

Weight Control Practices and Disordered Eating Behaviors Among Adolescent Females and Males With Type 1 Diabetes

Associations with sociodemographics, weight concerns, familial factors, and metabolic outcomes

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OBJECTIVE— This study examines the prevalence of specific weight control practices/disordered eating behaviors and associations with sociodemographic characteristics, BMI and weight perceptions, family functioning, and metabolic control among adolescent females and males with type 1 diabetes.

RESEARCH DESIGN AND METHODS— The study population included 70 adolescent females and 73 adolescent males with type 1 diabetes who completed the AHEAD (Assessing Health and Eating among Adolescents with Diabetes) survey. Data on BMI and glycosylated hemoglobin (HbA_{1c}) were drawn from medical records.

RESULTS— Unhealthy weight control practices were reported by 37.9% of the females and by 15.9% of the males. Among the females, 10.3% reported skipping insulin and 7.4% reported taking less insulin to control their weight. Only one male reported doing either of these behaviors. Weight control/disordered eating behaviors were not associated with age, parental level of education, family structure, or race/ethnicity. Higher levels of weight dissatisfaction tended to be associated with unhealthy weight control/disordered eating; associations with BMI were inconsistent. Family cohesion was negatively associated with disordered eating among females ($r = -0.52$; $P < 0.001$) and males ($r = -0.41$; $P < 0.001$), but correlations with other measures of family environment (control, independence, and responsibility for diabetes management) were not significant. Correlations between disordered eating and HbA_{1c} levels were significant among females ($r = 0.33$; $P < 0.01$) and males ($r = 0.26$; $P < 0.05$).

CONCLUSIONS— Special attention is needed for youth with weight concerns and those from less cohesive families to assist in the development of healthy diabetes management behaviors.

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Several studies have compared the prevalence of unhealthy weight control practices and other disordered eating behaviors among adolescents with and without type 1 diabetes. Findings have been inconsistent; in some studies, prevalence was higher among youth with type 1 diabetes (9,13,25), while in other

studies no differences were found (28, 40). Unhealthy weight control practices and other disordered eating behaviors have potentially harmful consequences for all adolescents and are associated with negative psychological well-being (39), nutritional inadequacy (10,15,22), and the later onset of eating disorders (19,27) and obesity (38). The potential consequences of unhealthy weight control practices for adolescents with type 1 diabetes are of particular concern since these practices are associated with poorer metabolic control (8,13,32,41). Furthermore, disordered eating behaviors and poor metabolic control among young women with type 1 diabetes have been associated with microvascular complications (7,34,37). Therefore, there is real concern about youth with type 1 diabetes who are engaging in unhealthy weight control practices and other disordered eating behaviors, regardless of whether prevalences differ between individuals with and without diabetes.

In light of the potential serious consequences of engaging in unhealthy weight control practices, it is important to understand aspects unique to adolescent development that are associated with these behaviors among youth with type 1 diabetes. A greater understanding of risk and protective factors can assist in identifying youth at increased risk for unhealthy weight control practices and in guiding the development of effective interventions.

The pubertal changes in body shape and weight predispose some adolescent females to develop unhealthy eating attitudes (42). The presence of type 1 diabetes may heighten attention to dietary restraints, weight gain, and food preoccupation (42). Being overweight seems to be a risk factor associated with disordered eating among females with type 1 diabetes (9,28). Furthermore, the risk for being

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Abbreviations: AHEAD, Assessing Health and Eating among Adolescents with Diabetes; DEPS, Diabetes Eating Problems Survey; DFRQ, Diabetes and Family Responsibility Questionnaire; EAT, Eating Among Teens Survey; FES-R, Family Environment Scale-Revised.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

overweight may be higher among females with type 1 diabetes, as compared with other females (9). Rodin and Daneman (33) have suggested the following potential pathway from a diagnosis of type 1 diabetes to unhealthy weight control behaviors: Before a youth is diagnosed with diabetes, there is often weight loss, which may be perceived as desirable by many young females. Once insulin therapy begins, weight gain usually ensues, which could lead to or increase body dissatisfaction. Weight gain and body dissatisfaction may lead to the use of unhealthy weight control behaviors, particularly in the form of insulin restriction as a method to lose or maintain weight (29,32).

