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ASSOCIATION BETWEEN THE DIETARY APPROACHES TO HYPERTENSION (DASH) DIET AND HYPERTENSION IN YOUTH WITH DIABETES

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Abstract

Among youth with diabetes mellitus, elevated blood pressure represents one of the most common co-morbidities. Hence, exploring dietary factors that may help prevent or control hypertension in this population is of paramount importance. We investigated whether adherence to the Dietary Approaches to Stop Hypertension (DASH) is associated with hypertension in youth with diabetes from the SEARCH for Diabetes in Youth Study. Between 2001 and 2005, 2,830 youth aged 10 to 22 years (2,440 with type 1,390 with type 2 diabetes) completed a study visit. For each of the 8 DASH food groups, a score of 10 was assigned when the DASH recommendation was met. Lower intakes were scored proportionately, and the 8 individual scores were summed. The association between the overall DASH score and hypertension was evaluated using multiple logistic regression. The crude prevalence of hypertension was 6.8% for youth with type 1 and 28.2 % for type 2 diabetes. In youth with type 1, a higher adherence to DASH was inversely related to hypertension, independent of demographic, clinical, and behavioral characteristics (tertile 2 vs. 1:

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OR 0.7, 95% CI 0.5–1.0; 3 vs. 1: 0.6, 0.4–0.9; p_{trend}=0.007). For type 2 diabetes, the DASH diet was not associated with hypertension (tertile 2 vs. 1: 0.8, 0.5–1.4; 3 vs. 1: 0.9, 0.5–1.5; p_{trend}=0.6). Prospective observational studies or clinical trials are needed to investigate whether adherence to the DASH guidelines may help prevent hypertension in youth with type 1 diabetes. In type 2 diabetes, more research with a larger sample is necessary.

Keywords

DASH; diabetes mellitus; hypertension; dietary pattern; nutrition

INTRODUCTION

Hypertension represents one of the most common co-morbidities in persons with diabetes mellitus (DM) and seriously affects morbidity and mortality[1, 2]. Recent evidence from the SEARCH for Diabetes in Youth Study suggests that 30% of adolescents aged 10–19 years with type 1 or type 2 DM (T1DM, T2DM) have elevated blood pressure (BP), with a particularly high proportion in those with T2DM[3].

Dietary modification is a central part of any treatment strategy for (pre)hypertensive youth[4]. The Dietary Approaches to Stop Hypertension (DASH) trials demonstrated that a dietary pattern rich in vegetables, fruits and low-fat dairy products can effectively lower systolic and diastolic BP in normo- and hypertensive adults[5]. However, subsequent attempts to evaluate the importance of the DASH diet have yielded mixed results[6–8]. It has also been suggested that higher intakes of fruit, vegetables and dairy might be related to lower BP in children[9]. Studies investigating the total DASH pattern in youth, in particular in the critical population of youth with DM, are lacking[2, 10, 11].

The aim of the present analysis was to examine the association between adherence to the DASH dietary pattern and hypertension in youth with DM, using cross-sectional data from the SEARCH for Diabetes in Youth Study.

METHODS

Study population

SEARCH for Diabetes in Youth is a multi-center, observational study of physician-diagnosed DM in children, adolescents and young adults <20 years of age. A detailed description has been published previously[12]. Population-based ascertainment included youth with DM prevalent in 2001 and incident from 2002 through the present. Diabetes cases are being identified in geographically defined populations (Ohio, Washington, South Carolina, Colorado), among health plan enrollees (Hawaii, California), and among several American Indian populations.

The study was reviewed and approved by the local Institutional Review Board(s) and complied with the privacy rules of the Health Insurance Portability and Accountability Act. DM cases were asked to complete an initial survey including age at diagnosis and self-reported race/ethnicity and subsequently invited to a study visit. Written informed consent was obtained from participants ≥18 years of age, or from a parent in participants <18 years. Minors provided written assent.

