

Weight-Loss Practices and Weight-Related Issues Among Youth With Type 1 or Type 2 Diabetes

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OBJECTIVE — The purpose of this study was to describe the weight-loss practices and weight-related issues reported by youth with diabetes, according to sex and diabetes type.

RESEARCH DESIGN AND METHODS — A total of 1,742 female and 1,615 male youth aged 10–21 years with type 1 or type 2 diabetes completed a SEARCH for Diabetes in Youth study visit during which height, weight, and A1C were measured. A survey assessed weight-related issues and weight-loss practices.

RESULTS — Although more common in youth with type 2 diabetes, youth with type 1 diabetes also reported weight-related concerns and had elevated BMI. Among youth who had ever tried to lose weight ($n = 1,646$), healthy weight-loss practices (diet [76.5%] and exercise [94.8%]) were the most common, whereas unhealthy practices (fasting [8.6%], using diet aids [7.5%], vomiting or laxative use [2.3%], and skipping insulin doses [4.2%]) were less common. In sex-specific multivariable models including age, race/ethnicity, diabetes type, BMI category, and glycemic control, obese females and overweight/obese males were more likely to report ever practicing any unhealthy weight-loss practice than normal-weight youth. These practices were associated with poor glycemic control for female but not male subjects. All unhealthy weight-loss practices except fasting were more common in female than in male subjects. Dieting, fasting, and using diet aids were all more common in youth with type 2 diabetes than in those with type 1 diabetes.

CONCLUSIONS — Given the prevalence of overweight and obesity among youth with type 1 or type 2 diabetes, health care professionals caring for youth with diabetes need to pay particular attention to identifying youth, particularly females, with unhealthy weight-loss practices.

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D iabetes is one of the three most prevalent chronic diseases of youth (1), with the majority of affected youth having type 1 diabetes (2). However, type 2 diabetes is being diagnosed more frequently in youth than has been reported in previous decades (2–4). Although youth with type 2 diabetes are

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likely to be overweight or obese, the increase in overweight in the U.S. population is mirrored among youth with type 1 diabetes (5,6). Strategies used to lose or manage weight include those that are healthy, such as regular physical activity and consuming a healthy diet, as well as those that are unhealthy, such as using over-the-counter diet aids without physician's advice, fasting, taking laxatives or diuretics, and vomiting. In 2005, 12.3% of 9th to 12th graders went without eating for at least 24 hours, 6.3% used diet pills, powders, or liquids, and 4.5% vomited or took laxatives to maintain or lose weight (7). Females were significantly more likely than males to use these unhealthy strategies; some racial/ethnic differences were observed.

Certain features of diabetes and its management, including weight gain after the initiation of insulin treatment, dietary restraint, and the knowledge that withholding insulin can cause weight loss, may trigger eating disturbances in youth with type 1 diabetes (8). Eating disorders have been associated with poor metabolic control and microvascular complications in type 1 diabetic youth (9–12). There is limited information about weight-related concerns among youth with type 2 diabetes. The American Diabetes Association recommends that youth with type 2 diabetes implement lifestyle modifications to reduce their intake of high-fat, high-energy foods and to increase physical activity to optimize glycemic control as well as their cardiovascular risk profile, including their lipid levels and blood pressure (13). At the same time, medical nutrition therapy must take in to account the nutritional needs required to support normal growth and development during childhood and adolescence (13,14). In this article, we describe the approaches to healthy and unhealthy weight-loss practices reported by youth with type 1 or type 2 diabetes by sex. In addition, we explore the associations between any unhealthy weight-loss practice, body weight perception, weight management goal, and worry about weight and glycemic control among youth with type 1 or type 2 diabetes by sex.

RESEARCH DESIGN AND METHODS

SEARCH for Diabetes in Youth (SEARCH) is a multicenter study that began conducting population-based ascertainment of youth with clinically diagnosed diabetes who were <20 years of age in 2001 and is continuing to enroll youth with newly diagnosed (incident) diabetes (15). SEARCH recruited youth from four geographically defined populations, Indian Health Service beneficiaries from four American Indian populations, and enrollees in several managed health care plans. Institutional review board(s) for each site approved the study protocol. At the time of the SEARCH study visit, informed consent was obtained, physical measurements and fasting blood samples were obtained from metabolically stable participants (no episodes of diabetic ketoacidosis during the previous month) after a minimum 8-h overnight fast, and questionnaires were administered. Non-fasting blood samples were obtained from participants who had not fasted or had not withheld their medications but agreed to give a blood sample.

BMI measures

BMI (weight in kilograms divided by the square of height in meters) was calculated using height/weight measurements taken at the study visit. Percentiles for BMI z-scores specific to sex and age were assessed using algorithms prepared by the U.S. Centers for Disease Control and Prevention (CDC) based on the 2000 CDC growth charts (16,17). Youth were classified on BMI z-scores as follows: ≥ 95 th percentile, obese; 85–94.9 percentiles, overweight; > 5 th to < 85 th percentiles, healthy weight; and < 5 th percentile, underweight (18).