Parent-adolescent relationships are sometimes challenged when a youth has diabetes, which can create distress and a greater risk for engaging in health-compromising behaviors, including disordered eating habits (3,20). Parents are often unsure of appropriate limits for their youth with diabetes, which may increase family conflict. Maharaj et al. (18) reported that eating disturbances among youth with type 1 diabetes were associated with poor family communication, a lack of trust in the family, conflict, and inadequate support.

The present study expands upon the growing body of research examining weight control practices/disordered eating among youth with type 1 diabetes. The following specific research questions are addressed: 1) What types of weight control and disordered eating behaviors are used by adolescent females and males with type 1 diabetes? 2) Do unhealthy weight control behaviors differ by gender, age, parental level of education, weight status, or weight perception? 3) Does family structure (one versus two parents) or family functioning (cohesion, control, and/or independence) increase or reduce the risk of unhealthy weight control behaviors? and 4) What is the association between unhealthy weight control behaviors and glycosylated hemoglobin (HbA_{1c})?

RESEARCH DESIGN AND METHODS

Study population and design

Adolescents with type 1 diabetes who were followed at a Diabetes Clinic at Children's Hospital in St. Paul, MN, were invited to participate in the AHEAD study

(Assessing Health and Eating among Adolescents with Diabetes). The AHEAD study comprised two phases: 1) a paper-pencil survey sent to all eligible youth being followed at the clinic and 2) in-depth interviews with a subsample of adolescents who completed the survey and one of their parents. The present study describes the first phase of the AHEAD study.

Participants were between the ages of 12 and 21 years and had been diagnosed with type 1 diabetes at least 1 year before study participation. Eligible participants under age 18 years and their parents were invited to participate in the study by the adolescents' physicians, either through a mailed letter or during a clinic visit. After receipt of signed informed parental consent and adolescent assent, adolescent participants were mailed a survey to complete. For eligible participants older than 18 years, similar procedures were used, but only adolescent informed consent (sent together with the survey) was required. To improve response rate and minimize bias, study staff mailed invitation packets to nonresponders on two additional occasions. Concurrently, clinic staff distributed invitation packets to potential participants during their clinic visits. All participants received a small monetary incentive for completing the survey. All study procedures were approved by both the University of Minnesota and the Children's Hospital/Clinic Institutional Review Boards.

Of a potential 246 adolescents who were being seen in the clinic, surveys were completed by 143 youth, yielding a response rate of 58%. Responders and nonresponders were compared for BMI, age, and HbA_{1c} levels. Mean BMI values were similar for responders ($23.8 \pm 6.0 \text{ kg/m}^2$) and nonresponders ($23.8 \pm 4.2 \text{ kg/m}^2$) ($P = 0.989$). However, responders tended to be older (15.2 ± 2.3 years) than nonresponders (14.3 ± 2.4 years) ($P < 0.001$). In addition, responders had lower HbA_{1c} levels ($8.8 \pm 1.6\%$) than nonresponders ($9.5 \pm 2.0\%$) ($P = 0.001$).

The study population was equally split on gender (females: $n = 70$, 49%; males: $n = 73$, 51%). The mean age of the study population was 15.3 years ($SD = 2.3$). The mean BMI of the population was 23.8 kg/m^2 ($SD = 4.2$). It is noteworthy that a large proportion of participants were overweight; 41% ($n = 58$) had a BMI greater than the 85th percentile; of these,

8% ($n = 12$) had a BMI greater than the 95th percentile. The majority of the participants (84%) lived in two-parent families, and more than half of participants (59%) reported that at least one parent had attained a level of education equivalent to a college degree or higher. While the majority of the population identified their race/ethnicity as white, the sample included 10% ($n = 14$) minority youth. This proportion is representative of the number of minority youth living in the geographic area of the study.

