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Diabetes-specific eating disorder, psychological flexibility and metabolic control in adolescents with Type 1 Diabetes

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ABSTRACT

Objective: This study aimed to evaluate the risk of diabetes-specific eating disorders (EDs) and disease acceptance in adolescents with type 1 diabetes mellitus (T1DM) and to examine their associations with metabolic control and anthropometric measurements.

Material and Methods: A total of 73 adolescent with T1DM (11-19 years) participated. Data were collected face to face using questionnaires on sociodemographic and clinical characteristics, the Diabetes Eating Problem Survey-Revised (DEPS-R), and Acceptance and Action Diabetes Questionnaire (AADQ). Biochemical results and anthropometric measurements were obtained from medical records and direct assessment. Data were analyzed via SPSS and JASP.

Results: Nearly half of the participants (45.2%) were at high risk for diabetes-specific EDs. The mean DEPS-R score was 21.3±12.0, and the mean AADQ score was 47.6±9.7. Skipping main meals was associated with higher DEPS-R scores (p=0.025) and lower AADQ scores (p=0.009). A weak negative correlation was found between HbA1c and AADQ score (r=-0.280, p=0.018).

Conclusion: A considerable proportion of adolescents with T1DM are at high risk for EDs, and poor disease acceptance is linked to worse metabolic control. These findings underscore the importance of routine screening for disordered eating in clinical practice and the potential value of incorporating psychological flexibility-based interventions to improve outcomes.

Keywords: Anthropometry, eating disorders, disease acceptance, metabolic control, T1DM

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease characterized by insufficient insulin production, accounting for 5–10% of all diabetes cases worldwide. Its rising incidence and prevalence pose a major public health challenge with serious long-term effects on individuals, families, and communities (1,2). It is one of the most prevalent endocrine and chronic disorders in children and adolescents, and requires lifelong glycemic control to prevent long-term complications associated with hyperglycemia (3). Good metabolic control in T1DM patients, when HbA1c levels are maintained close to those of non-diabetic individuals, can prevent the onset of microvascular and cardiovascular complications and slow the progression of existing complications (4).

Managing T1DM is complex and requires active involvement from patients and caregivers. This burden is particularly high for children, who must adapt early to the demands of the disease, and for adolescents, who face additional challenges as they seek independence and assume greater responsibilities (5,6). Therefore, a diagnosis of diabetes in childhood or adolescence can cause interference with normal developmental changes and lead to facing psychological and social challenges (7). Psychological flexibility, along with factors such as diabetes-related stress, peer interactions, and family conflict, is reported to be significantly negatively associated with HbA1c in youth with T1DM (8). In this process, acceptance of the disease, which is related to recognizing the significance of the illness, encourages the patient to mobilize their strengths, facilitates the adaptation process, prevents a decrease in quality of life,

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and reduces the risk of disease-related complications (9). The Action and Acceptance Diabetes Questionnaire (AADQ) is used as a brief measure of general acceptance and psychological flexibility that has been validated in type 1 diabetes and type 2 diabetes populations (10).

Diabetes-specific eating disorders (EDs), which can significantly impact diabetes management and complicate both metabolic control and overall well-being, are more common in individuals with T1DM, especially in females (11). Hormonal changes, dietary restrictions, social pressures, higher body mass index (BMI), body image, and self-control concerns are potential factors that can affect the process of accepting the disease and lead to diabetes-specific EDs, which are common concerns among youth with T1DM (12,13). Although various screening tools are available to identify individuals at risk of developing EDs or those already experiencing eating problems, the Diabetes Eating Problem Questionnaire-Revised (DEPS-R) has been validated as an effective screening tool for EDs in individuals with T1DM (14). It is stated that young individuals with DEPS-R scores above the clinical threshold are 8.5 times more likely to be diagnosed with an eating disorder according to the DSM-5 classification (15).

Despite increasing recognition of these psychological and behavioral factors, the combined influence of psychological acceptance and diabetes-specific eating disorder risk on metabolic control and anthropometric outcomes in adolescents with T1DM remains underexplored. This study aims to fill this gap by examining the relationships between disease acceptance, EDs risk, and clinical outcomes in adolescents. Early identification of acceptance difficulties and diabetes-related eating disorders is essential for developing disease management skills and adopting a healthy lifestyle. This study may help improve the quality of life and optimize long-term health outcomes in adolescents with T1DM.

