DOI: 10.14744/DAJPNS.2026.00325
Dusunen Adam J Psychiatr Neurol Sci
2026;39:124-135

RESEARCH ARTICLE

Associations of alexithymia, psychological problems, and emotion regulation difficulties with disordered eating behaviors in adolescents with type 1 diabetes

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ABSTRACT

Objective: This study aimed to compare levels of alexithymia, psychological problems, emotion regulation difficulties, and disordered eating behaviors between adolescents with type 1 diabetes mellitus (T1D) and healthy controls and to examine the relationship among these factors.

Method: The study was conducted at Ankara Bilkent City Hospital and included 115 adolescents aged 12–18 years, comprising 64 adolescents with T1D and 51 healthy controls. All participants completed the Alexithymia Questionnaire for Children (AQC), Difficulties in Emotion Regulation Scale (DERS), Strengths and Difficulties Questionnaire (SDQ), and Eating Disorder Examination Questionnaire (EDE-Q). Adolescents with diabetes were additionally assessed using the Diabetes Eating Problem Survey–Revised (DEPS-R), and their hemoglobin A1c (HbA1c) levels from the previous six months were recorded.

Results: No differences were found between adolescents with T1D and healthy controls in total scores on the AQC, DERS, SDQ, and EDE-Q. Female participants and adolescents with psychiatric disorders had higher DEPS-R score. DEPS-R scores were positively correlated with total SDQ, DERS, and AQC scores, as well as body mass index (BMI), and negatively correlated with maternal education level. Multiple linear regression analysis revealed that SDQ total difficulties scores and BMI were associated with higher DEPS-R scores.

Conclusion: These findings suggest that disordered eating behaviors in adolescents with T1D may be associated with psychological difficulties and higher BMI. Addressing these factors is important in the clinical management of adolescents with diabetes.

Keywords: Adolescent, alexithymia, diabetes mellitus, disordered eating behaviors, emotion regulation

How to cite this article: Onat M, Gurbuz F, Boyraz M, Akin Soyupek YO, Avci H, Konuksever D, Yigit M, Goren R, Senses Dinc G, Cop E. Associations of alexithymia, psychological problems, and emotion regulation difficulties with disordered eating behaviors in adolescents with type 1 diabetes. Dusunen Adam J Psychiatr Neurol Sci 2026;39:124-135.

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Received: December 09, 2025; **Revised:** May 20, 2026; **Accepted:** May 25, 2026

INTRODUCTION

Type 1 diabetes mellitus (T1D) is a chronic disease with peak incidence during early adolescence and may lead to cardiovascular and microvascular complications (1). Adolescents with T1D are more likely to develop eating disorders and disordered eating behaviors (DEBs), including subthreshold symptoms, than their healthy peers (2). In addition to dietary restriction, binge eating, purging, and excessive exercise for weight control, adolescents with T1D may intentionally restrict insulin doses to induce glucosuria and promote weight loss (3). Eating disorders and DEBs in individuals with T1D often emerge during adolescence, may persist into adulthood, and, if left untreated, can increase the risk of morbidity and mortality (4).

Previous studies have examined factors associated with DEBs in adolescents with T1D, including age, sex, body mass index (BMI), family-related factors, and mood disturbances (5, 6). Emotional problems, particularly anxiety and depressive symptoms, are common among adolescents with T1D and have been associated with DEBs (7). Although studies have linked emotional problems to DEBs in adolescents with T1D, these problems do not invariably lead to DEBs, suggesting that other factors may contribute to this relationship (8).

Alexithymia is one such factor that has been linked to DEBs but remains relatively understudied in adolescents with T1D (9, 10). Alexithymia is characterized by difficulties in identifying and distinguishing emotional experiences from bodily sensations (11). It has been associated with both psychiatric and medical conditions, including anxiety, depression, hypertension, and gastrointestinal disorders, and may occur more frequently in individuals with T1D than in healthy controls (12-14). Studies have also shown that alexithymia adversely affects diabetes self-management and glycemic control in both adolescents and adults (15, 16). Furthermore, alexithymia may be conceptualized as a stress-related response to chronic conditions such as diabetes, contributing to negative emotional states including anxiety and depression (13, 17).

Emotion dysregulation, which is closely related to alexithymia, is another psychological factor associated with DEBs and poor glycemic control in individuals with T1D (18-22). Emotion regulation refers to the processes through which individuals influence the initiation, intensity, frequency, and duration of emotional experiences (23). Adolescents with T1D face ongoing challenges related to treatment adherence, dietary restrictions, and disease management, all of which require effective emotion regulation. Individuals who have difficulty regulating their emotions may respond maladaptively to negative emotional experiences, potentially compromising their well-being (24). For example, DEBs may represent maladaptive coping strategies used to manage negative affect among adolescents with T1D (25).