Measures

Items assessing weight perceptions and weight control behaviors were drawn from the Project EAT (Eating Among Teens) Survey (24). The Diabetes Eating Problems Survey (DEPS) (2) was used to further assess disordered eating attitudes and behaviors and manipulation of insulin for weight control purposes among the respondents. Adolescent-perceived family functioning was assessed using three subscales of the Family Environment Scale-Revised (FES-R): cohesion, independence, and control (21). These subscales were chosen because they assess constructs of interest to the research questions. Responsibility for diabetes management was assessed with the Diabetes and Family Responsibility Questionnaire (DFRQ) (1). The DFRQ assesses the adolescent's perceptions of who in the family (parent most of the time, adolescent most of the time, or both about equally) is responsible for 17 different diabetes-management tasks. Sociodemographic variables were based on self-report and included age, grade level, ethnicity, family structure, and parental educational level. BMI was based on the respondent's height and weight recorded during the medical visit that was closest to the date the adolescent filled out the survey. Metabolic control was assessed using the HbA_{1c} value obtained at the medical visit that was closest to the date the adolescent filled out the survey. A more detailed description of each of these measures is included in Appendix A.

Data analysis

Demographic and weight control behavior frequencies were examined with cross-tabulations using the χ^2 as the test for significance. Frequency of weight-control categories (none, healthy, unhealthy, very unhealthy) was assessed

separately by gender. Continuous scores on dependent variables were examined with means and were compared using ANOVA across demographic categories and categories of weight control behaviors. For all group comparisons, post hoc Tukey multiple comparison tests were conducted to assess differences between pairs of groups at $P < 0.05$. Two-tailed correlation coefficients between continuous variables were calculated using Pearson's r . Analyses controlling for age were also run. Patterns tended to be similar in age-adjusted analyses; therefore, these data are not presented. All analyses were completed using SPSS for the Macintosh, Version 6.1 (36).

RESULTS

Prevalence of weight control/disordered eating behaviors

More female respondents (92.4%) than male respondents (53.6%) reported engaging in weight control behaviors over the past year to lose weight or keep from gaining weight ($P < 0.001$). Disordered eating behaviors, as assessed with the DEPS, also tended to be higher among females than males, although differences were not statistically significant (females: $44.8 \pm 10.7\%$; males: $41.7 \pm 8.0\%$; $P = 0.068$).

The frequencies for each of the specific weight control behaviors used by females and males are shown in Table 1. Healthy weight control behaviors were the most commonly reported practices, especially for females. Among the unhealthy behaviors used to control weight, skipping meals was used the most frequently. Of the very unhealthy weight control behaviors, 10.3% of the females reported skipping insulin, and 7.4% of the females reported taking less insulin as a way to control weight. Only one male reported engaging in any method of insulin mismanagement for weight control.

In classifying respondents into one of the four weight control behavior categories, 7.6% of females and 46.4% of males used no weight control behaviors, and 54.5% of females and 37.7% of males used only healthy weight control behaviors. Among females, 18.2% engaged in unhealthy weight control behaviors, and an additional 19.7% used very unhealthy behaviors to control their weight. For males, these last two categories of behaviors were less frequent with 13.0% and

Table 1—Specific weight control behaviors* used by adolescents with type 1 diabetes

	Females (N = 66)		Males (N = 69)	
	n	%	n	%
Healthy behaviors				
Exercise	62	89.9	34	47.9
More fruits/vegetables	53	75.7	20	28.2
Less high-fat foods	50	72.5	22	30.6
Less sweets	46	66.7	24	33.3
Unhealthy behaviors				
Fasted	5	7.4	1	1.4
Ate very little	16	23.5	4	5.6
Used food substitute	6	8.8	1	1.4
Skipped meals	19	27.9	5	7.0
Increased smoking	4	5.9	3	4.2
Very unhealthy behaviors				
Diet pills	2	2.9	1	1.4
Vomited	2	2.9	0	—
Skipped insulin	7	10.3	1	1.4
Used less insulin	5	7.4	1	1.4
Laxatives	2	3.0	0	—
Diuretics	0	—	0	—

*Reported using to "lose weight" or "keep from gaining weight" in past year.

2.9% reporting unhealthy behaviors and very unhealthy weight control behaviors, respectively.

