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Relations between Intensity of Symptoms of Eating Disorders and Glycated Hemoglobin, Number of Complications, Mood, and Problems with Type 2 Diabetes in a One-Year Follow-Up Study

ABSTRACT

Objective: Assessment of the relations between intensity of symptoms of eating disorders with psychological factors, glycated hemoglobin (HbA1c) levels, and number of complications in type 2 diabetes (T2D).

Materials and methods: Sixty-eight (68) individuals aged 38 to 71 years (M = 61.1; SD = 8.2) took part in the baseline of prospective and 36 (52.9%) in follow-up after one year. They completed the Eating Attitude Test (EAT-26), Questionnaire for Binge Eating Screening (QBES), Brief Self-Rating Scale of Depression and Anxiety (BS-RSDA), and Problem Areas in Diabetes Questionnaire (PAID).

Results: At baseline, 12 individuals (18.5%) met the screening criteria of eating disorders and 29 (42.6%) met the screening criteria of binge eating disorder. The level of HbA1c among persons with symptoms of eating disorders was significantly higher than in the group without these symptoms. The intensity of binge eating at baseline was significantly correlated with intensity of depressive symptoms after 6 months (r = 0.34) and 12 months (r = 0.52), anxiety symptoms after 6 months (r = 0.42) and 12 months (r = 0.49), and problems with diabetes after 6 months (r = 0.5). Intensity of bulimia and food preoccupation symptoms at baseline was correlated after 6 months with intensity of anxiety symptoms (r = 0.35) and problems with diabetes (r = 0.52) and HbA1c level (r = –0.42), and after 12 months with intensity of symptoms of anxiety (r = 0.56), depression (r = 0.35), and problems with diabetes (r = 0.39).

Conclusions: The intensity of eating disorder symptoms had moderate correlations with the level of depressive and anxiety symptoms and intensity of diabetes-related problems. Due the small and non-representative sample size, these findings should be confirmed in a future high-quality study. (Clin Diabetol 2024; 13, 6: 331–340)

Keywords: eating disorders, diabetes, HbA1c, depression, anxiety

Introduction

Epidemiological data indicate that there were 536.6 million individuals with diabetes in 2021, and it is expected that a total of 783.2 million will be affected by diabetes in 2045 [1]. Diabetes frequently leads to serious and often life-threatening and lethal complications, including cardiovascular complications, such as heart attack and stroke, neuropathy (nerve damage), nephropathy (kidney damage), and retinopathy (eye damage). Management of diabetes requires the daily monitoring of blood glucose levels and modification of one's lifestyle, mainly in maintaining a healthy diet and doing regular physical exercise. Ultimately, adhering to these requirements constitutes a problem for many people with diabetes. Psychological factors also play an important role in this process, and the current guidelines for diabetes treatment, i.e. the American Diabetes Association [2], International Diabetes Federation [3], and Poland Diabetes Association [4], recommend inclusion of the psychological aspects of diabetes in diagnosis, treatment, and management.

The largest international study to date that focused on gaining a comprehensive understanding of the situation of individuals with diabetes confirmed that the psychological difficulties they encounter constitute an important and widespread phenomenon in the course of the disease [5]. The study in question did not include the individuals' eating attitudes or eating disorders, which are also listed in the guidelines as an area requiring routine assessment.

Eating disorders in diabetes remain an under-investigated topic, particularly in comparison with comprehensive studies on depression in diabetes. The vast majority of studies on relationships between eating disorders and diabetes have focused on individuals with type 1 diabetes (T1D), especially on adolescents and women aged 15-35 years [6–9]. Relatively little research has been conducted on the population of individuals with type 2 diabetes (T2D). This is mainly because T1D occurs mainly in persons under 30 years of age, and most frequently in children and adolescents, i.e., in groups where eating disorders are also generally more frequent [7].