In this analysis, DM type as assigned by the health care provider was used for classification into T1DM (combining T1A, T1B and T1) and T2DM based on information collected from the health care providers at the time of the case report or from medical records.

Blood pressure and anthropometry

Physical examinations at the study visits included measurements of height, weight, and BP and were conducted according to standardized protocols by trained and certified staff members. Three BP measurements were obtained at the right arm with a mercury manometer after the patient had been sitting for at least 5 minutes, with a break of at least 30 seconds between readings. Five cuff sizes were available. The mean of the three measurements was calculated for this analysis.

In accordance with the 4th Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in children and adolescents[4], hypertension was defined as having a diastolic or systolic BP (SBP, DBP) ≥95th percentile for age, height and sex (in participants ≥18 years, 140 mmHg and 90 mmHg served as cut-offs for SBP and DBP), or taking antihypertensive medication[1, 13].

Standard deviation scores (SDS) of anthropometric parameters were constructed according to the U.S. Centers for Disease Control and Prevention (CDC) 2000 growth standards[14], with interpolations made for those who were older than 20 years of age at the time of the measurement. Obesity was defined as having a BMI ≥95th percentile for age and sex[15].

Dietary assessment

At study visits, dietary intake was assessed in participants ≥10 years with a food frequency questionnaire (FFQ), which represented a modified version of the Block Kid's Food Questionnaire[16]. Details of the dietary assessment methodology in SEARCH can be found elsewhere[17]. The SEARCH FFQ incorporates 85 food lines, and for each food, the participants indicated whether it was consumed in the past week, on how many days, and the average portion. Portion size was queried either as a number (e.g., number of slices) or in relation to pictures of food in bowls or plates. The nutrient and portion-size databases were based on the Nutrition Data System for Research (database 3, version 4.05/33, 2002, University of Minnesota, Minneapolis), and industry sources.

Staff certified on the SEARCH protocol instructed study participants on the completion of the SEARCH FFQ, which was generally self-administered with interviewer assistance. However, interview administration was offered if necessary.

DASH score

Adherence to the DASH Eating Plan was assessed with an index variable that comprised the 8 DASH food groups (grains, vegetables, fruits, dairy, meat, nuts/seeds/legumes, fats/oils, and sweets)[18,19]. For each food group, a maximum score of 10 could be achieved when the intake met the recommendation[19], while lower intakes were scored proportionately. If lower intakes are favored by DASH, reverse scoring was applied, and a score of 0 was applied to intakes ≥200% the upper recommended level. The resulting 8 component scores were summed to create the overall DASH adherence score, which could range from 0 to 80.

Details of the index components and the score standards are summarized in Table 1. In order to more closely reflect the recommendations of DASH[18–20], the grain and dairy components consisted of two items and addressed a qualitative goal in addition to an absolute quantitative one.

Wherever possible, we adjusted the standard serving sizes in SEARCH to those of the DASH Eating Plan. Adjustments were not feasible for a variety of mixed (meat) dishes, but usually 1 (medium) piece or portion represented 1 serving. Because the DASH Eating Plan of the National Heart, Lung, and Blood Institute (NHLBI) gives recommendations for four levels of daily energy intake (1,600/2,000/2,300/3,100 kcal/day), we assigned each individual the energy level that was closest to the estimated energy requirement based on age, sex, and physical activity level (PAL)[21]. Physical activity in SEARCH was assessed by questions derived from the Youth Risk Behavior Surveillance System[22]. Youth who reported neither moderate nor vigorous physical activity ≥5 days/week were classified as sedentary, those who were either moderately or vigorously physically active ≥5 days/week as low active, and those who were both moderately and vigorously physically active ≥5 days/week as active.

