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RESEARCH

Effects of diabetes-related distress on diabetes follow-up in adolescents with type 1 diabetes mellitus

Tip 1 diyabetli adölesanlarda diyabete bağlı stresin diyabet takibi üzerindeki etkileri

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Abstract

Purpose: The aim of this study was to evaluate the effects of diabetes-related distress (DRD) on diabetes management in adolescents with type 1 diabetes mellitus (T1DM) followed in the Pediatric Endocrinology outpatient clinic.

Materials and Methods: Cross-sectional study at Adana City Training and Research Hospital (February 2021–February 2022) of consecutive adolescents with T1DM (N=124). DRD was measured with the clinician-administered Diabetes Distress Scale (DDS-17); participants were classified as Group 1 (mean item score <2; little/no distress) or Group 2 (≥2; clinically significant distress). Primary outcomes were HbA1c, number of hospitalizations, and regular SMBG (study-defined operational cutoff: ≥4 capillary checks/day).

Results: Among 124 adolescents with T1DM, 27 (21.8%) were in Group 1 and 97 (78.2%) in Group 2. Compared with Group 1, Group 2 had higher mean HbA1c (8.51±1.17% vs 9.22±1.72%), more hospitalizations (1.15±0.95 vs 2.04±1.40) and less regular SMBG (63.0% vs 39.2%). In continuous analyses, HbA1c correlated positively with the DDS-17 total score and with the Emotional Burden, Regimen-Related Distress and Interpersonal Distress subscales.

Conclusion: Clinically significant DRD is common in adolescents with T1DM and is associated with higher average HbA1c, greater hospitalization burden and less regular self-monitoring of blood glucose. These findings support routine DRD screening alongside targeted psychosocial interventions that address emotional burden and day-to-day regimen demands.

Keywords: Adolescent; diabetes-related distress; diabetes distress scale (DDS-17); HbA1c; Type 1 diabetes mellitus.

Öz

Amaç: Bu çalışmanın amacı, Pediatrik Endokrinoloji polikliniğinde takip edilen tip 1 diabetes mellitus (T1DM) hastası ergenlerde diyabetle ilişkili sıkıntıların (DRD) diyabet yönetimine etkilerini değerlendirmektir.

Gereç ve Yöntem: Şubat 2021–Şubat 2022 döneminde Adana Şehir Eğitim ve Araştırma Hastanesi'nde yürütülen kesitsel çalışmada, ardışık T1DM'li adölesanlar dâhil edildi (N=124). DRD, klinisyen tarafından uygulanan Diyabet Stres Ölçeği (DDS-17) ile ölçüldü; katılımcılar Grup 1 (madde ortalaması <2; düşük/hiç sıkıntı) veya Grup 2 (≥2; klinik olarak anlamlı sıkıntı) olarak sınıflandırıldı. Birincil sonlanımlar HbA1c, hastaneye yatış sayısı ve düzenli SMBG idi (çalışma-içi operasyonel eşik: günde ≥4 kapiller ölçüm).

Bulgular: T1DM'li 124 adölesanın 27'si (%21,8) Grup 1, 97'si (%78,2) Grup 2'de yer aldı. Grup 2, Grup 1'e kıyasla daha yüksek ortalama HbA1c (%8,51±1,17'ye karşı %9,22±1,72), daha fazla hastaneye yatış (1,15±0,95'e karşı 2,04±1,40) ve daha az düzenli SMBG (%63,0'a karşı %39,2) ile karakterizeydi. Sürekli analizlerde HbA1c, DDS-17 toplam puanı ile ve Duygusal Yük, Rejimle İlişkili Sıkıntı ve Kişilerarası Sıkıntı alt boyutlarıyla pozitif orelasyon gösterdi.

Sonuç: Klinik olarak anlamlı DRD, T1DM'li adölesanlarda oldukça yaygındır ve daha yüksek ortalama HbA1c, daha fazla hastaneye yatış ve daha az düzenli SMBG ile ilişkilidir. Bu bulgular, duygusal yük ve günlük tedavi gerekliliklerini hedefleyen rutin DRD taraması ve odaklı psikososyal müdahalelerin uygulanmasını desteklemektedir.

