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Consistency with the Dietary Approaches to Stop Hypertension Diet among Adults with Diabetes

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Abstract

Few studies have documented whether the dietary patterns of adults with diabetes are similar to the Dietary Approaches to Stop Hypertension (DASH) diet. Our objective was to determine differences in the degree of consistency with the DASH diet among adults with self-reported diabetes (with and without self-reported high blood pressure) compared with those without either disease. It was a cross-sectional study using data from 5,867 nonpregnant, noninstitutionalized adults aged ≥20 years with two reliable 24-hour recall dietary interviews in the National Health and Nutrition Examination Survey during 2003–2004 and 2005–2006. Diabetes and hypertension status were obtained from a questionnaire, and degree of consistency with the DASH diet was calculated based on nine nutrient targets (0- to 9-point DASH score). Multiple linear regression (adjusting for age, energy intake, and other covariates such as education, race, and body mass index) was performed to compare mean DASH scores and mean nutrient intakes among adults with diabetes, with and without high blood pressure, to those without either disease. No statistically significant differences were seen in mean DASH score among the three groups in the unadjusted or fully adjusted multivariable models. Compared with adults without either disease, those with only diabetes had higher intakes of fiber (8.1 g/1,000 kcal vs 7.6 g/1,000 kcal; P=0.02) and total fat as a percentage of total energy (35.3% vs 34.1%; P=0.006), and those with both diabetes and hypertension had higher sodium intake (153.0% of DASH target vs 146.6%; P=0.04). This information about individual nutrients could help guide the development of education programs.

Keywords

Diabetes; Hypertension; Dietary Approaches to Stop Hypertension (DASH) diet

The estimated prevalence of diagnosed diabetes in adults aged ≥18 years rose during 2010 and was flat at 8.8% in 2011.[1] During 2005–2008, 67% of adults aged ≥20 years with self-reported diabetes had blood pressure ≥140/90 mm Hg or used a prescription medication for

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

high blood pressure.[2] Controlling blood pressure in people with diabetes reduces risk of heart disease and stroke by 33% to 50%, and reduces risk of eye, kidney, and nerve diseases by approximately 33%.[3–6]

The Dietary Approaches to Stop Hypertension (DASH) diet has been shown to decrease blood pressure.[7,8] It has also been associated with a lower incidence of self-reported hypertension in women.[9] The DASH diet provides high amounts of whole grains, fruits, and vegetables; a moderate amount of low-fat protein; and low levels of fat, added sugars, and sodium. Food group recommendations are designed to reach specific targets for macronutrients and micronutrients based on a person's total energy intake. Clinicians often advise people with diabetes to lose weight and improve their diet to come in line with the American Diabetes Association's nutrition recommendations, which are similar to the DASH diet.[10–12] The American Diabetes Association also specifically recommends the DASH diet for people with diabetes who have high blood pressure.[10] However, there have been few studies examining whether the dietary patterns of people with diabetes differ from those of people without diabetes, especially with regard to the DASH diet.

Our purpose was to examine consistency with the DASH diet among adults with self-reported diabetes (with and without self-reported high blood pressure, separately) compared with adults without self-report of diabetes and without self-report of high blood pressure in a large, nationally representative sample of US adults. The hypothesis was that adults with both self-reported diabetes and self-reported high blood pressure may be more likely to have dietary patterns closer to the DASH diet than those without either disease. Some studies have shown slightly healthier eating patterns for adults with diabetes than adults without diabetes, such as lower intake of fat or more servings of oatmeal/oat foods and fruit.[13,14]

METHODS

A cross-sectional study was conducted using data from the National Health and Nutrition Examination Survey (NHANES) from the 2003–2004 and 2005–2006 cycles, which uses a stratified, multistage probability sample.[15] In 2003–2006, certain groups (eg, blacks and Mexican Americans, persons with low income, and adults aged ≥60 years) were oversampled for statistical reliability.[16]

Study Population

The study population consisted of nonpregnant adults aged ≥20 years who had two reliable dietary interviews (N=8,184). Three groups were used in the analysis: no self-reported diabetes and no self-reported high blood pressure (n=5,024), self-reported diabetes without self-reported high blood pressure (n=338), and self-reported diabetes with self-reported high blood pressure (n=505). Having diagnosed diabetes was based on being told by a doctor or other health professional that one has diabetes. Diagnosed high blood pressure was based on being told two or more times by a doctor or other health professional that one has high blood pressure.