MATERIALS and METHODS

Participants

The inclusion criteria of the study were i) being a volunteer and having obtained permission from her/his parent, ii) being an adolescent (aged between 11-19 years), iii) being diagnosed with T1DM for more than one year, iv) receiving treatment the hospital where conducting this study, v) receiving regular follow-up for at least 1 year considering factors such as treatment adherence, stabilization of metabolic control, self-management, and psychological adaptation processes, and vi) having the cognitive and language skills to understand and respond to measurement tools. The exclusion criteria of the study were i) not being a volunteer and or lacking parental permission, ii) aged below 11 years or above 19 years, iii) diagnosis of T1DM for less than one year, iv) lack of metabolic control, v) presence of serious psychiatric disorders (evaluated through patient history and clinical records during general health consultations), or chronic gastrointestinal, endocrinological, or systemic illnesses (e.g., hypothyroidism, celiac disease, irritable bowel syndrome), and vi) insufficient cognitive and language skills to understand and respond to measurement tools.

The study was performed between June and December 2023, and 90 adolescents with T1DM were reached and assessed for eligibility in the data collection process (six months). seven patients were excluded with reasons including lack of time (n=12), out of the study age range (n=2), or without any reason (n=3). Finally, the study was completed with 73 adolescents with T1DM, and their data were analyzed. In post-hoc power analysis, the observed power (one-tailed hypothesis) with 0.8 observed effect size (Cohen's d) and 0.050 probability level was 96.7% using the Free Statistics Calculators website (Soper, D., Free Statistics Calculators, Version 4.0).

Study design

The type of this study was self-reported, face-to-face, cross-sectional, and it was conducted with adolescents with T1DM receiving treatment at the Pediatric Endocrinology Clinic of Mardin Training and Research Hospital.

Data collection instruments

Data from this study was collected using the face-to-face interview method via a questionnaire created by researchers after literature searching and consisted of sections including the participants' characteristics (age, gender, diabetes duration, onset of diabetes, parental education status, family size), information on diabetes health (family diabetes history, carbohydrate counting, insulin pump usage, daily blood sugar measurement), eating habits (meal time, snack habit, meal skip, etc.), DEPS-R, and AADQ.

Diabetes Eating Problem Survey-Revised: Markowitz et al. (14) developed the DEPS-R self-report instrument to screen for eating disorders in individuals with T1DM with excellent internal consistency (Cronbach's α=0.86). Atik Altınok et al. (16) conducted the reliability and validity of the scale in Turkish children and adolescents with T1DM (Cronbach's α= 0.847). DEPS-R is a 16-item, 6-point Likert-scale self-report questionnaire designed to test diabetes-specific eating disorders. The lowest score that can be obtained from the scale is 0, and the highest score is 80. As the score obtained from the scale increases, it reflects more disturbed eating behavior, while a total score of ≥20 indicates a high risk for eating disorders (16).

Acceptance and Action Diabetes Questionnaire: The AADQ was developed to measure acceptance of diabetes-related thoughts and feelings and the degree to which they interfere with valued action. High internal consistency (Cronbach's alpha 0.94) was found in Gregg et al.'s (10) study analysis. The reliability and validity of the Turkish version of the tool was conducted by Karadere et al. (17) (Cronbach's α=0.84). The scale consists of 9 items in total while the original form is an 11-item scale. The items are rated on a 7-point Likert scale (1: never true, 7: always true). Except for the first item, the scores of the scale are reverse scored. The scores that can be obtained from the scale are between 9-63. A high score on the scale is evaluated in favor of acceptance of diabetes and psychological flexibility (17).

Laboratory Assessment

The most recent biochemical analysis results including fasting blood glucose (FBG) (mg/dL), HbA1c (%), C peptide (nmol/L), urea (mg/dL), creatinine (mg/dL), ALT (U/L), ALP (U/L), P (mg/dL), Mg (mg/dL), Na (nmol/L) and K (nmol/L) were obtained from the medical records of the hospital where the research was conducted. The laboratory parameters, including P, Mg, Na, and potassium K, were evaluated as part of a comprehensive assessment of the patients' metabolic and electrolyte status. Other values were included to monitor metabolic balance and overall biochemical status alongside kidney and liver function markers. The glycemic targets in the ISPAD Clinical Practice Consensus Guidelines were used for FBG and HbA1c, and the reference ranges of the measured laboratory were used for other parameters (18).

