

Disordered Eating Behaviors Are Associated with Poorer Diet Quality in Adolescents with Type 1 Diabetes

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ABSTRACT

Disordered eating behaviors may pose a risk for poor long-term health outcomes in patients with type 1 diabetes. This cross-sectional study examined associations of disordered eating behaviors with diet quality, diet-related attitudes, and diabetes management in adolescents with type 1 diabetes (N=151, 48% female). Participants, recruited July 2008 through February 2009, completed 3-day diet records and survey measures, including the Diabetes Eating Problem Survey (DEPS) and measures of eating-related attitudes. Biomedical data were obtained from medical records. Participants scoring more than 1 standard deviation above the mean DEPS were classified as at risk for disordered eating. The Healthy Eating Index-2005 was calculated to assess diet quality. Analysis of covariance was used to test for differences between risk groups in diet quality, eating attitudes, and diabetes management, controlling for age, sex, and body mass index (BMI) percentile. Youth at risk for disordered eating were more likely to be overweight/obese than those at low risk (59.1% vs 31.8%, $P=0.01$). The at-risk group had poorer diet quality ($P=0.003$) as well as higher intake of total fat ($P=0.01$) and saturated fat ($P=0.007$) compared with the low-risk group. The at-risk group reported lower self-efficacy ($P=0.005$), greater barriers ($P<0.001$), and more negative outcome expectations ($P<0.001$) for healthful eating, as well as worse dietary satisfaction ($P=0.004$). The at-risk group had lower diabetes adherence ($P<0.01$), less-frequent blood glucose monitoring ($P<0.002$), and higher hemoglobin A1c ($P<0.001$). The constellation of excess weight, poorer dietary intake, and poorer diabetes management associated with youth at risk for disordered eating suggests potential risk of future poor health outcomes. Attention should be given to healthful weight management, especially among overweight youth with type 1 diabetes.

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DISORDERED EATING BEHAVIORS ARE AN important health issue among youth with type 1 diabetes because of their prevalence¹ and adverse impact on glycemic control and long-term health outcomes.² Individuals with type 1 diabetes may be at greater risk for the development of disordered eating due to an emphasis on nutrition management in diabetes care. Adolescent girls with type 1 diabetes have been found to be 2.4 times more likely to have a diagnosed eating disorder than are adolescents without diabetes.³ Disordered eating behaviors are defined as problematic eating patterns that are not practiced at a high enough frequency or severity to merit the formal diagnosis of an eating disorder. These include excessive dieting for weight loss; binge-eating; calorie purging through self-induced vomiting, laxative, or diuretic use; excessive exercise; and, in insulin-treated patients, intentional insulin restriction.⁴ In type 1 diabetes, skipping or taking less insulin may be used more often to control weight than diet pills, laxatives, diuretics, and vomiting.^{2,3} Among young women with type 1 diabetes, ages 12 to 21 years, 10.3% reported skipping insulin and 7.4% reported taking less insulin specifically for weight management, compared with 1.4% of males who reported either behavior. Disordered eating behaviors often persist and become more serious over time, especially

as weight concerns and dietary restraint increase during young adulthood.⁵

Concern about weight is known to be a risk factor for the development of disordered eating. In a cross-sectional study of adolescent girls with type 1 diabetes, those who reported ever being overweight also reported more disordered eating behaviors.⁶ In a 5-year longitudinal study of adolescent girls with type 1 diabetes, weight concerns significantly predicted the onset of disordered eating behaviors,⁷ and an 11-year study of adult women with type 1 diabetes showed that greater fear of weight gain was associated with higher risk of insulin restriction.⁸ The epidemic of childhood overweight and obesity has not spared youth with type 1 diabetes, with rates of overweight and obesity similar to the general population.⁹ Research early in the advent of intensive insulin therapy found weight gain to be associated with regimen intensification,¹⁰⁻¹² although the extent to which these findings apply to contemporary insulin therapy is not known.

Although disordered eating behaviors are known to be associated with poorer glycemic control,² it is not known whether disordered eating is associated with diet quality among youth with type 1 diabetes. Similar to the US popula-

tion, youth with type 1 diabetes are not meeting dietary recommendations.¹³ Further, diets high in saturated fat and lower in carbohydrate are associated with worse glycemic control and a higher risk of long-term complications.¹⁴ If disordered eating is associated with poorer diet quality, this may represent an additional pathway by which these youth are at high risk for complications, including weight problems, lipid abnormalities, and hypertension.¹⁵ Therefore, the purpose of the present study is to expand current knowledge about disordered eating behaviors in adolescents with type 1 diabetes by examining the relationship of disordered eating behaviors with dietary intake and attitudes toward healthful eating.

