Prediction of the Onset of Disturbed Eating Behavior in Adolescent Girls With Type 1 Diabetes

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OBJECTIVE — The purpose of this study was to identify predictors of the onset of disturbed eating behavior (DEB) in adolescent girls with type 1 diabetes.

RESEARCH DESIGN AND METHODS — In this prospective study, participants completed the Children's Eating Disorder Examination interview and self-report measures at baseline and at four follow-up assessments over 5 years. Participants were 126 girls with type 1 diabetes, aged 9–13 years at baseline. Of the 101 girls who did not have DEB at baseline, 45 developed DEB during the follow-up period; the 38 for whom data were available for the assessment before onset of DEB were compared with 38 age-matched girls who did not develop DEB. DEB was defined as dieting for weight control, binge eating, self-induced vomiting, or the use of diuretics, laxatives, insulin omission, or intense exercise for weight control.

RESULTS — Logistic regression indicated that a model including BMI percentile, weight and shape concern, global and physical appearance-based self-worth, and depression was significantly associated with DEB onset ($\chi^2 = 46.0$, 5 d.f., $P < 0.0001$) and accounted for 48.2% of the variance.

CONCLUSIONS — Even though scores on the measures were within the published normal range, the onset of DEB was predicted by higher depression and weight and shape concerns and lower global and physical appearance–based self-worth as well as higher BMI percentile 1–2 years earlier compared with those not developing DEB. Early interventions focused on helping girls with diabetes develop positive feelings about themselves, their weight and shape, and their physical appearance may have protective value.

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Disturbed eating behavior (DEB) tends to persist and worsen over time and is associated with the development of clinical eating disorders (1). Both clinical and subthreshold eating disorders are more common in teenage girls and young women with type 1 diabetes than in their nondiabetic peers (2,3) and have more significant health consequences in this population related to compromised metabolic control (2,4) and increased risk of hospitalization and diabetes-related medical complications (5,6). Identification of risk factors for DEB in girls with diabetes is of practical utility because it may allow targeted interventions to be instituted to prevent or diminish the onset of DEB in this high-risk group.

In their recent review of risk factors for eating disorders, Striegel-Moore and Bulik (1) noted that internalization of an ideal of bodily thinness, body dissatisfaction, higher body weight, and dieting have consistently been identified as predictors of eating disturbance in longitudinal studies. Negative affect, including depressed mood and low self-esteem (7), and low perceived social support (8) have also been shown to predict subsequent disordered eating in some studies. However, evidence for the role of all of these risk factors has been limited. Although the mechanisms that account for the increased risk in girls with diabetes are not certain, diabetes has been associated with elevations in some of the risk factors. In particular, higher BMI and depression and lower self-esteem have been noted in adolescents with diabetes compared with their nondiabetic peers and have been postulated to be important risk factors (9). In addition, the attention to dietary intake required for management of diabetes may amplify problems related to eating and body weight in these individuals.

The purpose of this study was to identify predictors of the onset of DEB in adolescent girls with type 1 diabetes by conducting a prospective longitudinal investigation that spanned 5 years. Age at recruitment was intended to select girls who had not yet developed DEB but who would move into the age of peak risk over the follow-up period. Careful attention was paid to the assessment of DEB with the use of age-appropriate semistructured interviews, taking into account the appropriate balance between the comprehensiveness of the assessment and participant burden. In addition to evaluating eating attitudes and behaviors, longitudinal assessments included indicators of body weight, body dissatisfaction, self-esteem, depression, and quality of relationships with parents and peers.

RESEARCH DESIGN AND METHODS — Girls with type 1 diabetes, aged 9–13 years, were recruited into the baseline phase of this study during diabetes clinic appointments at the Hospital for Sick Children in Toronto, Ontario, Canada, from 1998 to 2001, as described in an earlier report (10). Exclusion criteria were lack of fluency in English, developmental delay, and diagnosis of type 1 diabetes <6 months before the start of the study (i.e., at baseline). Informed written consent from a parent or guardian and verbal assent from the girl were obtained for participants aged <18

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years; for those aged ≥18 years, informed written consent was obtained from each participant. Girls with a significant eating problem were offered referral to an eating disorder program.

