Subclinical Eating Disorders and Glycemic Control in Adolescents with Type I Diabetes

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Several recent case reports have shown that anorexia nervosa and bulimia negatively affect glycemic control in diabetic patients. However, there have been no systematic studies to assess the prevalence of clinical or subclinical eating disorders among diabetic patients or to determine the impact of such disturbances on glycemic control. This study reports a survey of 202 adolescents, aged 12–18 yr, seen in the Diabetes Clinic, Children's Hospital of Pittsburgh, who were asked to complete the Binge Eating Scale (BES) and the EAT-26 questionnaire. Responses of diabetic patients to the EAT-26 questionnaire were compared with those of a nondiabetic control group and were related to measures of glycemic control. Diabetic subjects scored higher on the total EAT-26 than nondiabetic control subjects, ordinarily indicative of more eating pathology. However, diabetic subjects scored higher only on the dieting subscale of this questionnaire, probably reflecting adherence to the diabetes dietary regimen. Subjects with diabetes scored lower, or did not differ significantly, from nondiabetic control subjects on measures of oral control and bulimia. Among diabetic subjects, self-reported bulimic behaviors were related to poorer glycemic control. Patients with the highest scores on the BES had an average HbA_1 of 13.1% compared with 11.8% for age- and sex-matched patients at the 50th percentile, and 10.8% for patients in the lowest 10th percentile. Further studies are needed to determine whether modification of these eating behaviors would improve glycemic control. DIABETES CARE 1986; 9:162–67.

Recently, there have been several case reports of anorexia nervosa and bulimia in patients with insulin-dependent diabetes mellitus (IDDM).[1–6] These patients all experienced extreme shifts in blood sugar during periods of fasting and gorging, in some cases with dire consequences.[7]

Both anorexia nervosa (a syndrome of compulsive dieting, fear of obesity, and severe weight loss) and bulimia (a syndrome of compulsive eating binges, with guilt and self-hate following a binge) are being noted with increased frequency among adolescents in the United States. In addition, there are many other individuals who do not meet the diagnostic criteria for anorexia nervosa or bulimia, but report subclinical manifestations of eating disorders that may interfere with normal psychosocial functioning.[8–10]

There are at present no systematic data available on the frequency of clinical or subclinical eating disorders in patients with IDDM, although some authors have noted that the association of anorexia nervosa and diabetes is rare.[11] The present study assesses the frequency of anorexigenic and bulimic eating behaviors among adolescents with IDDM and examines (1) whether such behaviors are more or less frequent among diabetic patients than among nondiabetic control subjects and (2) whether these behaviors are related to glycemic control.

MATERIALS AND METHODS

Subjects. All patients with IDDM who were >12 yr old and were seen at the Diabetes Clinic in Children's Hospital of Pittsburgh during June and July of 1983 (N = 241) were asked to participate in this study. Two hundred twenty (91%) agreed to participate and completed the questionnaires. Patients who had diabetes for <1 yr and might therefore retain significant residual insulin secretion were excluded from the study, bringing the final sample size to 202.

Procedure. Patients and parents were asked to sign a consent form previously approved by the Institutional Review Board of Children's Hospital of Pittsburgh. Patients were then

asked to complete two questionnaires either before or after their clinic visits. Questionnaires were distributed by research associates who were not affiliated with the diabetes clinic, and patients were assured that all responses would be kept strictly confidential.

Glycemic control was assessed as part of the patient's routine clinic visit by the measurement of the percentage of glycosylated hemoglobin and blood glucose concentration. Insulin dose, height, and weight were recorded during the clinic visit. Body mass index (BMI), which has been found to be highly related to measures of body fat, was calculated by the formula kg/m^2. Duration of diabetes was determined by a review of the patient's records. Interviews were conducted at a later date with randomly selected patients who had unusually high or low scores on the questionnaire to confirm the validity of their responses.

Questionnaires. Patients were asked to complete two questionnaires: the EAT-26[10] and the Binge Eating Scale (BES).[12] Both of these questionnaires have been shown to be reliable and valid instruments for assessing eating behaviors in nondiabetic populations[10,12] but have not been used previously with diabetic patients.

The EAT-26 consists of 26 questions describing eating attitudes or behaviors, and patients indicate whether each statement always, usually, often, sometimes, rarely, or never applies to them. The 26 questions are grouped into three factors related to (1) dieting, (2) bulimia and food preoccupation, and (3) oral control. Sample factor statements include:

Dieting: like my stomach to be empty; feel extremely guilty after eating; am terrified about being overweight; engage in dieting behavior.

