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Dietary Pattern Adherence Of Adults With Diabetes In The Reasons For Geographic And Racial Differences In Stroke (Regards) Study 2003-2007

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DIETARY PATTERN ADHERENCE OF ADULTS WITH DIABETES IN THE REASONS FOR GEOGRAPHIC AND RACIAL DIFFERENCES IN STROKE (REGARDS) STUDY 2003-2007

by

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A THESIS

Submitted to the graduate faculty of The University of Alabama at Birmingham, in partial fulfillment of the requirements for the degree of Master of Science

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ABSTRACT

The objective of this study was to determine if adults with diabetes engage in different dietary practices compared to adults without diabetes in a national cohort of adults 45 years of age or older. Dietary practices were evaluated using five dietary patterns derived previously using factor analysis in a sample of 21,636 African American and European American participants who completed the Block 98 Food Frequency Questionnaire in the REasons for Geographic And Racial Differences in Stroke (REGARDS) study. Logistic regression was used to calculate odds ratios (OR) and 95% confidence intervals (CI) measuring dietary pattern adherence of adults with diabetes compared to adults without diabetes. After adjustment for potential confounding variables, adults with diabetes were more likely than adults without diabetes to adhere to the Plant- based (OR=1.33, 95% CI: 1.22, 1.45), Southern (OR=1.14, 95% CI: 1.05, 1.25), and Alcohol/Salads (OR=1.15, 95% CI: 1.06, 1.25) dietary patterns. Adults with diabetes were less likely to adhere to the Sweets/Fats pattern (OR=0.80, 95% CI: 0.73, 0.87). There was no difference in adherence to the Convenience dietary pattern. With higher adherence to the Plant-based pattern and lower adherence to the Sweets/Fats pattern, adults with diabetes may be adhering to some of the recommended dietary guidelines. However, the higher adherence to the Southern dietary pattern of adults with diabetes suggests that nutrition education in this population should strongly emphasize the reduction of fried foods and added fats that

may increase the risk of developing future diabetes-related comorbidities, particularly cardiovascular disease.

Keywords: diabetes, diet, nutrition

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by

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ABSTRACT

The objective of this study was to determine if adults with diabetes engage in different dietary practices compared to adults without diabetes in a national cohort of adults 45 years of age or older. Dietary practices were evaluated using five dietary patterns derived previously using factor analysis in a sample of 21,636 African American and European American participants who completed the Block 98 Food Frequency Questionnaire in the REasons for Geographic And Racial Differences in Stroke (REGARDS) study. Logistic regression was used to calculate odds ratios (OR) and 95% confidence intervals (CI) measuring dietary pattern adherence of adults with diabetes compared to adults without diabetes. After adjustment for potential confounding variables, adults with diabetes were more likely than adults without diabetes to adhere to the Plant-based (OR=1.33, 95% CI: 1.22, 1.45), Southern (OR=1.14, 95% CI: 1.05, 1.25), and Alcohol/Salads (OR=1.15, 95% CI: 1.06, 1.25) dietary patterns. Adults with diabetes were less likely to adhere to the Sweets/Fats pattern (OR=0.80, 95% CI: 0.73, 0.87). There was no difference in adherence to the Convenience dietary pattern. With higher adherence to the Plant-based pattern and lower adherence to the Sweets/Fats pattern, adults with diabetes may be adhering to some of the recommended dietary guidelines. However, the higher adherence to the Southern dietary pattern of adults with diabetes suggests that nutrition education in this population should strongly emphasize the reduction of fried foods and added fats that may increase the risk of developing future diabetes-related comorbidities, particularly cardiovascular disease.

INTRODUCTION

The prevalence of diabetes in the United States has risen in the past decade[1, 2], with the disease being ranked the seventh leading cause of death in 2009[3] and placing a financial burden on the United States of over 245 billion dollars annually in direct medical costs and indirect expenses[4]. To combat the physiological and financial burden of the disease, many health care providers have turned to dietary interventions, which have been shown to be beneficial in the treatment and management of diabetes[5]. Because the treatment and management of diabetes include recommendations to monitor dietary intake, knowledge of the existing dietary practices of the population of people with diabetes could equip clinicians and other health care professionals with the ability to identify effective nutrition education strategies that may positively impact their patients with diabetes. However, there has been no consensus regarding the dietary practices followed by individuals with diabetes at the population level. Some studies have shown that individuals with diabetes consume diets relatively high in soft drinks[6] and total[7] and saturated fat[8] while not meeting the guidelines for fruit and vegetable intake[9]. Conversely, studies have also shown individuals with diabetes have diets relatively low in total energy intake and total fat[10] and high in dietary fiber[11]. Interestingly, other studies have shown that individuals with diabetes have a similar diet quality compared to individuals without diabetes[12, 13].

