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Correlates of Dietary Intake in Youth with Diabetes: Results from the SEARCH for Diabetes in Youth Study

Andrey Bortsov, M.D.[1], **Angela D Liese, PhD, MPH**[1,2], **Ronny A Bell, PhD**[3], **Dana Dabelea, M.D., PhD**[4], **Ralph B D'Agostino Jr., PhD**[5], **Richard F Hamman, M.D., DrPH**[4], **Georgeanna J Klingensmith, M.D.**[4,6], **Jean M Lawrence, PhD**[7], **David M Maahs, M.D.**[4,6], **Robert McKeown, PhD**[1], **Santica M Marcovina, PhD, ScD**[8], **Joan Thomas, MS**[1,2], and **Elizabeth J Mayer-Davis, PhD**[1,9]

[1] Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA 29208

[2] Center for Research in Nutrition and Health Disparities, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA 29208

[3] Department of Epidemiology and Prevention, Wake Forest University School of Medicine, Winston-Salem, NC, USA 27157

[4] University of Colorado Health Sciences Center, Denver, CO, USA 80262

[5] Department of Biostatistical Sciences, Wake Forest University School of Medicine, Winston-Salem, NC, USA 27157

[6] University of Colorado Barbara Davis Center, Denver, CO, USA 80262

[7] Department of Research & Evaluation, Kaiser Permanente Southern California, Pasadena, CA, USA 91101

[8] Northwest Lipid Research Laboratories, Department of Medicine, University of Washington, Seattle, WA, USA 98109

[9] Department of Nutrition, University of North Carolina, Chapel Hill, NC, USA 27599

INTRODUCTION

Dietary behavior is among the important modifiable patient-associated factors for optimizing health among youth with diabetes. It is also well established that youth with either type 1 diabetes (T1DM) or with type 2 diabetes (T2DM) have increased risk for cardiovascular complications later in life.[1] The joint American Heart Association (AHA)/ American Diabetes Association (ADA) Scientific Statement emphasizes the importance of weight management, medical nutrition therapy and physical activity in prevention of cardiovascular disease in people with diabetes.[2] The statement also explicitly indicates that all of the recommendations for patients with T2DM appear appropriate for individuals with T1DM as well.

Corresponding author: Angela D Liese, PhD, MPH, FAHA, Department of Epidemiology and Biostatistics Arnold School of Public Health, University of South Carolina, 800 Sumter Street, Columbia, SC 29208, Phone: 803-777-9414, Fax: 803-777-2504, Liese@sc.edu.

Medical nutrition therapy principles and recommendations for people with diabetes released by the ADA stress the importance of sufficient intake of certain foods and nutrients, such as whole grains, fruits, vegetables, and low-fat milk and lower consumption of others, including saturated fats.[3] However, a large proportion of youth with diabetes do not follow the nutrition recommendations.[4] Unhealthy diet may contribute to increased risk of other cardiovascular risk factors or complications in these patients.[5] Detailed exploration of factors associated with unhealthy diet in youth with diabetes is needed.

The objective of this study is to explore demographic, socio-economic, diabetes-related and behavioral correlates of dietary intake of dairy, fruits, vegetables, sweetened soda, fiber, calcium, and saturated fat in youth with T1DM and T2DM using data from the SEARCH for Diabetes in Youth Study.

METHODS

The SEARCH study is an ongoing multi-center study based on ascertainment of cases of physician-diagnosed diabetes mellitus in youth younger than age 20 years beginning in 2001 and continuing through the present. SEARCH has six centers, located in Ohio, Colorado, Washington, South Carolina, Hawaii, and California. Diabetes cases were also identified among three American Indian populations in Arizona and Colorado and among members of the Gila River Pima Indian community participating in the National Institute of Diabetes and Digestive and Kidney Diseases Pima Indian Diabetes Study. A detailed description of the SEARCH study was published elsewhere.[6] The study was reviewed and approved by the local Institutional Review Boards at each center. Parents of participants under age 18 years at the time of data collection provided informed consent and minor participants assented; all participants aged 18 years or older provided signed informed consent.

The SEARCH food frequency questionnaire (FFQ) has been described in detail previously.[4] The FFQ consisted of 85 food lines for which the participant indicated if the item(s) was/were consumed in the past week (“yes/no”) and if yes, how many days, and the average portion size. The food groups were created by either collapsing food lines based on their major components, or by disaggregating composite foods into constituent foods. The FFQ was self-administered by study participants age 10 years or older after careful instruction by study staff. A small percentage (7%) of FFQs were interviewer-administered because of participant difficulties in form completion.