Although several studies have investigated the roles of alexithymia, psychological problems, and emotion dysregulation in DEBs, most have focused on adults or general populations rather than adolescents with T1D. The present study aimed to examine the relationships among psychological problems, alexithymia, emotion regulation difficulties, DEBs, and glycemic control in adolescents with T1D and to compare psychological characteristics and DEBs between adolescents with T1D and healthy controls. Based on the existing literature, we proposed the following hypotheses:

1. Psychological problems, alexithymia, emotion regulation difficulties, and DEBs are more prevalent among adolescents with T1D than among healthy controls.
2. Psychological problems, alexithymia, and emotion regulation difficulties are associated with DEBs and glycemic control in adolescents with T1D.

To our knowledge, no previous study has simultaneously examined alexithymia, emotion regulation difficulties, psychological problems, and DEBs in adolescents with T1D. This study aims to contribute to the literature by clarifying the relationships among these psychological factors, DEBs, and metabolic control in this population.

METHODS

Participants

Between May and October 2023, 71 of 80 adolescents aged 12–18 years who had been diagnosed with T1D and attended the Pediatric Endocrinology Outpatient Clinic at Ankara Bilkent City Hospital volunteered to participate in the study. The remaining nine adolescents declined participation. Inclusion criteria for the T1D group were: (1) age between 12 and 18 years; (2) diagnosis of T1D for at least one year; (3) availability of a hemoglobin A1c (HbA1c) measurement obtained within the previous six months during routine pediatric endocrinology follow-up; (4) clinically normal intellectual functioning; and (5) provision of written informed consent by both

the participant and their parent(s). Exclusion criteria for the T1D group included a diagnosis of intellectual disability, autism spectrum disorder, psychotic disorder, or bipolar disorder, as these conditions were considered likely to interfere with study assessments. Intellectual disability was determined based on clinical evaluation and psychiatric history obtained during the clinical interview. Four adolescents with T1D were excluded because of coexisting intellectual disability, and three additional participants were excluded because of incomplete data. Psychiatric evaluations were conducted by the same child and adolescent psychiatrist using clinical interviews based on the criteria of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association). The inclusion criteria for the healthy control group were: age between 12 and 18 years; (2) no current or past psychiatric disorder according to DSM-5 criteria based on clinical evaluation; (3) clinically normal intellectual functioning; and (4) absence of any chronic medical condition. Participants and their parents were also required to provide informed consent. Healthy controls were recruited from adolescents aged 12–18 years attending the general pediatric outpatient clinic at the same hospital. Although no structured diagnostic interview was conducted, all participants in the control group underwent clinical evaluation by a child and adolescent psychiatrist. Adolescents with a history of psychiatric disorders, psychotropic medication use, or ongoing psychiatric follow-up were excluded. The control group was comparable to the T1D group in terms of sociodemographic characteristics, including age, sex, and socioeconomic status. The final sample consisted of 115 adolescents: 64 with T1D and 51 healthy controls.

Participants' sociodemographic characteristics, including age, sex, family characteristics, and socioeconomic status, were recorded using a researcher-developed sociodemographic data form. All participants completed the Alexithymia Questionnaire for Children (AQC), Difficulties in Emotion Regulation Scale (DERS), Strengths and Difficulties Questionnaire (SDQ) Youth Self-Report, and Eating Disorder Examination Questionnaire (EDE-Q) to assess alexithymia, emotion regulation difficulties, psychological problems, and DEBs, respectively. Adolescents with T1D additionally completed the Diabetes Eating Problem Survey–Revised (DEPS-R) and their HbA1c values measured within the previous six months were obtained from medical records to assess diabetes-specific DEBs and glycemic control.

Written informed consent was obtained from all participants and their parents. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Ankara Bilkent City Hospital (Date: 25.04.2023/No: E2-23-3957).

Data Collection Tools

Sociodemographic Data Form

The sociodemographic data form was developed by the researchers to collect information on participants' age, sex, family characteristics, and socioeconomic status.

Alexithymia Questionnaire for Children (AQC)

The AQC is based on the Toronto Alexithymia Scale-20 developed by Bagby et al. (11) for assessing alexithymia in adults. Rieffe et al. (26) developed the AQC as a 20-item, three-point Likert-type scale consisting of three subdimensions: Externally Oriented Thinking, Difficulty Identifying Feelings, and Difficulty Describing Feelings. Each item is scored from 0 to 2. Kocak et al. (27) conducted the Turkish adaptation study and confirmed that the original three-factor structure of the AQC was preserved in the Turkish version.

Difficulties in Emotion Regulation Scale (DERS)

The DERS is a 36-item, five-point Likert-type scale developed by Gratz and Roemer (28). It consists of six dimensions: Awareness, Clarity, Nonacceptance, Strategies, Impulse, and Goals. Higher scores indicate greater difficulties in emotion regulation. The Turkish validity and reliability study was conducted by Rugancı and Gencoz (29). A study conducted in Türkiye demonstrated that the DERS is a valid instrument for assessing emotion regulation difficulties in Turkish adolescents (30).