Statistical analysis

We considered all youth whose DM was prevalent in 2001 or incident between 2002 and 2005. Of 8,031 registered youth that met these criteria, 3,707 attended a study visit and were aged ≥10 years at that time. Youth with other or unknown clinical DM type (n=39) were excluded. Among the remaining 3,668 participants, 462 did not fill out the FFQ, and 159 were excluded because of serious quality problems with the dietary data. This number was further reduced after excluding those without measured blood pressure (n=151). Other information relevant to this analysis, such as physical activity or parental education, was missing in 156. The final sample size thus was 2,830 (2,440 with T1DM, 390 with T2DM).

Proportionately more youth with T2DM than T1DM were excluded (n=248 vs. n=590; 39% vs. 19.5%), mainly due to lack or limited quality of the dietary data. Excluded youth with T1DM were more likely to be male than those with T1DM in the final dataset, while excluded youth with T2DM were older and characterized by a longer diabetes duration ($p<0.05$).

We investigated the relation between DASH adherence and hypertension by calculating crude and adjusted prevalence of hypertension in tertiles of DASH adherence. In addition, odds ratios (OR) with 95% confidence intervals (CI) were calculated, relative to the lowest tertile. Potential confounders were evaluated on an individual basis and in full models. BMI-SDS and energy intake (kcal/day) were considered as potential mediators, since they might lie on the pathway between the DASH diet pattern and hypertension. Linear trends across categories were performed by assigning each individual the median value of the category and modeling this variable continuously.

Because of the differences in both etiology and management, the analyses were undertaken separately for youth with T1DM and T2DM, further justified by an interaction between DASH adherence and DM type (p=0.046). In addition, potential effect modifiers were evaluated. All analyses were carried out using SAS (version 9.1), and a p-value <0.05 was considered statistically significant.

RESULTS

The overall prevalence of hypertension in the study sample was 9.8%, however, marked differences existed between youth with T1DM and T2DM (6.8% vs. 28.2%; p<0.0001). Adherence to DASH was slightly higher in T1DM than in T2DM (39.9±9.1 vs. 36.6±9.1; p<0.0001) (data not shown).

General characteristics of the study sample according to DASH adherence are summarized in Table 2. In both T1DM and T2DM, a greater adherence to DASH was associated with younger age, a higher parental education, less experience with smoking and higher physical activity. No clear relationship existed between the DASH score and obesity or BMI-SDS. As expected however, more youth with T2DM than with T1DM were obese (76.2% vs. 12.1%, p<0.0001) (data not shown).

Consumption of all food groups comprised in our DASH index differed significantly between tertiles (p<0.05) (Table 3). In particular, youth in the highest tertiles consumed twice as many servings of fruits and low-fat dairy products than those in the lowest. Achieving a higher DASH score was associated with a lower intake of total and saturated fat, but higher intakes of carbohydrates, fiber, calcium, magnesium and potassium (p<0.05). A higher adherence to DASH was not related to total energy intake. Despite being in the highest tertile of the DASH score, the average single food scores were still remarkably low at 0.4 out of 5 (whole grains), 3.6 out of 5 (low-fat dairy), 5.1 out of 10 (fruits), 5.3 out of 10 (vegetables) and 8.4 out of 10 for meat (data not shown).

In youth with T1DM, mean DBP decreased across tertiles of DASH adherence (p=0.04, Table 4). A similar tendency in SBP existed for both T1DM and T2DM (p=0.1), but was eliminated by adjusting for potential confounders (data not shown). Comparable results were obtained for the prevalence of hypertension: With increasing adherence to DASH, the crude prevalence declined markedly for youth with T1DM. Adjustment for confounders did not change this result (Figure 1). A decreasing tendency in the crude hypertension prevalence across tertiles of DASH adherence could also be observed in T2DM, but the differences did not reach statistical significance. Adjusting for confounders further attenuated this tendency.