Exclusions included pregnancy (and those of unknown pregnancy status) (n=555), adults without self-reported diabetes but with self-reported high blood pressure (n=1,704), and

those with missing self-reported diabetes and/or high blood pressure status (n=58) for a final study population of 5,867. The “other” and “other Hispanic” categories for race and ethnicity (n=411) were excluded in regression analyses because of small subgroup sample sizes and NHANES analytic guidance for analysis of Hispanics.[17] For all regression analyses, a complete case analysis using only participants with data for all variables in the model (n=5,071) was performed because there were significant differences in two outcome variables among adults who had and did not have a value for poverty income ratio.

Dietary Variables

Dietary patterns were ascertained using data from the average of two 24-hour recall interviews completed using the US Department of Agriculture’s dietary data collection instrument, the Automated Multiple Pass Method. Only reliable interviews, those with completion of first four steps of the five-step Automated Multiple Pass Method and identified foods consumed for each reported meal, are reported by NHANES.[18] The primary outcome variable was a person’s degree of consistency with the DASH diet, estimated based on a score combining nine nutrient targets (ie, fat, saturated fat, protein, cholesterol, fiber, magnesium, calcium, sodium, and potassium). Individuals who met the DASH target for a given nutrient received one point. Those who met an intermediate target halfway between the DASH target and a control diet target (from the original DASH studies) received one-half point; those who did not meet the intermediate target received 0 points. Points for each key nutrient were summed (0 to 9 points) using a method similar to that of a study by Mellen and colleagues,[19] with an adjustment to use the linear index model from the original DASH study for all minerals.[20,21] Table 1 shows the dietary targets. Additional outcome variables were intakes of individual DASH-highlighted nutrients (ie, fat, saturated fat, protein, cholesterol, fiber, magnesium, calcium, sodium, and potassium). Total energy intake was based on all kilocalories consumed from food and beverages. The average of 2 days of 24-hour recall data was used because the nutrients analyzed are typically consumed daily compared with individual foods, which may not be eaten every day.

A variable for whether or not a person was following a specific type of diet that included one or more elements of the DASH diet (or a total decrease in energy) was based on a report of following one of the following types of diets: weight loss or low-energy diet, high-fiber diet, low-fat or low-cholesterol diet, low-salt or low-sodium diet, sugar-free or low-sugar diet, or diabetic diet.

Additional Variables

Additional variables were used as covariates in the models. Demographic variables included sex, age (years), total energy intake (kilocalories/day), race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican American), education (less than high school, high school/General Educational Development Test, some college, college graduate), poverty income ratio level (≤1.3, >1.3 to ≤3.5, or >3.5),[22] and country of birth (born in the United States or born outside the United States).

Body mass index was categorized as normal or underweight (<25), overweight (≥25 and <30), and obese (≥30). Smoking status was classified as “current smoker” or “not a current

smoker." An individual's level of physical activity from leisure activities, home and yard work, and biking and walking for transportation was categorized by compliance with the 2008 Physical Activity Guidelines as low, medium, or high.[23] Participants were asked about the number of days (during the past 30 days) that they did each type of activity, the number of minutes per occasion, and the level of intensity, which was summed to determine the average minutes of moderate and vigorous aerobic activity per week. Those who did not meet the guideline for "substantial" health benefits were classified as "low." Those with an activity level that met the guideline for "substantial" and "more extensive" health benefits were classified as "medium" and "high," respectively.

Statistical Analysis

Characteristics of the three diabetes status groups (ie, diagnosed diabetes, diagnosed diabetes and hypertension, or neither) were compared using χ^2 tests for categorical variables and analysis of variance for continuous variables. Multiple linear regression was conducted to compare mean DASH scores and mean nutrient intakes of the two diabetes groups to the group without diabetes. The individual nutrients were analyzed as continuous variables based on the DASH scoring method (ie, percentage of total energy, grams or micrograms per 1,000 kcal, or percentage of the DASH target). Three models were developed: an unadjusted model, a model controlling for age and total energy intake, and a model with additional covariates, including sex, race/ethnicity, education, poverty income ratio level, body mass index, physical activity level, reported diet status, smoking status, and country of birth. A P value of <0.05 for the β coefficient using a t test was used to determine statistical significance of the outcomes.