Diabetes Eating Problem Survey–Revised (DEPS-R)

The original Diabetes Eating Problem Survey (DEPS) is a 28-item scale developed to assess DEBs in adults. Markowitz et al. (31) revised the instrument into a 16-item version suitable for children and adolescents. The DEPS-R includes items related to weight concerns, eating behaviors, weight-control practices such as vomiting or insulin omission, and diabetes management. Items are scored on a scale from 0 to 5, and total scores ≥20 indicate risk for diabetes-related eating problems. Atik Altinok et al. (32) adapted the scale into Turkish and demonstrated its validity and reliability.

Eating Disorder Examination Questionnaire (EDE-Q)

The EDE-Q is a self-report version of the Eating Disorder Examination semi-structured interview. It consists of 33 items and includes five subscales that assess the severity of eating disorder psychopathology: Restraint, Binge Eating, Shape Concern, Eating Concern, and Weight Concern. Subscale and total scores range from 0 to 6, with higher scores indicating greater eating disorder psychopathology. The Turkish validity and reliability study for adolescents was conducted by Yucel et al. (33).

Strengths and Difficulties Questionnaire (SDQ)

The SDQ was developed by Goodman as a screening instrument for emotional and behavioral problems in children and adolescents and was later adapted into Turkish by Guvenir et al. (34, 35). The questionnaire includes parent-report, teacher-report, and self-report versions and comprises 25 items across five subscales: Emotional Symptoms, Conduct Problems, Hyperactivity/Inattention, Peer Problems, and Prosocial Behavior. Although each subscale is evaluated separately, the sum of the first four subscales yields the total difficulties score. Responses are scored from 0 to 2 (35). In the present study, only the adolescent self-report version was administered.

Hemoglobin A1c (HbA1c)

HbA1c levels were measured using capillary electrophoresis method (Capillarys Tera 3, Sebia, Lisses, France).

Post Hoc Power Analysis

A post hoc power analysis for the multiple linear regression model (F-test; fixed model, R^2 deviation from zero) was conducted using $\alpha=0.05$, a sample size of 64, and seven predictors. The model explained 62.3% of the variance ($R^2=0.623$). Cohen's effect size was calculated as $f^2=R^2/(1-R^2)$, indicating a very large effect size. Based on these parameters, the achieved statistical power was $1-\beta=1.00$, suggesting that the study had very high power to detect a significant overall regression model at the observed effect size.

Statistical Analysis

Analyses were conducted using the free and open-source software R version 4.4.1 (https://cran.r-project.org) and SPSS for Windows, version 23.0 (Chicago, IL), with the assistance of an academic biostatistician. Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was evaluated using Levene's test. Descriptive statistics are presented as n (%) for categorical variables. Continuous variables are expressed as mean ± standard deviation when normally distributed and as median and interquartile range (IQR) when non-normally distributed. Pearson's chi-square test was used to compare categorical variables between groups. For continuous variables, between-group differences were assessed using the Mann–Whitney U test, the Kruskal–Wallis test or Student's t-test, depending on distributional assumptions. Appropriate effect sizes were calculated for hypothesis testing. A sensitivity analysis was also performed after excluding participants with psychiatric disorders from the T1D group. Within the T1D group, relationships between numerical variables were examined using Spearman's rank correlation coefficient. The Hmisc (36), GGally (37), and corrplot (38) packages were used to generate the correlation matrix plot. Univariate analyses and multiple linear regression analysis using the Enter method were performed to identify factors associated with the DEPS-R total score in adolescents with T1D. Because the DEPS-R assesses diabetes-specific DEBs, these analyses were conducted only in the T1D group. Variables with $p<0.20$ in univariate analyses were included in the multiple linear regression model (39, 40). Multicollinearity was assessed using variance inflation factor (VIF) values. Because the residuals were normally distributed, a multiple linear regression model was established. The ggplot (41) and qqnorm (42) functions were used to generate residual plots and Q-Q plots, respectively. A p-value <5% was considered statistically significant.

