectively. These two dietary patterns resemble the "western" and the "healthy" patterns observed in other studies (8,10,23,25,26,28). The "southern" pattern is less commonly reported but is highlighted as a major recognizable dietary pattern in our study sample. Using the Delta NIRI JHS FFQ that was specifically designed for the southern United States populations to capture the regional eating habits and the regional foods, this pattern may reflect the southern roots and African American ancestral experiences of living in the South (11). Moreover, the observed associations between the "southern" dietary pattern, cardiometabolic risk factors and abdominal adiposity are especially intriguing because

African Americans are more likely to consume this pattern (11), and this may contribute to higher risk for cardiovascular disease and obesity (1).

Characterized by high intakes of energy, fat, saturated fat and *trans* fatty acids from typical southern food items including grits, corn products, processed meats and poultry, margarine and butter, and miscellaneous fat (24), our results support the hypothesis that the “southern” dietary pattern, similar to the “fast food” pattern, is associated with increased risk for cardiometabolic abnormalities and abdominal fat accumulation. The detrimental association between the “southern” dietary pattern and cardiometabolic risk factors could be attributed to high-energy or high-fat but low-fiber constituents, which have been reported to be associated with visceral fat accumulation (29) or with lower insulin sensitivity (28) but higher plasma lipids (26), inflammatory cytokines (25) and metabolic syndrome (9,26). Therefore, it is possible that the “southern” dietary pattern clustering with other risk factors, such as socioeconomic status (4,5), physical activity (6) and genetic factors (7), represents one of the possible mechanisms leading to the high prevalence of hypertension, diabetes and obesity in this cohort (2,17).

Implications

Identifying and recognizing existing dietary patterns and their relationships with unhealthy outcomes in African American cohort from Jackson, MS are critically important to understand the pathological mechanisms linking obesity and CVD, two of most pressing diseases in the African American community. Our findings highlight an important role of the “southern” dietary pattern in the development of cardiometabolic abnormalities for the African American populations living in the south United States.

Limitations

The dietary pattern approach is complementary to analyses using individual food or nutrients, which are limited by biological explanations because of numerous dietary factors that can act individually, in combination and/or in interaction with each other. Thus, the logic behind the dietary pattern approach is that foods and nutrients are not eaten separately but are eaten in the form of specified dietary patterns. Although the statistical methods that have been used for data reduction have their own limitations, similar dietary patterns derived by factor analysis have been observed in different populations (8–10,23–28). In addition, limitations of the FFQ also apply to dietary pattern analyses that are based on dietary information collected by this method. The other limitation of this study is its cross-sectional nature, thus, the associations between these dietary patterns and cardiometabolic risk factors remain to be confirmed in prospective analyses. We cannot generalize our findings to other ethnic groups because of geographical locations and cultural differences in eating behaviors and eating habits.

Conclusions

Dietary patterns, especially the “southern” pattern, identified from a regionally specific FFQ in this population of Deep South African Americans, are correlated with abdominal VAT and cardiometabolic risk factors.