A sensitivity analysis was conducted to see whether excluding individuals following a diet related to the DASH diet would change the multiple regression results (n=4,321). This was due to the potential for a diet change to have occurred after a diabetes diagnosis. In addition, although US Department of Agriculture methodology has >50 checks for illogical responses,[18] another sensitivity analysis was performed excluding those consuming an average of <700 kcal/day or >7,000 kcal/day (n=5,006).

SAS (version 9.1.3, 2003, SAS Institute, Inc) was used to prepare data for analysis. SUDAAN (version 10.0.1, 2009, RTI International) was used for all analyses with dietary weights to account for complex design effects.[24] All NHANES data used in this study were publicly available and deidentified. The National Center for Health Statistics Research Ethics Review Board reviewed and approved NHANES.

RESULTS AND DISCUSSION

Adults in the two diabetes groups were older, had a lower education level, and lived in a household with a lower poverty income ratio compared with those in the group without diabetes (Table 2). Both groups of adults with diabetes had a higher percentage of non-Hispanic blacks; however, the diabetes/high blood pressure group had a significantly lower percentage of Hispanics than the other two groups. Adults in the two diabetes groups had a greater proportion of obesity than the group without diabetes, but reported consuming fewer kilocalories per day and were more likely to report following a diet.

The unadjusted linear regression model showed no statistically significant differences in mean DASH score among the three groups, nor did the models adjusting for age and energy intake and adjusting for all potential confounders (Table 3). The mean DASH scores of the three groups ranged from 1.95 to 2.02 in the fully adjusted model.

In the unadjusted models, there were several statistically significant differences in individual nutrient intakes among the three groups (Table 3). Models adjusting for age and energy intake showed similar results. However, in the fully adjusted models, only a few significant differences remained. Adults with only diabetes had significantly higher intakes of fiber (8.1 g/1,000 kcal vs 7.6 g/1,000 kcal; P=0.02) and total fat as a percentage of total energy (35.3% vs 34.1%; P=0.006) than adults without either disease. Adults with both diabetes and high blood pressure had a higher sodium intake (153.0% of the DASH target vs 146.6%; P=0.04).

The sensitivity analysis that excluded adults following a diet related to the DASH diet did not substantially change the study results. In the fully adjusted models excluding those consuming <700 kcal/day or >7,000 kcal/day, two differences occurred from the original models where the P values were borderline. The diabetes-only group showed a significantly lower intake of saturated fat (as a percentage of total energy) than the group without diabetes (11.1% vs 11.4%; P=0.04), and the diabetes/high blood pressure group did not show a significantly higher intake of sodium than the group without diabetes (P=0.06), as in the original model.

Our study showed similar results to three other studies. A cross-sectional study among adults with hypertension showed no difference in consistency with the DASH diet among adults with and without self-reported diabetes.[19] Two other studies, one in youth with physician-diagnosed diabetes and another in adults with and without self-reported diabetes, showed similar trends in adherence to the DASH diet or DASH nutrients.[25,26] However, other studies have shown some healthier eating habits in adults with self-reported diabetes than those without diabetes.[13,14] Differing results may come from differences in the type of dietary measurement methods used, the time period, the level of control for confounding, and differing populations. Our study used the DASH nutrient targets because achieving nutrient intakes is the goal of the food group recommendations.[27]

The DASH diet can be a tool for controlling blood pressure. In the first randomized clinical trial, the DASH diet reduced systolic and diastolic blood pressure by 5.5 and 3.0 mm Hg, respectively, more than the control diet.[7] Recent prospective cohort studies using various DASH scoring methods have shown adherence to the DASH diet to be associated with a lower incidence of self-reported hypertension in women,[9] a lower risk of coronary heart disease and stroke in women,[28] and lower mortality from all causes and from stroke in adults with hypertension.[29] Because of the high prevalence of high blood pressure in people with diabetes, the DASH diet could be useful in preventing or controlling high blood pressure and associated negative outcomes.