RESULTS

A total of 115 adolescents participated in the study: 64 diagnosed with T1D and 51 healthy controls. In the T1D group, 50% (n=32) were female and 50% (n=32) were male. In the control group, 47.1% (n=24) were female and 52.9% (n=27) were male. The median age was 13.5 years (IQR=4) in the T1D group and 15 years (IQR=3) in the control group. No significant differences were found between the groups in age, sex, BMI, or family characteristics ($p>0.05$). According to psychiatric assessment, 26.6% (n=17) of adolescents in the T1D group had at least one psychiatric disorder. The most common diagnoses were anxiety disorder (7.8%, n=5) and attention-deficit/hyperactivity disorder (7.8%, n=5), followed by specific learning disorder (6.3%, n=4), major depressive disorder (4.7%, n=3), and adjustment disorder (4.7%, n=3). No participant in

Table 1: Comparison of sociodemographic characteristics between adolescents with type 1 diabetes mellitus and healthy controls

Variables	HC (n=51)	T1D (n=64)	p	Effect size
Sex			0.754[a]	-0.029
Male	27 (52.9%)	32 (50%)		
Female	24 (47.1%)	32 (50%)		
Age	15 (3)	13.50 (4)	0.147[b]	0.136
BMI	19.60 (4.21)	20.54 (5.26)	0.263[b]	0.106
Number of siblings			0.732[a]	0.075
Only child	4 (8%)	7 (11.5%)		
One	19 (38%)	25 (41%)		
Two or more	27 (54%)	29 (47.5%)		
Birth order			0.956[a]	0.028
First	19 (38%)	23 (37.7%)		
Second	21 (42%)	27 (44.3%)		
Third or later	10 (20%)	11 (18%)		
Maternal age	41 (9)	40 (9)	0.156[b]	0.138
Maternal education (years)	12 (11)	8 (7)	0.102[b]	0.154
Paternal age	45 (8.50)	45 (9)	0.704[b]	0.038
Paternal education (years)	12 (8)	12 (4)	0.072[b]	0.170
Household income (TL)	20,000 (16,000)	17,000 (13,000)	0.070[b]	0.180

Data are presented as median (interquartile range) or n (%). BMI: Body mass index; HC: Healthy control; T1D: Type 1 diabetes mellitus; TL: Turkish Lira; a: Pearson Chi-Square Test; b: Mann–Whitney U test.

the T1D group met diagnostic criteria for any eating disorder. In addition, 7.8% (n=5) of adolescents in the T1D group were receiving psychotropic medication. Among adolescents with T1D, 40.6% (n=26) used a blood glucose sensor, and 12.5% (n=8) used an insulin pump. Table 1 presents the demographic characteristics of the study participants.

No significant differences were found between adolescents with T1D and healthy controls in AQC, SDQ, or EDE-Q scores (p>0.05). However, DERS Nonacceptance subscale scores were higher in healthy controls than in adolescents with T1D (p=0.020) (Table 2). A supplementary sensitivity analysis was conducted after excluding adolescents with psychiatric disorders (n=17) from the T1D group. Most primary findings remained consistent. However, the statistical significance of SDQ Internalizing Problems, SDQ Total Difficulties Score (SDQ-TDS), and DERS Strategies scores changed in the sensitivity analysis. Detailed results are presented in Supplementary Table 1.

Spearman correlation analysis was conducted in the T1D group to examine relationships among age, BMI, total daily insulin dose (units/kg/day), duration of T1D, HbA1c, maternal and paternal education levels, and total scores on the DEPS-R, SDQ, DERS, AQC, and EDE-Q. No significant correlations were found between the DEPS-R total score and age, total daily insulin dose, or HbA1c levels. However, a weak positive correlation was found between the DEPS-R total score and BMI (r=0.386, p=0.002). A weak negative correlation was also found between maternal education level and the DEPS-R total score (r=-0.280, p=0.029). Moderate positive correlations were found between the DEPS-R total score and SDQ Internalizing Problems and SDQ Externalizing Problems scores (r=0.667 and r=0.688, respectively; both p<0.001). A strong positive correlation was found between the DEPS-R total score and SDQ-TDS (r=0.731, p<0.001). Additionally, statistically significant moderate positive correlations were observed between the DEPS-R total score and the total scores of the DERS, AQC, and EDE-Q (r=0.671, r=0.599, and r=0.701, respectively; all p<0.001).

A significant negative correlation was found between HbA1c and total scores on the AQC and DERS (Fig. 1). In our study, HbA1c values were lower among adolescents using blood glucose sensors and insulin pumps (p<0.001 and p=0.043, respectively). Because sensor and insulin pump use were associated with HbA1c, Spearman correlation analyses were also performed among adolescents who did not use these

Table 2: Comparison of clinical characteristics between adolescents with type 1 diabetes mellitus and healthy controls