Measures

All participants were interviewed by using the Children's Eating Disorder Examination (cEDE) (11) at baseline through to the 3-year follow-up and then by using the adult version of the Eating Disorder Examination (EDE) (12) at the 5-year follow-up. The EDE is a widely used semistructured diagnostic interview with acceptable reliability and validity (12,13). It can be used to identify and rate the severity of the psychological and behavioral disturbances associated with eating disorders and to make clinical diagnoses of eating disorders, based on *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, criteria. The language of the cEDE has been slightly modified to be appropriate for individuals aged 7–14 years (11), but otherwise the cEDE and EDE are psychometrically identical. The cEDE also has acceptable validity and reliability (11,14). The cEDE consists of 38 items including questions that were added regarding the use of insulin dosage manipulation or omission as a weight control strategy (2). Some cEDE items provide information about specific behaviors such as binge eating, vomiting, and excessive exercise for the purpose of weight control, and other items contribute to four composite subscales that assess Restraint, Eating Concern, Shape Concern, and Weight Concern. Inter-rater reliability was high: 0.93–0.98 on cEDE subscales. The Eating Concern subscales and the average of the Weight Concern and Shape Concern subscales were used as predictors of DEB. Specific behavioral items from the cEDE were used to define DEB. Because the dieting item was included in our definition of DEB, the Restraint subscale, which includes this item, was not included as a potential predictor. There was no overlap between items used to define DEB and items included on subscales used as predictors of DEB.

Definition of DEB

DEB was defined as the presence of any of the following in the past month, as reported in the cEDE interview: dieting (identified by item 3 on the cEDE, which was modified with an additional question to ensure that the individual had decreased dietary intake with the goal of los-

ing weight rather than for diabetes management); objective binge-eating; self-induced vomiting for weight control; the use of diuretics, laxatives, or insulin omission for weight control; or intense, excessive exercise for weight control (defined as >30 min/day, predominantly for weight control, and not for fitness or leisure) (15).

Self-esteem was measured with the Self-Perception Profile for Children (SPPC) (16). This 36-item multidimensional instrument evaluates children's perception of their own competence in several domains. In the current study, the Physical Appearance and Global Self-Worth subscales were used as indicators of self-esteem, and the Social Acceptance subscale was included as an indicator of peer support. Reliability and validity have been established for this measure (14).

Depression was assessed with the Children's Depression Inventory (CDI) (17), a 27-item self-report measure of the severity of depressive symptoms that was derived from the Beck Depression Inventory for use in children and adolescents aged 7–17 years. This measure has been shown to have high internal consistency (18) and construct and discriminant validity in clinical and nonclinical pediatric populations (19).

Quality of attachment to parents was measured with the Inventory of Parent and Peer Attachment (IPPA) (20). The IPPA is a 60-item self-report that has been widely used in adolescent and preadolescent populations to investigate feelings about parents' accessibility and degree of emotional attunement. Separate subscales are generated for feelings about mother and father. The IPPA demonstrates good reliability and validity (20).

Height and weight were measured by diabetes clinic personnel. BMI was calculated and expressed as a percentile based on U.S. norms (21). A1C was measured by high-performance liquid chromatography using the Bio-Rad Variant method (nondiabetic range 4–6.3%) (22). This method has been standardized against the Diabetes Control and Complications Trial A1C values.

Socioeconomic status level was estimated from the participant's postal code, using Statistics Canada 1998 data, which provide mean family income level by postal walk (a geographic grouping of several hundred households). Using Statistics Canada's guidelines, six levels of mean family income were defined, with 1 being the lowest and 6 being the highest.

Procedures

Repeated assessments were performed at baseline and 1, 2, 3, and 5 years later. From the 1-year to the 3-year follow-up, girls who had refused participation at one assessment point were not asked to participate at a subsequent assessment date. However, at the 5-year follow-up, all girls who had participated at baseline were again invited to take part in the study.

Girls who met the criteria for DEB at the baseline assessment were excluded from the current study. Girls who developed DEB over the course of the study were compared with age-matched girls who did not develop DEB. Predictor variables were measured at the assessment directly before onset; for girls with no onset the same assessment time as their matched case subject was used.