Sociodemographic characteristics and weight control/disordered eating

When the categories of weight control behaviors (none, healthy only, unhealthy, and very unhealthy) were compared separately for females and males by age, parental level of education, and race, there were no differences between the categories (data not shown). Although the difference was not statistically significant, it is noteworthy that 66.7% of the nonwhite females (6 of 9) reported unhealthy or very unhealthy weight control behaviors in comparison to 31.6% of the white females (18 of 57). Similarly, associations between sociodemographic characteristics and disordered eating behaviors, as assessed with the DEPS, were not statistically significant (data not shown). Family structure was not associated with weight control behaviors or DEPS scores.

BMI, perceived weight, weight dissatisfaction, and weight control/disordered eating

For males, BMI differed by weight control behavior category; males in the very unhealthy weight control category had a sig-

nificantly higher mean BMI than those in the other three categories (see Table 2). There were significant differences in weight perception by category of weight control behaviors for both females and males; respondents with more unhealthy weight control behaviors reported perceiving their weight as being heavier. Weight dissatisfaction differed significantly across the weight control behavior categories for females; those engaging in unhealthy behaviors reported the highest rates of weight dissatisfaction.

Slightly different patterns were found in examining associations between disordered eating behaviors, using scores from the DEPS, and BMI, weight perception, and weight dissatisfaction. Among females, DEPS scores were associated with weight dissatisfaction ($r = 0.40$; $P = 0.001$) but were not associated with BMI ($r = 0.10$; $P = 0.442$) or weight perception ($r = 0.22$; $P = 0.090$). Similarly, among males, DEPS scores were associated with weight dissatisfaction ($r = 0.31$; $P = 0.013$), but were not associated with BMI ($r = 0.10$; $P = 0.424$) or weight perception ($r = 0.10$; $P = 0.417$).

Family functioning and weight control/disordered eating

Family cohesion scores differed significantly between the weight control behavior categories among the females. Females using only healthy weight control behaviors reported the highest levels of family cohesion, while females using very unhealthy behaviors reported the lowest levels of family cohesion (see Table 3). Similarly, among the females, family cohesion was significantly associated with the DEPS scores ($r = -0.52$; $P < 0.001$). Other measures of the family social environment (control, independence, and responsibility for diabetes management) were not significantly different between the weight control behavior categories. The correlations between DEPS scores and the family environment were also nonsignificant.

Among the males, family cohesion did not differ significantly between the weight control behavior categories, although (like the females) the highest levels of family cohesion were reported by males using only healthy weight control behaviors, followed by males not using any weight control behaviors (see Table 3). For males, family cohesion was significantly associated with DEPS scores ($r =$

Table 2—Comparisons of BMI, weight perceptions, and dissatisfaction by weight control behavior categories

	n	BMI		Weight perception		Weight dissatisfaction	
		Mean	SD	Mean	SD	Mean	SD
Females							
Weight control behavior category							
None	5	25.1	8.3	3.0 ^a	0.7	2.0 ^a	1.2
Only healthy	35	24.0	4.6	3.2 ^a	0.6	2.9 ^a	1.5
Unhealthy	11	24.0	2.6	3.8 ^{ab}	0.5	3.8 ^{ab}	1.1
Very unhealthy	12	26.5	4.7	4.1 ^b	0.6	4.2 ^b	1.6
		P = 0.460		P < 0.001		P = 0.005	
Males							
Weight control behavior category							
None	32	22.4 ^a	2.5	2.7 ^a	0.5	2.2	1.4
Only healthy	26	23.9 ^a	3.6	3.1 ^b	0.7	2.3	1.3
Unhealthy	9	22.5 ^a	3.4	3.3 ^b	0.5	2.3	1.1
Very unhealthy	2	31.5 ^b	14.6	3.0 ^{ab}	1.4	4.0	1.4
		P = 0.006		P = 0.013		P = 0.314	

Different superscripts are used to denote statistically significant differences (P < 0.05) between categories using post hoc Tukey multiple comparison tests.

−0.41; P < 0.001); males from more cohesive families reported fewer disordered eating behaviors. Other measures of family social environment (control, independence, and responsibility for diabetes management) were neither significantly different between weight control behavior categories nor correlated with DEPS scores.