We next evaluated the association in multiple logistic regression models. After adjustment for demographic, clinical, and behavioral characteristics, the odds of having hypertension among youth in the highest tertile of DASH adherence was 40% lower than in the lowest tertile (model 1, 95%CI: 0.38; 0.86) (Table 5). In addition, a statistically significant trend towards decreasing odds existed across tertiles (p=0.007). Additional inclusion of energy intake (model 2) and BMI-SDS (model 3) did not affect these results. In youth with T2DM, the crude OR indicated a slightly decreasing trend across tertiles of DASH adherence too, but it did not reach statistical significance (p=0.4). Adjusting for demographic, clinical, behavioral factors, energy intake, and BMI-SDS (models 1–3) further reduced these differences.

Finally, adjustment for the micronutrients potassium, calcium or magnesium did not attenuate the findings in T1DM, and the association remained statistically significant (data not shown). In addition, we evaluated potential effect modification by sex, age, race/ethnicity, and obesity by conducting stratified analyses and including interaction terms in models. No evidence for effect modification existed (p-values for interaction terms>0.1).

DISCUSSION

To the best of our knowledge, this is the first study to examine the association between the DASH diet pattern and hypertension in persons with DM, and the first to focus on youth. A greater adherence to DASH was associated with markedly decreased odds of hypertension in youth with T1DM. It is noteworthy that the effect size was large compared to observational studies that focused on single nutrients or food groups only when assessing diet-disease relationships, a potential advantage of dietary pattern analysis discussed previously.

We did not observe a significant association between DASH adherence and hypertension in youth with T2DM. The most likely reason for this is limited statistical power. Our sample size was sufficient to detect an OR of 0.41 between two tertiles with 80% power (alpha=0.05, two-tailed). However, the absence of a relation might also stem from the differences in hypertension pathophysiology in T2DM, compared to T1DM[1]. In addition, most youth with T2DM were obese (76.8%). It is possible that in the obese state, quantitative aspects of diet, in particular energy balance, are of greater relevance than qualitative ones. Finally, the DASH adherence scores were statistically significantly lower in youth with T2DM than in T1DM.

Since the publication of the DASH trial results in 1997[5], the DASH dietary pattern has been widely recommended to prevent and treat hypertension[23] and is now part of the 2005 Dietary Guidelines for Americans[24]. However, its practical application has recently been questioned[25]. While the DASH trials were designed as feeding studies and thus represented a best case scenario with optimal adherence, intervention studies in free-living populations have been inconsistant[6, 25].

Only a limited number of studies have assessed adherence to DASH in observational settings. In the EPIC-Potsdam Study, women in the third, but not the highest quartile of a DASH score had a lower risk for hypertension[26]. A higher DASH score was associated with lower BP increases in the SU.VI.MAX cohort too, but the effect was not stronger than that of fruit and vegetables alone[27]. Although fat quality was evaluated in SU.VI.MAX, the DASH index used in both studies only included standardized intakes of vegetables, fruits and dairy. This might be an important shortcoming, because each DASH food group contributes critical nutrients[20]. More comprehensive applications of the DASH diet to observational data were used in the Iowa Womeńs Health Study (IWHS)[7] and the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial[28]. In the IWHS, no association between DASH adherence and incidence of (self-reported) hypertension and cardiovascular mortality existed. However, their DASH index was positively associated with energy and sodium intake, thus perhaps not capturing a truly favorable overall diet. By contrast, the cross-sectional analysis of the PLCO Study focused on distal colorectal adenoma. A reduced risk with increasing DASH adherence existed in the group of male former smokers only.

Overall, the limited number of observational studies was almost exclusively based on adult study populations. One of the few studies focusing on children has demonstrated that an increased intake of fruits, vegetables and dairy in the pre-school years might be related to lower BP levels during childhood[9]. In fact, it is generally assumed that a greater DASH adherence would equally benefit pediatric age groups. An increased intake of central food groups are accordingly recommended for (pre)hypertensive youth, and prevention purposes[4]. With regards to DM, the current ADA guidelines on Medical Nutrition Therapy (MNT) in DM advocate a diet low in sodium and high in fruits, vegetables and low-fat dairy products to lower BP in normo- and hypertensive diabetic persons, with DASH being explicitly mentioned[29]. Furthermore, a joint scientific statement by the American Heart Association (AHA) and the ADA, targeting primary prevention of cardiovascular disease in DM, recommends lifestyle therapy, including a diet pattern similar to DASH, for (pre)hypertensive patients[2]. However, only studies in general populations served as references.