Anahtar kelimeler: Adölesan; diyabete bağlı stres; diyabet stres ölçeği (DDS-17); HbA1c; Tip 1 diabetes mellitus.

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INTRODUCTION

Type 1 diabetes mellitus is one of the most common chronic childhood diseases, and its incidence is rapidly increasing worldwide. According to the World Health Organization, individuals aged 10–19 years are defined as adolescents, a period in which diabetes management and metabolic control are particularly challenging for both patients and families. Psychosocial difficulties during adolescence often impede optimal metabolic control and increase complication risk[1,2].

Diabetes-related distress denotes negative emotions such as anger, hopelessness, guilt, and fear that arise from living with and managing diabetes[3]. The substantial burden of disease management in adolescence, compounded by challenges in family and peer relationships, may exacerbate this situation. Unlike depression and anxiety, DRD is not a psychiatric disorder, but rather an emotional response to the specific demands of diabetes. Although depression, anxiety, and DRD may coexist, several studies have demonstrated that DRD is more strongly associated with glycemic control than depression[3,4].

The Diabetes Distress Scale (DDS-17), first published in 2005, is a 17-item scale that assesses DRD. The scale was developed by the Behavioral Diabetes Institute, translated into multiple languages (including Turkish) and is freely available[4,5]. The validity and reliability of the Turkish version of the DDS-17 were confirmed by Telci Çaklılı et al. (2020), demonstrating that the instrument is appropriate for use in Turkish patients[5]. The DDS-17 provides the following total diabetes distress score and four subscale scores, each addressing a different type of distress: "Emotional burden," "Physician distress," "Regimen-related distress," and "Diabetes-related interpersonal distress."

In this study, we aimed to evaluate the effects of DRD on diabetes management in adolescents with T1DM followed in the Pediatric Endocrinology outpatient clinic of Adana City Training and Research Hospital. Previous research has reported that the prevalence of clinically significant DRD in adolescents with T1DM ranges from 22% to 36%[6]. These findings highlight DRD as a common psychosocial barrier in this age group, underscoring the need for early recognition and targeted interventions. Despite its clinical importance, research on adolescent DRD remains scarce; most studies to date have been conducted in Western populations. By addressing this gap, our study aims to evaluate the prevalence and impact of DRD in a different cultural and healthcare context, thereby providing novel insights that may guide more effective diabetes management strategies for adolescents.

Building on the pediatric T1DM literature, we hypothesized that adolescents with DRD (defined as a DDS-17 mean item score ≥2) would exhibit poorer metabolic control than those with little or no distress (DDS-17 <2), manifested by higher HbA1c levels and less consistent SMBG. As a secondary hypothesis, we expected a positive association between continuous DDS-17 scores (total and subscales) and HbA1c. We also planned exploratory analyses to evaluate whether these relationships differ by stage of adolescence (early vs. late) or by sex. Given the participants' age range and typical duration of diabetes, we did not anticipate strong cross-sectional associations between DRD and microvascular complications such as microalbuminuria or retinopathy.

MATERIALS AND METHODS

The study was approved by the Adana City Training and Research Hospital Clinical Research Ethics Committee (Date: 13.01.2021 Meeting Number: 74, Decision No: 1253). Written informed consent was obtained from all participants and their legal guardians prior to study enrollment.

Patients and study design

This cross-sectional study evaluated the effects of DRD on diabetes management in adolescents with T1DM. Enrollment took place between February 2021 and February 2022 in the Pediatric Endocrinology services of Adana City Training and Research Hospital (Adana, Türkiye), a tertiary referral center. Adolescents were recruited across three care settings (routine outpatient visits, inpatient ward admissions and intensive care unit (ICU) admissions) during which physicians administered the 17-item DDS-17 and completed study assessments within the clinical encounter.

