Adherence to the DASH Diet Is Inversely Associated With Incidence of Type 2 Diabetes: The Insulin Resistance Atherosclerosis Study

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OBJECTIVE — The Dietary Approaches to Stop Hypertension (DASH) diet has been widely promoted; however, little is known about its impact on type 2 diabetes.

RESEARCH DESIGN AND METHODS — We evaluated the association of the DASH diet with incidence of type 2 diabetes among 862 participants of the Insulin Resistance Atherosclerosis Study (IRAS) who completed a 1-year food frequency questionnaire at baseline. Type 2 diabetes odds ratios (ORs) were estimated at tertiles of the DASH score.

RESULTS — An inverse association was observed in whites (tertile 2 vs. tertile 1, OR 0.66 [95% CI 0.29–1.48]) that became significant for the most extreme contrast (tertile 3 vs. tertile 1, 0.31 [0.13–0.75]), with adjustment for covariates. No association was observed in blacks or Hispanics (tertile 2 vs. tertile 1, 1.16 [0.61–2.18]; tertile 3 vs. tertile 1, 1.34 [0.70–2.58]).

CONCLUSIONS — Adherence to the DASH dietary pattern, which is rich in vegetables, fruit, and low-fat dairy products, may have the potential to prevent type 2 diabetes.

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T he effectiveness of dietary and life-style modification approaches in the prevention of type 2 diabetes is well recognized. The American Diabetes Association Nutritional Recommendations emphasize moderate weight loss via modification of energy and fat intake and physical activity for primary prevention among high-risk individuals but do not provide specific information regarding a dietary pattern (1). The Dietary Approaches to Stop Hypertension (DASH) trial demonstrated that a dietary pattern rich in vegetables, fruit, and low-fat dairy products can reduce blood pressure (2) and has been widely promoted (3,4). To the best of our knowledge, the DASH dietary pattern has not been evaluated with respect to potential influence on diabetes development. Thus, the aim of our study was to evaluate the impact of adherence to the DASH diet on risk of type 2 diabetes in the multiethnic Insulin Resistance Atherosclerosis Study (IRAS).

RESEARCH DESIGN AND METHODS — Study design details have been previously published (5). Between 1992 and 1994, 1,624 participants were recruited at four clinical centers, aiming for equal representation across glucose tolerance status (normal, impaired glucose tolerance, non–insulin-dependent type 2 diabetes), ethnicity (black, Hispanic, and non-Hispanic white), sex, and age (40–49, 50–59, and 60–69 years). Of 1,087 subjects with normal or impaired glucose tolerance at baseline, 906 (83%) returned to 5-year follow-up, among whom 148 type 2 diabetes cases developed. Low educational attainment was associated with reduced follow-up, which somewhat limits generalizability. Analyses included 862 participants with complete data on exposure, outcome, and key covariates. Data completeness was unrelated to demographic variables except the study center.

At baseline, habitual dietary intake was assessed by using a 1-year, semiquantitative 114-item food frequency interview ascertaining both frequency and serving size. We created 33 food groups based on similarities in food and nutrient composition (6) that were collapsed to create eight DASH food groups (grains, vegetables, fruits, dairy, meat, nuts/seeds/legumes, fats/oils, and sweets). Adherence to the DASH diet was assessed with an index variable (7). We additionally distinguished whole grain and low-fat dairy to address the qualitative DASH goals. For each food group, a maximum score of 10 was assigned if the recommended intake was met, whereas lower intakes were scored proportionately. If lower intakes were recommended, reverse scoring was applied, and a score of 0 was applied to intakes ≥200% the upper recommendation. The resulting eight component scores were summed to create the overall DASH adherence score (range 0–80) (7).

Anthropometric measures were taken in a standardized manner following the protocol. A 12-sample, insulin enhanced, frequently sampled intravenous glucose tolerance test was conducted, and insulin sensitivity and acute insulin response were assessed using minimal model analysis. Acute insulin response was calculated based on insulin levels through the 8-min blood samples prior to insulin infusion.

At 5-year follow-up, individuals who met the World Health Organization criteria for diabetes on their oral glucose tolerance test or who were taking hypoglycemic medication not previ-

Table 1—*Food group intake and odds of type 2 diabetes by tertile of DASH dietary pattern score*