Weight-related issues

With the use of questions similar to those in the Youth Risk Behavior Surveillance System (YRBSS) (7,19), youth aged ≥ 10 years were asked about their current weight (very underweight, slightly underweight, about the right weight, slightly overweight, and very overweight [perception of weight]), what they were trying to do about their weight (nothing, lose weight, gain weight, or trying to stay the same [weight management goal]), whether they worried a lot about their weight (yes/no), and whether they had ever tried to lose weight (yes/no).

Weight-loss practices

Youth who reported ever trying to lose weight were asked whether they had tried to do so by any of the following methods: 1) eating less food, fewer calories, or foods lower in fat (dieting); 2) exercising; 3) going without eating for > 24 h (fasting); 4) using diet pills, powders, or liquids without a doctor's advice (diet aids); 5) vomiting or taking laxatives; or 6) skipping insulin doses. Response 6 was added to be specific to diabetes. Using terminology consistent with YRBSS publications, diet and exercise were considered "healthy"; fasting, using diet aids without a doctor's advice, vomiting or taking laxatives, and skipping insulin doses were considered "unhealthy" (7,19). We created two dichotomous unhealthy composite measures: one that included fasting, diet aids, and vomiting or laxative use and a second with these three practices plus skipping insulin doses.

Other variables

A1C was measured at the study visit and used to categorize glycemic control using the American Diabetes Association guidelines as good (A1C $< 8.0\%$), marginal (8.0–9.4%), and poor ($\geq 9.5\%$) (20). Race/ethnicity was obtained through self-report using the standard census questions (21). Youth who reported Hispanic ethnicity were categorized as Hispanic, non-Hispanic youth were categorized by their race, and youth who reported multiple races or did not report race/ethnicity were categorized as other/unknown race/ethnicity. Highest parental education was based on the parent with the highest education as reported on a questionnaire. Type of diabetes was based on the clinical diagnosis by the physician. Youth with a clinical diagnosis of type 1 diabetes were much more likely to have a positive diabetes autoantibody and had much lower fasting C-peptide concentrations than youth with a clinical diagnosis of type 2 diabetes (3).

Statistical analysis

These analyses were restricted to youth with type 1 or type 2 diabetes who were ≥ 10 years of age at the time of their study visit. Of the 3,708 youth aged ≥ 10 years who completed a study visit and whose diabetes was prevalent (2001) or incident (2002–2005), exclusions were made sequentially for having diabetes type other than type 1 or 2 or having type missing ($n = 39$, 1.1%), height or weight missing ($n = 222$, 6.0%), and for not an-

swering the weight-related or weight-loss questions ($n = 90$, 2.4%) for a final analytic sample of 3,357 youth.

Analyses, performed with SAS (version 9.1; SAS Institute, Cary, NC), were stratified by sex. We describe the demographic and clinical characteristics and weight-related issues of all youth in the sample as well as the weight-loss practices of youth who had ever tried to lose weight by diabetes type within sex categories and then compare youth by sex, combining youth with type 1 and type 2 diabetes. Using multiple logistic regression, we calculated adjusted odds ratios (AOR) and 95% CI to explore the associations between diabetes type, sex, and weight-loss practices. Then, associations between demographic characteristics, diabetes type, BMI percentile categories, and glycemic control categories and outcomes of any unhealthy weight-loss practices and the three weight-related outcomes were examined among youth with measured A1C.

RESULTS

The study population comprised 1,742 female and 1,615 male youth with a mean age of 15.0 years and a mean duration of diabetes of just > 4 years (Table 1). The majority (84.5%) of the participants had type 1 diabetes. About 43% of the participants were overweight or obese, 39% perceived they were slightly or very overweight, $\sim 27\%$ worried about their weight, and almost 40% were trying to lose weight. All of these characteristics varied by sex ($P < 0.0001$). As expected, youth with type 2 diabetes were more likely than youth with type 1 diabetes to be overweight or obese. However, 37.0% of females and 32.0% of males with type 1 diabetes were overweight or obese. Of the youth with type 2 diabetes, 38% ($n = 125$) of females and 34% ($n = 65$) of males reported taking insulin.

Weight-loss practices

Just less than half of the youth surveyed reported ever trying to lose weight. Youth with type 2 diabetes were more likely than youth with type 1 diabetes to have ever tried to lose weight (90.5 vs. 52.4% for females and 79.3 vs. 32.1% for males) (Table 1). Of these 1,646 youth who reported ever trying to lose weight, healthy practices, including diet (76.5%) and exercise (94.8%), were very common. Females were more likely to report dieting (81 vs. 66%, $P < 0.001$), whereas males were more likely to report exercising (97 vs. 94%, $P < 0.01$) (Table 2).