The nutrient and portion-size databases for this instrument were modified from the respective Diabetes Prevention Program databases, using the Nutrition Data System for Research (database 3 version 4.05/33, 2002, Nutrition Coordinating Center, University of Minnesota, Minneapolis) and industry sources. This analysis focused on dairy, fruits, vegetables, sweetened soda, total fiber, calcium, and percent of calories from saturated fat. This selection was based on the components’ likely influence on metabolic status and on the development of complications associated with diabetes.

Race and ethnicity were obtained through self-report using the standard census questions.[7] Highest parental education was based on the parent with the highest education as reported on a questionnaire. Household income was assessed through self-report in predetermined categories. Type of diabetes was based on the clinical diagnosis by the physician. Diabetes treatment mode, diabetes duration, diabetes-related self-care, weight management and parental education on healthy food choices were included in the analysis as probable correlates of dietary adherence. Diabetes-related self-care was assessed by the question “How much of your own diabetes care do you do for yourself?” with answers categorized as “none”, “less than 25%”, “25–75%”, “more than 75%” and “all”. Diabetes education was

assessed by the question to the parent “Have you been taught about how to make healthy food choices?” Weight management and physical activity were assessed by questions developed for the Youth Risk Behavior Surveillance System (YRBSS).[8] Weight management goal was assessed with a question “Which of the following are you trying to do about your weight?” with possible answers “not trying to do anything”, “trying to lose”, “trying to gain”, and “trying to stay the same weight”. Physical activity was assessed by the question: “On how many of the past 7 days did you exercise or participate in a physical activity for at least 20 minutes that made you sweat and breathe hard?” Sedentary behavior was assessed by a slightly modified YRBSS question “On each weekday, about how much do you usually spend watching TV?”

This analysis included youth whose diabetes was prevalent in 2001 or incident in 2002–2005 who participated in the SEARCH examination. Of the 11,437 registered, valid subjects, 8,338 youth (73%) were contacted by phone and had an initial patient survey; of these, 5,293 youth (63%) attended the SEARCH clinic visit; 3,074 of whom were age-eligible (10 years and older at the study visit) and completed the dietary assessment. Among these youth, we excluded those with provider-defined diabetes type other than type 1 and type 2 or with type missing (n=27); diabetes duration less than 6 months (n=369); race/ethnicity other than non-Hispanic white, African American, Hispanic, Asian/Pacific Islander, or Native American (n=12); and those who reported eating much more or much less in the week when food intake was assessed than their typical week (n=154). A total of 533 observations were excluded from the analysis due to one or more criteria listed above; data from 2,541 youth were included in these analyses.

Analyses were conducted using the SAS (version 9.1, 2003, SAS Institute Inc, Cary, NC). Across subgroups of demographic, socio-economic, behavioral and diabetes-related variables, the medians of intake were compared by means of quantile regression.[9] We also explored the overall significance of the association for covariates with more than 2 levels or categories (i.e. race/ethnicity, income, diabetes-related self-management and weight management) with Wald test. Due to the number of statistical tests conducted, alpha=.01 was used to determine statistical significance.

RESULTS

Of the 2,541 youth, 2,176 had T1DM and 365 had T2DM (Table 1). As compared to youth with T1DM, those with T2DM were older, more likely to be females, and more likely to be from a minority racial/ethnic group (Asian Pacific Islanders, African Americans, Hispanic, and Native Americans). Median intake for selected food groups and nutrients, as well as lower and upper quartiles, is presented by diabetes type (Table 2). All estimates of dietary intake presented in Tables 2 to 4 are per 1000 kcal of total energy intake.

Among youth with T1DM, older participants had lower dairy and calcium intake and higher soda intake in comparison to younger youth (Table 3). Males had lower consumption of vegetables, fruits, and fiber, and higher consumption of soda and saturated fat than females. In comparison to non-Hispanic whites, African Americans had lower dairy and calcium intake and higher soda intake (Table 3).

Among the youth with T2DM, participants age 15 years and older had higher soda intake than the younger ones. The median consumption of dairy and calories from saturated fat by Native Americans was lower than intake by non-Hispanic whites. On the other hand, vegetable, total fiber and soda intake was higher in Native Americans than in whites. Hispanics also consumed more fiber than non-Hispanic whites. Calcium intake was highest in Hispanics and lowest in Asian/Pacific Islanders (p=0.03).