Variables	HC (n=51)	T1D (n=64)	p	Effect size
SDQ				
Emotional symptoms	4 (4)	3 (4.50)	0.204[a]	0.119
Conduct problems	2 (4)	2 (3)	0.586[a]	0.051
Hyperactivity/inattention	4.20±1.70	4.84±2.32	0.468[b]	0.137
Peer problems	3 (4)	2.50 (3)	0.406[a]	0.078
Prosocial behavior	7 (3.25)	8 (3)	0.593[a]	0.050
Externalizing problems	7 (6)	7 (6)	0.794[a]	0.024
Internalizing problems	7 (5.25)	6 (5.75)	0.154[a]	0.134
Total difficulties score	13.50 (10.25)	13 (10)	0.229[a]	0.113
EDE-Q				
Restraint	0.40 (1.40)	0.60 (2.20)	0.797[a]	0.024
Shape concern	0.75 (2.22)	0.87 (2.50)	0.951[a]	0.006
Eating concern	0.40 (1.45)	0.60 (1.75)	0.140[a]	0.138
Weight concern	1 (1.90)	0.80 (2.15)	0.662[a]	0.041
Global score	0.82 (1.60)	0.86 (1.51)	0.554[a]	0.056
DERS				
Awareness	17 (7.25)	17 (8)	0.510[a]	0.062
Clarity	14 (5.25)	13.50 (4)	0.911[a]	0.010
Nonacceptance	11 (9)	9.50 (6)	0.020[a]	0.219
Strategies	18.50 (12.75)	14 (13)	0.181[a]	0.126
Impulse	14 (9.75)	13.50 (13.50)	0.614[a]	0.048
Goals	17 (9.50)	14 (8)	0.364[a]	0.085
Total score	98 (37)	85 (41.13)	0.306[a]	0.097
AQC				
Difficulty identifying feelings	5 (7)	4 (6)	0.415[a]	0.077
Difficulty describing feelings	4 (4)	3.50 (4)	0.875[a]	0.015
Externally oriented thinking	7 (3)	7 (4)	0.597[a]	0.050
Total score	16.33±6.69	15.85±6.09	0.700[b]	0.075

Data are presented as mean±standard deviation (SD) or median (interquartile range). AQC: Alexithymia Questionnaire for Children; DERS: Difficulties in Emotion Regulation Scale; EDE-Q: Eating Disorder Examination Questionnaire; HC: Healthy control; SDQ: Strengths and Difficulties Questionnaire; T1D: Type 1 diabetes mellitus; a: Mann–Whitney U test; b: Student's t Test.

devices. The significant negative correlations between DERS and AQC scores and HbA1c remained among adolescents who did not use insulin pumps (r=-0.409, p<0.01; r=-0.313, p<0.05, respectively). Similarly, the significant negative correlations between DERS and AQC scores and HbA1c remained among adolescents who did not use blood glucose sensors (r=-0.464, p<0.01; r=-0.365, p<0.05, respectively). In addition, AQC total scores were positively correlated with the Restraint, Shape Concern, Eating Concern, Weight Concern, and Global scores of the EDE-Q (r=0.352, p=0.004; r=0.595, p<0.001; r=0.510, p<0.001; r=0.489, p<0.001; and r=0.603, p<0.001, respectively). DERS total scores were also positively correlated with the Restraint, Shape Concern, Eating Concern, Weight Concern, and Global scores of the EDE-Q (r=0.492, r=0.581, r=0.533, r=0.502, and r=0.633, respectively; all p<0.001).

Differences in DEPS-R total scores according to sex, presence of a psychiatric disorder, number of siblings, and birth order were analyzed using the Mann–Whitney U test or Kruskal–Wallis test. DEPS-R total scores were significantly higher in girls than in boys and in adolescents with psychiatric disorders than in those without psychiatric disorders (p=0.025 and p=0.008, respectively). Number of siblings and birth order had no significant effect on DEPS-R total scores (Table 3). Based on the univariate analysis of DEPS-R

Table 3: Comparison of DEPS-R total scores according to demographic characteristics

Variables	DEPS-R (n=64)	p	Effect size
Sex		0.025[a]	0.284
Male	16 (17)		
Female	20 (19)		
Psychiatric disorder		0.008[a]	0.337
Absent	14.75 (16.25)		
Present	27.25 (17)		
Number of siblings		0.289[b]	0.042
Only child	20 (18)		
One	13.50 (21)		
Two or more	19.75 (16.88)		
Birth order		0.425[b]	0.029
First	18 (17)		
Second	16.50 (16)		
Third or later	27 (19)		

Data are presented as median (interquartile range). DEPS-R: Diabetes Eating Problem Survey–Revised; a: Mann–Whitney U test; b: Kruskal–Wallis test.

total scores, variables with p<0.20 were identified as candidate variables for the multiple linear regression model. Accordingly, both sex and the presence of a psychiatric disorder were included in the model, and no multicollinearity or autocorrelation was detected in the data.