The inconsistency of the findings regarding the dietary practices of individuals with diabetes may be a consequence of a) the limited ability of researchers to accurately measure the dietary intake of humans in non-experimental settings and b) the improper analysis of the collected dietary data. While the limitations regarding the measurement of diet in humans still persist, there have been several advances in the recent past concerning the limitation of the analysis of the data. In previous studies, the analysis of the dietary data of individuals with diabetes has focused on individual food and nutrient intake, which fails to accurately picture human food consumption because people often eat foods in combination rather than in isolation[14]. However, recent nutritional epidemiology has turned to dietary patterns, derived from cluster or factor analysis, to assess overall dietary intake, rather than isolated foods and nutrients. Dietary pattern analysis more accurately reflects typical eating behaviors and takes advantage of the interactions and intercorrelations among foods and nutrients that could potentially contribute to overall health[15]. While many studies have characterized the relationship between dietary patterns and diabetes incidence[16-20], we plan to examine the dietary pattern adherence of adults with diabetes compared to adults without diabetes in a nationwide sample of the United States population.

METHODS

Study Population

The REasons for Geographic And Racial Differences in Stroke (REGARDS) study is a population-based study of 30,239 African American (AA) and European American (EA) participants 45 years of age or older. The original aim of REGARDS was to elucidate the causes of the racial and geographical differences in stroke prevalence and stroke mortality. The participants for this study were recruited from 2003-2007 using nationwide lists purchased through Genesys, Inc, designed to oversample AAs and residents living in the Southeast United States, which are two groups with a disproportionately high stroke prevalence and mortality. The participants were initially informed by mail of the REGARDS study and then contacted by telephone during which demographics, socioeconomic status, medical history, and other risk factors were collected using computer-assisted telephone interviewing. Following the telephone interview, a trained medical professional performed an in-home examination during which anthropometrics were measured, blood and urine samples were collected, and an electrocardiogram was performed. The medical professional left several self-administered questionnaires, including the Block 98 Food Frequency Questionnaire (FFQ), to be completed by the participants and mailed back to the coordinating center.

Of the 30, 239 original REGARDS participants, participants who did not return the FFQ (n=4,837) or whose FFQ was unusable due to missing or incomplete data (n=3,826) were excluded from the dietary pattern analysis, which included only the 21,636 participants who returned a usable FFQ. This cross-sectional investigation of dietary pattern adherence by diabetes status includes data from 21,573 participants with usable dietary data, after additional exclusions of participants who did not answer the question pertaining to diabetes status (n=63).

Assessment of Diabetes Status

Diabetes status was obtained during the telephone interview given to all REGARDS participants, where 4,335 adults in our sample reported a diagnosis of diabetes and 17,238 adults reported no diagnosis of diabetes. Previous studies have indicated a strong agreement between self-reported diagnosis and physician-reported medical history[21, 22], and, since we were particularly interested in dietary patterns among those aware of their diagnosis of diabetes, this definition of diabetes status was concluded to be appropriate for the analyses.

Assessment of Dietary Patterns

Dietary intake was assessed using the Block 98 FFQ, a 107-item questionnaire that aims to assess usual dietary intake over the past year. The Block FFQ has been validated using multiple diet records[23, 24] and in diverse populations[25]. Upon being returned to the REGARDS coordinating center by the participants, the completed FFQs were sent to NutritionQuest for scoring, where the number of grams per day of each item was calculated.

Dietary patterns were previously derived and have been described in detail in a previous paper[26]. Briefly, the 107 food items from the FFQ were collapsed into 56 food groups based on nutrient similarities, culinary use, and similar studies. Using a random split sample technique to ensure validity and replication of the patterns, principal component analysis (PCA) with varimax rotation was utilized in the first half of the sample. Factor solutions were examined for interpretability and separate PCA analyses were conducted to test for congruence by region, gender, and race. In the second half of the sample, a confirmatory factor analysis (CFA), including only the food groups with absolute value loadings ≥0.20, was employed to independently validate the results from the PCA and test for model fit. Based on the eigenvalues (>1.5), congruence (for region, gender, and race), and interpretability, the analysis retained five factors, and a final factor analysis was performed in the full sample. Factor scores were calculated for each participant for each dietary pattern by multiplying the factor loading of each food group by the average consumption of each food group for each participant.