Statistical analysis

Student's *t* tests were used to compare participant groups on age, BMI, and A1C levels and to compare participants to nonparticipants on a series of measures at baseline. Nine variables were chosen as potential predictors of DEB onset, all measured at the assessment immediately before onset: *1*) BMI expressed as a percentile for age; *2*) the Eating Concern and *3*) mean of the Weight Concern and Shape Concerns subscales of the EDE; *4*) the Social Acceptance, *5*) Physical Appearance, and *6*) Global Self-Worth subscales of the SPPC; *7*) the CDI; and *8*) the Mother and *9*) Father subscales of the IPPA. Logistic ordinal regression with DEB onset as the dependent variable was performed for each of the nine independent variables to examine the predictive utility of each variable separately. This was followed by a stepwise logistic regression with backward elimination to identify a multivariate predictor model. Backward elimination allows for the detection of suppressor effects that can be missed with forward inclusion methods (23). The McFadden R^2 is reported as a measure of effect size following the recommendations of Menard (23).

RESULTS

Participation rates and selection bias

Of the 126 girls who participated at baseline (126 of 177, 71.2% participation), 106 participated at the 1-year follow-up, 88 participated at the 2-year follow-up, 76 participated at the 3-year follow-up, and 98 participated at the 5-year follow-up (77.8%

participation overall). Of the 177 girls who were invited to participate in the study at baseline, 51 declined; participation bias could not be assessed because no information was available for nonparticipants. Of the 126 girls who participated at baseline, 19 were identified as having DEB at that time and were excluded from the current study. Of these 19 girls, 3 reported insulin manipulation, 4 reported binge episodes, 10 reported excessive exercises for weight control, and 13 reported dieting to lose weight. Of the 107 girls with no DEB at baseline, 101 had at least one follow-up assessment and could be included in the current study. Of these 101 girls, 45 developed DEB during the follow-up period. The 38 who had data available for the assessment directly before the onset of DEB were compared with 38 age-matched girls who did not develop DEB during the study.

To assess for selection bias, the 76 participants in the current study were compared with the remaining 31 girls who did not have DEB at baseline and were thus eligible for the current study but did not have sufficient follow-up data. These two groups were compared with a series of *t* tests on the nine predictor variables noted above as well as on age, duration of diabetes, A1C, and socioeconomic status at baseline. There were significant differences on EDE Eating Concern ($P <$ 0.05) and the Mother ($P <$ 0.02) and Father ($P <$ 0.03) subscales of the IPPA, indicating that study participants had stronger eating concerns and weaker attachments to both parents. Although the differences were small and means for both groups on all of these measures were in the normal range, these differences do indicate that the study sample is not completely representative of the baseline sample.

Characteristics of study sample. At baseline the mean ± SD age of the girls was 11.9 ± 1.4 years and the duration of diabetes was 4.3 ± 3.1 years. Their BMI expressed as a percentile was 64.1 ± 24.0, indicating that they were above the median weight for their age and height. A1C was 8.3 ± 1.1. Families for 12.6% of the girls were from the two lowest socioeconomic status categories, families for 69.6% were from the two middle categories, and families for 17.7% were from the highest groups.

Of the 38 girls who developed DEB during the study, first onset occurred at the 1-year follow-up for 10 girls, at the

Table 1—Characteristics of study sample

	No DEB	DEB onset	*t*	d.f.	*P*
Baseline					
Age (years)	11.9 + 1.4	11.9 + 1.4	0.06	74	NS
BMI (percentile)	52.9 + 23.6	75.2 + 18.7	4.54	74	<0.0001
A1C	8.2 + 1.2	8.3 + 1.0	70.89	73	NS
Assessment before onset					
Age (years)	13.6 + 1.6	13.7 + 1.6	0.14	74	NS
BMI (percentile)	60.5 + 26.1	79.7 + 17.9	3.72	73	<0.0001
A1C	8.2 + 1.2	8.4 + 1.0	0.60	73	NS
Assessment at onset					
Age (years)	15.2 + 1.9	15.2 + 1.9	0.03	74	NS
BMI (percentile)	66.1 + 25.4	80.7 + 17.4	2.93	74	<0.005
A1C	8.1 + 1.0	8.6 + 1.2	2.09	74	<0.04

Data are means ± SD.