The model was considered adequate because the scatter plot of studentized deleted residuals against predicted values showed a random distribution around zero. According to the Kolmogorov–Smirnov test, the studentized deleted residuals were normally distributed (z=0.077, p=0.200) (Supplementary Fig. 1, 2). Multiple linear regression analysis was used to identify factors associated with DEBs. The analysis of variance (ANOVA) test showed that the model was statistically significant (F=12.065, p<0.001). SDQ-TDS and BMI were significantly associated with the DEPS-R total score (p=0.006 and p=0.036, respectively). The coefficient of determination for the multiple linear regression model predicting the DEPS-R total score was R^2=0.623. Based on the beta coefficients from the multiple linear regression model, the SDQ-TDS score made the largest contribution to the DEPS-R total score. Specifically, a one-standard-deviation increase in SDQ-TDS was associated with a 0.421-standard-deviation increase in the DEPS-R total score, whereas a one-standard-deviation increase in BMI was associated with a 0.205-standard-deviation increase in the DEPS-R total score (Table 4).

DISCUSSION

To the best of our knowledge, this is the first study to examine the roles of alexithymia, psychological problems, and emotion regulation difficulties in DEBs among adolescents diagnosed with T1D. In our study, psychological problems, alexithymia, emotional dysregulation, higher BMI, female sex, and lower maternal education level were associated with DEBs in adolescents with T1D. However, no relationship was found between DEBs and glycemic control.

In our study, alexithymia levels did not differ between adolescents with T1D and their healthy peers. Previous studies have reported high levels of alexithymia in both adults and adolescents with T1D (14, 43). However, Friedman et al. (44) suggested that alexithymia was low in patients with T1D. Our findings suggest that elevated alexithymia may not characterize all adolescents with T1D, but rather a subgroup of young patients. The finding that alexithymia was correlated with DEBs in adolescents with T1D is difficult to compare with previous work, as no prior study has directly examined this association in this population. However, DEBs have been associated with alexithymia in various other samples (45, 46). Surprisingly, alexithymia was associated with lower HbA1c levels in our study. The literature reports conflicting findings, with some studies linking alexithymia to poor glycemic control in T1D (47, 48) and others reporting no association (13, 45). Given these inconsistencies and the cross-sectional design of the present study, this finding should be interpreted cautiously. Overall, our findings suggest that alexithymia may be a relevant psychological factor to consider when DEBs are suspected in adolescents with T1D.

In our study, emotional dysregulation levels in adolescents with T1D were comparable to those of healthy controls. Similarly, a Turkish study found no difference between youth with T1D and healthy controls in emotion regulation difficulties (49). Contrary to our expectations, however, a group difference was observed specifically in the DERS Nonacceptance subscale, with adolescents with T1D reporting lower Nonacceptance scores than healthy controls. This finding may reflect differences in how emotional experiences are perceived or reported across groups. It should also be interpreted with caution because, although the control group was considered healthy based on clinical evaluation, the presence of subclinical emotional difficulties cannot