Data on the co-occurrence of eating disorders, abnormal eating attitudes, and T2D are rather limited. An analysis of the literature shows that the prevalence of eating disorders and abnormal eating attitudes differs depending on the characteristics of the subjects in question (outpatients vs. inpatients), the method that is used for diagnosis (self-descriptive questionnaires vs. diagnostic interviews), and on the subject matter of the measurement (eating disorders according to diagnostic criteria vs. their subclinical forms). Nevertheless, available studies indicate a significant co-occurrence of eating disorders and abnormal eating attitudes with T2D [8, 10–13]. Binge eating disorder (BED) is the most prevalent eating disorder among individuals with T2D, and it is mainly related to overweight and obesity in this group of individuals [8, 14]. Binge eating differs from bulimia mainly by the lack of compensatory behaviors (e.g., self-induced vomiting, using laxatives, and excessive exercising). A literature review identified 9 studies on the prevalence of binge eating disorder among persons with T2D in the range between 1.2% and 8% [13]. The prevalence was lower in studies when the diagnosis was made during a clinical examination than when self-rating questionnaires were used. Some studies indicated a higher level of glycated hemoglobin (HbA1c) among patients with BED than among those without BED [15, 16], but the results of most research studies indicate no differences in HbA1c between the above-mentioned groups [8, 17–19]. Persons with T2D and comorbid BED had a higher prevalence of depressive disorders and a higher intensity of depressive symptoms than persons without it [8, 18]. Only a few studies indicated positive correlations between intensity of symptoms of eating disorders as measured by the Eating Attitudes Test (EAT-26) and intensity of depressive symptoms as measured by the Beck Depression Inventory [8, 18].

One available prospective study on people with T2D indicated that having satisfactory follow-up HbA1c levels (< 7%) after one year was correlated with baseline variables such as HbA1c, insulin use, and eating behavior [20]. The authors concluded that clinical variables are more important than psychopathological variables for the achievement of therapeutic goals.

The first objective of this study was to conduct a cross-sectional and prospective study assessment of differences in intensity of depressive and anxiety symptoms, intensity of problem areas in diabetes, HbA1c levels, and the number of complications among subjects who met the criteria for eating disorders according to EAT-26 and QBES and among those who did not. The second objective was to conduct a cross-sectional and prospective study assessment of the relationship between intensity of symptoms of eating disorders and intensity of depressive and anxiety symptoms, intensity of problem areas in diabetes, HbA1c level, and the number of complications.

Materials and methods
Subjects

The study involved individuals with T2D who had been diagnosed in the last 12 months and who were at the point of treatment intensification, i.e., the introduc-

tion of insulin hypoglycemic drugs or insulin analogs to their treatment regimen.

Study design

The study was prospective and consisted of 3 phases: the first phase took place within one month after change of treatment, the second phase followed after 6 months, and the third phase took place 12 months after the start of the study. At each phase, participants completed a set of questionnaires and their HbA1c level was tested. Sixty-eight respondents took part in the first phase, 44 respondents (64.7%) in the second phase, and 36 respondents (52.9%) in the third phase. The study was approved by an Ethics Committee, and all participants signed an informed consent participation form.

Data collection

The Eating Attitudes Test (EAT-26) was used to assess symptoms of eating disorders [21, 22]. EAT-26 is a popular tool that is used worldwide to screen for self-assessment of eating disorders, and it has proven psychometric properties [22, 23]. EAT-26 consists of 26 items that cover 3 subscales to assess symptoms in 3 areas, i.e., dieting, bulimia and food preoccupation, and oral control. The test may be used for screening diagnosis of eating disorders that requires verification in a clinical examination.

The occurrence of binge eating was assessed using the Questionnaire for Binge Eating Screening (QBES) [24]. It consists of 4 closed YES/NO questions. According to the QBES authors, a positive answer to at least one question indicates that symptoms of binge eating may be present. Sensitivity and specificity of the QBES was assessed among Polish women with polycystic ovary syndrome (PCOS). A positive answer to at least one question had a sensitivity of 88% and a specificity of 67% in detecting BED.