Study variables were obtained from the hospital's standardized electronic medical records and included demographics, laboratory results (including HbA1c),

diabetes duration, comorbid conditions, regularity of SMBG, hospitalization and ICU frequency/need and diabetes-related complications. For participants with more than one HbA1c measurement in the preceding 12 months, the mean value was recorded; otherwise, the enrollment HbA1c was used. Regular SMBG was defined as ≥4 capillary glucose checks per day. The study was conducted in the Pediatric Endocrinology outpatient clinic, inpatient ward, and ICU of Adana City Training and Research Hospital, a tertiary referral and academic center affiliated with the University of Health Sciences. All HbA1c assays were performed in the hospital's biochemistry laboratory, which follows national quality-control procedures, and all clinical data were extracted from the hospital's integrated electronic medical record system to ensure data reliability. The 17-item DDS-17 interviews and all study assessments were administered face-to-face by the first author (a pediatric resident at the time of data collection), ensuring consistency and methodological rigor. Study conduct adhered to institutional practice and the approved protocol; written informed consent/assent was obtained from participants and guardians and ethics approval was granted by the Adana City Training and Research Hospital Clinical Research Ethics Committee (13 January 2021; meeting 74; decision 1253).

Sample

We included adolescents aged 10–18 years with clinician-diagnosed T1DM of ≥1-year duration who were receiving care in the Pediatric Endocrinology services of Adana City Training and Research Hospital (outpatient, ward, or ICU) and provided consent/assent to participate and complete the DDS-17. We **e**xcluded adolescents who did not consent, had a diagnosed psychiatric disorder, had T1DM <1 year, or were unable to validly complete the DDS-17 due to language barriers.

Between February 2021 and February 2022, we screened 130 adolescents. Six were excluded for language ineligibility and no additional exclusions occurred for other predefined reasons. Excluding non-Turkish-speaking adolescents due to language ineligibility limits generalizability to migrant populations; future work should use validated translations and professional interpreter support to include these groups. The final analytic cohort comprised 124 adolescents, all with complete DDS-17 and HbA1c data; accordingly, analyses were conducted on a complete-case dataset without imputation. For secondary outcomes**,** hypoglycemia data were unavailable for 17 participants; percentages are reported using available denominators.

Patients were divided into two groups: early and late adolescence. Early adolescents were children aged 10-14 and late adolescents were children aged 15-18[1,7].

Patients were grouped according to their DDS-17 scores. Group 1 were patients with DDS-17 mean item score <2, with little or no DRD, and Group 2 was defined as patients with a DDS score ≥ 2 who had clinically significant DRD.

Patients who self-measured their blood glucose level at least four times a day were considered to have regular self-monitoring of blood glucose[8].

Patients were grouped according to their HbA1c values. HbA1c was divided into two groups: Below 8 (optimal control + insufficient control); 8 and above (poor control) (study-defined operational cutoff).

Measure

Diabetes Distress Scale

The DDS-17 provides a total DDS-17 score and four subscale scores, addressing regimen-related distress (five items), physician-related distress (four items), emotional burden (five items) and diabetes-related interpersonal distress (three items). The mean total distress score was calculated by dividing the sum of the 17 items by 17. Additionally, each subscale was scored separately by dividing the sum of its item scores by the number of items. A mean item score of ≥ 3.0 indicates high distress, 2.0–2.9 indicates moderate distress and < 2.0 indicates little or no distress[4,5].

Sample size and power

The sample size was feasibility-based: we enrolled a consecutive census of all eligible adolescents with T1DM seen across the Pediatric Endocrinology outpatient clinic, inpatient ward, and ICU at Adana City Training and Research Hospital from February 2021 to February 2022 (N=124). To quantify precision and detectable effects (two-sided α=0.05), we ran sensitivity power analyses.

For continuous between-group differences in HbA1c (n_1=27, n_2=97), 80% power corresponds to a standardized mean difference ≈0.61 (Cohen's d); the

observed difference (0.71%, pooled d≈0.44) yields ~52% power.

For proportions (regular SMBG) under worst-case variance (baseline ≈50%), the minimum detectable absolute difference at 80% power is ~30 percentage points; the observed Δ≈23.8 pp implies ~60% power.

For correlations (HbA1c vs DDS-17), the 80% powered threshold is $|r|\approx0.25$; observed correlations (r=0.216 total; 0.229 emotional burden; 0.177 interpersonal; 0.128 physician distress) correspond to ~68%, ~73%, ~50% and ~29% power, respectively. Overall, these calculations indicate that the study was well powered to detect moderate differences (e.g., hospitalizations; pooled d ≈ 0.68) but had limited power for small effects and subgroup contrasts, consistent with the mix of significant and borderline associations observed.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics, version 20 (IBM Corp., Armonk, NY, USA). Normality of continuous variables (e.g., HbA1c, age, diabetes duration, number of hospitalizations) was assessed with the Kolmogorov–Smirnov test. Descriptive statistics are reported as mean ± standard deviation for approximately normal data, median (interquartile range; additionally minimum–maximum) for skewed data, and percentages (%) for categorical variables.