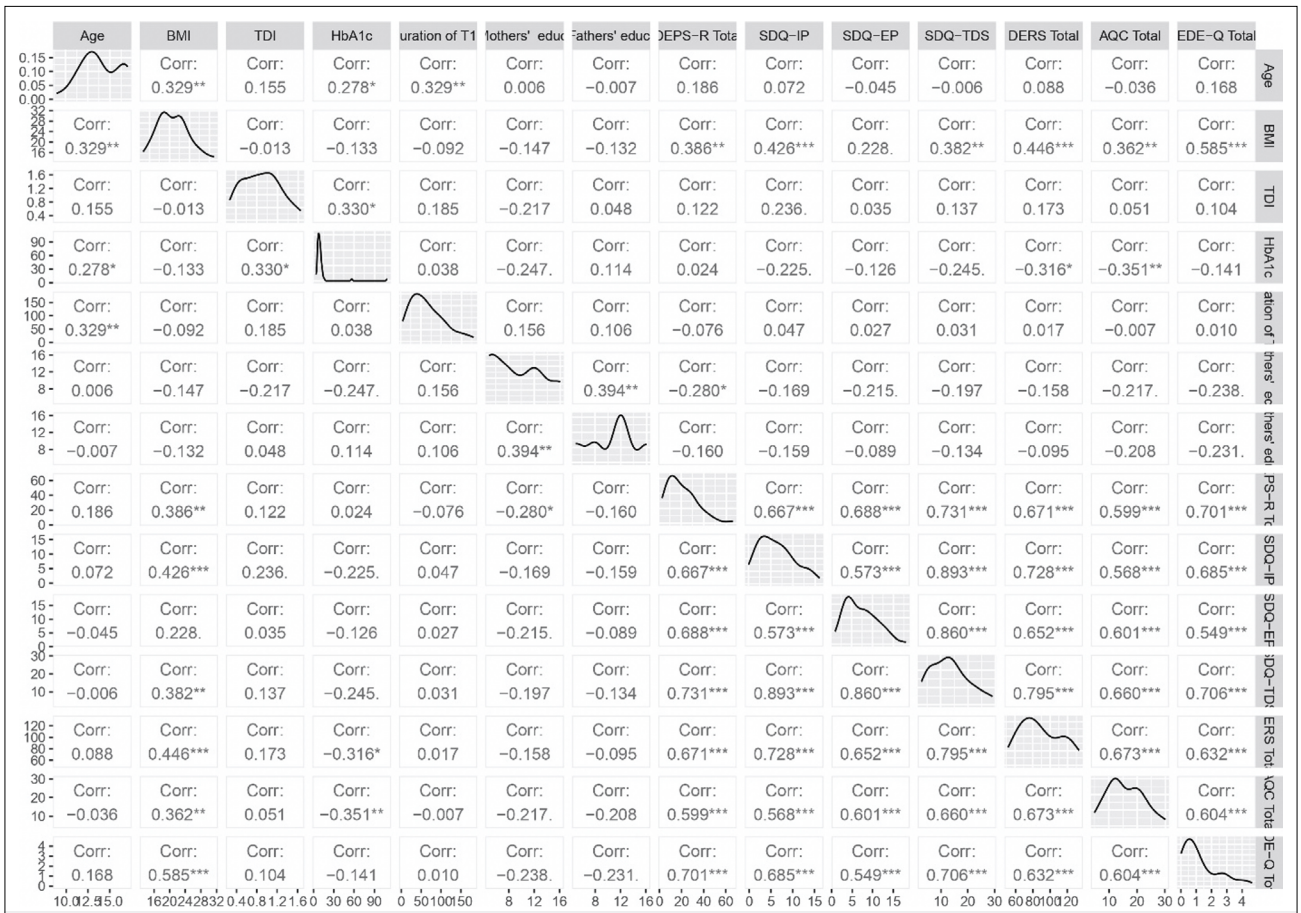

Figure 1. Correlation matrix showing the relationships between DEPS-R scores and sociodemographic and clinical variables.

*p<0.05; **p<0.01; ***p<0.001; AQC: Alexithymia Questionnaire for Children; BMI: Body mass index; DEPS-R: Diabetes Eating Problem Survey–Revised; DERS: Difficulties in Emotion Regulation Scale; EDE-Q: Eating Disorder Examination Questionnaire; HbA1c: Hemoglobin A1c; SDQ-EP: Strengths and Difficulties Questionnaire–Externalizing Problems; SDQ-IP: Strengths and Difficulties Questionnaire–Internalizing Problems; SDQ-TDS: Strengths and Difficulties Questionnaire Total Difficulties Score; TDI: Total daily insulin dose (units/kg/day); T1D: Type 1 diabetes mellitus.

be entirely excluded. Consistent with previous studies, emotion dysregulation was correlated with DEBs in adolescents with T1D (50, 51). However, contrary to expectations, an inverse relationship was observed between emotional dysregulation and HbA1c. Although previous studies (22, 52) have reported associations between emotion dysregulation and elevated HbA1c in adolescents and adults with T1D, a recent adolescent study (53) did not confirm this association. Considering the variability of previous findings and the cross-sectional design of our study, this association should be interpreted cautiously.

Psychological problem levels among adolescents with T1D were similar to those of healthy controls. Although youth with T1D are generally considered at increased risk for psychological difficulties (54, 55), a large-sample study (56) also found comparable levels between youth with T1D and the general population. Among the variables examined in our study, psychological problems were identified as the strongest factor associated with increased DEBs in adolescents with T1D. Previous studies support the association between DEBs and psychological problems in adolescents with T1D (50, 53). A recent systematic review also highlighted robust associations between psychological distress and DEBs in young people with T1D, suggesting that broader psychological difficulties may contribute to the development and maintenance of maladaptive eating patterns in this population (57). The association between psychological problems and DEBs may be explained by emotion regulation difficulties, whereby eating becomes a coping strategy for managing psychological distress (58, 59). These findings highlight the importance of screening for DEBs in adolescents with T1D, particularly when psychological problems are present.

Although DEBs have been reported more frequently in adolescents and adults with T1D (60,

Table 4: Multiple linear regression analysis of factors associated with DEPS-R total scores in adolescents with type 1 diabetes mellitus

	Unstandardized coefficients		Standardized coefficients	t	p	95% CI	VIF
	B	SE	β				
Constant	-8.809	7.749		-1.137	0.261	-24.377 to 6.748	
Sex	-2.702	2.430	-0.104	-1.112	0.271	-7.581 to 2.177	1.176
Presence of a psychiatric disorder	0.934	2.791	0.031	0.335	0.739	-4.670 to 6.537	1.179
Maternal education level	-0.356	0.288	-0.110	-1.239	0.221	-0.933 to 0.221	1.070
DERS Total Score	0.020	0.090	0.035	0.226	0.822	-0.160 to 0.201	3.178
SDQ-TDS	0.822	0.287	0.421	2.867	0.006	0.247 to 1.398	2.920
AQC total score	0.525	0.268	0.230	1.954	0.056	-0.014 to 1.064	1.870
BMI	0.789	0.366	0.205	2.159	0.036	0.055 to 1.523	1.219
$R=0.790$; $R^2=0.623$; $F=12.065$; $p<0.001$.							