Table 1—Demographic and clinical characteristics, and weight-related issues and practices of 3,357 youth aged ≥ 10 years, as well as weight-loss practices reported by 1,646 youth who had ever tried to lose weight, by diabetes type and sex: SEARCH 2001–2005 cohorts

	Female			P value for type*	Male			P value for type*	P value for sex†
	All	Type 1	Type 2		All	Type 1	Type 2		
<i>n</i>	1,742	1,415	327		1,615	1,422	193		
Age at study visit (years)	15.0 \pm 3.1	14.7 \pm 3.1	16.1 \pm 2.8	<0.001	15.0 \pm 3.0	14.8 \pm 3.0	16.5 \pm 2.8	<0.001	0.796
Race/ethnicity				<0.001				<0.001	<0.001
Non-Hispanic white	1,086 (62.3)	1,031 (72.9)	55 (16.8)		1,131 (70.0)	1,085 (76.3)	46 (23.8)		
Hispanic	238 (13.7)	169 (11.9)	69 (21.1)		216 (13.4)	171 (12.0)	45 (23.3)		
Black	241 (13.8)	119 (8.4)	122 (37.3)		140 (8.7)	89 (6.3)	51 (26.4)		
Asian/Pacific Islander	58 (3.3)	32 (2.3)	26 (8.0)		34 (2.1)	20 (1.4)	14 (7.3)		
Native American	58 (3.3)	11 (0.8)	47 (14.4)		40 (2.5)	10 (0.7)	30 (15.5)		
Other/unknown	61 (3.5)	53 (3.8)	8 (2.5)		54 (3.3)	47 (3.3)	7 (3.6)		
Diabetes duration (years)	4.3 \pm 4.1	4.8 \pm 4.3	2.2 \pm 1.9	<0.001	4.0 \pm 4.0	4.3 \pm 4.1	1.8 \pm 1.7	<0.001	0.039
Duration of diabetes at study visit				<0.001				<0.001	0.181
<1 year	412 (23.7)	318 (22.5)	95 (29.1)		415 (25.7)	332 (23.4)	83 (43.0)		
1 year–<3 years	481 (27.6)	334 (23.6)	147 (45.0)		468 (29.0)	396 (27.9)	72 (37.3)		
3–<6 years	344 (19.8)	278 (19.7)	66 (20.2)		315 (19.5)	283 (19.9)	32 (16.6)		
≥ 6 years	505 (29.0)	485 (34.3)	19 (5.8)		417 (25.8)	411 (28.9)	6 (3.1)		
Highest parental education				<0.001				<0.001	0.371
<High school graduate	117 (6.8)	59 (4.2)	58 (18.0)		91 (5.7)	62 (4.4)	29 (15.3)		
High school graduate or GED	323 (18.7)	221 (15.7)	102 (31.6)		291 (18.2)	232 (16.5)	59 (31.2)		
Some college	590 (34.1)	487 (34.6)	103 (31.9)		527 (33.0)	457 (32.5)	70 (37.0)		
\geq Bachelor degree	701 (40.5)	641 (45.5)	60 (18.6)		687 (43.1)	656 (46.6)	31 (16.4)		
BMI percentile category				<0.001				<0.001	<0.0001
Obese	413 (23.7)	159 (11.2)	254 (77.7)		333 (20.6)	186 (13.1)	147 (76.2)		
Overweight	404 (23.2)	364 (25.7)	40 (12.2)		293 (18.1)	269 (18.9)	24 (12.4)		
Healthy	905 (52.0)	873 (61.7)	32 (9.8)		972 (60.2)	951 (66.9)	21 (10.9)		
Underweight	20 (1.2)	19 (1.3)	1 (0.3)		17 (1.1)	16 (1.1)	1 (0.5)		
Self-perception of body weight				<0.001				<0.001	<0.0001
Very overweight	184 (10.6)	59 (4.2)	125 (38.2)		93 (5.8)	33 (2.3)	60 (31.1)		
Slightly overweight	640 (36.7)	494 (34.9)	146 (44.7)		391 (24.2)	299 (21.0)	92 (47.7)		
About right	815 (46.8)	767 (54.2)	48 (14.7)		892 (55.2)	858 (60.3)	34 (17.6)		
Slightly or very underweight	103 (5.9)	95 (6.7)	8 (2.5)		239 (14.8)	232 (16.3)	7 (3.6)		
Worry about weight				<0.001				<0.001	<0.001
Yes	641 (36.8)	432 (30.5)	209 (64.1)		249 (15.4)	171 (12.0)	78 (40.4)		
No	1,100 (63.2)	983 (69.5)	117 (35.9)		1,366 (84.6)	1,251 (88.0)	115 (59.6)		
Weight management goals				<0.001				<0.001	<0.001
Lose weight	839 (48.2)	570 (40.3)	269 (82.3)		457 (28.3)	349 (22.4)	138 (71.5)		
Stay the same	490 (28.1)	461 (32.6)	29 (8.9)		447 (27.7)	416 (29.3)	31 (16.1)		
Gain weight	55 (3.2)	50 (3.5)	5 (1.5)		242 (15.0)	233 (16.4)	9 (4.7)		
Do nothing	358 (20.5)	334 (23.6)	24 (7.3)		469 (29.0)	454 (31.9)	15 (7.8)		
Ever tried to lose weight				<0.001				<0.001	<0.001
Yes	1,037 (59.6)	742 (52.4)	295 (90.5)		609 (37.7)	456 (32.1)	153 (79.3)		
No	704 (40.4)	673 (47.6)	31 (9.5)		1,005 (62.3)	965 (67.9)	40 (20.7)		