Between-group comparisons (DRD Group 1: DDS-17 mean item score <2 vs Group 2: ≥2) used the independent-samples t test when assumptions were met (approximate normality and homogeneity of variances, checked with Levene's test); otherwise, the Mann–Whitney U test was applied. Categorical variables (e.g., regular SMBG, sex, presence of hypoglycemia/microalbuminuria/retinopathy) were compared using the chi-square test, with Fisher's exact test when expected cell counts were <5. Associations between HbA1c and DDS-17 scores (total and subscales) were examined with Spearman rank-order correlations, chosen a priori because DDS-17 subscales derive from Likert-type items (ordinal) and because monotonic but non-normal relationships were anticipated.

All tests were two-sided with $\alpha=0.05$. Complete-case analyses were used; DDS-17 and HbA1c were available for all 124 participants. Where appropriate, we also report effect sizes (e.g., Cohen's d or Spearman's ϱ) to aid interpretation.

RESULTS

124 patients with T1DM were included in the study. The T1DM management period of the patients was between 1-15 years (median 5 years) and the mean follow-up period was 5.19±2.73 years. Of the patients, 62 (50%) were female and 62 (50%) were male. The ages of the patients ranged from 10 to 18 years, with a mean of 14.48±2.22 years (Table 1). 46 (37.1%) patients were in early adolescence (10-14 years), 78 (62.9%) were in late adolescence (15-19 years). The mean age was 14.31±2.29 years in girls and 14.65±2.15 years in boys. While no comorbid disease was observed in 100 (80.6%) of 124 patients, comorbid disease was detected in 24 (19.4%). Thyroid diseases in 11 patients (45.8%), celiac disease in 6 (25%), hypertension in 3 (12.5%), limbic encephalitis in 1 (4.2%), congenital adrenal hyperplasia in 1 (4.2%), epilepsy in 1 (4.2%), and cystic fibrosis was detected in 1 (4.2%). The mean HbA1c value of the patients at the time of admission was 9.07%±1.64%. Mean fasting blood glucose was 142.85±35.03 mg/dL, and the mean postprandial blood glucose was 245.11±66.43 mg/dL. 115 (92.7%) of the patients self-monitored their blood glucose. 9 (7.3%) did not (Table 1). Hypoglycemia was observed in 31 patients (29%), microalbuminuria in 33 (26.6%), retinopathy in 1 (0.8%), hospitalization in 105 (84.7%) and ICU admission in 60 (48.4%). The number of hospitalizations ranged from 0 to 6 (median, 2; mean ± SD, 1.85 ± 1.36) (Table 1).

An analysis of the relation between gender and hospitalization history revealed that while 55 of 62 (88.7%) female patients had a history of hospitalization, 7 (11.3%) had no history of hospitalization. In 62 male patients; 50 (80.6%) had a history of hospitalization, 12 (19.4%) had none (p=0.319). Notably, analysis of gender and hospitalization frequency revealed that the number of hospitalizations among female patients ranged from 0 to 5, with a median of 2 and a mean of 1.98±1.37. The number of hospitalizations in male patients was between 0-6 (median 2) and the mean number of hospitalizations was 1.71±1.36 (p=0.668). An analysis of the relation between gender and history of intensive care hospitalization showed that 43 (69.4%) of 62 female patients had a history of intensive care admission and 19 (30.6%) had no history of intensive care admission. In 62 male patients, 41 (66.1%) had a

history of intensive care admission; 21 (33.9%) did not have a history of intensive care admission (p=0.701).