Bulimia and food preoccupation: feel that food controls my life; have gone on eating binges where I feel that I may not be able to stop.

Oral control: take longer than others to eat meals; feel others would prefer if I ate more; avoid eating when I am hungry.

Higher scores on the overall EAT-26 and its factors indicate greater disturbances in eating behavior. In previous studies, scores on the total EAT-26 and on these separate factors have been shown to reliably discriminate between anorexic patients and normal control subjects. This scale has also been useful in identifying eating disturbances in nonclinical samples.

The BES is a 16-item self-report instrument that has been shown to discriminate between patients with no, moderate, or severe binge eating problems. Patients are given sets of four statements and must indicate the statement that best applies to them. For example, patients must choose between the following statements:

1. I feel capable to control my eating urges when I want to.
2. I feel like I have failed to control my eating more than the average person.
3. I feel utterly helpless when it comes to feeling in control of my eating urges.
4. Because I feel so helpless about controlling my eating I have become very desperate about trying to get in control.

Higher scores indicate more bulimic behaviors. Although to date the BES has been used only with obese patients, it was included in the present study because it focuses specifically on binge eating severity.

Validation of questionnaire responses by clinical interview. To confirm the validity of the questionnaire responses, five patients were selected at random from among those who scored >2 standard deviations above the sample mean on the BES and were matched for age, sex, and percent overweight with five patients who scored very low on the BES. These 10 patients agreed to participate in an interview regarding their eating habits. Patients with extreme scores were interviewed to ensure that these patients had completed the questionnaires accurately, and that the extreme scores truly reflected the presence or absence of disturbed eating patterns.

The interviews were conducted by a clinical psychologist who has had extensive experience with anorexic and bulimic patients. The interviewer was blind to the patients' scores on the eating questionnaires and the patients' level of glycemic control, and had had no previous contact with the patients. A semistructured interview based on the DSM-III criteria for bulimia was used. At the end of the interview, the psychologist rated the patients' eating behaviors on a five-point scale from clearly normal (1) to clearly disturbed (5) and provided a brief written report about each patient's eating behaviors.

The clinical interviews confirmed the validity of the patients' questionnaire responses. The five patients who were selected for high scores on the BES were all given scores of 4 or 5 on the five-point rating scale used by the interviewer to describe the extent of eating disturbances. The five matched control patients, selected for low scores on the questionnaire, were all given ratings of 1 or 2.

Assessment of glycemic control. Serum glucose concentration and HbA_1 level were assessed for all patients as part of their routine clinic visit. Serum glucose concentration was analyzed using a glucose autoanalyzer (Yellow Springs Instruments, Yellow Springs, Ohio). Glycosylated hemoglobin was analyzed at the Diabetes Research Laboratory of Children's Hospital of Pittsburgh. Saline-incubated samples were used to measure HbA_1 by column chromatography (Isolab mini-

TABLE 1
Comparison of demographic characteristics and eating attitudes of male and female patients (mean ± SEM)

	Male patients (N = 101)	Female patients (N = 101)
BMI	20.7 ± 0.2	21.5 ± 0.3*
Age (yr)	15.1 ± 0.2	14.5 ± 0.2†
HbA_1 (%)	10.7 ± 0.2	11.6 ± 0.2‡
Random serum glucose (mg/dl)	228 ± 12	226 ± 12
Total score on BES	5.5 ± 0.5	9.8 ± 0.7‡
Total score on EAT-26	11.1 ± 0.8	13.0 ± 0.8
Dieting factor	7.4 ± 0.5	9.9 ± 0.6†
Bulimia factor	0.76 ± 0.2	0.68 ± 0.1
Oral control factor	2.9 ± 0.2	2.5 ± 0.2

*$P < 0.05$; †$P < 0.01$; and ‡$P < 0.001$ compared with male patients.