The Problem Areas in Diabetes Questionnaire (PAID) was used to assess the intensity of diabetes-related problem areas [25]. This questionnaire has proven psychometric properties and is widely used throughout the world to assess the intensity of problem areas associated with diabetes, both for individuals with T1D and for those with T2D [25–28]. It consists of 4 subscales that describe the intensity of problems related to negative emotions, treatment, food, and lack of social support. PAID's reliability and accuracy are high in the Dutch version, although the original English version does not differentiate these subscales. An analysis of the Polish version does not allow the subscales to be distinguished, although the whole scale is reliable and accurate

The intensity of depressive and anxiety symptoms was assessed using the Brief Self-Rating Scale of Depression and Anxiety (BS-RSDA) [29], which is a part of the Psychodiabetic Kit [30]. The questionnaire consists of 2 subscales. Its psychometric properties have been tested on a population of individuals with diabetes, and it has standards developed for this population.

For this study, questionnaires were constructed to collect both demographic and medical data, such as information regarding complications of diabetes and past episodes of severe hypoglycemia. The questionnaires were filled out by either doctors or researchers during each measurement.

The level of HbA1c was measured to assess glycemic control.

Statistical analysis

The differences in the measured variables between the first, second, and third measurements were calculated using ANOVA variance analysis with repeated measurement. For statistically significant contrasts, Duncan's post-hoc tests were calculated. Comparison of psychological and clinical characteristics between groups with and without eating disorders was calculated with the Mann-Whitney U-test. Relationships between intensity of eating disorders and other psychological and clinical factors in cross-sectional and prospective study were calculated with the Pearson correlation coefficient.

Results

Sixty-eight subjects aged 38 to 71 years (M = 61.1; SD = 8.2) were qualified for the study, of whom 45.6% were men (N = 31) and 54.4% were women (N = 36). The period from diagnosis of T2D was 2 to 30 years (M = 10.4; SD = 6.3), and the mean HbA1c was 9.15%. Of all the subjects, 39 (60%) had secondary education, 17 (26.2%) had a university degree, and 9 (13.8%) had an elementary education. Fifty (75.8%) respondents lived in a large city (> 100,000), 10 (15.2%) lived in a small city (< 100,000), and 6 (9.1%) lived in a rural area.

Out of 68 respondents, 12 (18.5%) met the EAT-26 screening criteria for eating disorders, and 29 (42.6%) met the binge eating disorder screening criteria. Both diagnoses were more frequent in women, but this relationship was not statistically significant.

Table 1 shows the values of the measured variables in 3 measurements. It was found that the mean score on the EAT-26 Bulimia scale increased significantly during the study. The third measurement value was significantly higher than the first and second measurement values, which did not differ significantly. The level of

Table 1. Baseline, 6-Month, and 12 -Month Follow-Up Results

		Baseline I	6 months II	12 months III	ANOVA test statistics with repeated measurements
QBES	Mean	1.60	1.57	1.31	F (2; 70) = 1.460
	N	68	44	36	p=0.239
	SD	1.43	1.39	1.47	
EAT-26 Dieting scale	Mean	10.15	10.59	9.00	F (2; 58) = 0.416
	N	65	41	35	p = 0.662
	SD	6.03	6.76	5.21	
EAT-26 Bulimia and Food Preoccupation scale	Mean	1.09	1.20	2.11	F (2; 60) = 4.696
	N	65	41	35	p = 0.013*
	SD	2.19	1.65	2.48	
EAT-26 Oral Control scale	Mean	2.75	2.83	2.80	F (2; 60) = 1.510
	N	65	42	35	p = 0.229
	SD	3.03	3.04	3.47	
EAT-26 Total score	Mean	14.00	14.70	13.91	F (2; 58) = 1.678
	N	65	40	35	p = 0.196
	SD	8.94	10.00	8.63	
BS-RSDA Depression scale	Mean	11.71	8.95	9.50	F (2; 70) = 0.178
	N	68	44	36	p = 0.387
	SD	10.66	8.06	8.02	
BS-RSDA Anxiety scale	Mean	10.62	7.91	9.56	F (2; 70) = 1.099
	N	68	44	36	p = 0.339
	SD	11.00	6.87	8.42	
PAID Total score	Mean	26.84	26.93	27.36	F (2; 70) = 2.858
	N	68	44	36	p = 0.064
	SD	22.70	21.88	22.11	
HbA1c	Mean	9.15	7.74	7.97	F (2; 60) = 16.407
	N	62	35	34	p < 0.01*
	SD	1.98	1.09	1.53	
Number of complications	Mean	0.60	0.70	0.89	F (2;70) = 8.448
	N	67	43	36	p < 0.01*
	SD	0,74	0,80	0,95	