Continued on following page

Table 1—Continued

	Female				Male				
	All	Type 1	Type 2	P value for type*	All	Type 1	Type 2	P value for type*	P value for sex†
Weight-loss practices‡									
Diet	841 (81.1)	586 (79.0)	255 (86.4)	0.006	403 (66.3)	282 (62.0)	121 (79.1)	<0.001	<0.001
Exercise	971 (93.6)	693 (93.4)	278 (94.2)	0.617	590 (96.9)	442 (96.9)	148 (96.7)	0.903	0.004
Fasting	98 (9.5)	46 (6.2)	52 (17.6)	<0.001	44 (7.2)	24 (5.3)	20 (13.1)	0.001	0.119
Diet pills	98 (9.5)	59 (8.0)	39 (13.2)	0.009	26 (4.3)	13 (2.8)	13 (8.5)	0.003	<0.001
Vomiting/laxative	31 (3.0)	19 (2.6)	12 (4.1)	0.200	6 (1.0)	3 (0.7)	3 (2.0)	0.158	0.008
Skip insulin§	49 (5.9)	39 (5.3)	10 (9.3)	0.100	7 (1.4)	6 (1.3)	1 (2.0)	0.699	<0.001
Any fasting, diet pills, vomiting, or laxative use	172 (16.6)	96 (12.9)	76 (25.8)	<0.001	67 (11.0)	35 (7.7)	32 (20.9)	<0.001	<0.001
Any of above or skip insulin	193 (18.6)	112 (15.0)	81 (27.5)	<0.001	70 (11.5)	38 (8.3)	32 (20.9)	<0.001	0.002

Data are means ± SD or n (%). *P values derived from χ^2 tests for categorical variables and t test for continuous variables, showing associations with diabetes type (type 1 versus type 2 diabetes) stratified by sex. †P values derived from χ^2 tests for categorical variables and t test for continuous variables, showing associations with sex (type 1 and type 2 diabetes combined). ‡Among youth who reported ever trying to lose weight. §Among those who reported ever trying to lose weight and were taking insulin at the time of the study visit. GED, general equivalency degree (high school).

The prevalence of fasting was 8.6%, diet aid use was 7.5%, vomiting or laxative use was 2.3%, and skipping insulin doses (among insulin users) was 4.2%. Females were more likely than males to report any unhealthy weight-loss practices, including ($P < 0.01$) and excluding ($P < 0.001$) skipping insulin doses.

Dieting, fasting, and using diet aids were more common among type 2 diabetic youth than among type 1 diabetic youth for both sexes, whereas exercise, vomiting or laxative use, and skipping insulin doses were equally prevalent for youth with either type of diabetes (Table 1). Type 2 diabetic youth were more likely to report unhealthy weight-loss practices than type 1 diabetic youth for both sexes. After adjustment for age, highest parental education, and race/ethnicity, type 2 diabetic females were more likely to diet and fast to lose weight than

type 1 diabetic females (Table 2). Although using diet aids, vomiting or laxative use, and skipping insulin were all more common among females with type 2 versus type 1 diabetes, the smaller number of females with type 2 diabetes and the low prevalence of these practices limited our power to detect a difference by type. Only dieting was more common among males with type 2 versus type 1 diabetes. In the model with both sexes combined, dieting, fasting, and using diet aids were all more common in youth with type 2 versus type 1 diabetes.

Correlates of any unhealthy weight-loss practice and weight-related issues

Separate multiple logistic regression analyses for females and males were used to identify the associations between the four outcomes (any unhealthy weight-loss

practice, self-perception of overweight, trying to lose weight, and worry about weight) and covariates (age category, BMI category, diabetes type, glycemic control, and race/ethnicity) (Table 3). For both females and males, being obese or overweight (compared with healthy weight) was associated with all outcomes with two exceptions: being overweight was not associated with any unhealthy weight-loss practice for females nor with worrying about weight for males.