2-year follow-up for 7 girls, at the 3-year follow-up for 7 girls, and at the 5-year follow-up for 14 girls. None of the girls developed a clinical eating disorder during the course of the study, and none reported insulin manipulation at the time DEB onset was identified. However, two girls reported insulin omission at an assessment 2 or 3 years after they were classified as having onset of DEB.

Data for age, A1C, and BMI percentile at baseline, and the assessments immediately before onset and at onset are presented for girls with DEB onset and girls with no onset in Table 1. The two groups were well matched on age. They had similar A1C levels before onset of DEB, but higher A1C levels occurred with DEB onset. The group with DEB onset had significantly higher BMI percentiles at each assessment time. At the assessment before onset, the correlation between BMI percentile and the mean of the EDE Weight Concern and Shape Concern subscales was 0.30 ($P <$ 0.01), indicating that although weight and concern with weight are clearly related they are also distinct constructs.

Prediction of DEB onset. The predictive utility of each of the nine predictor variables was examined separately in a series of univariate logistic regressions. Means, univariate significance levels, and McFadden R^2 are presented in Table 2 for the nine predictor variables. The strongest univariate predictors of the onset of DEB were the mean of the Weight Concern and Shape Concern subscales (21.0% of the variance), the Physical Appearance subscale of the SPPC (20.0% of the variance), the CDI (15.4% of the variance), and BMI percentile (12.4% of the variance). To assess overall multivariate

predictive utility and control for redundancy among predictor variables, logistic regression analysis with backward stepwise selection from the full model of nine variables was used to identify a model that efficiently predicted DEB onset. Four of the nine predictor variables were removed from the model without a significant reduction in predictive utility. The variables removed were either not significantly associated with DEB onset (EDE Eating Concern and SPPC Social Acceptance) or were statistically redundant (IPPA Mother and IPPA Father) with the variables that remained in the model. The remaining model included *1*) BMI percentile, *2*) the mean of the Weight Concern and Shape Concern subscales of the EDE, *3*) the Physical Appearance and *4*) Self-Worth subscales of the SPPC, and *5*) the CDI. This five-variable model was significantly associated with DEB onset (χ^2 = 46.0, 5 d.f., $P <$ 0.0001) and accounted for 48.2% of the variance, based on McFadden's R^2.

CONCLUSIONS — In one of the first longitudinal studies conducted to track the development of DEB in girls with type 1 diabetes, we found that new-onset DEB was predicted by BMI percentile, concerns with weight and shape, lower self-esteem related to physical appearance, lower global self-esteem, and more reported depressive symptoms 1–2 years earlier. The findings are strong, and the predictors identified are consistent with previous research conducted with girls who did not have diabetes. The failure to establish predictive utility for peer support and quality of relationships with parents is also consistent with findings in previous studies (24).

Table 2—*Group means and univariate regressions at assessment immediately before onset*

| | No DEB | DEB onset | Univariate logistic regression | | |
			χ^2 (1 d.f.)	P	R^2
BMI percentile	60.5 + 26.1	79.7 + 17.9	12.86	<0.0001	0.124
EDE Eating Concern	0.01 + 0.03	0.02 + 0.05	1.05	NS	0.010
EDE Weight Concern and					
Shape Concern	0.05 + 0.10	0.36 + 0.47	22.09	<0.0001	0.210
SPPC Physical Appearance	3.35 + 0.50	2.61 + 0.81	20.80	<0.0001	0.200
SPPC Self-Worth	3.52 + 0.46	3.24 + 0.65	4.54	<0.03	0.044
SPPC Social Acceptance	3.39 + 0.43	3.22 + 0.69	1.69	NS	0.016
IPPA Mother	106.3 + 14.1	96.8 + 18.9	6.03	<0.02	0.058
IPPA Father	100.8 + 17.7	91.6 + 21.2	3.91	<0.05	0.040
CDI Depression	3.4 + 3.4	8.5 + 6.9	16.02	<0.0001	0.154

Data are means ± SD unless indicated otherwise.