Until today, it is unclear through which mechanism(s) the DASH diet exerts its antihypertensive properties, although a natriuretic action has been proposed[30]. Reduced sodium and increased potassium intake represent dietary factors that seem to lower BP, at least in adults[23]. However, the original DASH trial held sodium intake constant, although a combination of DASH and sodium restriction was even more effective[31]. Other dietary factors targeted by the DASH diet (fiber, saturated fat, magnesium) differed significantly between tertiles of DASH adherence in our study, but the evidence for BP lowering properties is inconclusive for them[23]. Only a higher protein intake yielded promising results in observational and intervention studies, in particular when substituting carbohydrates[32, 33]. However, differences in protein intake between tertiles of DASH adherence in our study were small, and intake of carbohydrates was positively associated with adherence to DASH. To summarize, it is most likely that DASH exerts a beneficial effect beyond that of single dietary factors, as has been hypothesized earlier[34]. Accordingly, adjusting for several nutrients that could function as mediators did not explain our results in T1DM.

Our study has several limitations. First, our results are based on cross-sectional data, and youth diagnosed with hypertension might have changed their dietary habits accordingly. However, taking into account awareness of hypertension did not change our results. Second, our BP data was based on three averaged BP measurements, taken at one visit instead of at least three different occasions[4]. In addition, our definition of hypertension included taking antihypertensive medication, as is common practice in general[35] as well as diabetic[36–38] populations. It is possible that some of the SEARCH participants will have been prescribed these medications for reasons other than to reduce BP levels, in particular for renal protection. However, changing our definition of hypertension to a) having elevated SBP or

DBP (≥95th percentile), or b) having a diagnosis of hypertension and/or elevated SBP or DBP (≥95th percentile), did not change our conclusions. Third, as already stated above, overall adherence to DASH was low, but will most likely have resulted in an underestimation of effects. Fourth, no consensus exists about how to best create a DASH index, i.e. which items to include, whether to consider food groups and/or nutrients, or how to weight components. Fifth, we were not able to adjust for sodium intake, which might have mediated the association between DASH adherence and hypertension, but estimation of sodium from a FFQ is questionable[39]. A final limitation is that applying a FFQ to estimate dietary intake is prone to measurement error. Since obese study participants tend to greater underreporting of dietary intakes[40], the lack of an association in T2DM could also stem from less valid dietary data. However, currently no biomarker capturing dietary patterns as a whole is available.

Perspectives

In conclusion, a higher adherence to the DASH Eating Plan was associated with decreased odds of hypertension in youth with T1DM. Prospective studies are needed to investigate whether advocating central aspects of DASH may help prevent and control elevated BP levels in this population. In T2DM, DASH adherence was not associated with hypertension, perhaps because of inadequate sample size.