BED — binge eating disorder; BS-RSDA — Brief Self-Rating Scale of Depression and Anxiety; EAT-26 — Eating Attitude Test; HbA1c — glycated hemoglobin; QBES — Questionnaire for Binge Eating Screening; PAID — Problem Areas in Diabetes Questionnaire; SD — standard deviation

HbA1c decreased, which was significantly higher in the first measurement than in the second and third measurements (although there was no difference between the second and third measurements). The number of complications increased, and it was significantly higher in the third measurement than in the first, and significantly higher than in the second measurement. No significant changes in intensity of the other variables were observed.

Based on existing sten standards for persons with diabetes [29, 30], the intensity of depressive symptoms in the 3 measurements was average, and although it decreased slightly over the course of the study, the change was not statistically significant. The intensity of anxiety symptoms was average in the first and third measurements and low in the second. However, these differences were not statistically significant. Similarly, the level of diabetes-related problems measured with

Table 2. Comparison of Psychological and Clinical Characteristics between Groups with and without Eating Disorders According to EAT-26

	Baseline measurement						U Mann-Whitney test	
	Absence of eating disorders according to EAT-26			Presence of eating disorders according to EAT-26				
	M	n	SD	M	n	SD	Z	p
BS-RSDA Depression scale	10.23	53	8.85	17.58	12	16.09	−1.314	0.189
BS-RSDA Anxiety scale	8.94	53	8.85	14.17	12	15.33	−0.806	0.420
PAID Total score	24.29	53	21.78	36.15	12	24.28	−1.540	0.124
Height	165.5	48	8.70	165.25	12	13.32	−0.590	0.611
Age	62.38	52	7.48	56.17	12	10.55	−2.025	0.043
Weight	86.33	48	20.58	97.15	12	23.00	−1.387	0.166
BMI	31.12	48	6.87	35.60	12	7.55	−1.904	0.057
Years of diabetes	11.17	52	6.62	8.79	12	4.26	−0.932	0.351
HbA1C	8.93	49	1.97	10.45	11	1.50	−2.459	0.014
Number of complications	0.56	52	0.70	0.92	12	0.90	−1.371	0.170

BED — binge eating disorder; BS-RSDA — Brief Self-Rating Scale of Depression and Anxiety; EAT-26 — Eating Attitude Test; HbA1c — glycated hemoglobin; QBES — Questionnaire for Binge Eating Screening; PAID — Problem Areas in Diabetes Questionnaire; SD — standard deviation

the PAID, which remained low, did not change significantly.

Cross-sectional and prospective study comparison of psychological and clinical characteristics between groups

Table 2 shows the differences between the group of subjects with the EAT-26 diagnosis of eating disorders and the group without this diagnosis, in the first phase of the study (baseline measurement).

Individuals who met the EAT-26 criteria for eating disorders were younger and had a higher HbA1c level than those who did not meet the criteria. There were no other statistically significant differences between these groups. However, according to the adopted sten standards,[29,30] the intensity of depressive symptoms in patients with diagnosed eating disorders was high, and it was average in individuals without such a diagnosis.

Among those who were diagnosed with binge eating disorder according to the QBES, the intensity of depressive symptoms was high (M = 14.72), and the intensity of depressive symptoms was average in those without the diagnosis (M = 9.46); this difference was statistically significant (p = 0.037). No significant differences were observed among the sizes of the other variables.