As shown in Table 4, after adjustment for age, gender and race/ethnicity, among youth with T1DM, lower parental education was significantly associated with lower fruit intake. Youth from low income families consumed less calcium than youth from high income families. Among youth with T2DM, family income was associated with sweetened soda and vegetable intake. Soda consumption was higher in youth from medium-income families (household income $25,000–$74,999) as compared to high-income families ($75,000 and greater), whereas vegetable consumption was highest in high-income families and lowest in medium-income families.

Diabetes-related self-management, weight control efforts and parent education about healthy food choices were significant correlates for food and nutrient intake in youth with T1DM after adjustment for age, gender and race/ethnicity (Table 4). Youth with less self-management had higher fruit intake and lower saturated fat intake. Lower vegetable intake was associated with parental education about healthy food choices. Those youth who were trying to gain weight had lower vegetable intake as contrasted to those who tried to lose weight ($p<0.01$).

Among youth with T1DM, watching television for ≥ 2 hours every weekday was associated with lower fruit and total fiber intake (Table 4). On the other hand, fruit intake was higher among youth who were involved in rigorous physical activity 3 days per week or more as compared to those who had less rigorous physical activity. In the T2DM group, rigorous physical activity was associated with higher calcium intake (Table 4)

DISCUSSION

The ADA recommends inclusion of whole grains, fruits, vegetables, and low-fat milk in a healthy diet and discourages excessive intake of saturated fats.[3] We have previously shown that a significant proportion of youth with diabetes does not meet AHA/ADA recommendations.[4] In this study we explored the correlates of selected food and nutrient intake among these youth.

Gender differences in diet found in youth with T1DM include higher intake of vegetables, fruits, and total fiber by females, and higher intake of soda and percent of calories from saturated fat by males. In this study, females had a healthier diet at least with respect to the foods and nutrients included in this analysis, which may be associated with the higher prevalence of dieting among female than male adolescents. Forty percent of females with T1DM reported that they were trying to lose weight as compared with 21% of males. Among youth with T2DM, 82% of females and 73% of males reported that they were trying to lose weight. Higher prevalence of healthful dieting among females with T1DM than in males with T1DM may explain the observed differences in dietary intake between males and females. Increased prevalence of overweight among T1DM and T2DM found in the recent study may contribute to the dieting behavior in these youth. [10]

Among racial/ethnic groups, non-Hispanic white youth seem to eat the healthiest diet, regardless of diabetes type. They consumed more dairy, calcium and less sweetened soda than African American youth. Higher calcium and dairy intake in whites as compared to other race/ethnicity groups was reported by Xie et al.[11] Consistent with the results of these analyses, Storey et al[12] and Xie et al[11] both found that family income had a positive association with calcium and dairy consumption among adolescents. Moreover, we observed an association of income with soda intake in T2DM youth, which is similar with the data presented by Xie et al[11] for added sugar.

Watching television more than 2 hours per day was associated with a poorer diet – less fruits and fiber. Using YRBSS data, Pate et al[13] reported that, among high school students,

watching television was associated with low levels of physical activity. Furthermore, low activity was associated with eating less fruits and vegetables. Wilson et al[14] found that both low exercise frequency and decreased consumption of vegetables and milk/dairy products by high school students was associated with smoking. Lowry et al[15] found that trying to lose weight was associated with increased fruit and vegetable consumption in adolescent males. To summarize, diet, physical activity, and other lifestyle and behavioral factors represent complex set of interconnected variables affecting the health of youth with diabetes.

Besides the strengths of the SEARCH study which include among others large sample size and diverse populations, our study has some limitations. The cross-sectional study design, though adequate for exploratory association studies, does not allow any causal inferences. Lack of precision in diet measurement may have had an impact on the results of the study. Food frequency questionnaire usually tends to underestimate the actual intake.[16] Moreover, random error in diet estimates may result in insufficient power to detect small differences between groups. We also found that participation in the SEARCH baseline study visit declined with increasing age. Non-participants to the in-person research visits may differ in terms of diet structure from those who actively collaborate with study personnel. Specifically, the latter may have a healthier diet in comparison to those who refused to participate in the study. Groups with low socio-economic status may be underrepresented in our sample. All these probably affect absolute estimates of intake, but are unlikely to substantially influence the associations found in the analysis.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study has several potential clinical and research implications. Recent nutritional management guidelines for youth with diabetes provide comprehensive recommendations on dietary treatment.[17] Data provided by our study may help dietitians to focus on groups of youth with diabetes who have lower adherence to a healthy diet. Youth with diabetes who adhere poorly to dietary guidelines are more likely to be minority male adolescents aged fifteen and above with low level of parental education and low or middle family income; low parental involvement in diabetes management; and a sedentary lifestyle; all of which are additional risk factors for inadequate diet. Therefore, diet counseling groups may be tailored according to these major determinants of diet behavior among youth with diabetes.