Dependent variable: DEPS-R score. Abbreviations: AQC: Alexithymia Questionnaire for Children; BMI: Body mass index; CI: Confidence interval; DEPS-R: Diabetes Eating Problem Survey–Revised; DERS: Difficulties in Emotion Regulation Scale; SDQ-TDS: Strengths and Difficulties Questionnaire–Total Difficulties Score; SE: Standard error; T1D: Type 1 diabetes mellitus; VIF: Variance inflation factor.

61), no group differences were observed in our study. This may be because the study sample was closely monitored in a pediatric endocrinology outpatient clinic for diabetes management and eating attitudes. No relationship was found between DEBs and HbA1c. Similarly, Colton et al. (62) reported no association between DEBs and metabolic control, as assessed by HbA1c, in adolescent girls with T1D. The absence of a relationship between DEBs and glycemic control in our study may reflect the fact that some DEPS-R items assessing eating attitudes also capture general adolescent weight-loss behaviors.

Disordered eating behaviors in adolescents with T1D were associated with individual factors, including BMI, female sex, and lower maternal education level. Previous studies have shown that adolescents with T1D and higher BMI values may engage in more DEBs (50, 63). Consistent with our findings, other studies have reported that DEBs in adolescents with T1D are more common in girls than in boys (61, 64). Similarly, studies have shown that adolescents whose parents have lower educational levels are more likely to develop DEBs (65, 66). Thus, our findings are consistent with the literature.

A supplementary sensitivity analysis excluding adolescents with psychiatric disorders from the T1D group showed that most primary findings remained unchanged. Although the statistical significance of some psychological subscale comparisons differed, the associated effect sizes were small. Therefore, these findings should be interpreted cautiously, as psychiatric comorbidity may have influenced psychological scale scores.

This study has several limitations. One limitation of this study is that alexithymia, emotion regulation difficulties, and DEBs were assessed using self-report measures. Another limitation of this study is the absence of a structured diagnostic interview for the assessment of the adolescents included in the study. In the control group, psychiatric exclusion criteria were based on clinical evaluation rather than standardized diagnostic interviews. Consequently, undetected subclinical psychiatric symptoms or emotional difficulties may have been present in some participants and could have influenced comparisons involving psychological measures. Another important limitation is that adolescents with psychiatric disorders were included in the T1D group, whereas such individuals were excluded from the healthy control group. Although a supplementary sensitivity analysis was conducted, psychiatric comorbidity may still have influenced psychological scale scores and should be considered when interpreting the findings. Additionally, the cross-sectional design of the study precludes conclusions regarding causal relationships among the variables examined. As this was a single-center study, the generalizability of the findings may also be limited. Furthermore, the sample size was not determined using a power analysis. Although the post hoc analysis indicated high statistical power for the observed effect size, future studies with prospectively determined sample sizes would strengthen methodological rigor. Additionally, although psychotropic medication use was recorded, only a small proportion of participants were receiving such treatment. Because of the substantial imbalance between medication users and

non-users, medication status was not included in the statistical analyses. Therefore, the potential influence of medication use on DEBs cannot be entirely excluded. Finally, although the presence of a psychiatric disorder was included as a variable in the regression model, the absence of structured diagnostic interviews and the heterogeneity of comorbid conditions may still have resulted in residual confounding.

CONCLUSION

The findings of this study suggest that alexithymia, emotional dysregulation, and psychological problems may be associated with DEBs in adolescents with T1D. Additionally, DEBs in this population may also be associated with higher BMI, female sex, and lower maternal education level.

Online Supplementary Digital Appendix File: https://dusunenadamdergisi.org/storage/upload/files/1780929756-appendix-en.pdf

Ethical Approval: Ethics committee approval dated 25.04.2023 and numbered E2-23-3957 was obtained from the Ankara Bilkent City Hospital Ethics Committee for the research.

Informed Consent: Written informed consent was obtained from all participants.

Conflict of Interest: The authors declare that there is no conflict of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The authors declared that artificial intelligence was not used in the study.

Contribution Categories		Author Initials
Category 1	Concept/Design	M.O., F.G., M.B., G.S.D., E.C.
	Data acquisition	Y.O.A.S., DK, M.Y., R.G.
	Data analysis/Interpretation	H.A.
Category 2	Drafting manuscript	M.O., Y.O.A.S., H.A., D.K., M.Y., R.G.
	Critical revision of manuscript	F.G., M.B., G.S.D., E.C.
Category 3	Final approval and accountability	M.O., F.G., M.B., Y.O.A.S., H.A., D.K., M.Y., R.G., G.S.D. E.C.

Peer-review: Externally peer-reviewed.

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