Anthropometric measurement

Body weight, height, waist circumference (WC), and middle upper arm circumference (MUAC) of adolescents were measured by the researcher in accordance with measurement techniques. Height (cm) was measured with a stadiometer, ensuring that the patients were without shoes and were in the Frankfort plane. Body weight (kg) was measured using a scale, considering that they were barefoot and wearing light clothing. WC (cm) was measured between the lowest rib bone and the crista iliac crest, with a non-stretchable tape measure passing through the midpoint. MUAC (cm) was measured using a non-elastic plastic tape at the midpoint between the olecranon and acromion process on the upper left arm, with patients in a comfortable standing position. BMI (kg/m^2) was calculated [(bodyweight, kg) / (body height, m^2)]. Height-for-age and BMI-for-age were assessed according to WHO Anthro (version 3.2.2) percentile values (19). MUAC was evaluated according to the NCHS (20). WC percentiles were evaluated and waist-to-height ratio (WHtR) was calculated based using the formula [WC (cm) / H (cm)] and considered (21,22).

Statistical analysis

The data obtained from this study were analyzed using the IBM SPSS Statistics 23.0 (Statistical Package for the Social Sciences) package program (Armonk, NY, USA: IBM Corp; 2013) and the JASP Statistical Software version 0.18.2 (JASP, Amsterdam, the Netherlands). Mean, standard deviation (SD), lower and upper values were calculated for the quantitative data, and the qualitative data were presented as frequency (n), percentage (%). The normality of the distribution for each variable was assessed using the Kolmogorov–Smirnov test.

For comparisons between two groups, the independent t test was applied, and for comparisons among more than two groups, the One-Way ANOVA test was performed. Post-hoc pairwise comparisons were conducted using the Bonferroni test. The One Sample t test was used to compare variables with established biochemical reference values. Effect sizes were reported as Cohen's d for t-tests and as eta-squared (η^2) for ANOVA to indicate the magnitude of observed differences. The Pearson and Spearman correlation coefficients were conducted to assess the strength and direction of relationships between continuous variables, depending on their distribution, with correlation coefficients interpreted as follows: 0.00-0.10 (negligible), 0.10-0.39 (weak), 0.40-0.69 (moderate), 0.70-0.89 (strong), and 0.90-1.00 (very strong). The statistical significance was set at $p<0.050$.

RESULTS

The study population comprised 31 (42.5%) female and 42 (57.5%) male adolescents with T1DM. The mean age, onset of diabetes, and diabetes duration were 15.2±2.3, 8.7±4.0, and 6.5±4.5 years, respectively. Most were in the 14-17 years middle-adolescent group (50.7%). A total of 42.5% of them had been diagnosed above 10 years old, and 46.6% of them had 1–5-year(s) diabetes duration.The proportion of parents with a high education status was 20.5% for mothers and 52.1% for fathers, and most fathers (91.8%) had working status. While only 6 (8.2%) participants used an insulin pump and 44 (60.3%) of them measured capillary blood glucose >4 times/day. The mean of DEPS-R score and AADQ were 21.3±12.0 and 47.6±9.7, respectively. The study found that 54.8% (n=40) of the participants were EDs risk-negative and 45.2% (n=33) were EDs risk-positive. When examining diabetes-specific eating disorders and accepting disease scores according to participants' characteristics, there were no statistically significant results (Table I).

DEPS-R score and AADQ score according to participants' eating habits are shown in Table II. Most adolescents did not use the carbohydrate counting method (n=44, 60.3%), had ≥3 main meals/day (n=65, 89.0%), and had 2 snacks/day (n=38, 52.1%). There were more than three hours between consecutive main and snacks in the diet of 58.9%. The mean DEPS-R score was significantly higher in adolescents who skipped main meals compared with those who did not (24.5 ±13.5 vs. 18.2±9.6; t=2.296; Cohen's d=0.540; p=0.025). In contrast, the mean AADQ score was significantly lower in those who skipped meals (44.6 ±11.0 vs. 50.5±7.3; t =–2.690; Cohen's d =–0.630; p=0.009).