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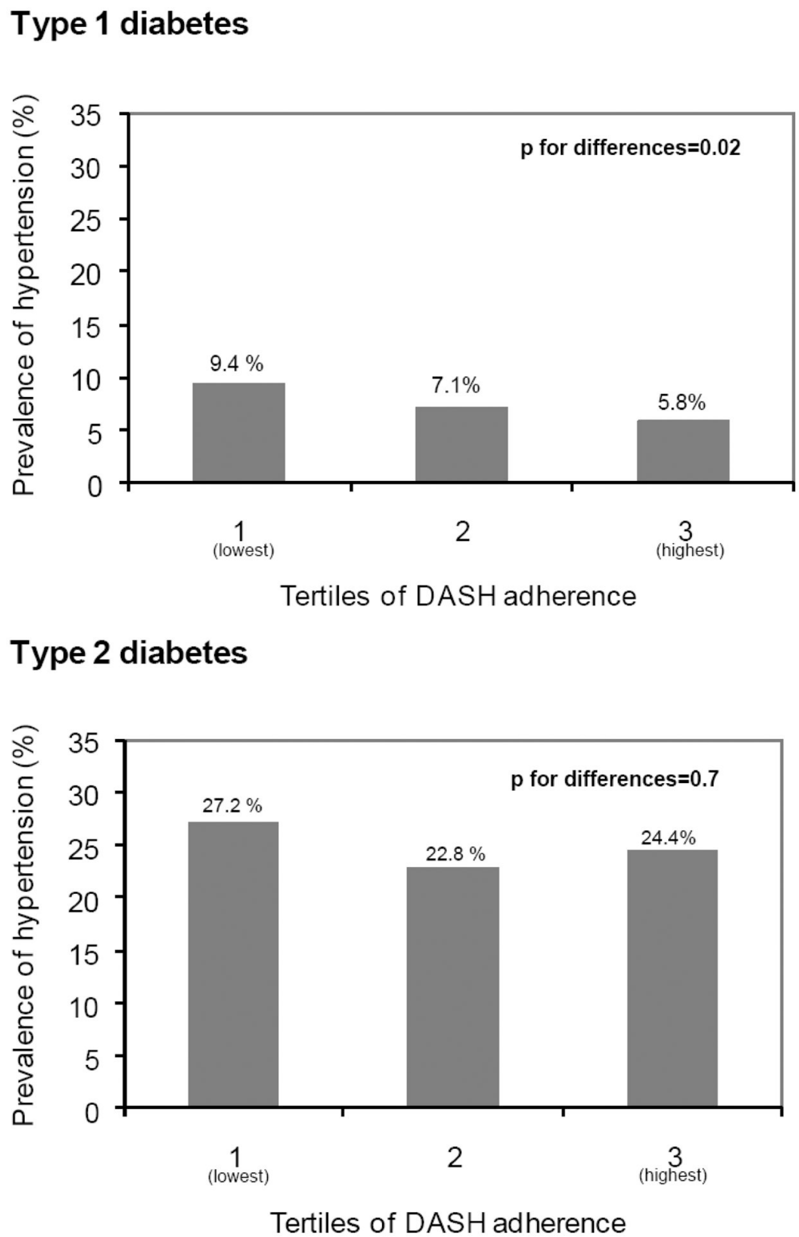

Figure 1. Adjusted* hypertension prevalence according to diabetes type and DASH adherence.
*Adjusted for sex, age, study center, race/ethnicity, diabetes duration, family history of high BP, vigorous physical activity (<5 days/week yes/no).

Table 1.

Components of the DASH index*.

Score Component	Maximum score	Standard for maximum score	Standard for minimum score of 0
1) Grains			
a) total	5	≥6 servings/day	0 servings/day
b) high fiber	5	≥50% of daily servings	0% of daily servings
2) Vegetables	10	≥4 servings/day	0 servings/day
3) Fruit	10	≥4 servings/day	0 servings/day
4) Dairy			
a) total	5	≥2 servings/day	0 servings/day
b) low-fat	5	≥75% of daily servings	0% of daily servings
5) Meat, poultry, fish, eggs	10	≤2 servings/day	≥ 4 servings/day
6) Nuts, seeds, legumes	10	≥4 servings/week	0 servings/week
7) Fats, oils	10	≤3 servings/day	≥ 6 servings/day
8) Sweets	10	≤5 servings/week	≥ 10 servings/week

*For 2,000 kcal/day. Intakes between minimum and maximum levels scored proportionally.

Table 2.

General characteristics according to diabetes type and DASH adherence.

