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 EDE interview and self-report measures at baseline and at 4 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 prior to onset of DEB were compared to 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-square=46.0, d.f.=5, p < .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 one to two years earlier compared to 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.
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 non-diabetic 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 as 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) note 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 to their non-diabetic peers and have been postulated to be important risk factors (9). As well 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 five 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 semi-structured 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**

**Participants**—Girls with type 1 diabetes, 9-13 years of age, were recruited into the baseline phase of this study during Diabetes Clinic appointments at the Hospital for Sick Children in Toronto, Canada, from 1998-2001, 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 prior to the start of the study (i.e., at baseline). Informed written consent from a parent or guardian and verbal assent from the participant were obtained for participants less than 18 years old; for those 18 or older, 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 using the Children's Eating Disorder Examination (cEDE; 11) at baseline through to the 3-year follow-up, and then using the adult version of the Eating Disorder Examination (EDE; 12) at 5-year follow-up. The EDE is a widely-used semi-structured 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 DSM-IV criteria. The language of the cEDE has been slightly modified to be appropriate for individuals 7-14 years of age (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 4 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 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 losing 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 minutes/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 7-17 years of age. This measure has been shown to have high internal consistency (18) and construct and discriminant validity in clinical and non-clinical 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). Hemoglobin A1c (HbA1c) was measured by HPLC using the Bio-Rad Variant Method (non-diabetic range 4 - 6.3%; 22). This method has been standardized against the DCCT HbA1c values.

Socioeconomic status (SES) 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, 6 levels of mean family income were defined, with 1 the lowest and 6 the highest.

**Procedures**—Repeated assessments were performed at baseline and 1, 2, 3 and 5 years later. From 1-year to 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 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 to age-matched girls who did not develop DEB. Predictor variables were measured at the assessment directly prior to onset; for girls with no onset the same assessment time as their matched case was used.

**Statistical Analysis**—Student’s t-tests were used to compare participant groups on age, BMI and HbA1c levels and to compare participants to non-participants on a series of measures at baseline. Nine variables were chosen as potential predictors of DEB onset, all measured at the assessment immediately prior to onset: 1) BMI expressed as a percentile for age, 2) the Eating Concern and 3) mean of the Weight 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 conducted 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 R² is reported as a measure of effect size following the recommendations of Menard (23).

**RESULTS**

**Participation Rates and Selection Bias**—One hundred and twenty-six girls participated at baseline (126/177, 71.2% participation), 106 at 1-year follow-up, 88 at 2-year, 76 at 3-year, and 98 at 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 as no information was available for non-participants. 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 prior to the onset of DEB were compared to 38 age-matched girls who did not develop DEB during the study.

In order to assess for selection bias, the 76 participants in the current study were compared to 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, HbA1c and socioeconomic status at baseline. There were significant differences on EDE Eating
Concern \((p < .05)\), and the Mother \((p < .02)\) and Father \((p < .03)\) 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 age of the girls was 11.9 (SD = 1.4) years and the mean duration of diabetes was 4.3 (SD = 3.1) years. Their mean BMI expressed as a percentile was 64.1 (SD = 24.0) indicating that they were above the median weight for their age and height. Mean HbA1c was 8.3 (SD = 1.1). Families for 12.6\% of the girls were from the two lowest socioeconomic status categories, 69.6\% were from the two middle categories and 17.7\% were from the highest groups.

Of the 38 girls who developed DEB during the study, first onset occurred at 1-year follow-up for 10 girls, 2-year follow-up for 7, 3-year follow-up for 7, and 5-year follow-up for 14. 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 two or three years after they were classified as having DEB onset.

Means on age, HbA1c and BMI percentile at baseline, the assessment immediately prior to 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 HbA1c levels prior to onset of DEB but higher mean HbA1c occurred with DEB onset. The group with DEB onset had significantly higher BMI percentiles at each assessment time. At the assessment prior to onset, the correlation between BMI percentile and the mean of the EDE Weight and Shape Concerns subscales was 0.30 \((p < .01)\) indicating that while 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 R² 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 and Shape Concern subscales \((21.0\% \text{ of the variance})\), the Physical Appearance subscale of the SPPC \((20.0\% \text{ of the variance})\), the CDI \((15.4\% \text{ of the variance})\) and BMI percentile \((12.4\% \text{ of the variance})\). In order 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 removed variables 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 and Shape Concern subscales of the EDE, 3) the Physical Appearance and 4) Self Worth subscales of the SPPC and 5) the CDI. This 5 variable model was significantly associated with DEB onset \((\text{Chi-square} = 46.0, \text{d.f.} = 5, p < .0001)\) and accounted for 48.2\% of the variance, based on McFadden’s R².

**DISCUSSION**

In one of the first longitudinal studies conducted tracking 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 one to two years earlier. The findings are strong and the identified predictors 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 previous studies (24).

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. Since there are no established clinical cut-offs for the EDE, SPPC or CDI, the only method available to evaluate the magnitude of 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 non-clinical samples of similarly aged school children (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 non-clinical 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 non-clinical 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 developing DEB. In fact, if girls with DEB at baseline are included, half of the sample showed DEB at one or more assessments over the five 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 and Shape Concern subscales of the EDE at the assessment prior to onset is counter-intuitive. However, since girls with DEB at baseline were excluded from the study, the current sample is biased toward lower levels of eating-related disturbance. This might explain the generally low scores on the risk factors, in comparison to those found in unselected samples.
Although scores for the DEB onset group were not elevated compared to 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 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 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 prior to 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 non-diabetic peers (29), which may partially explain their increased risk for disturbed eating behavior. 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 disturbed eating behavior 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 disturbed eating behavior, 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 as 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 and shape and their physical appearance may be helpful and protect from the development of DEB.

ACKNOWLEDGEMENTS

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REFERENCES
Table 1 Characteristics of Study Sample

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Table 2 Group Means and Univariate Regressions at Assessment Immediately Prior to Onset

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<td>EDE-Weight &amp; Shape Concern</td>
<td>0.05 ± 0.10</td>
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<td>SPPC-Physical Appearance</td>
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<td>106.3 ± 14.1</td>
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