Biochemical results of adolescents with T1DM and differences from reference values are in Table III. As metabolic parameters,

Table I: DEPS-R and AADQ scores by participants' general and diabetes characteristics

General and diabetes characteristics	Overall	DEPS-R score		AADQ score	
		values	p	values	p
Age (years)	15.2±2.3 (11-19)*	-0.130†	0.274	0.163†	0.169
Onset of diabetes (years)	8.7±4.0 (1-15)*	-0.022†	0.852	-0.037†	0.756
Diabetes duration	6.5±4.5 (1-16)*	-0.048†	0.686	0.118†	0.320
Age (years)					
11-13	21 (28.8)‡	22.6±12.2 (3-49)*		45.9±9.0 (20-57)*	
14-17	37 (50.7)‡	21.0±13.3 (3-61)*	0.828§	47.4±10.9 (19-60)*	0.328§
18-19	15 (20.5)‡	20.2±8.3 (5-35)*		50.7±7.1 (38-62)*	
Gender					
Female	31 (42.5)‡	23.0±14.1 (3-61)*		45.8±10.8 (19-60)*	0.166ǁ
Male	42 (57.5)‡	20.0±10.3 (3-49)*	0.310ǁ	49.0±8.7 (20-62)*	
Mother education status					
Low education status	58 (79.5)‡	20.9±11.8 (3-61)*	0.618ǁ	48.5±8.4 (20-60)*	0.128ǁ
High education status	15 (20.5)‡	22.7±13.4 (3-44)*		44.2±13.5 (19-62)*	
Father education status					
Low education status	35 (47.9)‡	22.7±13.9 (3-61)*	0.330ǁ	46.4±9.7 (20-60)*	0.297ǁ
High education status	38 (52.1)‡	20.0±10.0 (3-44)*		48.8±9.7 (19-62)*	
Mother working status					
Yes	10 (13.7)‡	25.8±14.1 (8-48)*	0.203ǁ	45.5±9.5 (28-62)*	0.463ǁ
No	63 (86.3)‡	20.6±11.6 (3-61)*		48.0±9.8 (19-60)*	
Father working status					
Yes	67 (91.8)‡	20.7±12.2 (3-61)*	0.200ǁ	47.6±9.9 (19-62)*	0.955ǁ
No	6 (8.2)‡	27.3±8.8 (14-37)*		47.8±8.2 (33-56)*	
Sibling number					
≤2	25 (34.2)‡	20.0±10.6 (3-44)*		47.7±10.1 (19-62)*	
3-4	33 (45.2)‡	19.3±9.6 (5-42)*	0.063§	49.5±6.7 (32-58)*	0.141§
≥5	15 (20.6)‡	27.7±16.9 (7-61)*		43.5±13.6 (20-60)*	
Onset of diabetes					
<5 years	16 (21.9)‡	21.6±12.2 (10-49)*		47.8±10.8 (20-60)*	
5-10 years	26 (35.6)‡	19.6±11.1 (3-48)*	0.652§	49.0±9.3 (19-62)*	0.622§
>10 years	31 (42.5)‡	22.6±12.9 (7-61)*		46.4±9.7 (21-59)*	
Diabetes duration					
<5 years	34 (46.6)‡	21.3±12.3 (7-61)*		47.5±9.3 (21-59)*	
5-10 years	22 (30.1)‡	22.2±13.0 (3-49)*	0.865§	46.1±11.5 (19-62)*	0.478§
>10 years	17 (23.3)‡	20.1±10.8 (5-44)*		49.9±7.9 (28-60)*	
Insulin pump usage					
Yes	6 (8.2)‡	17.4±14.1 (3-42)*	0.426ǁ	50.7±10.6 (32-60)*	0.426ǁ
No	67 (91.8)‡	21.6±11.9 (3-61)*		47.3±9.7 (19-62)*	
Family history of diabetes					
Yes	38 (52.1)‡	22.8±13.2 (3-61)*	0.257ǁ	46.1±10.8 (19-59)*	0.176ǁ
No	35 (47.9)‡	19.6±10.6 (3-44)*		49.2±8.3 (28-62)*	
Daily capillary blood glucose measurement (times)					
≤4	29 (39.7)‡	20.9±6.7 (3-40)*	0.830ǁ	47.6±7.5 (19-62)*	0.997ǁ
>4	44 (60.3)‡	21.5±13.5 (3-61)*		47.6±11.0 (20-60)*	