The low consistency with the DASH diet among adults with diagnosed diabetes seen in our study may reflect a lack of sufficient and effective education and behavior change efforts toward patients with diabetes or a lack of inclusion of the DASH diet in these efforts. The

American Diabetes Association recommends that people with diabetes receive individualized medical nutrition therapy, and studies have shown a role for diet in preventing complications from diabetes.[10] However, only 57.4% (age-adjusted) of adults with diabetes aged ≥18 years have ever attended a diabetes self-management class,[30] and a review of community-based diabetes self-management education programs showed little evaluation of dietary intake and inconsistent results.[31]

A strength of our study is that NHANES is a survey of a large, nationally representative sample of the noninstitutionalized US population with high response rates.[32] Nutrient content was also coded using the US Department of Agriculture's Food and Nutrient Database for Dietary Studies.[18] There are some limitations. With the exception of body mass index, all data were self-reported. A social desirability bias exists in reporting of diet and smoking status, and obese people have been shown to report proportionally lower total energy intake and higher protein intake than nonobese people compared with their true intake.[33] Use of medication for blood pressure reduction was also not considered; people using medication may be less likely to make dietary changes. Although a 24-hour recall is one of the most precise methods of assessing diet, we used only 2 days of recall data, which has not been shown to represent a person's usual intake.[34] There is less of a challenge with assessment of population mean intake for foods or nutrients that are consumed daily compared with specific foods or nutrients such as broccoli, whole grains, and lycopene, which are consumed episodically.[35,36] However, it is still a limitation of this study. The study's cross-sectional nature makes the association between diet and diabetes challenging to interpret, and causal inferences cannot be drawn.

CONCLUSIONS

Overall, the degree of consistency with the DASH diet was very low among adults with self-reported diabetes (regardless of hypertension status) and similar to that of adults without either disease. Although it would be helpful to know whether physicians recommend the DASH diet to patients with diabetes and whether or not patients have been referred for nutrition counseling, our results show that the dietary habits of adults with and without diabetes can be improved. The information we present about intake of specific individual nutrients can help health care practitioners learn which aspects of the DASH diet require more emphasis in education programs.

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Table 1

Nutrient targets for Dietary Approaches to Stop Hypertension (DASH) score, based on each participant's total energy intake, in a study using data from adults aged ≥20 years participating in the National Health and Nutrition Examination Surveys (2003–2006)[a]

DASH nutrient	DASH target (1 point)	Intermediate target (0.5 point)	Not meeting a target (0 points)
Total fat (% of total energy)	<27	≥27% and <32%	≥32%
Saturated fat (% of total energy)	<6	≥6% and <11%	≥11%
Protein (% of total energy)	>18	>16.5% and ≤18%	≤16.5%
Fiber (g/1,000 kcal)	>14.3	>9.3 g and ≤14.3	≤9.3
Cholesterol (mg/1,000 kcal)	<71	≥71mg and <107	≥107
Potassium (linear index model)[b]	>2,433.02+1.0668×kcal	> (2,966.04+1.6336×kcal)/2 and ≤ 2,433.02+1.0668×kcal	≤(2,966.04+1.6336×kcal)/2
Magnesium (linear index model)[b]	>216.98+0.1332×kcal	>(283.44+0.1796×kcal)/2 and ≤ 216.98+0.1332×kcal	≤(283.44+0.1796×kcal)/2
Calcium (linear index model)[b]	>400+0.4×kcal	> (566.98+0.5322×kcal)/2 and ≤ 400+0.4×kcal	≤(566.98+0.5322×kcal)/2
Sodium (linear index model)[c]	<368+0.92×kcal	≥ 368+0.92×kcal and <(1,268+1.92×kcal)/2	≥(1,268+1.92×kcal)/2

[a] Adapted from reference 12. Nutrient targets (except for minerals) are based on a 2,100 kcal diet (as % or amount per 1,000 kcal).

[b] Source: reference 20.

[c] Source: reference 21.