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Table 1

Food Grouping Used in Dietary Pattern Analysis in the Jackson Heart Study

Foods Groups	Food Items
Alcohol	Beer, Wine, liquor, other alcoholic beverages.
Beans & Legumes	Beans (dried and mixed bean preparations), soy products
Baked Desserts	Cakes, pies, doughnuts, sweet rolls, cereal bars, pop tarts, cookies, muffins
Bread	Bread (all types), crackers (all types), stuffing, other grain products
Sugar & Candy	Jams, jellies, syrup, chocolate, non chocolate candy, sugar, gelatin, sherbet
Cold Cereal	Ready to eat cold cereal, oats, bran, granola
Poultry	Chicken and turkey preparations (regular and dark meat)
Corn & Corn Products	Grits, cornbread, corn muffins, prepared corn meal, hush puppies, corn tortillas
Dairy Desserts	Puddings, cheesecakes, ice-creams, frozen yogurt, ice-milk
Eggs	Egg and egg preparations (regular and egg beaters)
Fast Food	Food from fast food restaurants (hamburgers, chicken, fish, french fries, onion rings, fast food desserts etc.)
Fruit Drinks	Fruit drinks (fortified and unfortified)
Fruit Juice	Fruit Juices (citrus and non citrus, sweetened and unsweetened, fortified and unfortified)
Fruit	Fruit (citrus and non citrus)
Hot Cereal	Oatmeal, cream of wheat, other hot breakfast cereal
Margarine & Butter	Butter (regular, unsalted, light, fat free and spreads), margarine (regular, light, stick or spread)
Meat	Beef, Pork and Lamb preparations (all cuts)
Miscellaneous Fats	Non dairy creamer, gravy, spray oils, lard, cream cheese, sour cream
Milk & Dairy	Milk and chocolate milk (whole, 1 or 2% fat and skim), cheese or cottage cheese (regular, low fat and fat free), yogurt (regular, low fat and fat free), cream (heavy, light and half & half)
Nuts & Seeds	Almonds, walnuts, sunflower seeds, pecans, pistachios, cashews, coconuts, Peanut, peanut butter (including peanut butter sandwich)
Oils & Salad Dressing	Vegetable oils, salad dressings (regular, light and fat free), mayonnaise
Organ Meats	Liver, venison, ham hocks, neck bones, other organ meats
Vegetables	Orange vegetables, tomato and tomato products, green leafy vegetables, cruciferous vegetables, other vegetables including onions, lettuce, radish, mixed greens, peppers, string beans, plantains, turnips, etc.
Potato	Potato and potato preparations
Processed Meat & Poultry	Processed meats and poultry, including breakfast type (regular, lean and extra lean)
Rice & Pasta	Rice and mixed rice preparations, pasta and pasta preparations, tortillas, burritos, tacos
Sea Food	Fish and shell fish preparations
Soda	Carbonated soft drinks (regular and diet), powdered drink mixes
Soups	Soups (water and cream based)
Salty Snacks	Salted chips, crackling, popcorn, peanuts or other nut
Tea & Coffee	Coffee (regular and decaf), Tea (regular, decaf and green)

Table 2

Factor Loadings* for Food Groups to the Dietary Patterns (Southern, Fast Food and Prudent)

Foods Group	Southern	Fast Food	Prudent
Alcohol	-	-	-
Beans & Legumes	0.593	-	-
Baked Desserts	-	0.483	-
Bread	0.423	-	-
Sugar & Candy	-	0.600	-
Cold Cereal	-	-	0.477
Chicken &Turkey	0.340	-	-
Corn & Corn Products	0.529	-	-
Dairy Desserts	-	-	0.369
Eggs	0.468	-	-
Fast Food	0.320	0.620	-
Fruit Drinks	-	0.420	-
Fruit Juice	-	-	0.311
Fruit	-	-	0.632
Hot Cereal	-	-	0.492
Margarine & Butter	0.581	-	-
Meat	0.446	0.475	-
Miscellaneous Fats	0.525	-	-
Milk & Dairy	-	0.355	0.307
Nuts & Seeds	-	-	0.339
Oils & Salad Dressing	-	0.395	-
Organ Meats	0.458	-	-
Vegetables	0.453	-	-
Processed Meat & Poultry	0.473	0.394	-
Rice & Pasta	0.674	-	-
Sea Food	0.311	-	-
Soda	-	0.427	-
Soups	0.361	-	-
Salty Snacks	-	0.612	-
Potato	0.638	-	-
Tea & Coffee	-	-	-

*Values < 0.30 were excluded for simplicity.

Table 3

Baseline Characteristics of Jackson Heart Study Participants without Medical Conditions by Dietary Pattern