Among females, all four outcomes were associated with increasing age and having type 2 versus type 1 diabetes. Poor glycemic control (A1C >9.5%) was associated with reporting any unhealthy weight-loss practice (OR 1.82 [95% CI 1.23–2.70]) and self-perception of overweight (1.47 [1.06–2.04]) but not with trying to lose weight or worry about

Table 2—Associations between each healthy and unhealthy weight-loss practices and diabetes type, by sex, among 1,646 youth aged ≥10 years of age who had ever tried to lose weight

	Healthy weight-loss practices		Unhealthy weight-loss practices			
	Exercise	Diet	Fasting	Diet aids	Vomiting/laxatives	Skip insulin
Female (n = 1,037)†						
Type 2 (referent, type 1)	1.41 (0.71–2.80)	1.97 (1.26–3.07)	2.43 (1.44–4.10)	1.71 (0.98–2.96)	2.34 (0.90–6.14)	1.34 (0.56–3.17)
Male (n = 609)†						
Type 2 (referent, type 1)	1.42 (0.42–4.81)	1.93 (1.17–3.19)	1.80 (0.84–3.84)	—‡	—‡	—‡
All youth (n = 1,646)§						
Type 2 (referent, type 1)	1.40 (0.77–2.54)	1.91 (1.37–2.67)	2.22 (1.45–3.40)	1.89 (1.18–3.02)	2.06 (0.89–4.76)	1.16 (0.52–2.59)

Data are ORs (95% CI) by logistic regression, modeling the probability of each weight-loss practice separately. †Adjusted for respondents' age category, highest parental education category, and race/ethnicity category. For these models, Asian/Pacific Islander youth, Native American youth, and youth of other race/ethnicity were combined into one group. ‡Prevalence too low to generate models. §Adjusted for covariates in previous model (†) plus sex.

Table 3—Prevalence and adjusted ORs for any unhealthy weight-loss practice, self-perception of overweight, trying to lose weight, and worry about weight by demographic characteristics, BMI categories, glycemic control, and diabetes type among 3,136 youth aged ≥ 10 years of age with type 1 or type 2 diabetes

	Outcomes for logistic regression models by sex								
	Any unhealthy weight-loss practices*		Self-perception of overweight†		Trying to lose weight‡		Worry about weight§		
	%	OR (95% CI)¶	%	OR (95% CI)	%	OR (95% CI)	%	OR (95% CI)	
Female (n = 1,165)									
BMI percentile									
Normal/underweight	53.0	6.4	1.00 (referent)	20.0	1.00 (referent)	24.2	1.00 (referent)	23.7	1.00 (referent)
Overweight	23.0	10.0	1.32 (0.84–2.07)	65.6	7.92 (5.93–10.59)	62.6	4.99 (3.80–6.56)	37.9	1.78 (1.36–2.33)
Obese	24.0	22.5	2.73 (1.71–4.37)	89.4	34.87 (22.20–54.77)	87.6	19.30 (12.77–29.15)	63.7	4.10 (2.96–5.67)
Age category									
10–12 years	31.6	3.5	1.00 (referent)	30.5	1.00 (referent)	31.3	1.00 (referent)	24.5	1.00 (referent)
13–15 years	32.3	8.8	2.09 (1.18–3.70)	46.6	1.56 (1.13–2.15)	50.3	1.86 (1.38–2.52)	38.4	1.58 (1.19–2.10)
16–18 years	23.5	19.2	5.03 (2.90–8.71)	61.8	3.41 (2.40–4.86)	61.3	3.06 (2.19–4.26)	43.3	1.81 (1.33–2.46)
≥ 19 years	12.6	20.7	5.61 (3.07–10.23)	63.6	4.50 (2.93–6.90)	61.1	3.64 (2.43–5.45)	49.8	2.51 (1.74–3.63)
Diabetes type									
Type 1	80.9	7.9	1.00 (referent)	38.8	1.00 (referent)	40.3	1.00 (referent)	30.1	1.00 (referent)
Type 2	19.1	24.7	1.82 (1.11–2.99)	83.1	1.56 (0.96–2.53)	81.8	1.49 (0.94–2.37)	64.2	1.56 (1.07–2.25)
Glycemic control¶									
A1C $< 8.0\%$	46.4	9.5	1.00 (referent)	46.9	1.00 (referent)	48.5	1.00 (referent)	35.6	1.00 (referent)
A1C 8.0–9.4%	29.9	8.9	1.16 (0.76–1.78)	41.6	0.98 (0.73–1.33)	43.7	1.03 (0.77–1.36)	33.8	1.13 (0.87–1.48)
A1C $> 9.5\%$	23.7	17.0	1.82 (1.23–2.70)	55.0	1.47 (1.06–2.04)	53.4	1.19 (0.87–1.62)	42.0	1.22 (0.92–1.62)
Male (n = 1,521)									
BMI percentile									
Normal/underweight	61.3	1.7	1.00 (referent)	7.7	1.00 (referent)	9.3	1.00 (referent)	9.5	1.00 (referent)
Overweight	18.1	5.5	3.03 (1.44–6.38)	44.4	9.47 (6.69–13.40)	40.0	6.14 (4.41–8.56)	13.5	1.32 (0.87–2.02)
Obese	20.6	11.5	4.60 (2.22–9.56)	82.1	44.16 (29.16–66.88)	72.8	20.24 (13.98–29.32)	34.5	3.28 (2.24–4.82)
Age category									
10–12 years	29.4	2.7	1.00 (referent)	26.9	1.00 (referent)	28.0	1.00 (referent)	14.5	1.00 (referent)
13–15 years	33.8	3.7	1.05 (0.49–2.26)	30.4	1.07 (0.73–1.55)	29.4	0.92 (0.66–1.30)	15.4	0.89 (0.61–1.30)
16–18 years	24.9	5.0	1.32 (0.60–2.89)	31.9	1.32 (0.87–2.01)	26.4	0.75 (0.51–1.10)	14.3	0.71 (0.46–1.09)
≥ 19 years	11.9	9.4	2.45 (1.04–5.77)	29.8	1.62 (0.96–2.73)	27.1	1.06 (0.65–1.73)	19.9	1.17 (0.71–1.94)
Diabetes type									
Type 1	88.0	2.7	1.00 (referent)	23.1	1.00 (referent)	22.2	1.00 (referent)	12.0	1.00 (referent)
Type 2	12.0	16.9	2.28 (1.09–4.75)	77.6	2.99 (1.72–5.20)	70.0	2.47 (1.52–4.01)	40.4	2.04 (1.29–3.22)
Glycemic control¶									
A1C $< 8.0\%$	50.6	4.4	1.00 (referent)	33.0	1.00 (referent)	30.7	1.00 (referent)	14.7	1.00 (referent)
A1C 8.0–9.4%	29.5	2.7	0.87 (0.43–1.76)	27.2	1.06 (0.75–1.49)	26.8	1.17 (0.85–1.61)	14.3	1.33 (0.93–1.91)
A1C $> 9.5\%$	19.9	6.9	1.49 (0.78–2.82)	24.8	0.79 (0.52–1.20)	22.8	0.80 (0.54–1.20)	18.8	1.31 (0.88–1.96)