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Table 1

Baseline characteristics of the study population

	Type 1 diabetes		Type 2 diabetes	
	N=2176	%	N=365	%
AGE				
10–14 years	1191	54.7	114	31.2
15 years or older	985	45.3	251	68.8
GENDER				
Females	1092	50.2	239	65.5
Males	1084	49.8	126	34.5
RACE/ETHNICITY				
Asian/Pacific islander	74	3.4	35	9.6
African American	169	7.8	133	36.4
Hispanic	251	11.5	73	20.0
Native American	16	0.7	59	16.2
Non-Hispanic white	1666	76.6	65	17.8
PARENT EDUCATION				
More than high school	1725	79.6	184	50.4
High school graduate or less	441	20.4	181	49.6
INCOME [a]				
$75,000 or more	862	43.5	33	11.0
$25,000 to $74,999	873	44.1	131	43.7
Less than $25,000	246	12.4	136	45.3
DIABETES SELF-CARE				
100%	744	34.2	177	48.5
>75%	736	33.8	68	18.6
<75%	696	32.0	120	32.9
WEIGHT CONTROL EFFORTS				
Not trying to alter weight	606	28.2	25	7.0
Trying to gain weight	207	9.6	12	3.4
Trying to lose weight	661	30.7	280	78.6
Trying to maintain weight	677	31.5	39	11.0
PARENT TAUGHT ABOUT HEALTHY FOOD CHOICES				
No	307	14.1	109	29.9
Yes	1869	85.9	256	70.1
TIME WATCHING TELEVISION				
Less than 2 hours/day	971	45.2	91	25.4
2 hours/day or more	1177	54.8	267	74.6
PHYSICAL ACTIVITY				
2 days/week or less	852	39.1	180	49.3
3 days/week or more	1324	60.9	185	50.7
WEIGHT, kg				

	Type 1 diabetes		Type 2 diabetes	
	N=2176	**%**	**N=365**	**%**
Mean (Standard deviation)	60(17)		97(30)	

[a]Missing values constituted >5% of the sample

Table 2

Baseline intake of selected foods and nutrients by diabetes type (per 1000 kcal)

	Quartile	Dairy, servings/week	Vegetables, servings/week	Fruits, servings/week	Soda, servings/week	Total fiber, g/day	Calcium, mg/day	% calories from saturated fat	Total calories per day
Type 1 diabetes	25th percentile	4	3	2	0	5.5	406	12.1	1356
	Median	6½	5½	4	0	6.7	587	13.7	1752
	75th percentile	9½	8½	6½	2	8.3	778	15.2	2342
Type 2 diabetes	25th percentile	2½	4	2	0	5.5	285	11.6	1201
	Median	4½	6½	4½	1½	6.6	392	13.4	1617
	75th percentile	7½	10	7	5	8.3	565	15.2	2301

Table 3

Median intake of selected foods and nutrients by demographic groups and diabetes type (per 1000 kcal)

	Type 1 Diabetes							Type 2 Diabetes						
	Dairy, servings/week	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium, mg/day**	**% calories from saturated fat**	**Dairy, servings/week**	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium, mg/day**	**% calories from saturated fat**
AGE														
10–14 years [a]	7½	5½	4	0	6.7	606	13.5	5½	5½	4	½	6.8	387	13.8
15 years or older	**6***	5½	4	**½***	6.7	**555***	13.8	4	6½	4½	**2½***	6.6	398	13.3
GENDER														
Female [a]	6½	6	4½	0	7.0	577	13.4	4	6½	4½	1½	6.7	406	13.5
Male	6½	**5***	**3½***	**½***	**6.4***	594	**13.9***	4½	6	3½	2	6.5	383	13.2
RACE/ETHNICITY														
Asian/Pacific islanders	6	6	4	½	6.7	504	13.3	5	5½	4 ½	1½	6.3	326	13.0
African American	**4***	6	4	**1***	6.5	**461***	14.2	4	6½	4½	2	6.3	374	13.4
Hispanic	6½	5	4	0	7.2	604	13.6	5½	6	4½	1	**7.7***	464	13.3
Native American	4½	4½	4½	2½	7.4	434	12.0	**2½***	**8***	5	**3½***	**7.6***	338	**12.8***
Non-Hispanic white [a]	7	5½	4	0	6.7	596	13.7	6	5	4	½	6.2	423	14.3
Overall p-value [b]	*<0.01*	*n/s*	*n/s*	*<0.01*	*n/s*	*<0.01*	*n/s*	*<0.01*	*0.03*	*n/s*	*<0.01*	*<0.01*	*0.03*	*n/s*