:** *mean±SD (min-max),* **†:** *r (Pearson correlation test),* **‡:** *n(%),* **§:** *One Way ANOVA test,* **ǁ:** *Independent t test,* ***AADQ: *Acceptance and Action Diabetes Questionnaire,* ***DEPS-R:*** *Diabetes Eating Problem Survey-Revised,* ***Low education status:*** *Literature/primary school/secondary school,* ***High education status:*** *High school/bachelor's degree*

the mean FBG (214.5±119.4 mg/dL) was found to be higher than the reference (upper level 144 mg/dL, mean difference=70.5 mg/dL, Cohen's d=0.590, p<0.001). The mean HbA1c (9.2±2.5) was higher than the reference (upper level 7%, mean difference=2.2%, Cohen's d=0.860, p <0.001). Additionally, the mean of ALP (U/L) differed from the maximum level of reference (129 U/L, mean difference=101.4 U/L, Cohen's d=0.996, p<0.001). The deviations from references were shown with raincloud plots. There was no relationship between biochemical results and DEPS-R, AADQ scores of participants (p>0.050). A weak and negative significant relationship was found between HbA1c and the AADQ score (rho=-0.280, p=0.018).

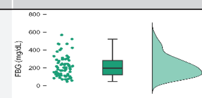
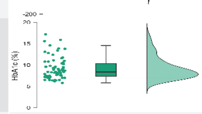
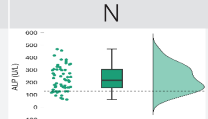
Most participants were in the normal percentile range of anthropometric measurements (height for age 69.8%, BMI for

Table II: DEPS-R and AADQ scores by participants' eating habits

Eating habits	Overall*	DEPS-R score		AADQ score	
		values†	p	values†	p
Carbohydrate counting method usage					
Yes	29 (39.7)	21.0±13.1 (3-61)	0.860‡	48.7±9.4 (21-59)	0.463‡
No	44 (60.3)	21.5±11.5 (3-49)		46.9±10.0 (19-62)	
Main meal(s)/day					
2	8 (11.0)	28.0±18.1 (8-61)	0.283‡	38.9±13.6 (19-53)	0.082‡
≥3	65 (89.0)	20.5±11.0 (3-49)		48.7±8.7 (20-62)	
Snack/day					
1	13 (17.8)	24.2±15.8 (8-61)	0.630§	47.4±9.6 (24-60)	0.989§
2	38 (52.1)	20.4±11.0 (3-49)		47.6±9.3 (20-62)	
≥3	22 (30.1)	21.1±11.7 (3-40)		47.9±10.9 (19-59)	
Main meal(s) skip habits					
Yes/sometimes	36 (49.3)	24.5±13.5 (8-61)	0.025‡	44.6±11.0 (19-59)	0.009‡
No	37 (50.7)	18.2±9.6 (3-40)		50.5±7.3 (32-62)	
Snack skip habits					
Yes/sometimes	46 (63.0)	22.4±12.8 (3-61)	0.323‡	47.4±10.5 (19-62)	0.760‡
No	27 (37.0)	19.4±10.6 (3-40)		48.1±8.3 (21-58)	
Time between consecutive main and snack (hours)					
≤3	30 (41.1)	21.4±12.4 (3-49)	0.957‡	46.9±11.2 (19-62)	0.596‡
>3	43 (58.9)	21.2±11.9 (3-61)		48.1±8.6 (24-59)	

:** *n(%),* **†:** *mean±SD (min-max),* **‡ :** *Independent t test,* **§ :** *One Way ANOVA test,* ***AADQ: *Acceptance and Action Diabetes Questionnaire,* ***DEPS-R:*** *Diabetes Eating Problem Survey-Revised*