*Includes 179 females and 67 males who reported ever having tried to lose weight through fasting, using diet pills without a physician's prescription, vomiting or laxative use, or skipping insulin versus all other youth. †Includes 763 female and 451 male youth who describe themselves as slightly or very overweight. ‡Includes 779 female and 425 male youth who reported that they were trying to lose weight. §Includes 510 female and 234 male youth reported that they worried about their weight. ¶ORs are adjusted for race/ethnicity as well as all other variables in the model as shown in each column. ¶A1C was measured at the study visit and categorized as good (A1C $< 8.0\%$), marginal (8.0–9.4%), and poor ($\geq 9.5\%$) glycemic control using the American Diabetes Association recommendations (20).

weight. Race/ethnicity was only associated with perception of being overweight or obese ($P = 0.03$). Among males, age was only associated with reporting any unhealthy weight-loss practice, with youth aged ≥ 19 years having a higher odds of ever reporting any practice compared with those aged 10–12 years (2.45 [1.04–5.77]). Having type 2 diabetes was associated with all outcomes. There was no association between any outcome and glycemic control. Race/ethnicity was only associated with worrying about weight ($P = 0.01$).

CONCLUSIONS— To our knowledge, this is the first report of weight-related issues and weight-loss practices comparing youth with type 1 and type 2 diabetes by sex. Whereas desiring to lose weight, worrying about weight, and having ever tried to lose weight were very common and not unexpected findings among type 2 diabetic youth, these characteristics were not uncommon among type 1 diabetic youth either, particularly among females, of whom 11% were obese. We found that reporting any unhealthy weight-loss practice was more common among type 1 than type 2 diabetic youth. Obese females and overweight/obese males were more likely to report any of these unhealthy practices than healthy weight youth. Among females but not males, there was an association between poor glycemic control and reporting any unhealthy weight-loss practice.

We compared the weight-loss practices of the 2,837 type 1 diabetic youth in SEARCH with results from diabetes clinic cohorts from Minnesota ($n = 143$), eastern Canada ($n = 361$), and Philadelphia ($n = 295$) (9,10,22). Exercise for weight-loss was more common in SEARCH participants (females 93.4%; males 96.9%) than among youth in Minnesota (89.9 and 47.9%, respectively) or Philadelphia (77.8 and 62.5%, respectively) for weight loss or maintenance (10,22). In the Canadian study, only 12% of females reported dieting for weight loss compared with 79% in SEARCH. Of the unhealthy practices, for females and males, 7.4 and 1.4% from the Minnesota study and 6.7 and 2.6% from Philadelphia, respectively, reported fasting, compared with 6.2% of females and 5.3% of males in SEARCH. Skipping insulin was more prevalent in the Minnesota (10.3%) than in the SEARCH (2.6%) or Philadelphia (1.5%)

females but not in males (1.4, 1.3, and 1.3%, respectively). Skipping insulin was also more common in the female Canadian cohort (11%), although these researchers also included underdosing in their measure (23). Disordered eating in the Minnesota study was also associated with poor glycemic control in both sexes (10). In the Philadelphia cohort, older females with higher BMI and A1C exhibited significantly more weight-control behaviors (22). In SEARCH, we found that glycemic control was associated with any unhealthy weight-loss practice in females but not in males. The composite measure that we used for any unhealthy weight-loss practice in the current article differs from that in other studies. We found no published studies of weight-loss practices among type 2 diabetic youth with which we could compare our results.