HbA_{1c} and weight control/disordered eating

Among females, there was a statistically significant difference between weight control behavior categories and laboratory measures of HbA_{1c}; females reporting only healthy behaviors had significantly lower HbA_{1c} levels than females reporting unhealthy weight control

behaviors (see Table 4). The correlation between disordered eating behaviors (as assessed with the DEPS) and HbA_{1c} levels also was statistically significant (r = 0.33; P < 0.01). Females reporting more disordered eating behaviors had poorer metabolic control, as evidenced by their higher HbA_{1c} levels.

Among males, the difference between

Table 3—Comparisons of family relationship patterns by weight control behavior categories

	n†	Family environment*						Diabetes and family responsibility*	
		Cohesion		Control		Independence			
		Mean	SD	Mean	SD	Mean	SD		
Females									
Weight control behavior categories									
None	4	6.8 ^{ab‡}	1.7	4.8	2.6	6.3	1.3	36.0	2.6
Only healthy	35	8.1 ^a	1.1	4.5	1.9	6.6	1.2	38.1	2.8
Unhealthy	12	6.7 ^b	2.3	5.3	2.0	6.3	0.9	38.7	5.7
Very unhealthy	11	6.2 ^b	1.8	5.7	2.0	6.4	1.8	39.5	3.0
		P < 0.001		P = 0.307		P = 0.881		P = 0.613	
Males									
Weight control behavior categories									
None	30	6.6	2.6	5.4	2.3	5.9	1.8	37.4	4.3
Only healthy	25	7.0	2.0	4.8	2.0	6.4	1.5	37.6	3.4
Unhealthy	7	6.0	3.0	4.3	1.9	6.0	1.7	36.4	4.9
Very unhealthy	2	5.0	—	5.0	5.7	9.0	—	41.0	—
		P = 0.640		P = 0.571		P = 0.252		P = 0.714	

Different superscripts are used to denote statistically significant differences (P < 0.05) between categories using post hoc Tukey multiple comparison tests. *Potential ranges: Family environment scales (0–9); Diabetes and family responsibility (17–51): higher scores, more adolescent responsibility. †Total n may differ slightly due to missing responses. Only one of the two males reporting very unhealthy weight control behaviors had responses for cohesion and diabetes management responsibility; therefore, no SDs are given. ‡Different superscripts are used to denote statistically significant differences (P < 0.05) between categories using post hoc Tukey multiple comparison tests.

Table 4—Comparisons of HbA_{1c} levels by weight control behavior categories

Weight control behavior categories	Females (n = 65)			Males (n = 66)			
	n	Mean	SD	n	Mean	SD	
None	5	8.3 ^{ab*}	1.1	31	8.9	1.8	
Healthy	36	8.3 ^a	1.2	25	8.4	1.3	
Unhealthy	11	10.2 ^b	2.1	8	9.8	1.8	
Very unhealthy	13	9.2 ^{ab}	1.5	2	9.8	0.2	
		P = 0.002			P = 0.188		

*Different superscripts are used to denote statistically significant differences ($P < 0.05$) between categories using post hoc Tukey multiple comparison tests.

weight control behavior categories and HbA_{1c} level was not statistically significant, although a trend similar to that found among females was noted. The correlation between DEPS scores and HbA_{1c} levels for males was statistically significant ($r = 0.26$; $P < 0.05$).

CONCLUSIONS— Weight control practices were prevalent among the study population. Although the use of healthy weight control behaviors was most commonly reported, significant percentages of females (37%) and males (15%) reported the use of unhealthy or very unhealthy behaviors. Of particular concern was the misuse of insulin for weight regulation, reported by 7–10% of the females. While prevalences of unhealthy weight control behaviors reported in this study are of concern, they were lower than those found in a recent large population-based survey of adolescents in the greater St. Paul/Minneapolis area, using similar questions (with the exception of insulin misuse) (24). Prevalences were also considerably lower than those found in an earlier population-based study of Minnesota youth who reported having diabetes (25), thus raising questions and concerns about the validity of making comparisons across studies, self-reported data on diabetes and on weight-control behaviors, and the representative nature of the study population in the current study.