Table 2

Weighted distribution of characteristics of adults aged ≥20 years participating in the National Health and Nutrition Examination Surveys (2003–2006) with valid dietary recall interviews (N=5,867), by diabetes and high blood pressure status[a]

	No Diabetes, No High Blood Pressure (n=5,024)		Diabetes, No High Blood Pressure (n=338)		Diabetes and High Blood Pressure (n=505)		
Characteristic	**n**	**Mean±standard error**	**n**	**Mean±standard error**	**n**	**Mean±standard error**	***P* value[b]**
Age (y)	5,024	42.8±0.4	338	56.4±1.2	505	61.1±0.9	<0.0001
Sex (%)							0.34
Male	2,592	50.2±0.9	173	51.3±3.7	240	45.3±3.3	
Female	2,432	49.8±0.9	165	48.7±3.7	265	54.7±3.3	
Race/ethnicity[c] (%)							<0.0001
Non-Hispanic white	2,707	79.5±2.2	131	69.5±4.2	219	74.7±3.4	
Non-Hispanic black	939	11.2±1.5	79	17.8±2.5	151	19.3±2.8	
Mexican American	1,018	9.3±1.2	106	12.6±3.0	106	6.0±1.7	
Education (%)							<0.0001
<High school	1,241	15.1±0.8	133	24.2±2.9	204	29.4±3.6	
High school/General Educational Development Test	1,224	25.2±1.1	83	29.2±4.1	122	26.6±2.6	
Some college	1,504	33.5±1.1	74	25.6±3.5	123	29.9±3.8	
College graduate	1,049	26.3±1.7	48	20.9±4.0	56	14.1±2.2	
Poverty income ratio (%)							0.001
≤1.3	1,184	17.9±1.3	93	21.0±3.4	164	23.6±2.9	
>1.3 but ≤3.5	1,860	35.5±1.4	141	43.6±5.4	192	42.2±4.3	
>3.5	1,708	46.6±1.8	81	35.5±4.7	115	34.2±4.4	
Country of birth (%)							0.02
United States	3,941	85.8±1.6	250	82.5±3.4	435	91.5±1.7	
Other than the United States	1,083	14.2±1.6	88	17.5±3.4	70	8.5±1.7	
Body mass index category (%)							<0.0001
Normal/underweight (≤25)	1,775	38.4±1.1	63	15.3±3.9	60	14.5±2.8	
Overweight (>25 but <30)	1,765	34.6±1.0	112	38.3±4.8	143	25.0±2.9	
Obese (≥30)	1,424	27.0±1.1	152	46.4±4.8	288	60.6±3.6	
Physical activity[d] (%)							<0.0001

Characteristic	No Diabetes, No High Blood Pressure (n=5,024)		Diabetes, No High Blood Pressure (n=338)		Diabetes and High Blood Pressure (n=505)		*P* value[b]
	n	Mean±standard error	n	Mean±standard error	n	Mean±standard error	
Low physical activity	2,346	41.6±1.3	187	50.2±3.6	324	63.1±3.8	
Meets 2008 guidelines for substantial benefits	643	13.3±0.7	48	12.8±2.3	60	14.1±2.8	
Meets 2008 guidelines for more extensive benefits	2,035	45.1±1.4	103	37.1±3.6	120	22.8±3.2	
Smoking status (%)							0.054
Not a current smoker	3,794	73.6±1.2	277	80.3±4.0	427	81.2±3.0	
Current smoker	1,224	26.4±1.2	61	19.8±4.0	78	18.8±3.0	
Diet status[e] (%)							<0.0001
Not following a diet	4,472	88.0±0.8	216	56.8±4.6	302	57.5±3.7	
Following a diet	551	12.0±0.8	122	43.2±4.6	203	42.5±3.7	
Total energy (kcal/d)	5,024	2,225±17.0	338	1,908±64.0	505	1,829±41.0	<0.0001

[a] Sample size for individual variables is sometimes <5,867 because of missing data for some participants.

[b] Statistical significance determined at $P<0.05$ using a χ^2 test for association between categorical row variables and the diabetes status groups and a *t* test for association between continuous row variables and the diabetes status groups.