The prevalence of healthy and unhealthy weight-loss practices reported by the SEARCH cohort could not be directly compared with the YRBSS because of the subgroups asked the questions (in SEARCH, those who had ever tried to lose weight; in YRBSS, those who tried for weight loss or maintenance) and different time frames specified for these questions (SEARCH, ever; YRBSS, past 30 days). In general, healthy practices, diet and exercise, were more common among SEARCH participants for weight loss than among YRBSS respondents for weight loss or maintenance (7). SEARCH males had a prevalence of unhealthy practices similar to that of those in YRBSS, whereas SEARCH females were more likely to fast and use vomiting or laxatives for weight-loss than females in YRBSS for weight loss or maintenance.

Of the youth aged ≥ 10 years in the SEARCH study cohort who completed a study visit, $\sim 21\%$ were overweight and 22% were obese. Data from the National Health and Nutrition Examination Survey for 2003–2006 demonstrated that 16.5% of U.S. youth aged 12–19 years were overweight (BMI $\geq 85^{\text{th}}$ – $< 95^{\text{th}}$ percentile) and 17.6% were obese (BMI $\geq 95^{\text{th}}$ percentile), whereas 15 and 17% of youth aged 6–11 years were overweight and obese, respectively (24). The higher prevalence of overweight and obesity among youth in SEARCH compared with the general U.S. population is to be expected, given that 15% of youth in the SEARCH study have type 2 diabetes, a condition that is strongly associated with obesity.

Strengths and limitations

Our study includes $> 3,000$ racially/ethnically diverse youth with diabetes, including > 500 youth with type 2 diabetes, probably the largest cohort of its kind in the U.S. Our data allowed us to compare the weight-related issues and weight-loss practices of youth with type 1 diabetes with those of youth with type 2 diabetes and by sex using the same methodology and survey questions. This study has several limitations. Because weight-loss practices may have occurred recently or in the distant past, we were not able to report associations between clinical indicators and individual weight-loss practice. Instead, we used a composite measure of “any unhealthy weight-loss practice” as a marker for a history of such unhealthy behavior. Additionally, we could not assume that the respondents’ current BMI category was reflective of BMI at the time of these practices or whether these practices occurred before or after diabetes diagnosis. Although we characterized eating less food, fewer calories, or foods lower in fat as a healthy weight-loss practice, some youth may have overrestricted their food/calorie intake. Finally, despite extensive efforts to optimize recruitment, $\sim 47\%$ of eligible youth completed the SEARCH study visit (25).

Summary and clinical implications

In this cohort of youth with type 1 and type 2 diabetes, overweight and obesity were common and 60% of females and 38% of males reported ever trying to lose weight. Healthy weight-loss practices such as dieting and physical activity were quite common among these youth with type 1 and type 2 diabetes. Youth with type 2 diabetes were more likely than those with type 1 diabetes to report using any unhealthy weight-loss practice; females exhibited a higher prevalence of unhealthy practices than did males. In addition, among females, poor glycemic control was associated with reporting any unhealthy weight-loss practice and perceiving that they were overweight.

Given the high prevalence of overweight and obesity among type 2 diabetic youth, the increasing prevalence of these conditions in type 1 diabetic youth (5,6), and the pressures on some overweight and obese youth to lose weight, it is likely that approaches to weight management will not always be healthy ones. Such practices may have a negative effect on diabetes management, including glycemic control, a risk factor for future com-

plications. Physicians and other health care professionals caring for diabetic youth, particularly females, need to identify those with unhealthy weight-loss practices and provide them with more healthy weight-management strategies in the context of their ongoing diabetes management.