Females who were more dissatisfied with their weight and who perceived themselves to be overweight were more likely to use unhealthy weight control behaviors. Among both genders, weight dissatisfaction was significantly correlated with disordered eating behaviors, as assessed with the DEPS; but associations between actual BMI and unhealthy weight control practices and disordered eating

behaviors tended to be weak and inconsistent. Other studies have found positive associations between BMI and disordered eating among females with type 1 diabetes (9,43). Together these findings suggest that special attention should be directed toward helping youth who are overweight, and particularly those who express body dissatisfaction, to find healthy ways to control their weight and to avoid unhealthy methods, especially insulin misuse.

The high prevalence of overweight among the study population is noteworthy in that 44% of the females and 40% of the males had BMI values at or above the 85th percentile. Similarly, Engstrom et al. (9) found that youth with type 1 diabetes were at increased risk for overweight. This raises challenges for health providers in helping adolescents with type 1 diabetes to engage in healthy weight control behaviors, yet avoid excessive weight preoccupation and the use of unhealthy weight control behaviors.

Associations between weight control and disordered eating behaviors and different aspects of the family environment were examined in order to gain insight into the types of family relationship patterns that might place youth at risk, or serve to protect them, from engaging in unhealthy behaviors. Fairly strong associations were found with family cohesiveness, indicating the importance of family support. This finding is consistent with results reported by others about the importance of good family relationships for optimal diabetes management (11,18, 35).

We did not find associations between the adolescents' weight control behaviors and the adolescents' perceptions of other aspects of the family environment, specifically family control or the encouragement of independence in individual

family members. There was a tendency toward higher perceived family control by the females using the unhealthy weight control behaviors, and it could be that our sample was too small to detect significant differences on this variable. The two males who used very unhealthy weight control behaviors did report higher scores for family independence, but again the sample was too small to obtain statistical significance. One of the challenges of parenting an adolescent with type 1 diabetes is finding the right balance between encouraging youth responsibility for self-care and management of their diabetes as they mature into young adults, while simultaneously providing emotional support as they grapple with the meaning of having a chronic illness. These are important issues that need to be examined in more depth, perhaps using qualitative research methodologies.

Unhealthy weight control and other disordered eating behaviors were associated with poorer metabolic control, as evidenced by higher HbA_{1c} levels. This is consistent with the findings of others (8,13,32,41). The mean HbA_{1c} levels of study participants were higher than the clinic goals for adolescents at the Diabetes Clinic, particularly among those who reported unhealthy and very unhealthy weight control practices. These findings suggest that even without a clinically significant eating disorder, the use of unhealthy weight control practices may have serious consequences for metabolic control among youth with type 1 diabetes.

This study had a number of strengths that increase the utility of the findings. The inclusion of males in the study population expands upon the current body of literature, as the majority of studies examining eating disorders/disordered eating among individuals with type 1 diabetes have included only females. The use of different measures of weight control practices/disordered eating and, in particular, the use of the DEPS (2), which is specific to diabetes, enhances our ability to draw conclusions from the data. In a review of the literature on eating disorders and type 1 diabetes, Nielson and Molbak (26) stress the importance of using diabetes-specific tools, since the use of general measures is "likely to lead to the loss of information." Other strengths include the assessment of both measured BMI and weight perceptions, HbA_{1c} values, and different aspects of the familial social en-

environment using previously validated tools (21).

A major study limitation was the relatively low response rate (58%), despite several attempts to reach the eligible clinic population. However, the attainment of data for BMI, age, and HbA_{1c} levels for nonrespondents was helpful. The finding that nonrespondents had higher levels of HbA_{1c} than respondents suggests that nonrespondents may have been more likely to engage in unhealthy weight control practices than respondents, but this cannot be stated with certainty. Thus, prevalence of data on unhealthy weight control behaviors among youth with type 1 diabetes should be interpreted cautiously. We would not expect associations (e.g., with family functioning or metabolic control) to be affected by the response rate. Furthermore, although the study population was diverse in terms of gender, age, and SES, its small size and its homogeneity in terms of family structure and race/ethnicity make it difficult to draw firm conclusions regarding the lack of sociodemographic differences in weight control/disordered eating behaviors. Finally, the cross-sectional study design limits our ability to discuss causality. Longitudinal studies are needed to assess whether low family cohesion leads to the use of unhealthy weight control practices. That said, it is noteworthy that family connectedness has been shown to be a key factor influencing a range of health-compromising behaviors in population-based samples of youth (23,30,31).