Table III: DEPS-R and AADQ scores by participants' biochemical analysis results

Biochemical results	n	Overall*	Reference	p†	Raincloud plots	DEPS-R score	AADQ score
						rho, p‡	rho, p‡
FBG (mg/dL)	73	214.5±119.4 (46-569)	70-144	<0.001		-0.150, 0.206	0.126, 0.289
HbA1c (%)	71	9.2±2.5 (5.8-17.2)	≤7	<0.001		0.160, 0.183	-0.280, 0.018
C peptide (nmol/L)	52	0.2±0.4 (0.0-1.7)	0.2-0.5	N	N	0.178, 0.206	-0.177, 0.209
Urea (mg/dL)	60	29.9±25.4 (8.3-214.0)	10-50	N	N	0.228, 0.079	-0.107, 0.415
Creatinine (mg/dL)	69	0.7±0.1 (0.4-1.1)	0.5-1.1	N	N	-0.181, 0.137	0.193, 0.113
ALT (U/L)	68	22.5±30.6 (5-234)	10-49	N	N	0.230, 0.060	-0.195, 0.111
ALP (U/L)	56	230.4±101.8 (62-469)	45-129	<0.001		-0.054, 0.692	-0.262, 0.051
P (mg/dL)	58	4.3±0.8 (2.6-7.0)	2.5-4.5	N	N	-0.078, 0.562	-0.106, 0.430
Mg (mg/dL)	56	1.8±0.3 (1.3±2.6)	1.7-2.5	N	N	0.077, 0.571	-0.117, 0.391
Na (mmol/L)	64	137.8±4.1 (120-144)	132-146	N	N	-0.053, 0.676	-0.029, 0.823
K (mmol/L)	64	4.5±0.9 (3.1-10.5)	3.5-5.5	N	N	-0.146, 0.250	0.036, 0.775

:** *mean±SD (min-max),* **†:** *One Sample t test,* **‡ :** *Spearman correlation test* ***AADQ: *Acceptance and Action Diabetes Questionnaire,* ***DEPS-R:*** *Diabetes Eating Problem Survey-Revised,* ***FBG:*** *Fasting blood glucose,* ***ALT:*** *Alanine transaminase,* ***ALP:*** *Alkaline phosphatase,* ***P:*** *phosphorus,* ***Mg:*** *magnesium,* ***Na:*** *sodium,* ***K:*** *potassium,* ***MD:*** *mean difference,* ***N:*** *normal range*

age 60.3%, MUAC for age 56.2%, and WC for age 52.0%). The proportion of subjects in the high-risk WHtR group was found to be 16.4%. The mean DEPS-R score differed by height-for-age groups. This difference was found to be between the normal and tall–very tall groups using the Bonferroni multiple comparison test. The mean DEPS-R score of those who were in the normal height percentile range was higher than the tall–very tall group (23.4±12.8 vs 11.6±5.0, $F=3.921$, $\eta^2=0.101$, $p=0.024$) (Table IV). As shown in scatter plots, there was no statistically significant relationship between anthropometric percentiles and scale scores ($p>0.050$) (Figure 1).

Table IV: DEPS-R and AADQ scores by participants' anthropometric measurements

Anthropometric measurements	Overall*	DEPS-R score †	p	AADQ score †	p
Height for age (cm)					
Short–very short	14 (19.2)	19.0±8.7[ab] (7-33)	0.024‡	49.9±7.9 (32-60)	0.224‡
Normal range	51 (69.8)	23.4±12.8[a] (3-61)		46.4±10.5 (19-62)	
Tall–very tall	8 (11.0)	11.6±5.0[b] (3-18)		51.6±4.9 (46-59)	
BMI for age (kg/m^2)					
Severely underweight/underweight	13 (17.8)	22.1±8.9 (11-39)	0.384‡	48.4±9.9 (21-62)	0.953‡
Normal range	44 (60.3)	19.8±11.4 (3-49)		47.5±9.9 (19-60)	
Overweight/obese	16 (21.9)	24.6±15.6 (3-61)		47.4±9.7 (24-59)	
MUAC for age (cm)					
Low–too low	26 (35.6)	22.4±9.2 (7-39)	0.148‡	45.9±10.7 (19-62)	0.487‡
Normal range	41 (56.2)	19.4±13.4 (3-61)		48.3±9.6 (20-60)	
High–too high	6 (8.2)	29.2±11.1 (18-48)		50.2±4.7 (42-56)	
WC for age (cm)					
Low–too low	27 (37.0)	21.4±9.0 (7-37)	0.806‡	47.3±6.9 (32-58)	0.891‡
Normal range	38 (52.0)	20.7±12.7 (3-49)		48.1±11.5 (19-62)	
High–too high	8 (11.0)	23.8±18.2 (8-61)		46.5±9.8 (24-55)	
WHtR					
Low risk	61 (83.6)	21.4±11.3 (3-49)	0.809§	47.4±9.9 (19-62)	0.685§
High risk	12 (16.4)	20.5±16.0 (5-61)		48.7±9.0 (24-60)	