Five dietary patterns emerged from the factor analysis and were given names characterized by the foods with the highest factor loadings. Factor one was named the Convenience pattern and consisted of mixed dishes with meat, Chinese food, and Mexican dishes. Factor two was named the Plant-based pattern and consisted of vegetables, fruits, fish, and beans. Factor three included miscellaneous sugars, desserts, and added fats and was named the Sweets/Fats pattern. Factor four was named the Southern pattern because of its high loadings of fried food, organ meats, processed meats, and sugar-sweetened beverages. Factor five loaded highly in green- leafy vegetables, tomatoes, salad dressing, wine, and liquor and was named the Alcohol/Salads pattern.

Covariate Assessment

Age, race, gender, region, education, income, and smoking status were collected during the initial telephone interview by self-report. Hours of television regularly watched and the number of times the participant had previously attempted to lose weight were included in the self-administered questionnaire mailed back to the coordinating center. Hypertension was defined by the self-reported use of medications to lower blood pressure, or having a blood pressure ≥140/90 mmHg. Heart disease was defined as self-reported myocardial infarction, revascularization, stenting of the coronary artery, or electrocardiogram evidence of heart disease. Stroke was defined as self-report at baseline while chronic kidney disease was defined as an estimated glomerular filtration rate ≤60 $mL/min/1.73m^2$ or a urinary albumin-creatinine ratio >30 mg/g. Creatinine was measured in serum using the Vitros 950IRC instrument (Johnson & Johnson Clinical Diagnostics, Rochester, NY). Urinary creatinine was measured in batches during enrollment on the Modular-P chemistry analyzer from Roche/Hitachi (Indianapolis, IN). Urinary albumin was measured in batches during enrollment using the BN ProSpec Nephelometer from Dade Behring (Marburg, Germany). Obesity was classified as having a BMI ≥30 kg/m^2 and was derived from measurements of height and weight collected during the in-home visits. Dyslipidemia was defined as fasting triglycerides ≥240 mg/dL, low-density lipoprotein (LDL) cholesterol ≥160 mg/dL, high-density lipoprotein (HDL) cholesterol ≤40 mg/dL, or on medication to control lipid levels. Total cholesterol, HDL cholesterol, and triglycerides were measured in serum using the Ortho Vitros Clinical Chemistry System 950IRC instrument (Johnson & Johnson Clinical Diagnostics, Rochester, NY).

Statistical Analysis

Likelihood ratio chi-square tests and t-tests were used to calculate unadjusted means of participant demographic, co-morbidity, and health behavior characteristics. Individual factor scores were split at the median to define adherence. Individuals with a factor score above the median were categorized as high adherers to a particular dietary pattern while individuals below the median were categorized as low adherers to that pattern.

Logistic regression was performed to calculate the odds ratios of dietary pattern adherence for adults with diabetes, using adults without diabetes as the referent group. Four models were included in the analyses and covariates were added incrementally to each model. Model 1 was adjusted for total energy and demographic factors (age, race, gender, and region). Model 2 added adjustments for socio-economic measures (income and education), Model 3 adjusted for health behaviors (smoking, hours of television watching, and intention to lose weight) and Model 4 added adjustments for several co-morbidities (hypertension, heart disease, stroke, chronic kidney disease, obesity, and dyslipidemia). To examine potential differences in dietary pattern adherence in adults with diabetes between race and gender, diabetes status by race and diabetes status by gender interaction terms were investigated in the full model (Model 4). All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, North Carolina).

RESULTS

Demographic, Co-morbidity, and Health Behavior Characteristics

Descriptive statistics for the study population are summarized in Table 1. Compared to adults without diabetes, adults with self-reported diabetes were more likely to be older and male but less likely to be white, less likely to have an income above $75,000 a year, and less likely to have graduated from college. Adults with diabetes also had significantly higher rates of several co-morbidities. Heart disease, stroke, kidney disease, obesity, and dyslipidemia were all more prevalent in adults with diabetes compared to adults without diabetes. In terms of health behaviors, adults with diabetes were more likely to watch television more than four hours per day and less likely to have never been on a diet to lose weight. When analyzing smoking status, adults with diabetes were more likely to be a past smoker but less likely to currently smoke or to have never smoked.