Findings from the present study have implications for research and practice. The findings suggest a need for further research to explore the reasons that adolescents with type 1 diabetes engage in unhealthy weight control practices, despite the serious consequences of these behaviors. Of particular interest is the further exploration of familial factors in order to provide insight into helpful strategies for parenting an adolescent with type 1 diabetes. In addition, different types of treatment strategies should be evaluated in terms of their impact on weight-related behaviors. Our findings suggest that special attention should be directed toward females, youth with weight concerns, and youth from families with low levels of cohesiveness. A few screening questions regarding weight-related concerns and behaviors and regarding family relationships may be

incorporated into clinic visits with adolescents. Some suggested introductory comments/questions include the following: "I would like to ask you a few questions about any weight-related concerns you may have. How concerned are you about your weight, let's say on a scale from 0 (not at all concerned) to 10 (extremely concerned)? Are you on a diet now to lose or maintain weight?" If there appear to be weight-related concerns, the following questions may be asked "Do you ever skip meals to lose or maintain weight? In the past year, have you ever tried to lose weight by vomiting, taking diet pills, using laxatives, skipping insulin, or modifying your insulin dose?" Responses to these questions should be addressed within the treatment plan. Treatment strategies need to take into account the unique needs of teenagers in their quest for independence from their parents, the desire of most teenagers to "fit in" with their peers, and strong social norms emphasizing thinness. Support activities for families, such as family counseling or group work with parents of adolescents with diabetes, may enhance family cohesiveness and lead to improved diabetes management and outcomes. Finally, health care providers working with adolescents with type 1 diabetes may need special training in identifying disordered eating behaviors, addressing the developmental needs of adolescent populations, and working with families to enhance communication and support.

APPENDIX A: DESCRIPTION OF MEASURES

Weight perceptions and weight control behaviors.

Items assessing weight perceptions and weight control behaviors were drawn from the Project EAT (Eating Among Teens) survey (24). The survey includes items assessing the following: 1) perception of current weight status—1 item (5-point Likert scale from very underweight to very overweight); 2) weight satisfaction—1 item (6-point Likert scale from very satisfied to very unsatisfied); 3) dieting frequency over the past year—1 item (5-point Likert scale from never to always dieting); 4) previous diagnosis of an eating disorder—1 item (yes/no); 5) binge eating behavior in past year—1 item (yes/no); and 6) 15 weight control behaviors to gain or lose weight over the past year, in-

cluding skipping insulin or using less insulin than prescribed (yes/no). Based on responses to these 15 weight control items, respondents were classified into one of four weight control categories: very unhealthy, unhealthy, only healthy, or none (based upon the most severe weight control behaviors reported). Respondents were classified as "very unhealthy" if they did any of the following for weight control: took diet pills, vomited, skipped insulin dose(s), took less insulin than prescribed, used laxatives, or used diuretics. Respondents were classified as "unhealthy" if they did any of the following for weight control: fasted, ate very little food, used food substitutes (powder/special drink), skipped meals, and/or smoked more cigarettes. Respondents were classified as "healthy" if they did any of the following for weight control: ate more fruits and vegetables, ate less high-fat foods, and ate less sweets. If respondents answered "no" for all 15 behaviors, they were included in the "none" category.

Diabetes Eating Problems Survey (DEPS).

The DEPS (2) was used to further assess disordered eating attitudes and behaviors and manipulation of insulin for weight control purposes among the respondents. The DEPS has reported predictive validity among diabetes patients diagnosed with an eating disorder; DEPS scores, as compared with EAT-26 scores, have been found to be more strongly correlated with diagnosed eating problems among females with type 1 diabetes ($r = 0.70$ and 0.50 , respectively) (2). For the present study, two questions regarding insulin omission/reduction for the purpose of weight control were added to the original version of the DEPS. A total score is derived by summing the 25 Likert-scaled items; scores can range from 25 to 150, with higher scores indicating more eating-related problems. The reliability estimate for the version of the DEPS used in the present study was 0.66.