After 6 months and after 12 months, there were no significant differences between groups with eating disorders according to EAT-26 and binge eating disorder according to QBES, and groups without such diagnosis in relation to HbA1c levels, number of complications, intensity of depressive and anxiety symptoms, and intensity of problem areas in diabetes. The exception was a higher intensity of depressive and anxiety symptoms in the binge eating group after 12 months.

Correlations between symptoms of eating disorders and binge eating and psychological and clinical characteristics in a cross-sectional study

The cross-sectional study assessed the relationship between intensity of binge eating and eating disorder symptoms and HbA1c levels, number of complications, intensity of depressive and anxiety symptoms, and intensity of problems in diabetes. Table 3 presents the results of the correlation matrix. The QBES result showed moderate positive correlations with all psychological factors at levels ranging from r = 0.345 to r = 0.408, which indicates a significant, moderate relationship between intensity of binge eating and intensity of depressive symptoms, and anxiety and negative emotions associated with various aspects of diabetes. The Bulimia and Food Preoccupation scale showed positive weak and moderate correlations with psychological factors at r = 0.258 to r = 0.472. The absence of any correlation between the EAT-26 Oral Control scale and psychological factors and clinical status is noteworthy. There were also no correlations between QBES, EAT-26, and its scales with clinical characteristics.

Table 3. Correlations of Intensity of Symptoms of Eating Disorders and Binge Eating with Psychological and Clinical Characteristics in the Cross-Sectional Study

`		BS-RSDA Depression scale	BS-RSDA Anxiety scale	PAID	Age	HbA1c	Number of complications
QBES	r	.345**	.380**	.408**	−0.020	0.111	−0.096
	p	0.004	0.001	0.001	0.873	0.393	0.439
EAT-26 Dieting scale	r	0.225	.275*	.334**	−.278*	0.121	0.139
	p	0.072	0.027	0.006	0.026	0.357	0.274
EAT-26 Bulimia and Food Preoccupation scale	r	.258*	.410**	.472**	−0.116	0.088	0.113
	p	0.038	0.001	0.000	0.360	0.502	0.375
EAT-26 Oral Control scale	r	−0.139	−0.046	0.075	−0.142	−0.111	0.120
	p	0.269	0.714	0.552	0.263	0.399	0.344
EAT-26 total score	r	0.170	.273*	.362**	−.261*	0.063	0.151
	p	0.176	0.028	0.003	0.037	0.631	0.232

BED — binge eating disorder; BS-RSDA — Brief Self-Rating Scale of Depression and Anxiety; EAT-26 — Eating Attitude Test; HbA1c — glycated hemoglobin; QBES — Questionnaire for Binge Eating Screening; PAID — Problem Areas in Diabetes Questionnaire; SD — standard deviation

Relationship between intensity of symptoms of eating disorders and binge eating and psychological characteristics and clinical condition in a prospective perspective

The prospective study assessed the relationship between intensity of symptoms of eating disorders and binge eating at the beginning of the study and the patients' psychological characteristics and clinical condition after 6 months and 12 months. The results are presented in Table 4.

There were numerous interactions between the results of the QBES scale, EAT-26 Bulimia and Food Preoccupation scale, and overall EAT-26 score with the intensity of symptoms of depression, anxiety, and negative emotions associated with different areas of diabetes, both after 6 months and after 12 months. In most cases, the strength of the relationship not only persisted but also increased. There was a small but significant inverse correlation between the Bulimia and Food Preoccupation scale at the baseline and the HbA1c level after 6 months. This correlation might be connected with the beneficial effect of food preoccupation, which is measured by this scale, on the course and control of diabetes when insulin treatment is included

Discussion

According to our knowledge, this is the first prospective study on the relationships between symptoms of eating disorders and BED and the clinical and psychological characteristics of the course of T2D. The negative, moderate correlation between the level of HbA1c and scores on the Bulimia and Food Preoccupation scale of the EAT-26 is a paradoxical finding. An analysis of the content of items included in this subscale indicates that they describe paying attention to one's diet and to the way of eating, both of which are helpful in diabetes. Because of this, applying EAT-26 among patients with diabetes should be done with consideration. Such sentences as "I give too much time and thought to food," "I find myself preoccupied with food," and "I feel that food controls my life," according to EAT-26, indicates an intensity of symptoms, but these can also reflect one's natural and positive focus on food as required to manage diabetes. This finding implies that a diagnosis of eating disorders among people with diabetes requires a careful assessment of the symptoms of one's preoccupation with food, and the self-rating scales should not include items that are open to doubt. The lack of other significant correlations between the level of HbA1c, number of complications, and other psychological factors suggests that they have no clinically significant meaning in comparison with the impact of implementing insulin or its analogs.