	n/N	β (*P*)	Tertiles of the DASH score			*P* for trend
			1	2	3	
DASH score			38.4 ± 5.3	49.5 ± 2.5	60.2 ± 4.5	
Food group (serving/day)						
Total grains*			2.6 ± 1.5	2.9 ± 1.5	3.3 ± 1.4	
High-fiber grains†			0.5 ± 0.6	0.8 ± 0.7	1.2 ± 0.8	
Vegetables‡			2.5 ± 1.5	3.3 ± 1.8	4.1 ± 1.6	
Fruit§			1.3 ± 1.1	2.3 ± 1.6	3.3 ± 1.6	
Total dairy‖			0.9 ± 0.6	1.0 ± 0.7	1.2 ± 0.8	
Low-fat dairy¶			0.1 ± 0.2	0.2 ± 0.3	0.4 ± 0.4	
Meat, poultry, eggs, fish#			2.0 ± 1.2	1.7 ± 1.0	1.7 ± 0.9	
Nuts, seeds, dried beans**			2.2 ± 2.7	3.0 ± 3.3	3.9 ± 2.9	
Fats and oils††			1.8 ± 1.4	1.6 ± 1.0	1.4 ± 0.9	
Sweets‡‡			11.0 ± 8.6	7.5 ± 6.4	5.6 ± 6.1	
Total population						
Model 1§§	141/864	−0.032 (0.77)	1.00	0.86 (0.54–1.38)	0.73 (0.45–1.21)	0.47
Model 2‖‖	141/862	−0.002 (0.98)	1.00	0.94 (0.58–1.52)	0.78 (0.47–1.29)	0.60
Model 3¶¶	129/822	−0.066 (0.58)	1.00	0.88 (0.51–1.51)	0.64 (0.37–1.13)	0.29
Whites						
Model 1§§	54/347	−0.429 (0.02)	1.00	0.53 (0.24–1.15)	0.25 (0.11–0.61)	<0.01
Model 2‖‖	54/346	−0.349 (0.07)	1.00	0.66 (0.29–1.48)	0.31 (0.13–0.75)	0.03
Model 3¶¶	49/327	−0.414 (0.05)	1.00	0.77 (0.31–1.90)	0.25 (0.09–0.67)	0.02
Blacks/Hispanics						
Model 1§§	87/517	0.176 (0.20)	1.00	1.11 (0.59–2.07)	1.34 (0.70–2.55)	0.67
Model 2‖‖	87/516	0.183 (0.19)	1.00	1.16 (0.61–2.18)	1.34 (0.70–2.58)	0.68
Model 3¶¶	80/495	0.075 (0.63)	1.00	0.90 (0.45–1.80)	0.96 (0.46–1.97)	0.95

Data are means ± SD, OR, and OR (95% CI) unless otherwise indicated. *High-fiber dark bread and cereal, low-fiber bread and cereal, salty snacks, rice, and pasta. †High-fiber dark bread and cereal. ‡Tomato vegetables, cruciferous vegetables, other vegetables, potatoes, and fries. §Fruit and fruit juices. ‖Milk, yogurt, cottage cheese, cheese, and ice cream. ¶Milk and yogurt up to 2% fat. #All meats including processed meats, poultry, eggs, fish, and shellfish. **Nuts, seeds, dried beans, and tofu. ††Fats, oils, salad dressing, gravies, and creamer. ‡‡Sweets including chocolate, regular soft drinks, and pastry. §§Adjusted for age, sex, race/ethnicity/ clinic, glucose tolerance status, family history of diabetes, education, smoking status, energy intake, and energy expenditure. ‖‖Adjusted for covariates contained in model 1 plus baseline BMI. ¶¶Adjusted for covariates contained in model 2 plus baseline insulin sensitivity and secretion. β, change per 10-unit increase in the DASH score; *n*, case subjects; *N*, population at risk.

ously reported at baseline were considered having incident type 2 diabetes.

Multiple logistic regression analysis was used to assess the relationship between the DASH diet and risk of type 2 diabetes. Parameter estimates and 95% CIs were calculated for DASH tertiles. The test for trend across tertiles used the resulting *P* value from the type 3 analysis of effects based on the Wald χ^2 test. Previous cross-sectional analyses have indicated a significant interaction between DASH adherence and race with respect to baseline BMI and waist circumference (8); thus, models were additionally stratified by race/ethnicity into white versus minority (blacks and Hispanics) and a DASH score–by–minority race interaction was tested.

RESULTS — The mean food group intake by the DASH tertile is shown for descriptive purposes (Table 1). The DASH score was associated with age, race/ethnicity, smoking, physical activity, and educational attainment (data not shown).

In the total study population, we initially observed a weak, inverse association of the DASH index with incident type 2 diabetes adjusting for age, sex, race/ethnicity/clinic, diabetes status, family history, education, smoking, energy intake, and expenditure (Table 1). Further adjustment for BMI had little impact. However, upon stratification by race/ethnicity, a strong inverse association of the DASH score with type 2 diabetes was observed in whites (tertile 3 vs. tertile 1, odds ratio (OR) 0.31 [95% CI 0.13–0.75]) but not in blacks or Hispanics. The interaction between DASH and minority race was statistically significant (*P* = 0.02) in the fully adjusted model. Adjustment for insulin sensitivity and secretion strengthened the association in the total population and in whites but had no effect in minorities. Adjustment for baseline glucose did not alter the findings (data not shown).

CONCLUSIONS — Intervention studies have shown that in addition to a blood pressure–lowering effect (2), the DASH diet has beneficial effects on total and LDL cholesterol (9), insulin sensitivity (10), and weight management (11). To date, however, findings from observational studies have not been encouraging (12), suggesting that very high adherence levels might be needed to produce an impact and that those may be achievable only in intervention settings. However, in the free-living IRAS population, higher adherence to the DASH dietary pattern was associated with markedly reduced odds of type 2 diabetes among white participants. No association was observed in blacks or Hispanics possibly because of the key limitation of our study—the relatively small sample size. Additionally, differential accuracy of diet assessment may play a role. Therefore, replication of our study findings in a larger cohort is needed.

The composition of the DASH diet pattern with its emphasis on vegetables, fruit, low-fat dairy products, nuts, seeds, and whole grains and its limits on meat, poultry, eggs, fats, and oils certainly makes this a likely candidate for diabetes prevention. Our findings are consistent with other epidemiological research data suggesting a beneficial effect of increased dairy (13), whole grain (14), and nuts (15) on diabetes risk. Unlike previous research, the magnitude of our results is noteworthy with an OR of 0.25 in the highest adherence tertile compared with the lowest. In conclusion, our results suggest that adherence to the DASH dietary pattern, which is based on a priori defined amounts of specific food groups, may have the potential to prevent diabetes.

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