[c] Other race/ethnicity is excluded in this table because of an unstable standard error for the diabetes, no high blood pressure group. Other Hispanic ethnicity is excluded by recommendation of National Health and Nutrition Examination Survey. Analytic note regarding 2007–2010 survey design changes and combining data across other survey cycles. National Center for Health Statistics website. http://www.cdc.gov/nchs/data/nhanes/analyticnote_2007-2010.pdf. Accessed April 21, 2012.

[d] Physical activity was measured from minutes of leisure activities, biking and walking as transportation, and home and yard work.

[e] Related to Dietary Approaches to Stop Hypertension diet.

Table 3

Unadjusted and adjusted mean Dietary Approaches to Stop Hypertension (DASH) score and nutrient intake among adults aged ≥20 years participating in the National Health and Nutrition Examination Surveys (2003–2006), by diabetes and high blood pressure status

Variable	No diabetes, no high blood pressure (n=4,356)	Diabetes, no high blood pressure (n=285)	Diabetes and high blood pressure (n=430)
		mean±standard error	
DASH score			
Unadjusted model	2.01±0.05	2.12±0.14	1.98±0.13
Model 1: adjusted for age and energy intake	2.02±0.05	2.00±0.15	1.82±0.13
Model 2: adjusted for all confounders[a]	2.01±0.04	2.02±0.13	1.95±0.13
Total fat (% total energy)			
Unadjusted model	33.9±0.3	35.5*±0.6	36.7***±0.7
Adjusted model[a]	34.1±0.2	35.3**±0.4	34.7±0.4
Saturated fat (% total energy)			
Unadjusted model	11.3±0.1	11.3±0.2	12.1*±0.3
Adjusted model[a]	11.3±0.1	11.0±0.2	11.5±0.2
Protein (% total energy)			
Unadjusted model	15.6±0.1	17.1***±0.3	16.7***±0.3
Adjusted model[a]	15.8±0.1	15.9±0.3	15.6±0.2
Cholesterol (mg/1,000 kcal)			
Unadjusted model	134.3±2.5	154.3*±7.8	155.9**±7.6
Adjusted model[a]	136.2±1.5	138.4±8.0	136.2±6.7
Fiber (g/1,000kcal)			
Unadjusted model	7.5±0.1	9.1***±0.4	8.8***±0.3
Adjusted model[a]	7.6±0.1	8.1*±0.2	8.1±0.2
Sodium (% of DASH target)			
Unadjusted model	146.3±1.2	152.0**±2.0	155.3**±2.6
Adjusted model[a]	146.6±1.0	148.2±2.6	153.0*±3.0
Potassium (% of DASH target)			
Unadjusted model	56.6±0.6	60.8*±1.8	56.9±1.8

Variable	No diabetes, no high blood pressure (n=4,356)	Diabetes, no high blood pressure (n=285)	Diabetes and high blood pressure (n=430)
Adjusted model[a]	56.9±0.3	57.6±1.0	55.2±0.9
Calcium (% of DASH target)			
Unadjusted model	71.9±1.0	71.1±3.2	70.5±1.9
Adjusted model[a]	71.6±0.5	74.4±2.5	73.7±2.2
Magnesium (% of DASH target)			
Unadjusted model	56.8±0.7	59.2±1.5	56.8±1.8
Adjusted model[a]	56.9±0.3	55.7±0.8	57.6±0.8

[a]Multiple linear regression model with adjustment for sex; age (continuous); total energy intake (continuous); race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican American); education (<high school, high school/General Educational Development Test, some college, or college graduate); poverty income ratio level (≤1.3, >1.3 but ≤3.5, or >3.5); body mass index (normal/underweight, overweight, or obese); physical activity level (no physical activity, meets 2008 guidelines for substantial benefits, meets 2008 guidelines for extensive benefits); smoking status (current smoker, not a current smoker); reported diet status (following a diet related to DASH, not following a diet related to DASH); and country of birth (born in United States, born outside the United States). Individual nutrient models are also adjusted for all other individual nutrients in this Table.

*P<0.05 for comparisons of β coefficients to the no diabetes/no high blood pressure group using a t test.

**P<0.01 for comparisons of β coefficients to the no diabetes/no high blood pressure group using a t test.

***P<0.001 for comparisons of β coefficients to the no diabetes/no high blood pressure group using a t test.