The EAT-26 results suggesting eating disorders in 18.5% of the respondents is one of the most important findings in the baseline studies. This result is similar to results presented by other researchers. In a study by Nicolau [8], eating disorders according to EAT-26 and QEWP-R were diagnosed in 14% and 16% of respondents, respectively. The fact that a higher percentage of respondents met the criteria for an eating disorder in our study may have resulted from

Table 4. Correlations between Intensity of Symptoms of Eating Disorders and Binge Eating at the Beginning of the Study and Psychological Characteristics and Clinical Condition after 6 Months and after 12 Months

			QBES	EAT-26 Dieting scale	EAT-26 Bulimia and Food Pre-occupation scale	EAT-26 Oral Control total	EAT-26 Total score
After 6 months	BS-RSDA Depression scale	r	.346*	0.037	0.263	−0.069	0.055
		p	0.022	0.816	0.092	0.663	0.730
	BS-RSDA Anxiety scale	r	.423**	0.144	.355*	0.041	0.194
		p	0.004	0.362	0.021	0.798	0.219
	PAID	r	.502**	0.280	.525**	0.082	.352*
		p	0.001	0.073	0.000	0.606	0.022
	HbA1c	r	−0.099	0.024	−.420*	−0.111	−0.086
		p	0.571	0.897	0.015	0.538	0.634
	Number of new complications	r	0.023	−0.230	−0.175	−0.274	−0.278
		p	0.884	0.148	0.273	0.083	0.078
	Number of complications	r	−0.076	−0.042	0.109	0.046	−0.003
		p	0.628	0.795	0.496	0.776	0.985
After 12 months	BS-RSDA Depression scale	r	.526**	−0.009	.357*	−0.156	0.025
		p	0.001	0.958	0.038	0.378	0.889
	BS-RSDA Anxiety scale	r	.494**	0.216	.563**	0.138	0.310
		p	0.002	0.220	0.001	0.437	0.074
	PAID	r	0.318	0.259	.394*	.376*	.389*
		p	0.058	0.139	0.021	0.028	0.023
	HbA1c	r	−0.096	−0.068	−0.151	−0.006	−0.104
		p	0.588	0.711	0.410	0.975	0.570
	Number of new complications	r	−0.035	−0.245	−0.128	−0.067	−0.237
		p	0.841	0.163	0.469	0.705	0.177
	Number of complications	r	0.015	−0.086	0.097	−0.093	−0.066
		p	0.930	0.629	0.584	0.601	0.709

BED — binge eating disorder; BS-RSDA — Brief Self-Rating Scale of Depression and Anxiety; EAT-26 — Eating Attitude Test; HbA1c — glycated hemoglobin; QBES — Questionnaire for Binge Eating Screening; PAID — Problem Areas in Diabetes Questionnaire; SD — standard deviation

a different, higher cut-off point in the EAT-26 test than the one Nicolau applied, thus resulting in a lower percentage of positive diagnoses. Furthermore, in our study, the subjects differed from Nicolau's subjects in a higher mean HbA1c level and were at the point of having a change introduced to their treatment for this very reason. Considering some of the literature data indicating higher HbA1c levels in patients with binge eating disorder and the results of our study on higher HbA1c levels in patients with eating disorders, we may hypothesize that patients who do not achieve satisfactory glycemic control are more likely to have symptoms of eating disorders — further research is needed to verify this hypothesis.