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References

- Allen P, Vessey J: *Primary Care of the Child with a Chronic Condition*. St. Louis, MO, Mosby, 2004
- Liese AD, D'Agostino RB Jr, Hamman RF, Kilgo PD, Lawrence JM, Liu LL, Loots B, Linder B, Marcovina S, Rodriguez B, Standiford D, Williams DE: The burden of diabetes mellitus among US youth: prevalence estimates from the SEARCH for Diabetes in Youth Study. *Pediatrics* 118:1510–1518, 2006
- Dabelea D, Bell RA, D'Agostino RB Jr, Imperatore G, Johansen JM, Linder B, Liu LL, Loots B, Marcovina S, Mayer-Davis EJ, Pettitt DJ, Waitzfelder B: Incidence of diabetes in youth in the United States. *JAMA* 297:2716–2724, 2007
- Shaw J: Epidemiology of childhood type 2 diabetes and obesity. *Pediatr Diabetes* 8 (Suppl. 9):7–15, 2007
- Reinehr T, Holl RW, Roth CL, Wiesel T, Stachow R, Wabitsch M, Andler W: Insulin resistance in children and adolescents with type 1 diabetes mellitus: relation to obesity. *Pediatr Diabetes* 6:5–12, 2005
- Libman IM, Pietropaolo M, Arslanian SA, LaPorte RE, Becker DJ: Changing prevalence of overweight children and adolescents at onset of insulin-treated diabetes. *Diabetes Care* 26:2871–2875, 2003
- Eaton DK, Kann L, Kinchen S, Ross J, Hawkins J, Harris WA, Lowry R, McManus T, Chyen D, Shanklin S, Lim C, Grunbaum JA, Wechsler H: Youth risk behavior surveillance—United States, 2005. *MMWR Surveill Summ* 55:1–108, 2006
- Hamilton J, Daneman D: Deteriorating diabetes control during adolescence: physiological or psychosocial? *J Pediatr Endocrinol Metab* 15:115–126, 2002
- Peveler RC, Bryden KS, Neil HA, Fairburn CG, Mayou RA, Dunger DB, Turner HM: The relationship of disordered eating habits and attitudes to clinical outcomes in young adult females with type 1 diabetes. *Diabetes Care* 28:84–88, 2005
- Neumark-Sztainer D, Patterson J, Mellin A, Ackard DM, Utter J, Story M, Sockalosky J: 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. *Diabetes Care* 25:1289–1296, 2002
- Affenito SG, Lammi-Keefe CJ, Vogel S, Backstrand JR, Welch GW, Adams CH: Women with insulin-dependent diabetes mellitus (IDDM) complicated by eating disorders are at risk for exacerbated alterations in lipid metabolism. *Eur J Clin Nutr* 51:462–466, 1997
- Affenito SG, Backstrand JR, Welch GW, Lammi-Keefe CJ, Rodriguez NR, Adams CH: Subclinical and clinical eating disorders in IDDM negatively affect metabolic control. *Diabetes Care* 20:182–184, 1997
- Bantle JP, Wylie-Rosett J, Albright AL, Apovian CM, Clark NG, Franz MJ, Hoogwerf BJ, Lichtenstein AH, Mayer-Davis E, Mooradian AD, Wheeler ML: Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. *Diabetes Care* 31 (Suppl 1):S61–S78, 2008
- Mayer-Davis EJ: Type 2 diabetes in youth: epidemiology and current research toward prevention and treatment. *J Am Diet Assoc* 108:S45–S51, 2008
- SEARCH for Diabetes in Youth: a multicenter study of the prevalence, incidence and classification of diabetes mellitus in youth. *Control Clin Trials* 25:458–471, 2004
- Kuczumarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, Mei Z, Curtin LR, Roche AF, Johnson CL: CDC growth charts: United States. *Adv Data* 8:1–27, 2000
- Kuczumarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL: CDC Growth Charts for the United States: methods and development. *Vital Health Stat* 11 1–190, 2002
- Barlow SE: Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 120 (Suppl 4):S164–S192, 2007
- Brener ND, Kann L, Kinchen SA, Grunbaum JA, Whalen L, Eaton D, Hawkins J, Ross JG: Methodology of the youth risk behavior surveillance system. *MMWR Recomm Rep* 53:1–13, 2004
- Silverstein J, Klingensmith G, Copeland K, Plotnick L, Kaufman F, Laffel L, Deeb L, Grey M, Anderson B, Holzmeister LA, Clark N: Care of children and adolescents with type 1 diabetes: a statement of the American Diabetes Association. *Diabetes Care* 28:186–212, 2005
- U.S. Census Bureau: United States Census, 2000. [article online], 2008. Available from <http://www.census.gov/main/www/cen2000.html>. Accessed 18 July 2008
- Howe CJ, Jawad AF, Kelly SD, Lipman TH: Weight-related concerns and behaviors in children and adolescents with type 1 diabetes. *J Am Psychiatr Nurses Assoc* 13:376–385, 2008
- Jones JM, Lawson ML, Daneman D, Olmsted MP, Rodin G: Eating disorders in adolescent females with and without type 1 diabetes: cross sectional study. *BMJ* 320:1563–1566, 2000
- Ogden CL, Carroll MD, Flegal KM: High body mass index for age among US children and adolescents, 2003–2006. *JAMA* 299:2401–2405, 2008
- Liese AD, Liu L, Davis C, Standiford D, Waitzfelder B, Dabelea D, Bell R, Williams D, Imperatore G, Lawrence JM: Participation in pediatric epidemiologic research: the SEARCH for Diabetes in Youth Study experience. *Contemp Clin Trials* 29:829–836, 2008