TABLE 2
Percentage of subjects answering always, very often, or often to EAT-26 questions

Factor	Item no.	Question	Nondiabetic male subjects*	Diabetic male subjects	Nondiabetic female subjects*	Diabetic female subjects
I: Dieting						
	1	Terrified of being overweight	19%	13%	48%	42%
	6	Aware of calorie content of foods I eat	16%	38%†	34%	38%
	7	Avoid high carbohydrate foods	6%	14%†	11%	18%
	10	Feel guilty after eating	5%	3%	18%	14%
	11	Preoccupied with desire to be thin	14%	4%†	47%	49%
	12	Think about burning calories when I exercise	18%	30%†	46%	55%
	14	Preoccupied with thoughts of having fat on my body	17%	8%†	42%	37%
	16	Avoid foods with sugar	12%	79%†	16%	65%†
	17	Eat diet foods	7%	52%†	19%	52%†
	22	Uncomfortable after eating sweets	10%	29%†	18%	46%†
	23	Engage in dieting behavior	8%	32%†	26%	31%
	24	Like my stomach to be empty	8%	4%	16%	12%
	25	Enjoy trying new rich foods‡	8%	26%†	5%	14%†
II: Bulimia						
	3	Preoccupied with food	18%	5%†	20%	12%
	4	Have gone on eating binges	9%	5%	13%	8%
	9	Vomit after I have eaten	4%	0%	3%	2%
	18	Feel food controls my life	13%	13%	13%	11%
	21	Give too much time and thought to food	12%	3%†	19%	17%
	26	Impulse to vomit after meals	8%	0%†	8%	2%
III: Oral control						
	2	Avoid eating when I am hungry	6%	6%	11%	11%
	5	Cut food into small pieces	21%	32%†	32%	32%
	8	Feel others want me to eat more	15%	6%	16%	3%†
	13	Other people think I'm too thin	6%	16%†	11%	3%
	15	Take longer to eat than others	19%	10%	29%	8%†
	19	Display self-control around food	48%	68%†	50%	57%
	20	Feel others pressure me to eat	10%	4%	15%	12%

*Data from Hsu et al.[14]
†Significant at least at the $P < 0.05$ level.
‡Percentage answering "never."

columns, Akron, Ohio) using a water bath at approximately 22°C and low, medium, and high control samples.[13] The laboratory normal value is 6.5 ± 0.5% (mean ± SD). Intra- and interassay coefficients of variation for the Diabetes Research Laboratory have been reported to be 2% and 4%, respectively.

Control population. Hsu et al.[14] have previously studied the eating attitudes and behaviors of over 2000 adolescents living in Pittsburgh, Pennsylvania, Fairfax County, New Jersey, and Detroit, Michigan. Responses of these adolescents to the items on the EAT-26 were made available to the present investigators and were used as a control population for the present study. Since Hsu et al. studied only adolescents between the ages of 14 and 18 yr, analyses comparing the diabetic patients to the control population were restricted to diabetic patients between the ages of 14 and 18 yr (77 male; 65 female).

RESULTS

Characteristics of the diabetic patients who completed the questionnaires are shown in Table 1. As seen in this table, female subjects scored significantly higher than male subjects on both the BES and the dieting subscale of the EAT-26. Scores on the eating questionnaires had a skewed distribution; therefore, nonparametric statistics were also used to compare diabetic male and female subjects. Using a median test, female subjects were found more likely to score above the median on the BES

TABLE 3
Average scores of diabetic and control subjects on EAT-26

EAT-26 factor	Nondiabetic male subjects*	Diabetic male subjects	Nondiabetic female subjects*	Diabetic female subjects
I: Dieting	3.3	7.8§	7.5	10.7§
II: Bulimia	1.2	0.6§	1.4	0.8‡
III: Oral control	2.3	2.8	3.0	2.3†
Total EAT-26	6.8	11.1§	11.9	13.8

*Data from Hsu et al.[14]
†$P < 0.05$; ‡$P < 0.01$; §$P < 0.001$ for comparison of diabetic and control subjects.

($P < 0.001$), the total score of the EAT-26 ($P < 0.05$), and the dieting subscale of the EAT-26 ($P < 0.01$).

Comparison with control population. Table 2 compares the EAT-26 responses of the diabetic patient with those of the nondiabetic control population studied by Hsu et al.[14] The questions from the EAT-26 are arranged by factor in Table 2. Chi-square analyses were used to compare the proportion of diabetic and nondiabetic subjects who answered each item of the EAT-26 affirmatively (always, very often, or often). As seen in this table, differences between diabetic and nondiabetic subjects occurred most frequently on the dieting factor of the EAT-26.

Overall scores of the diabetic and nondiabetic subjects were compared by *t*-tests (Table 3) and with nonparametric median tests. Using the sex-specific medians for the nondiabetic subjects, it was found that 83% of diabetic male ($P < 0.001$) and 69% of diabetic female ($P < 0.01$) subjects had overall EAT-26 scores that were above the control group's median. Diabetic female subjects were more likely to score above the control group's median on the dieting factor ($P < 0.001$). Diabetic male subjects were more likely to score above the median on the dieting factor ($P < 0.001$) and the oral control factor ($P < 0.01$), but below the median on the bulimia factor ($P < 0.01$).