In our study, 42% of individuals met the QBES binge eating screening criteria. According to a literature review, the prevalence of BED in persons with T2D ranges from 1.2% to 8% [18]. In a study of 82 patients not included in the above review, 34.1% were diagnosed with BED [16]. In a study by Nicolau [8], the prevalence of BED was 12.2% in a large study group of 320 patients. The much higher percentage of diagnosis of this disorder in our study may have resulted from both the tool that was used and from the screening diagnosis. However, given the available data on its high sensitivity and specificity, it is more likely that samples of patients who need treatment intensification include a larger number of persons with binge eating symptoms, which may then be the reason for problems with glycemia control.

Changes found in the subsequent phases of our study are particularly noteworthy. The Bulimia and Food Preoccupation scale score increased significantly. This may have been due to the implementation of insulin treatment and the need for the subjects to pay more attention to the food they ate. The HbA1c level

decreased significantly from 9.15% in the first measurement to 7.74% in the second measurement, which may be interpreted as the result of successful treatment intensification via inclusion of insulin. The mean number of complications increased from 0.6 in the first measurement to 0.7 in the second measurement, and to 0.89 in the third measurement. This is consistent with the results of studies indicating that the age of the patients and disease duration are factors that increase the risk of late complications, and current and short-term HbA1c levels do not lead to rapid changes in the development of complications [30, 31].

Individuals who were diagnosed with eating disorders according to EAT-26 at the point of a change in their treatment had significantly higher HbA1c levels than those who did not meet the criteria for such a diagnosis (M = 10.4 vs. M = 8.9; p = 0.014). This is a very important result, as the HbA1c level accurately reflects the quality of metabolic control in people with diabetes, and the available literature has found few psychological variables that may be related to it. Most of the studies cited in this paper which focused on persons with T2D confirmed no differences between individuals with and without eating disorders or abnormal eating attitudes in terms of HbA1c levels or their correlation with HbA1c levels. The results here are unique in the context of other studies and need to be verified in studies on larger, more representative groups of individuals with diabetes. We can hypothesize that the prevalence of eating disorders differs between patients with respect to HbA1c levels, but only in the group of patients with worse hemoglobin control and already elevated levels. Further research is necessary to fully investigate the dependencies described here.

Persons who were diagnosed with binge eating via a screening questionnaire were different from those who were not diagnosed in that manner, and a higher intensity of depressive symptoms measured with the BS-RSDA questionnaire was observed in those subjects (M = 14. 72 vs. M = 9.46; p = 0.037). In the study by Nicolau [8], individuals diagnosed with BED were significantly more likely to meet the Beck Depression Questionnaire depression screening criteria than those not diagnosed with the BED (p = 0.0021). Çelik et al. also described a significantly higher intensity of depressive symptoms in patients with BED as compared to patients without BED [18].

In a cross-sectional study, positive correlations were found between intensity of eating disorders, intensity of depressive and anxiety symptoms, and intensity of diabetes-related distress (including problems with treatment, food, social support, and negative emotions). Available studies have shown positive correlations between intensity of eating disorders and intensity of depressive symptoms [8, 18].

In this prospective study, several positive correlations were found between intensity of symptoms of eating disorders and binge eating and the subjects' psychological characteristics in subsequent measurements. As regards the symptoms, the relationship with the largest number of variables describing the subjects' mental state was exacerbated by the bulimia and food preoccupation scale of EAT-26 and scores of QBES. The higher the patient's intensity of particular traits at the beginning of the study, the more severe the symptoms of anxiety and diabetes-related problems after 6 months. One year later, the patients had more severe symptoms of depression, anxiety, and diabetes-related problems. Similarly, the intensity of binge eating at the beginning of the study was positively correlated with the intensity of depression symptoms, anxiety symptoms, and diabetes-related problems with the intensity of depression symptoms and anxiety symptoms after 6 months and then after one year.

According to our knowledge, this is the first study to analyze the relationship between the measured factors and different EAT-26 subscales, whereas in the other cited studies only general EAT-26 results were used. The practical conclusion from an assessment of EAT-26 subscale relationships is that the symptoms of bulimia and food preoccupation are significantly related to the intensity of depression and anxiety symptoms and problems in individuals with T2D. Oral control and dieting were found to have no significant relationship.