	Southern				Fast Food				Prudent			
	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*
Demographic Characteristics												
Age (years)	51±12	48±12	43±11	0.0001	53±12	47±11	42±11	0.0001	44±11	48±12	49±1	0.0001
Sex (% female)	76.6	58.7	48.1	0.0001	72.1	59.4	52.0	0.0001	56.6	62.4	64.4	0.02
Socioeconomic Status												
College Education	52.8	48.9	37.9	0.0001	52.1	46.7	40.2	0.0001	42.7	47.1	49.2	0.14
Income (affluent)	38.6	36.8	27.0	0.0001	37.9	38.1	26.4	0.0001	31.7	35.5	35.0	0.39
Health Behaviors												
Smoking %	6.9	12.6	20.1	0.0001	8.3	11.3	20.1	0.0001	18.2	8.8	12.6	0.0001
Alcohol Drinker%	48.1	54.7	64.7	0.0001	46.0	57.1	64.3	0.0001	65.9	53.9	47.6	0.0001
PA Score *	9.1±0.1	9.2±0.1	9.2±0.1	0.82	9.3±0.1	9.2±0.1	9.0±0.1	0.40	8.9±0.1	9.2±0.1†	9.3±0.1†	0.005
Energy (Kcal)	1580±25	1970±25†	2983±25†	0.0001	1568±25	1880±24†	3084±26†	0.0001	1961±28	1985±26†	2588±27†	0.0001
Nutrient Intake*												
Total Fat (g)	89.5±1.0	94.4±0.8†	104.7±1.1†	0.0001	90.0±1.0	95.8±0.8†	102.7±1.1†	0.0001	91.9±0.8	97.8±0.8†	98.8±0.8†	0.0001
Saturated Fat (g)	28.6±0.4	30.1±0.3†	33.5±0.4†	0.0001	28.5±0.4	30.4±0.3†	33.2±0.4†	0.0001	28.7±0.3	30.9±0.3	32.5±0.3†	0.0001
TRANS Fat (g)	5.2±0.1	5.3±0.1†	6.2±0.1†	0.0001	5.3±0.1	5.5±0.1	5.9±0.1†	0.0001	5.6±0.1	5.8±0.1†	5.3±0.1†	0.0001
Cholesterol (mg)	343±8.4	374±6.9†	448±9.1†	0.0001	388±8.7	393±7.0	383±9.0	0.0001	397±7.1	392±7.0	374±7.2†	0.0001
Carbohydrate (g)	319±3.1	308±2.6†	275±3.4†	0.0001	307±3.2	299±2.5	297±3.5	0.16	296±2.6	299±2.6	306±2.7†	0.03
Total Sugars (g)	182±3.7	168±3.0†	116±4.0†	0.0001	154±3.9	153±3.2	158±4.2	0.66	159±3.1	150±3.0	157±3.2	0.16
Total Protein (g)	78.8±1.1	82.6±0.8†	93.7±1.1†	0.0001	84.9±1.1	85.3±0.9	84.9±1.2	0.93	85.1±0.9	84.8±0.8	85.1±0.9	0.96
Dietary Fiber(g)	17.4±0.2	16.9±0.2	17.0±0.3	0.19	18.4±0.2	17.3±0.2†	15.6±0.3†	0.0001	15.6±0.2	17.0±0.2†	18.8±0.2†	0.0001

*age-, sex- and energy intake-adjusted (mean ± SE);

†difference with tertile 1 ($P<0.05$); *P* for trends.

PA: physical activity.

Table 4

Cardiometabolic Risk Factor Profiles (Mean ± SE or Prevalence %) in Jackson Heart Study Participants without Medical Conditions by Dietary Pattern

	Southern				Fast Food				Prudent			
	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*	T1 (n=588)	T2 (n=588)	T3 (n=589)	*p*
Fat-related												
BMI (kg/m^2)	30.4±0.3	31.2±0.3	31.1±0.3	0.16	30.5±0.3	30.8±0.3	31.4±0.3†	0.09	31.2±0.3	31.0±0.3	30.4±0.3	0.23
WC (cm)	95.9±0.7	99.2±0.7	99.8±0.7	0.0001	96.4±0.7	98.8±0.7	99.7±7.7	0.003	98.9±0.7	98.4±0.7	97.5±0.7	0.37
Log LA	4.08±0.01	4.07±0.01	4.08±0.01	0.79	4.09±0.01	4.07±0.01	4.08±0.01	0.58	4.08±0.01	4.08±0.01	4.08±0.01	0.99
VAT (cm^3)	681±18	722±18	764±18	0.007	691±17	740±18	731±19	0.12	714±20	722±18	721±18	0.93
Obesity %	38.1	40.6	38.4	0.63	38.1	39.6	39.4	0.85	41.0	39.4	36.7	0.38
High VAT %	35.1	39.1	41.6	0.22	35.8	39.7	40.1	0.44	36.8	39.3	38.3	0.79
High liver fat %	50.7	52.8	60.3	0.002	48.8	53.3	61.3	0.0001	59.0	51.3	53.5	0.02
BP-related												
SBP (mm Hg)	120±0.7	120±0.7	119±0.7	0.31	121±0.7	120±0.7	119±0.7	0.17	120±0.7	120±0.7	120±0.7	0.82
DBP (mm Hg)	76±0.4	77±0.4	78±0.4	0.002	76±0.4	77±0.4	78±0.4	0.002	78±0.4	77±0.4	77±0.4	0.12
HTN (%)	35.0	40.6	33.8	0.15	36.4	36.0	37.2	0.95	40.6	35.5	34.0	0.19
Lipid-related												
Log TRG	4.4±0.0	4.4±0.0	4.4±0.0	0.48	4.3±0.0	4.4±0.0	4.4±0.0	0.01	4.4±0.0	4.4±0.0	4.4±0.0	0.69
High TRG	11.4	11.4	12.7	0.71	9.9	12.9	12.7	0.19	11.4	13.2	10.9	0.41
HDL-C (mg/dl)	56.3±0.6	52.9±0.6	51.8±0.6	0.0001	57.1±0.6	52.1±0.6	51.8±0.6	0.0001	53.0±0.6	53.6±0.6	54.5±0.6	0.21
Low HDL-C	29.1	30.4	31.2	0.72	25.5	32.9	32.3	0.009	30.8	31.2	28.7	0.59
Glucose-related												
Glucose (mg/dl)	96.6±0.9	97.4±0.9	96.8±0.9	0.80	97.±0.9	98.4±0.9	96.±0.9	0.16	96.9±0.9	96.6±0.9	97.4±0.9	0.83
Impaired Glu %	12.4	13.4	11.9	0.72	13.3	14.4	10.0	0.06	11.9	13.6	12.2	0.65
T2D %	5.8	8.6	6.9	0.19	5.1	8.1	7.5	0.21	6.9	6.4	7.4	0.85
Syndrome-related												
MetS (%)	29.4	36.9	38.3	0.056	26.1	41.5	36.4	0.0006	36.4	33.7	33.0	0.62