Family Environment Scale-Revised (FES-R).

Adolescent-perceived family functioning was assessed using three subscales of the FES-R: cohesion, independence, and control (21). These subscales were chosen because they assess constructs of interest to the research questions. Two subscales (cohesion and control) have been linked

with adolescent adjustment to diabetes (11,35), eating disorders (12,17), and other areas of adolescent health and psychosocial well-being (5,6,14,16). Each subscale comprises nine true-false items. The cohesion subscale assesses the extent to which family members are helpful and supportive of one another. The control subscale assesses rules and decision-making in the family. The independence subscale assesses the degree to which family members are encouraged and expected to do things on their own. In the present study population, α reliabilities for the cohesion and control subscales were acceptable (0.75 and 0.63, respectively), but lower for the independence subscale (0.36), although the latter α reliability varied by age of respondent with higher values for older youth. Boyd et al. (4) calculated reliability estimates on the FES-R subscales using a large adolescent population ($n = 1,217$) and also found the cohesion and control reliability estimates to be higher (0.67 and 0.59, respectively) than the independence estimate (0.31).

Diabetes and Family Responsibility Questionnaire (DFRQ).

The DFRQ (1) includes 17 items assessing the adolescent's perceptions of who in the family (parent most of the time, adolescent most of the time, or both about equally) is responsible for a broad range of tasks involved in managing their diabetes. A total score (called "responsibility for diabetes management") is calculated by summing the items. A higher score indicates the adolescent is primarily responsible, a lower score suggests that the parent is primarily responsible, and a score in the middle indicates that, on average, responsibilities are shared between parent and adolescent. The reliability estimate (Cronbach's α) of the DFRQ in the present study population was satisfactory at 0.80.

Sociodemographic variables.

Adolescents reported their age, grade level, ethnicity, family structure, and parental educational level. Grade level was treated categorically and divided into four categories: 1) junior high (5th to 8th grade), 2) high school (9th to 12th grade), 3) college or technical school, and 4) not in school. Due to the small number of youth reporting an ethnicity other than "white" ($n = 10$), those who were Black/

African-American, Hispanic/Latino, Asian American, or American Indian were grouped together as "nonwhite." Two groups were created for family structure: "two-parent family" and "other family structure." Four groups were created for parental education level: 1) did not finish high school; 2) finished high school, has a GED, or some college or technical training after high school; 3) finished college; and 4) completed Master's degree or PhD. Questions were asked separately for each parent, and the maximum educational level for either the mother or father was used in the analysis.

BMI.

BMI is calculated as weight in kilograms divided by height in meters squared, and for the present study was based on the respondent's height and weight recorded during the medical visit that was closest to the date the adolescent filled out the survey. Medical visits during which heights and weights (and HbA_{1c} values, described below) were collected were within 3 months of survey completion for 83% of the participants and within 6 months for 97% of them.

Metabolic control.

Metabolic control was assessed using the HbA_{1c} value obtained at the medical visit that was closest to the date the adolescent filled out the survey. All blood samples were analyzed by high-performance liquid chromatography. The assay used is based on a latex immuno-agglutination inhibition methodology. HbA_{1c} is a commonly used measure of metabolic control and represents the mean glucose concentration for the 6–8 weeks preceding the test. Higher HbA_{1c} values indicate poorer metabolic control. In adolescents, the target HbA_{1c} depends on stage of puberty. Targets used in the diabetes clinic where participants were receiving treatment are as follows: for early to middle puberty the target HbA_{1c} is <8.0%; for the late and postpubertal adolescent, the target HbA_{1c} is <7.5%; and for young adults over 18 years of age, the target HbA_{1c} is <7.0%. Fair control is considered within 1% of the target HbA_{1c} on the high end. Beyond 1% of the target HbA_{1c} is considered poor control.

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