Characteristic	Type 1 Diabetes (n=2,440) Tertiles of DASH score 1 (lowest)	3 (highest)	p*	Type 2 Diabetes (n=390) Tertiles of DASH score 1 (lowest)	3 (highest)	p*
Demographics						
Female (%)	55.4	47.7	0.006	66.2	60.8	0.5
Age at examination (years)	14.9 ± 2.9	14.7 ± 3.1	0.07	16.6 ± 2.7	15.5 ± 2.8	0.003
Race/ethnicity (%)						
Non-Hispanic White	71.8	80.9		20.0	20.8	
African American	12.1	4.7		40.8	28.5	
Hispanic	11.3	11.1	0.0001	13.9	27.7	0.04
Native American	1.0	0.3		11.5	15.4	
All Other	3.8	3.1		13.9	7.7	
Highest parental education ≥ Bachelor's degree (%)	38.6	54.5	<0.0001	13.8	22.3	0.2
Clinical variables						
Diabetes duration (years)	3.4 (1.1;7.5)	3.0 (1.0;6.9)	0.2	1.4 (0.8;3.2)	1.2 (0.6;2.4)	0.2
BMI-SDS (SD)†	0.6 ± 0.9	0.6 ± 0.9	0.5	2.1 ± 0.7	1.9 ± 0.8	0.09
Obesity (%)‡	12.7	10.5	0.2	81.5	72.3	0.2
Family history of hypertension (%)	77.1	79.7	0.2	83.9	87.7	0.6
Behavioral Variables						
Ever smoked (%)	27.4	17.5	<0.0001	39.2	26.2	0.04
Vigorous physical activity <5 d/wk (%)	75.5	58.4	<0.0001	84.6	64.6	0.0006

SD, standard deviation; SDS, standard deviation score. Numbers are frequencies, medians (Q1;Q3) or means ± SD.

* χ^2-Test for categorical, Kruskal Wallis-Test and ANOVA for continuous variables (including all 3 tertiles).

† According to the 2000 CDC growth charts[14].

‡ BMI ≥95th percentile[15].

Table 3.

Median energy, food group and nutrient intakes according to diabetes type and DASH adherence.

	Type 1 Diabetes (n=2,440) Tertiles of DASH score				Type 2 Diabetes (n=390) Tertiles of DASH score			
Diet characteristic	**1 (lowest)**	**2**	**3 (highest)**	**p***	**1 (lowest)**	**2**	**3 (highest)**	**p***
Mean DASH score	29.9	39.9	50.0	-	26.7	36.5	46.6	-
Energy (kcal/day)	1752.2	1753.1	1783.6	0.5	1709.7	1579.4	1634.2	0.4
Food groups (servings/1000 kcal)								
Total grains	2.05	2.15	2.15	0.01	1.93	2.13	2.09	0.08
High fiber grains†	22.4	24.3	32.4	<0.0001	22.3	29.2	33.9	0.1
Vegetables	0.94	0.96	1.06	<0.0001	1.11	1.14	1.33	0.03
Fruit	0.53	0.81	1.16	<0.0001	0.50	0.85	1.04	<0.0001
Total dairy	0.76	0.91	1.10	<0.0001	0.46	0.59	0.82	<0.0001
Low-fat dairy	0.20	0.42	0.70	<0.0001	0	0.13	0.44	<0.0001
Meat	1.57	1.26	1.04	<0.0001	1.70	1.49	1.33	0.003
Nuts & seeds	0	0.18	0.44	<0.0001	0	0.09	0.35	<0.0001
Fats & oils	2.25	1.79	1.39	<0.0001	2.08	1.93	1.60	0.005
Sweets	0.89	0.85	0.68	<0.0001	1.02	0.91	0.65	0.002
Nutrients (per 1000 kcal)								
CHO (g)	114.4	118.2	124.4	<0.0001	113.7	117.8	119.0	0.02
Fat (g)	43.7	42.2	40.4	<0.0001	43.7	42.7	41.3	0.04
Saturated fat (g)	16.1	15.3	14.4	<0.0001	15.9	15.0	14.1	<0.0001
Protein (g)	40.2	39.6	39.4	0.004	40.0	38.0	39.2	0.5
Fiber (g)	6.0	6.6	7.8	<0.0001	5.8	6.8	8.2	<0.0001
Calcium (mg)	501.0	588.3	669.4	<0.0001	326.7	392.0	436.0	<0.0001
Magnesium (mg)	121.0	135.4	152.6	<0.0001	105.8	119.8	138.6	<0.0001
Potassium (mg)	1166.5	1286.1	1461.6	<0.0001	1048.2	1170.7	1348.6	<0.0001