METHODS

Study Population and Design

Participants were part of a larger cross-sectional study conducted at a pediatric diabetes center in Boston, MA, from July 2008 through February 2009. The entire study included youth who were 8 to 18 years old, although the current investigation was limited to those 13 years old and older. All were diagnosed with type 1 diabetes for 1 year or more, had daily insulin dose of at least 0.5 U/kg, and had no other major chronic illness in general and no gastrointestinal illnesses in particular. Eligible patients were recruited to participate during routine clinic appointments. Parents and children provided informed consent and assent, respectively. Participants completed survey measures at the time of the clinic visit; 3-day diet records were completed by families after the clinic visit. The Joslin Diabetes Center Institutional Review Board approved the study. Of 455 eligible families, 302 (66.4%) enrolled in the study. When multiple siblings participated, data from only the sibling with the longest diabetes duration were retained, resulting in elimination of 11 subjects. Of the remaining 291 subjects, only youth age 13 years or older ($n=151$) completed the measure of disordered eating. Dietary data were available for 134 of these youth. There were no significant differences in disordered eating behaviors score, hemoglobin A1c (HbA1c), or body mass index (BMI) percentile between participants ages 13 years or older who completed diet records and those who did not.

Measures

Disordered eating. The Diabetes Eating Problem Survey (DEPS) was used to assess risk of disordered eating behaviors. This diabetes-specific measure includes items specific to this population, such as "I like to have ketones in my urine because that means that I am burning fat" or "I try to keep my blood sugar high so that I will lose weight." The 28 items are scored on a 6-point Likert scale ranging from "never" to "always." The DEPS has demonstrated good psychometric properties and was strongly correlated with more general measures of disordered eating in a sample of insulin-treated patients age 18 years old or older.¹⁵ Because the DEPS was originally developed in an adult sample with no formal cutoff value for youth, the cutoff used to classify participants in this study was based on the sample distribution. Participants with scores greater than 1 standard deviation above the mean were classified as "at risk" for disordered eating; participants whose scores were less than or equal to 1 standard deviation were classified as "low risk" for disordered eating.

Dietary intake. Dietary intake was measured using 3-day dietary records. Participants received detailed instructions on how to measure and report food and beverage consumption and were given a sample diet record. Families were instructed to keep records on 3 consecutive days in 1 week, including 2 weekdays and 1 weekend day; to use measuring utensils at home, or if away from home, to provide their best estimate of portion size; and to provide all specific details for each food item, including names of brands or restaurants and specific item-labeling (eg, low-fat, 1% milk). Dietary records were analyzed using Nutrition Data System for Research software (NDS-R, Nutrition Coordinating Center, University of Minnesota). The Healthy Eating Index-2005 (HEI-2005) was calculated as a measure of diet quality.¹⁶ Total HEI-2005 score ranges from 0 to 100 and is derived as a sum of 12 component scores: total fruit (including 100% juice); whole fruit (not juice); total vegetables; dark green and orange vegetables and legumes; total grains; whole grains; milk; meat and beans; oils; saturated fat; sodium; and percentage energy from solid fats, alcoholic beverages, and added sugars. Higher scores represent greater conformance to dietary guidelines, with a total score of 100 indicating full compliance to the 2005 Dietary Guidelines for Americans.

Eating-related attitudes. Attitudes toward healthful eating were assessed by the Healthful Eating Attitudes Scale, which includes measures of self-efficacy, barriers, and positive and negative outcome expectations (desired and undesired consequences) regarding healthful eating. The measures have demonstrated good psychometric properties and associations with dietary intake.¹⁷ Participants also completed a five-item measure of dietary satisfaction developed by the investigators; example items include "I enjoy my food" and "I feel full enough after eating my meals." Scores on all measures range from 1 to 5, with higher scores indicating greater endorsement of the construct.

Diabetes management adherence. Adherence to diabetes management was assessed using the Diabetes Management Questionnaire, a 20-item self-report measure. Scores range from 0 to 100; higher scores indicate greater adherence. The measure has shown good psychometric properties and associations with HbA1c and other relevant diabetes management behaviors.¹⁸

Biomedical data. Biomedical data, including glycated hemoglobin (HbA1c), height, and weight, were abstracted from the medical record. BMI was calculated and compared to the Centers for Disease Control and Prevention 2000 reference standards to determine BMI percentiles according to age and sex; those at or above the 85th percentile were classified as overweight/obese.¹⁹

Data Analysis

Differences between the disordered eating risk groups on demographic and clinical characteristics were examined using χ^2 for categorical variables and t tests for continuous variables. Differences among the disordered eating groups on dietary intake, eating attitudes, and diabetes management were analyzed using analysis of variance, with age, sex, and BMI percentile as covariates. Analyses were conducted using Sta-