Scores on the eating questionnaires and glycemic control. To determine whether scores on the eating questionnaires were related to glycemic control, patients were divided into tertiles according to their scores on the BES or the EAT-26 and its three factors. Since female subjects scored higher than male subjects on several of these measures, the categorization was done separately for the two sexes. Analysis of variance was used to compare the HbA_1 concentration and demographic characteristics of patients with high, medium, and low eating questionnaire scores. Two categories rather than three were formed for the bulimia factor of the EAT-26, because about two-thirds of both male and female patients had a score of zero on this factor.

Scores on both the BES and the bulimia factor of the EAT-26 were related to glycemic control. Table 4 shows the pattern of results with the BES. A similar pattern occurred with the bulimia factor of the EAT-26. Female subjects with low scores on this factor had a mean HbA_1 level of 11.3%, compared with 12.5% for those with high scores ($P < 0.03$). Differences were not significant among male patients. Scores on the total EAT-26 and the oral control and dieting factors were not related to glycemic control.

To control for the possible confounding effect of age and sex on the relationship between BES scores and glycemic control, further analyses were done comparing 45 age- and sex-matched patients at three different levels of the BES: (1) more than two standard deviations above the mean ($N = 15$); (2) at the 50th percentile for their age and sex ($N = 15$); and (3) within the lowest 10% of scores for their age and sex ($N = 15$). These comparisons are summarized in Table 5 and show that scores on the BES are significantly associated with glycemic control ($P < 0.04$) when age and sex are controlled. Patients with high and low scores on the BES did not differ significantly in body weight, total insulin dose, insulin/kg, or random blood sugar.

DISCUSSION

This study suggests that adolescents with diabetes report more concern about their diet and comparable or lower levels of bulimia and oral control than nondiabetic control subjects. However, self-reported bulimic behavior was significantly associated with poorer glycemic control among these diabetic adolescents.

The diabetic patients in the present study had higher scores on the total EAT-26 than the nondiabetic control subjects, which would ordinarily indicate more eating pathology. How-

TABLE 4
Comparison of patients with lower, medium, and high BES scores

Patient characteristics	Low BES	Medium BES	High BES	P-value
Male				
Age (yr)	15.8	14.9	14.6	<0.03
BMI	21.0	20.7	20.4	NS
HbA_1 (%)	10.1	11.0	10.9	<0.07
Female				
Age (yr)	13.7	14.9	14.9	<0.008
BMI	20.5	21.9	22.3	<0.01
HbA_1 (%)	11.1	11.3	12.5	<0.03

TABLE 5
Comparison of patients with highest, medium, and lowest scores on the BES (matched for age and sex)

	Lowest (N = 3 male, 12 female) ($\bar{x}$ ± SEM)	50th Percentile (N = 3 male, 12 female) ($\bar{x}$ ± SEM)	Highest (N = 3 male, 12 female) ($\bar{x}$ ± SEM)	P-value
BES score	2.3 ± 0.57	8.4 ± 0.57	25.1 ± 0.92	<0.001
Age (yr)	15.4 ± 0.42	15.4 ± 0.40	15.5 ± 0.41	NS
BMI	20.8 ± 0.65	22.2 ± 0.75	22.6 ± 0.79	NS
HbA_1 (%)	10.8 ± 0.48	11.8 ± 0.66	13.1 ± 0.69	<0.04

ever, careful examination of the subscales of the EAT-26 indicates that the diabetic patients scored higher only on the dieting factor. This factor contains many items that would be considered appropriate and beneficial behaviors for diabetes control, e.g., avoid foods with sugar in them; know the content of foods. Thus, high scores on this scale may reflect adherence to the diabetes dietary regimen, rather than eating pathology.

In contrast, there is only one item on the bulimia or oral control factor that could be considered appropriate and beneficial for patients with diabetes (item 19: display self-control around food). For these factors, there were either no differences between diabetic and nondiabetic subjects or lower scores among the diabetic patients. Both male and female patients with diabetes scored lower on the bulimia factor of the EAT-26 than nondiabetic subjects, and female diabetic patients scored lower on the oral control factor as well. These findings suggest that diabetic patients may have less eating pathology than nondiabetic peers.