CHO, carbohydrates.

* χ^2-Test for categorical, Kruskal Wallis-Test for continuous variables.

† Frequency of consumption (%).

Table 4.

Blood pressure characteristics overall and according to diabetes type and DASH adherence.

		Type 1 Diabetes (n=2,440) Tertiles of DASH score				Type 2 Diabetes (n=390) Tertiles of DASH score			
Characteristic	**Total (n=2,830)**	**1 (lowest)**	**2**	**3 (highest)**	**p***	**1 (lowest)**	**2**	**3 (highest)**	**p***
SBP (mmHg)	107.7 ± 11.7	106.6 ± 11.2	105.7 ± 10.9	106.6 ± 10.6	0.1	118.1 ± 12.5	116.3 ± 12.2	115.0 ± 14.0	0.1
DBP (mmHg)	68.3 ± 10.0	68.2 ± 9.7	67.2 ± 9.7	67.2 ± 9.7	0.04	73.9 ± 10.9	72.6 ± 10.4	72.2 ± 10.0	0.4
Hypertension									
Elevated BP (%)†	6.4	5.7	4.4	3.1	0.04	20.8	18.5	16.9	0.7
BP medication (%)	4.1	3.9	2.2	2.1	0.04	15.4	10.0	13.1	0.4
Elevated BP and/or BP medication (%)	9.8	9.0	6.4	5.2	0.01	31.5	26.2	26.9	0.6

BP, blood pressure; SBP/DBP, systolic/diastolic blood pressure. Numbers are frequencies, or means ± SD.

* χ^2-test for categorical, ANOVA for continuous variables.

† SBP and/or DBP≥95th percentile[4].

Table 5.

Odds Ratios (95% confidence intervals) for hypertension according to diabetes type and DASH adherence.

	Type 1 Diabetes (n=2,440) Tertiles of DASH score				Type 2 Diabetes (n=390) Tertiles of DASH score			
Model	**1 (lowest)**	**2**	**3 (highest)**	p_{trend}	**1 (lowest)**	**2**	**3 (highest)**	p_{trend}
Crude	1.00	0.69 (0.48; 1.00)	0.55 (0.37; 0.82)	0.003	1.00	0.77 (0.45; 1.32)	0.80 (0.47; 1.37)	0.4
Model 1 *	1.00	0.71 (0.49; 1.04)	0.57 (0.38; 0.85)	0.006	1.00	0.81 (0.46; 1.42)	0.87 (0.49; 1.57)	0.6
Model 2 †	1.00	0.71 (0.49; 1.04)	0.56 (0.37; 0.84)	0.005	1.00	0.81 (0.46; 1.42)	0.87 (0.49; 1.57)	0.6
Model 3 ‡	1.00	0.70 (0.48; 1.03)	0.57 (0.38; 0.85)	0.006	1.00	0.97 (0.54; 1.75)	0.98 (0.53; 1.81)	0.9

* Adjusted for sex, age, study center, race/ethnicity, diabetes duration, family history of high blood pressure, vigorous physical activity (<5 days/week yes/no).

† Model 1+energy intake.

‡ Model 2+BMI standard deviation score (BMI-SDS).