Table 1. Demographic and clinical characteristics of the sample of youth with type 1 diabetes and comparison between low-risk and at-risk disordered eating risk groups

	Total sample (n=151)	Low risk (n=129)	At risk (n=22)	P value ^a
Age (y) (mean±SD ^b)	15.6±1.5	15.5±1.5	16.0±1.3	0.10
Diabetes duration (y) (mean±SD)	7.7±3.6	7.6±3.7	8.1±3.3	0.57
Sex (%)				
Male	51.7	54.3	34.6	0.12
Female	48.3	45.7	63.6	
Weight Status (%)				
Normal/underweight	64.2	68.2	40.9	0.01
Overweight/obese	35.8	31.8	59.1	
Insulin Regimen (%)				
Injections	35.1	34.9	36.4	0.89
Pump	64.9	65.1	63.6	

^at Test for continuous variables, χ^2 for categorical variables.

^bSD=standard deviation.

tistical Package for the Social Sciences software (SPSS version 17.0 for Windows, 2008, SPSS Inc).

RESULTS AND DISCUSSION

Participant characteristics by disordered eating risk group are shown in Table 1. The mean DEPS score was 24.9±14.0; those with scores ≥ 39 were considered at risk. Risk group classification was not significantly associated with age, sex, duration of diabetes, or insulin regimen. A greater percentage of those in the at-risk group were classified as overweight/obese compared with those in the low-risk group (59.1% vs 31.8%, $P=0.01$).

Associations of disordered eating risk group with dietary intake are shown in Table 2. The overall diet quality of the at-risk group was significantly poorer than the low-risk group (HEI score 45.9 vs 53.7, $P=0.003$). There were no significant differences between the groups in total energy intake or distribution of energy intake from carbohydrates or protein, but the at-risk group had a higher percentage of energy intake from total fat (38.2% vs 34.4%, $P=0.01$) and saturated fat (14.0 vs 12.2, $P=0.007$) than did the low-risk group. Analysis of HEI-2005 component scores indicated that the lower HEI-2005 total score among the at-risk group was primarily attributable to lower whole-grain intake ($P=0.01$), greater saturated fat intake ($P=0.02$), and greater intake of solid fats and added sugars ($P=0.02$).

Risk for disordered eating was also associated with poorer attitudes toward healthful eating (Table 2). Compared to the low-risk group, the at-risk group reported lower self-efficacy (3.5 vs 3.9, $P=0.005$), greater barriers (2.4 vs 1.9, $P<0.001$), and greater negative outcome expectations for healthful eating (2.9 vs 2.1, $P<0.001$), as well as lower dietary satisfaction (3.9 vs 4.3, $P=0.004$).

Youth at risk for disordered eating showed poorer diabetes management (Table 2). Compared with the low-risk group, the at-risk group reported poorer adherence (both parent, $P<0.002$, and youth, $P<0.001$, report), monitored their blood

glucose less frequently (3.2 vs 4.7 times/day, $P=0.002$), and had higher HbA1c (10.1% vs 8.6%, $P<0.001$).

Diet quality among youth at risk for disordered eating was significantly worse than youth at lower risk, controlling for BMI percentile. In particular, youth at risk for disordered eating showed higher intake of total and saturated fat, suggesting greater intake of energy-dense, nutrient-poor foods. These findings suggest that youth with type 1 diabetes who are overweight/obese may be more likely to resort to disordered eating behaviors in efforts to lose weight or, alternatively, youth at risk for disordered eating may be more likely to engage in unhealthy eating, leading to excess weight gain. The former is consistent with previous research suggesting that youth who are overweight are at greater risk for engaging in unhealthy methods of weight control.⁶ The latter possibility is supported by longitudinal research in the general population showing that unhealthy weight control behaviors during adolescence are associated with subsequent weight gain.²⁰ If the former is true, it may be important to assist overweight youth with type 1 diabetes to find healthful strategies for weight management to reduce their risk of disordered eating. Youth at risk for disordered eating also demonstrated poorer adherence to diabetes management and worse glycemic control, suggesting a constellation of poor self-care behaviors, potentially increasing the risk for poor long-term health outcomes.