However, the results of this study rely on self-report and should be interpreted with caution. Diabetic subjects may selectively overreport dietary adherence and underreport eating pathology. Further research using clinical interviews is needed to determine the prevalence of eating disturbances in diabetic patients. When self-report measures are used, care should be taken to control for items that could be considered diabetic-appropriate behaviors. Finally, future studies should include a concurrent control group of age- and sex-matched adolescents who have a chronic disease that does not involve dietary restriction. This would allow for more definite conclusions regarding the effect of diabetes and dietary restriction on disordered eating behaviors.

The most important finding of this study was that patients who scored highest on the bulimia subscale of the EAT-26 and/or highest on the BES had poorer levels of glycemic control. The effect of the BES score on glycemic control was most apparent when age and sex were controlled. Patients who scored highest on the BES had an HbA_1 level of 13.1%, compared with 11.8% for those at the 50th percentile and 10.8% for low-scoring patients. Additional studies are needed to determine whether there is a cause-and-effect relationship between these self-reported eating behaviors and glycemic control.

During the clinical interviews, patients with high BES scores frequently reported patterns of eating far removed from the recommended diabetes diets. For example, one patient reported a routine of skipping breakfast, having only a glass of milk for lunch, and then binge eating all evening. This patient's physician was completely unaware of this eating pattern. The inappropriate match of insulin and intake in this and other patients might be expected to have profound effects on glycemic control.

Our observations are that administration of the questionnaire in the clinic increased awareness of eating disorders and encouraged patients to discuss more freely their eating problems with physicians, nurses, and dietitians. Further studies are now needed to determine whether interventions can be developed to help patients with diabetes modify these eating behaviors and to ascertain whether such changes would be related to further improvements in glycemic control.

ACKNOWLEDGMENTS: The authors thank Allan Drash, Dorothy Becker, Leonard H. Epstein, Jacqueline Dunbar, and Linda Washington for their valuable contributions to this project. Special thanks are extended to George Hsu for making the control group's data available to us and to Tim Klepper for helping us with data analysis.

This study was supported in part by grant AM 29757-04 from the National Institute of Arthritis, Metabolism, and Digestive Disease (R. Wing).

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REFERENCES

[1] Fairburn, C. G., and Cooper, P. J.: Self-induced vomiting and bulimia nervosa: an undetected problem. Br. Med. J. 1982; 284:1153–55.

[2] Fairburn, C. G., and Steel, J. M.: Anorexia nervosa in diabetes mellitus. Br. Med. J. 1980; 1:1167–68.

[3] Hillard, J. R., Lobo, M. C., and Keeling, R. P.: Bulimia and diabetes: a potentially life-threatening combination. Psychosomatics 1983; 24:292–95.

[4] Hudson, J. I., Hudson, M. S., and Wentworth, S. M.: Self-induced glycosuria: a novel method of purging in bulimia. JAMA 1983; 249:2501.

[5] Powers, P. S., Malone, J. I., and Duncan, J. A.: Anorexia nervosa and diabetes mellitus. J. Clin. Psychiatry 1983; 44:133–35.

[6] Roland, J. M., and Bhanji, S.: Anorexia nervosa occurring in patients with diabetes mellitus. Postgrad. Med. J. 1982; 58:354–56.

[7] Hillard, J. R., and Hillard, P. J. A.: Bulimia, anorexia nervosa and diabetes: deadly combinations. Psychiatr. Clin. North Am. 1984; 7:367–79.

[8] Button, E. J., and Whitehouse, A.: Subclinical anorexia nervosa. Psychol. Med. 1981; 11:509–516.

[9] Garner, D. M., and Garfinkel, P. E.: Socio-cultural factors in the development of anorexia nervosa. Psychol. Med. 1980; 10:647–656.

[10] Garner, D. M., Olmstead, M. P., Bohr, R., and Garfinkel, P. E.: The Eating Attitudes Test: psychometric features and clinical correlates. Psychol. Med. 1982; 12:871–78.

[11] Crisp, A. H.: The differential diagnosis of anorexia nervosa. Proc. R. Soc. Med. 1977; 70:685–90.

[12] Gormally, J., Black, S., Daston, S., and Rardin, D.: The assessment of binge eating severity among obese persons. Addict. Behav. 1982; 7:47–55.

[13] Daneman, D., Wolfson, D. H., Becker, D., and Drash, H.: Factors affecting glycosylated hemoglobin values in children with insulin dependent diabetes. J. Pediatr. 1981; 99:847–53.

[14] Hsu, L. K. G., Milliones, J., Friedman, L., Holder, D., and Klepper, T.: A survey of eating attitudes and behaviors in adolescents in a Northeast urban school system. Paper presented at the American Academy of Child Psychiatry, Washington, D.C., 1982.