It was expected that DEB onset would be predicted by earlier signs of mild to moderate problems or distress, and examination of the means in Table 2 shows that the differences consistently follow this pattern. As there are no established clinical cutoffs for the EDE, SPPC, or CDI, the only method available to evaluate the magnitude of the pathology observed in the study sample is to compare our means to those observed in previous studies. Mean cEDE scores for the DEB onset group are similar to those observed in an age-matched group of school girls collected in a parallel study (25) and thus cannot be considered elevated. A similar pattern was observed for the SPPC; mean scores for the DEB onset group are in the same range as those reported for a normative sample of grade 5–6 girls (16). There are two previous reports of mean CDI scores for nonclinical samples of similarly aged schoolchildren (18,26), and, taken together, they lead to the conclusion that the DEB-onset group had mean scores toward the higher end of those observed in other nonclinical groups. Contrary to expectations, there is no evidence in the current study that the girls who subsequently developed DEB had elevated scores on the predictor variables relative to other nonclinical samples. Rather, the relatively low scores in the no-onset group contributed to the differences between DEB onset and no-onset groups.

That apparently "normal" scores are associated with subsequent development of DEB is surprising and suggests that, for early adolescent females with diabetes, particular strengths may be needed to avoid development of DEB. In fact, if girls with DEB at baseline are included, half of the sample showed DEB at one or more assessments over the 5-year course of the

study (15). The frequency of this behavior is of concern because of its potential association with impaired metabolic control and diabetes-related medical complications (2–4,6). In the current study the girls with DEB onset had poorer metabolic control coincident with the onset of DEB, indicating that even mild and relatively new disturbances in eating may have a significant impact.

The finding that statistically average levels of shape and weight concern are associated with subsequent onset of DEB is not consistent with at least some previous findings. In one study, more extreme responses to items measuring thin body preoccupation were associated with case identification (27), and in another study mean scores for participants who subsequently developed eating problems were above average (28). However, in other studies, the use of data reduction techniques, novel measures, and the presentation of results in terms of associations and relationships rather than in terms of absolute levels precludes identifying the degree of shape and weight concerns that predicts future eating disturbance.

The failure to observe high mean scores on the Weight Concern and Shape Concern subscales of the EDE at the assessment before onset is counterintuitive. However, because girls with DEB at baseline were excluded from the study, the current sample is biased toward lower levels of eating-related disturbance. This bias might explain the generally low scores on the risk factors, in comparison with those found in unselected samples. Although scores for the DEB onset group were not elevated compared with general population mean scores, they were higher than those in the no-onset group and do appear to be predictive of subsequent

DEB onset. A number of measures were taken to avoid differential assessment bias on the EDE. The EDE interviews were carefully conducted by trained assessors, and adjustments were made to ensure that the attention to diet required for diabetes care was not coded as weight control and would not influence ratings on the Weight Concern and Shape Concern subscales. Furthermore, at the assessment in which new-onset DEB was detected, mean EDE scores for the onset group were well above average, as would be expected, and the mean scores for the no-onset group remained unusually low. The fact that the assessment before onset occurred in different assessment years for different participants also argues against differential assessment bias.

Higher BMI percentile was associated with subsequent DEB onset in the current study and accounted for 12% of the variance. Girls with diabetes are on average heavier than their nondiabetic peers (29), which may partially explain their increased risk for DEB. A lower BMI, fewer weight and shape concerns, and more positive feelings about one's physical appearance and one's self are factors that cluster together and overlap substantially but not completely. This cluster, augmented by a notable lack of depressive symptoms, seems to offer protection from the development of DEB during adolescence in girls with diabetes. In contrast, even average levels of weight and shape concerns and feelings about physical appearance and self-worth combined with slight elevations in depressive symptoms may signal vulnerability to the future development of DEB.

Limitations of the current study include a relatively small sample size, failure to test the risk factors for specificity in the prediction of DEB, as opposed to other outcomes, and a potential lack of generalizability of the findings to girls who do not have diabetes. Strengths include the use of a validated diagnostic interview, a reasonable participation rate, and temporal precedence for the identified risk factors.

The findings of the study have important clinical implications because they suggest that the threshold for identifying girls with diabetes who are at risk for DEB needs to be set very low. Early interventions focused on helping girls with diabetes develop positive feelings about themselves and about their weight, shape, and physical appearance may be helpful

and protect from the development of DEB.

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