BMI: body mass index; WC: waist circumference; LA: liver attenuation in Hounsfield unit; VAT: abdominal visceral adipose tissue; BP: blood pressure; SBP/DBP: systolic/diastolic blood pressure; Glu: glucose; HTN: hypertension; TRG: triglyceride; T2D: type 2 diabetes; MetS: metabolic syndrome.

Table 5

Association* between Dietary Patterns and Cardiometabolic Risk Factors across Score Tertiles

	Southern			Fast Food			Prudent		
	T1	**T2**	**T3**	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
High VAT	1	1.39(0.9–1.9)	1.80(1.1–3.0)	1	1.38(0.9–1.9)	1.52(0.8–2.3)	1	1.13(0.8–1.6)	0.91(0.6–1.3)
p		0.056	0.02		0.06	0.14		0.47	0.61
n	130	130	121	134	137	113	112	140	132
High liver fat	1	0.71(0.5–1.1)	0.78(0.4–1.4)	1	0.92(0.7–1.2)	0.92(0.6–1.4)	1	0.94(0.6–1.4)	1.07(0.7–1.6)
p		0.24	0.29		0.48	0.68		0.24	0.82
n	298	311	355	287	314	363	347	302	315
HTN	1	1.42(1.1–1.9)	1.14(0.7–1.8)	1	1.35(0.9–1.8)	1.67(1.1–2.7)	1	0.75(0.6–0.9)	0.69(0.5–0.9)
p		0.02	0.6		0.057	0.03		0.049	0.02
n	172	189	137	177	173	148	167	167	164
Impair Glu	1	1.20(0.8–1.8)	1.23(0.7–2.2)	1	1.13(0.8–1.6)	0.80(0.5–1.4)	1	1.12(0.8–1.6)	0.98(0.7–1.5)
p		0.36	0.46		0.52	0.48		0.53	0.93
n	73	79	70	78	85	59	70	80	72
Diabetes	1	2.03(1.1–3.9)	1.55(0.6–4.0)	1	2.46(1.2–4.9)	2.86(1.0–7.9)	1	0.88(0.5–1.6)	0.88(0.5–1.7)
p		0.03	0.36		0.01	0.04		0.66	0.71
n	21	33	25	20	32	27	25	25	29
High TRG	1	0.78(0.5–1.2)	0.76(0.4–1.3)	1	1.26(0.8–1.9)	1.14(0.6–1.9)	1	1.25(0.9–1.8)	0.92(0.6–1.4)
p		0.23	0.31		0.25	0.65		0.22	0.70
n	67	67	75	58	76	75	67	78	64
Low HDL	1	1.01(0.8–1.3)	1.02(0.7–1.5)	1	1.34(1.0–1.7)	1.24(0.8–1.9)	1	1.15(0.8–1.5)	0.98(0.7–1.3)
p		0.96	0.93		0.04	0.29		0.29	0.92
n	171	179	184	150	194	190	181	184	169
MetS	1	1.88(1.3–2.7)	2.16(1.3–3.6)	1	2.48(1.7–3.6)	2.40(1.4–4.2)	1	0.94(0.7–1.3)	0.75(0.5–1.1)
p		0.0005	0.004		0.0001	0.002		0.71	0.12

	Southern			Fast Food			Prudent		
	T1	**T2**	**T3**	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
n	110	130	111	100	150	101	111	124	116

* Adjusted for age, sex, smoking and alcohol status, energy intake, education levels and physical activity.

n: numbers of participants with conditions.

VAT: abdominal visceral adipose tissue; Glu: glucose; HTN: hypertension; TRG: triglyceride; MetS: metabolic syndrome.