:** *n(%),* **†:** *mean±SD (min-max),* **‡:** *One Way ANOVA test,* **§:** *Independent t test,* ***AADQ: *Acceptance and Action Diabetes Questionnaire,* ***BMI:*** *Body mass index,* ***DEPS-R:*** *Diabetes Eating Problem Survey-Revised,* ***MUAC:*** *Middle upper arm circumference,* ***WC:*** *Waist circumference,* ***WHtR:*** *Waist-to-height ratio,* **a-b:** *Statistically significant difference between groups. Bonferroni correction was used to find the difference.*

DISCUSSION

Early detection of EDs is crucial in adolescents with T1DM, as these disorders increase the risk of developing diabetes-related complications (23). Findings of this study indicate that a significant proportion of adolescents with T1DM were at high risk for eating disorders, with no differences observed based on demographic or diabetes-related characteristics. Mean fasting blood glucose and HbA1c values were higher than reference ranges; however, no significant associations were found between these biochemical outcomes and DEPS-R scores. DEPS-R scores also did not differ according to BMI. Notably, a significant negative correlation was observed between HbA1c levels and AADQ scores, suggesting that higher disease acceptance was associated with better glycemic control in this cohort.

We found that 45.2% of adolescents with T1DM were at high risk for EDs, which did not differ by demographic and diabetes-related information. Ryman et al. (24) found that 21% of participants had EDs, with a higher prevalence in females, although no differences were observed based on age and duration of diabetes diagnosis. Daniel et al. (25) reported a prevalence of 43.3% among 395 adolescents aged 10–19 years, and Lawrence et al. (26) found a prevalence of 48.0% in a smaller Australian cohort. Nilsson et al. (27) reported 21.0% among 192 Danish children and adolescents, and Polat et al. (28) observed 30.5% in Turkish adolescents with T1DM. These findings highlight the increased risk of EDs in adolescents with chronic diseases such as diabetes, where food intake is closely related to disease management. It is also important to note that while screening tools such as the DEPS-R are useful in identifying at-risk individuals, they do not replace clinical diagnoses based on DSM-5 criteria. According to the DSM-5, eating disorders such as anorexia nervosa, bulimia nervosa, and binge eating disorder require the presence of specific behavioral and psychological characteristics, such as frequency, duration, and associated disorder (29). Therefore, our findings suggest a high risk, yet should not be interpreted as equivalent to a clinical diagnosis. However, these screenings can guide targeted interventions in adolescents with T1DM.

While some studies suggest an association between EDs and poorer diabetes control, as reflected by elevated HbA1c levels, the evidence is not entirely consistent. In this study, mean FBG and HbA1c values were higher than references, but no association was observed between HbA1c and DEPS-R. Some studies have shown an association between poorer glycemic control and EDs, while others have found a weak relationship (16,24,30). The differing results may be attributed to the type of EDs, characteristics of the studied population, and variations in approaches to diabetes management.

In this study, the mean DEPS-R score was higher in the normal height percentile group compared to the tall–very tall group, with no differences in other anthropometric indicators, including BMI. The literature on between BMI and EDs suggests that some studies have identified a link between increasing BMI and both the onset and persistence of EDs behaviors, whereas other studies found no such relationship (23,24,31). This finding should be interpreted cautiously, as the underlying mechanisms are unclear and may involve psychosocial or sociocultural factors not directly measured in this study.