[a] Reference level;

[b] Wald test; 'n/s' denotes p≥0.05;

* p<0.01

Table 4

Median intake of selected foods and nutrients by socio-economic status, behavioral correlates and diabetes type (per 1000 kcal)

	Type 1 Diabetes							Type 2 Diabetes						
	Dairy, servings/week	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium, mg/day**	**% calories from saturated fat**	**Dairy, servings/week**	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium,M mg/day**	**% calories from saturated fat**
PARENT EDUCATION LEVEL														
High school graduate or less	6	5	**3½***	½	6.6	585	13.8	4½	6½	4	2	6.7	384	13.3
More than high school [a]	6½	5½	4	0	6.8	588	13.6	4½	6½	4½	1	6.6	403	13.4
FAMILY INCOME														
Less than $25,000	6	5½	4½	½	6.7	**515***	13.9	4½	6½	4	1	6.6	402	13.5
$25,000–$74,999	**6***	5	4	0	6.6	579	13.6	5 ½	**5 ½***	4 ½	**3***	6.5	374	13.3
$75,000 or more [a]	7	5½	4½	0	6.8	613	13.6	3½	8	3½	0	7.2	478	13.8
Overall p-value [b]	*<0.01*	*n/s*	*n/s*	*n/s*	*n/s*	*<0.01*	*n/s*	*n/s*	*0.02*	*n/s*	*<0.01*	*n/s*	*n/s*	*n/s*
DIABETES-RELATED SELF MANAGEMENT														
<75%	7	5½	**4½***	0	6.8	600	**13.3***	4½	5½	4½	1½	6.5	391	13.0
>75%	7	5½	4	0	6.6	593	13.7	4	6	5	1	6.7	342	13.7
100% [a]	6	5½	3½	0	6.8	562	13.9	4½	7	4	2	6.7	408	13.3
Overall p-value [b]	*n/s*	*n/s*	*<0.01*	*n/s*	*n/s*	*n/s*	*<0.01*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*
WEIGHT CONTROL EFFORTS														
Trying to gain weight	6	4½	4	½	6.2	587	13.9	4½	5½	3½	3	6.9	456	13.7
Trying to lose weight	6½	6	4	½	6.8	587	13.7	4½	6½	4½	1½	6.6	398	13.3
Trying to maintain weight	7	5½	4½	0	6.9	578	13.4	4	6	4½	1	6.8	414	13.0
Not trying to alter weight [a]	6½	5	3½	0	6.5	607	13.9	4	6	3½	4	6.6	345	13.3
Overall p-value [b]	*n/s*	*<0.01*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*
PARENT EDUCATED ABOUT HEALTHY FOOD CHOICES														
No	6	**6***	3½	½	7.0	576	13.8	3½	7½	4½	2½	6.5	345	13.3
Yes [a]	7	5½	4	0	6.7	590	13.7	5	6	4	1½	6.8	407	13.4
WATCHING TV ON WEEKDAYS														
Less than 2 hours/day [a]	7	5½	4½	0	7.1	610	13.5	4	6½	4	1½	6.8	398	13.3

	Type 1 Diabetes							Type 2 Diabetes						
	Dairy, servings/week	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium, mg/day**	**% calories from saturated fat**	**Dairy, servings/week**	**Vegetables, servings/week**	**Fruits, servings/week**	**Soda, servings/week**	**Total fiber, g/day**	**Calcium,M mg/day**	**% calories from saturated fat**
2 hours/day or more	6½	5	**3½***	½	**6.5***	575	13.8	4½	6½	4½	1½	6.6	389	13.3
PHYSICAL ACTIVITY														
3 days/week or more	6½	5½	**4½***	½	6.8	590	13.7	5	7	4½	1½	6.9	**426***	13.2
2 days/week or less[a]	6½	5½	3½	0	6.6	585	13.6	4	6	4	1½	6.4	359	13.4

[a] Reference level;

[b] Wald test; 'n/s' denotes p≥0.05;

* p<0.01, adjusted for age, gender and race/ethnicity