Notably, apart from the inverse correlation of bulimia intensity with HbA1c levels after one year, there were no symptoms of eating disorders correlated with HbA1c levels and number of complications in the cross-sectional or prospective study. The results obtained here are similar to those of a prospective study that was conducted by other researchers [20]. Apparently, the widely examined psychopathology, including depressive symptoms, that was observed at the beginning of the study created no differentiation between the 2 groups in the follow-up study. The results of the "food-related behavior" scale were only marginally different for individuals from those who achieved their intended therapeutic goal. The correlations between psychological variables (symptoms of eating disorders) and HbA1c levels, as well as the number of complications, transpired to be insignificant. This can be explained, among other things, by the small sample size, especially in prospective measurements. Another explanation is the hypothesis that individuals with diabetes can use insulin to correct high blood sugar levels resulting from behaviors such as binge eating. This leads to a lack

of association between these variables and medical indicators.

Based on the results obtained here, we suggest that clinical variables such as duration of diabetes, insulin use, and baseline HbA1c level are more important than mental variables to achieve optimal HbA1c levels. In the study presented herein, only the results of the "Bulimia and Food Preoccupation" scale proved to be important, albeit in a counterproductive manner, probably because behaviors assessed by the food preoccupation questions were beneficial to those individuals with diabetes who had to maintain an optimal diet. The "Bulimia and Food Preoccupation" scale includes items such as: "Find myself preoccupied with food," "Feel that food controls my life," and "Give too much time and thought to food." In the case of individuals not being treated for diabetes, these may reflect significant, maladaptive preoccupation with food, possibly indicative of eating disorders. However, management of diabetes requires patients to pay considerable attention to their eating habits. Preoccupation with food may represent an adaptive approach in coping with diabetes and controlling the disease. Patients who pay a lot of attention to what they eat may thus better control their HbA1c levels. Therefore, scores on the "Bulimia and Food Preoccupation" scale at the beginning of the study may negatively correlate with HbA1c levels after 6 months.

This is an important finding because it shows that scores on a scale measuring psychopathology may be elevated due to adaptive attitudes and behaviors in this group of patients. Therefore, we suggest some consideration in interpreting the results of scales measuring eating disorder symptoms in diabetes patients.

The presented results have some significant limitations, mainly due to the small sample size, the lack of randomization in the study group, and the use of screening tools for diagnosis. These results should be considered as preliminary, due to the high drop-out rate in follow-up examinations. It is noteworthy that participation in prospective studies is difficult and demanding for participants. Replication in a randomized study with a large enough sample and a reliable diagnosis of eating disorders according to current diagnostic criteria is needed.

Conclusions

The cross-sectional data analysis indicates that throughout the course of the study there were considerable moderate correlations between intensity of symptoms of eating disorders and binge eating vs. symptoms of anxiety, depression, and intensity of diabetes-related problems that underwent no significant changes. At the baseline, the level of HbA1c among persons with symptoms of eating disorders was significantly higher than in the group without these symptoms. Successful treatment of symptoms of eating disorders could contribute to improvement of emotional state and disease management in people with T2D. The small and non-representative sample size means that these findings should be confirmed in a future study with a representative and larger group of participants.

The results of the Eating Attitude Test in individuals with diabetes should be interpreted with consideration of the potentially beneficial role of a person's attitude of focusing on food and their way of eating when coping with diabetes.

Article information
Ethical approval and consent to participate

The study was approved by an Ethics Committee of Medical University of Warsaw, and all participants signed an informed consent participation form.

Authors' contributions

Marcin Obrębski, Joanna Ostasz-Ważny, and Andrzej Kokoszka contributed to the study design. Edward Franek and Magdalena Walicka helped with patient recruitment and acquisition of data. All the authors contributed to data analysis and interpretation, discussion of the results, revision of the article, and approval of the final version of the manuscript for submission.

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Conflict of interest

The authors declare no conflict of interest.

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