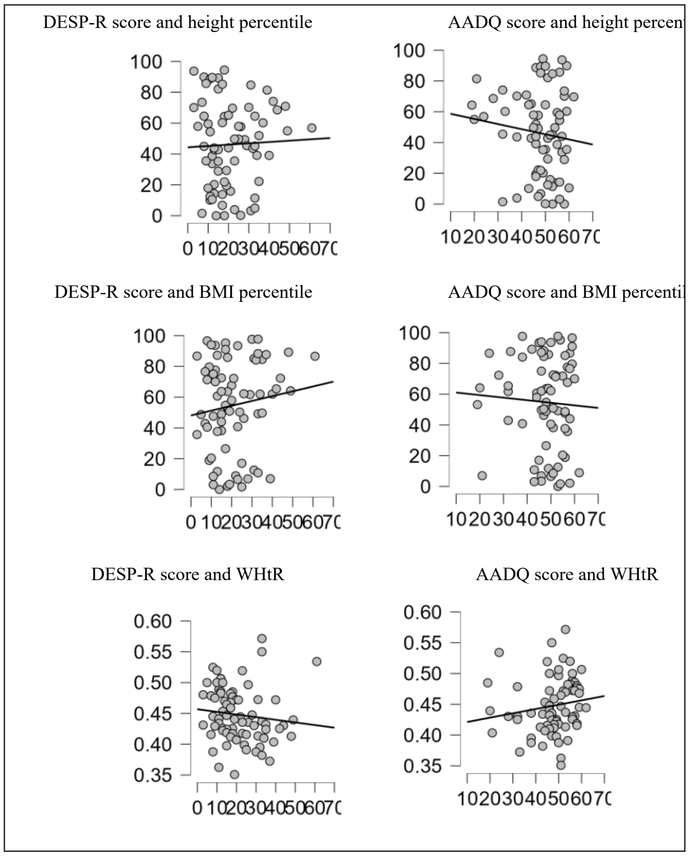


Figure 1: Scatter plots of correlation between anthropometric measurements' values and scale scores

T1DM is a serious condition associated with a high prevalence of impaired psychological health, with treatment targets being achieved by only a minority of individuals (32). In this study, we found a significant negative correlation between HbA1c and AADQ score. Saito et al. (33) showed that in type 2 diabetes, increased acceptance assessed with AADQ mediated improvements in HbA1c levels. Another study also reported improved AADQ scores linked to better HbA1c levels (32). Together with our findings, this suggests that enhancing acceptance may contribute to better psychological well-being and improved treatment outcomes, underscoring the importance of psychological factors in managing T1DM. Moreover, although insulin pump use was low in our sample (8.2%) and did not allow for subgroup analysis, it is important to note that diabetes management technologies such as insulin pumps, continuous glucose monitoring systems, and the frequency of self-monitoring have been shown in the literature to be associated with better psychological well-being and enhanced metabolic outcomes (34, 35).

In diabetes management, adherence to diet recommendations is crucial factor for preventing complications, and is influenced by psychosocial factors (36). We found that the adolescent who reported skipping main meals had significantly lower AADQ scores compared with those who did not skip meals. Jaworski et al. (37) similarly reported that patients' non-adherence to dietary recommendations was linked to lower levels of disease acceptance. This finding suggests that skipping main meals may reflect poorer acceptance of the disease, highlighting psychosocial adaptation and dietary adherence are closely intertwined in diabetes management.

In clinical practice, the DEPS-R and AADQ tools can support individualized treatment strategies by facilitating a more comprehensive assessment of both behavioral and psychological aspects of T1DM management. While not diagnostic tools, their ease of administration makes them suitable for routine follow-up visits and can help flag patients who may require further psychiatric evaluation. This allows healthcare providers to intervene early and provide appropriate psychological or nutritional support. However, given the reliance on self-report measures, clinicians should interpret the scores cautiously.

Several limitations should be considered when interpreting these results. The cross-sectional design limits the ability to conclude causality. Both DEPS-R and AADQ are self-report tools, which may introduce recall or reporting bias. DEPS-R cannot replace structured psychiatric evaluation, and AADQ would benefit from complementary objective assessments, such as neuropsychological testing, to more robustly capture psychological flexibility. Future research could incorporate objective measures, such as provider interviews or direct observations of eating behavior. The relatively small sample size may limit the generalizability and including a larger, more diverse cohort could improve understanding of the factors influencing eating behaviors in adolescents with T1DM. Exploring additional psychological factors, such as depression, anxiety, and family dynamics, would be valuable. Finally, the absence of a healthy control group limits interpretation, as it is unclear whether the DEPS-R findings are specific to T1DM or reflect general adolescent risk. Longitudinal studies are needed to examine the impact of eating disorders, psychological flexibility, metabolic control, and physical measures in T1DM.

CONCLUSION

This study demonstrates a high prevalence of eating disorder risk and highlights the importance of disease acceptance in adolescents with T1DM. Nearly half of the participants were identified as being at high risk for EDs. Lower acceptance was associated with poorer glycemic control, reflected by elevated HbA1c levels. Adolescents who skipped main meals showed lower disease acceptance, emphasizing the role of dietary behaviors in metabolic and psychological outcomes. These findings underscore the need for early screening and targeted psychological and behavioral interventions to improve both metabolic control and disease acceptance, particularly in adolescents at risk for eating disorders.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Mardin Artuklu University (14.12.2022, reference number: 2022/14-15).

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Contribution of the authors

Study conception and design: ACJ, GA; data collection: ACJ, GA; analysis and interpretation of results: ACJ, GA; draft manuscript preparation: ACJ, GA. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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