Table 1. Demographic, co-morbidity, and health behavior characteristics of adults with and without diabetes

		With Diabetes (n=4,335)	Without Diabetes (n=17,238)	p value
N±SD	Age (years)	65.4 ± 8.6	64.7 ± 9.4	<0.0001
	Total energy (kcal)	1672 ± 745	1717 ± 701	0.0002
N (%)	White	2258 (52.1)	12065 (70.0)	<0.0001
	Males	1983 (45.7)	7537 (43.7)	0.02
	Income above $75000	441 (10.2)	3229 (18.7)	<0.0001
	College graduate	1215 (28.0)	6838 (39.7)	<0.0001
N (%)	Heart disease	1134 (26.7)	2512 (14.8)	<0.0001
	Stroke	392 (9.1)	763 (4.4)	<0.0001
	Hypertension	3323 (76.9)	8928 (51.9)	<0.0001
	Kidney Disease	1649 (38.0)	3305 (19.2)	<0.0001
	Obesity	2399 (56.0)	5419 (31.6)	<0.0001
	Dyslipidemia	3091 (73.7)	9295 (55.8)	<0.0001
N (%)	> 4 hours TV/day	1690 (39.5)	4780 (28.1)	<0.0001
	Never dieted to lose weight	1071 (26.4)	6129 (37.3)	<0.0001
	Smoking Status			<0.0001
	Current smoker	585 (13.6)	2370 (13.8)	
	Never smoker	1799 (41.7)	7878 (45.9)	
	Past smoker	1934 (44.8)	6924 (40.3)	

Dietary Pattern Adherence of Adults with Diabetes

Odds ratios calculated from logistic regression for adherence to each dietary pattern in adults with diabetes are shown in Table 2 with adults without diabetes as the referent group. In a model adjusted for total energy intake and demographic factors (Model 1), adults with diabetes were more likely to adhere to the Plant-based (OR=1.18, 95% CI: 1.09, 1.26) and Southern (OR=1.41, 95% CI: 1.31, 1.53) dietary patterns, but less likely to adhere to the Sweets/Fats dietary pattern (OR=0.84, 95% CI: 0.77, 0.91). Additional adjustment for income and education (Model 2), health behaviors (Model 3), and co-morbidities (Model 4) yielded the following results: adults with diabetes were more likely to adhere to Plant-based (OR=1.33, 95% CI: 1.22, 1.45), Southern (OR=1.14, 95% CI: 1.05, 1.25), and Alcohol/Salads (OR=1.15, 95% CI: 1.06, 1.25) dietary patterns but less likely to adhere to the Sweets/Fats (OR=0.80, 95% CI: 0.73, 0.87) dietary pattern. In the full model (Model 4), the association in the Convenience pattern was non-significant (OR=0.99, 95% CI: 0.90, 1.08). Interactions between dietary patterns and both race and gender were also tested in the full model and yielded no statistically significant interactions for any of the dietary patterns.

Table 2. Adults with diabetes report adhering to different dietary patterns than participants without diabetes in the REasons for Geographic and Racial Differences in Stroke (REGARDS) Study 2003-2007

	Convenience	Plant-based	Sweets/Fats	Southern	Alcohol/Salads
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Model 1	1.01 (0.94, 1.09)	1.18 (1.09, 1.26)	0.84 (0.77, 0.91)	1.41 (1.31, 1.53)	1.04 (0.97, 1.12)
Model 2	1.05 (0.96, 1.14)	1.29 (1.19, 1.39)	0.77 (0.71, 0.84)	1.25 (1.15, 1.36)	1.16 (1.08, 1.26)
Model 3	1.00 (0.92, 1.09)	1.27 (1.17, 1.38)	0.81 (0.74, 0.88)	1.29 (1.18, 1.40)	1.07 (1.00, 1.17)
Model 4	0.99 (0.90, 1.08)	1.33 (1.22, 1.45)	0.80 (0.73, 0.88)	1.14 (1.05, 1.25)	1.15 (1.06, 1.25)

All odds ratios were calculated with adults without diabetes as the referent group. Model 1 reflects the dietary pattern adherence of adults with diabetes vs. adults without diabetes adjusted for total energy and demographic variables (age, race, gender, and region) and covariates were incrementally added to the subsequent models. Model 2 included socioeconomic measures (income and education). Health behaviors (smoking status, hours of television, intention to lose weight) were added to Model 3, and Model 4 additionally adjusted for common co-morbidities of diabetes (hypertension, heart disease, stroke, chronic kidney disease, obesity, and dyslipidemia).