Previous research has indicated that youth with diabetes tend to have lower carbohydrate intake and higher total and saturated fat intake than youth without diabetes.²¹⁻²³ Qualitative research suggests this is likely related to the perception that foods low in carbohydrate are better for diabetes management.^{13,24,25} Beliefs regarding foods that assist with diabetes management or weight control specifically among youth at risk for disordered eating are not known. Future research to determine perceptions about food as it relates to diabetes control and weight management would be useful in shaping intervention

Table 2. Comparison of mean dietary intake, diet-related attitudes, and diabetes management between youth with type 1 diabetes in low-risk and at-risk disordered eating risk groups

	Adjusted Mean ^a		P value
	Low risk	At risk	
Diet Quality			
Healthy Eating Index-2005 ^b	53.7	45.9	0.003
Macronutrients			
Energy intake (kcal)	2,029.5	2,127.0	0.48
Energy from fat (%)	34.4	38.2	0.01
Energy from carbohydrate (%)	49.0	46.3	0.11
Energy from protein (%)	16.6	15.5	0.15
Energy from saturated fat (%)	12.2	14.0	0.007
Diet-related attitudes			
Self-efficacy ^c	3.9	3.5	0.005
Barriers ^c	1.9	2.4	<0.001
Positive outcome expectations ^c	3.6	3.7	0.46
Negative outcome expectations ^c	2.1	2.9	<0.001
Dietary satisfaction ^d	4.3	3.9	0.004
Diabetes management			
Adherence, child report ^e	76.2	65.4	<0.001
Adherence, parent report ^e	77.0	69.1	0.002
Frequency (per day) of blood glucose monitoring	4.7	3.2	0.002
Hemoglobin A1c (%)	8.6	10.1	<0.001

^aAnalysis of variance controlling for age, sex, and body mass index percentile; n=115 low risk and 19 at risk for analysis of dietary intake, 129 low risk and 22 at risk for analysis of all other variables.

^bHEI ranges from 0-100, with higher scores reflecting greater adherence to the 2005 Dietary Guidelines for Americans.

^cMean of responses on 5-point scale ranging from "strongly disagree" to "strongly agree."

^dMean of responses on 5-point scale ranging from "almost never" to "almost always."

^eAdherence measure ranges from 0-100, with higher scores reflecting greater adherence.

approaches to prevent and treat disordered eating behaviors among youth with type 1 diabetes.

The lower diet quality of the at-risk group and these youths' report of poorer self-efficacy, greater barriers, and greater negative outcome expectations (that is, undesired consequences) for healthful eating are consistent with previous research in the general population regarding fruit and vegetable intake²⁶; however, these relations have not previously been examined in relation to disordered eating behaviors in the type 1 diabetes population. The type 1 diabetes population experiences unique challenges because type 1 diabetes management focuses on carbohydrate intake due to its profound impact on glycemic excursions.

Thus, diabetes management may negatively impact attitudes toward healthful eating. For example, a patient may perceive greater difficulty and burden associated with carbohydrate counting of fresh produce, such as fruits and vegetables, compared with the ease of carbohydrate counting associated with reading the nutrition label on a bag of chips.^{24,25} Interestingly, youth who endorsed disordered eating behaviors also reported lower satisfaction with their diet. Thus, while unhealthy foods are generally perceived as more palatable than healthful foods, and sugar and fat are known to elicit a strong pleasure response from the brain,²⁷ youth at risk for disordered eating reported less overall dietary satisfaction. Disordered eating is often associated with food restriction and a general preoccupation with food,²⁸ which may account for the lower dietary satisfaction in those at risk. The poorer diet quality, poorer attitudes related to healthful eating, and lower dietary satisfaction all support the existence of a maladaptive relationship with food among these youth.

Strengths of this study include the relatively large sample of youth with type 1 diabetes, the use of a diabetes-specific measure of disordered eating, and a comprehensive assessment of dietary intake, including assessment of overall diet quality in addition to energy and macronutrient intake. Assessment of attitudes about healthful eating further contributes to a comprehensive understanding of participants' diet, including cognitive underpinnings that may influence decisions related to dietary intake.

Findings should be interpreted in light of study limitations. The DEPS is a self-report measure of disordered eating behavior, not a clinical assessment tool; therefore, those in the at-risk group cannot be classified as having an eating disorder. In addition, the DEPS was developed in an adult population, although recent research supports the utility of a shortened version of the measure in pediatric patients.²⁶ Because the data are cross-sectional, causality cannot be examined; future longitudinal research on the relations of disordered eating behaviors, diet quality, weight status, and diabetes control in this population would be informative. Research within a type 1 diabetes population is important because factors associated with the disease and treatment may influence both the development and expression of disordered eating behaviors, as the treatment regimen requires meticulous attention to food intake.

CONCLUSIONS

Findings from the present study have important implications for research and practice. Adolescents at risk for disordered eating may represent a group at high risk for poor long-term outcomes, due to a constellation of excess weight, poor diet, and poor glycemic control. For those youth with type 1 diabetes, especially those who are overweight, routine clinical care should address healthful methods of weight management because excess weight may increase risk for the development of disordered eating behaviors. Further research to determine optimal dietary management of those at risk for disordered eating behaviors may be needed to prevent long-term adverse outcomes among these youth.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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