DISCUSSION AND CONCLUSIONS

Although previous studies have examined the dietary intake of adults with diabetes by observing individual food or nutrient intake, our study utilized dietary pattern analyses to better reflect true patterns of eating behavior in this population and suggests that the dietary practices of adults with diabetes do differ from the dietary practices of adults without diabetes.

The American Diabetes Association (ADA) recommended in 2008 that adults with diabetes consume a “dietary pattern that includes carbohydrate from fruits, vegetables, whole grains, legumes, and low-fat milk"[27]. With greater adherence to the Plant-based dietary pattern that consisted of fruits, vegetables, beans, and fish, it appears that adults with diabetes may be compliant to some of the nutritional recommendations of the ADA for the management of diabetes. Lower adherence to the Sweets/Fats dietary pattern may also denote that adults with diabetes are attempting to avoid many high glycemic index foods, such as the desserts, candy, and added sugars found in this pattern.

While our results suggest that adults with diabetes may be adhering to many of the carbohydrate recommendations for this population, the greater adherence to the Southern dietary pattern indicates a dietary compensation may be taking place, where adults with diabetes may be replacing the consumption of sweets with culturally influenced foods that foster greater fat intake. The Southern dietary pattern included many foods (fried foods, added fats, and processed meats) that are typically high in saturated fat and cholesterol – diverging from the recommendations by the ADA to consume a diet low in both saturated fat and cholesterol in the management of diabetes [27]. Many of the foods within the Southern dietary pattern have been independently associated with cardiovascular disease risk in previous cohorts[28, 29], and the Southern dietary pattern has previously been associated with increased risk of both stroke[26] and acute coronary heart disease incidence (Shikany, *in preparation*) in the REGARDS cohort. Given that adults with diabetes already have an increased risk of developing cardiovascular disease[30], clinicians and other health care professionals may need to more strongly emphasize compliance to the dietary fat recommendations for this population and stress a reduction in the fried and fatty foods consumed within the Southern dietary pattern.

The strengths of our study include the utilization of dietary patterns derived in a sample that is approximately two-thirds EA and one-third AA – a considerably heterogeneous sample relative to previous studies that derived dietary patterns in cohorts of similar sample sizes. This heterogeneity, coupled with the utilization of separate PCA analyses to test for congruence by race, gender, and region, allows us to conclude that our dietary patterns represent the eating behaviors of AA and EA participants, males and females, and individuals living throughout the United States (both stroke belt and non-stroke belt). However, one limitation to this study was the exclusion of all other race/ethnic groups, limiting the generalizability of the results to only AA and EA individuals living in the United States. Another limitation is potential residual confounding, which we attempted to minimize by controlling for several covariates representing demographic characteristics, health behaviors, and diabetes-related comorbidities. However, the lack of information regarding the nutrition knowledge or nutrition education received by the participants could confound our results.

In conclusion, our results suggest that the dietary practices of adults with diabetes differ from adults without diabetes. Adults with diabetes are more likely than adults without diabetes to adhere to the Plant-based dietary pattern and less likely to adhere to the Sweets/Fats dietary pattern, indicating that this population may be receptive to some of the nutrition education received upon diagnosis. However, with greater adherence to the Southern dietary pattern, adults with diabetes may be compensating by replacing the consumption of sweets with the culturally-influenced foods of the Southern dietary pattern that are typically higher in dietary fat. While controlling blood glucose is the primary goal of diabetes management[27], nutrition educators may need to further emphasize the importance of reducing fried foods and added fats in our nutrition education of this population to reduce future cardiovascular events.

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Appendix

Institutional Review Board for Human Use

THE UNIVERSITY OF
ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

DATE: September 26, 2013

MEMORANDUM

TO: Keith Pearson
Principal Investigator

FROM: Cari Oliver, CIP
Assistant Director
Office of the Institutional Review Board (OIRB)

RE: Request for Determination—Human Subjects Research
IRB Protocol #N130905005 – The Influence of Diet Quality on Cardiovascular Health and Cognitive Function (Etiology of Geographic and Racial Differences in Stroke)

A member of the Office of the IRB has reviewed your Application for Not Human Subjects Research Designation for above referenced proposal.

The reviewer has determined that this proposal is **not** subject to FDA regulations and is **not** Human Subjects Research. Note that any changes to the project should be resubmitted to the Office of the IRB for determination.

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