Table 1. Comparison of DDS score and demographic/clinic data

Characteristics	Group 1 (n=27, 21.8%)	Group 2 (n=97, 78.2%)	Overall (n=124, 100%)	P value
Age (year)	14.63±2.07	14.43±2.27	14.48±2.22	0.405
HbA1c (%)	8.51±1.17	9.22±1.72	9.07±1.64	0.046
Gender				
Boy	14 (51.8%)	48 (49.5%)	62 (50%)	
Girl	13 (48.2%)	49 (50.5%)	62 (50%)	1
Comorbid Disease				
Yes	8 (29.6%)	16 (16.5%)	24 (19.4%)	
No	19 (70.4%)	81 (83.5%)	100 (80.6%)	0.167
Number of hospitalizations	1.15±0.95	2.04±1.4	1.85±1.36	0.002
Hospitalization (n, %)				
Yes	20 (74%)	85 (87.7%)	(84.7%)	0.127
No	7 (26%)	12 (12.3%)	19 (15.3%)	
Intensive Care Hospitalization (n, %)				
Yes	15 (55.6%)	69 (71.1%)	(67.8%)	
No	12 (44.4%)	28 (28.9%)	40 (32.2%)	0.163
Self-monitoring of blood glucose (n, %)				
Yes	27 (100%)	88 (90.7%)	115 (92.7%)	
No	0 (60%)	9 (9.3%)	9 (7.3%)	0.204
Self-monitoring of blood glucose (n, %)				
Regular	17 (63%)	38 (39.2%)	55 (44.4%)	
Irregular	10 (37%)	59 (60.8%)	69 (55.6%)	0.028
Hypoglycemia*				
Yes	5 (23.8%)	26 (30.2%)	31 (29%)	0.789
No	16 (76.2%)	60 (69.8%)	76 (71%)	
Microalbuminuria				
Yes	7 (25.9%)	26 (26.8%)	33 (26.6%)	0.927
No	20 (74.1%)	71 (83.2%)	91 (73.4%)	
Retinopathy				
Yes	0 (0%)	1 (1.1%)	1 (0.8%)	0.453
No	27 (100%)	96 (98.9%)	123 (99.2%)	

* Data on hypoglycemia in 17 patients could not be obtained. Denominators as shown for variables with missing data.
DDS: Diabetes Distress Scale

When DDS score and subscale scores of the patients were calculated, it was seen that 27 (21.8%) were in Group 1 and 97 (78.2%) were in Group 2. Spearman correlation analysis was performed to further evaluate the relationship between HbA1c levels and diabetes distress. Statistically significant positive correlation was observed between HbA1c and the total DDS score (r=0.216, p=0.016). Among the DDS subscales, Emotional Burden (r=0.229, p=0.011), Regimen Distress (r=0.216, p=0.016), and Interpersonal Distress (r=0.177, p=0.049) were significantly correlated with HbA1c, while Physician Distress was not (r=0.128, p=0.155) (Table 4).

When the relationship between age groups and DDS score clinical classification was examined, no statistically significant difference was found (p=0.094) (Table 2). The comparison of the relationship between age groups and the clinical classification of Emotional Burden DDS sub-score, Physician distress DDS sub-score, Regimen distress DDS sub-score and Interpersonal distress DDS sub-score were provided no statistically significant difference (Table 2). There was no statistically significant difference between DDS score clinical classification and age, history of hospitalization, history of ICU admission, self-monitoring of blood glucose, hypoglycemia, microalbuminuria and

retinopathy. A clinically significant level of DRD (group 2) was found to be associated with irregular blood glucose monitoring, HbA1c, and the number of hospitalizations (p=0.028) (Table 1). When the relationship between HbA1c groups and DDS score clinical classification was compared, no statistically significant difference was found (Table 3). When the relationship between HbA1c groups and Emotional Burden DDS sub-score, physician distress DDS sub-score, regimen distress DDS sub-score and interpersonal distress DDS sub-score were compared, no statistically significant difference was found either (Table 3)

Table 2. Comparison of adolescence periods and DDS score classification

Characteristics	Group 1 (n=27, 21.8%)	Group 2 (n=97, 78.2%)	Overall (n=124, 100%)	P value
Total DDS Score (n, %)				
Early Adolescent	9 (19.6%)	37 (80.4%)	46 (100%)	0.094
Late Adolescent	18 (23.1%)	60 (76.9%)	78 (100%)	
Emotional Burden (n, %)				
Early Adolescent	9 (19.6%)	37 (80.4%)	46 (37.1%)	1
Late Adolescent	16 (20.5%)	62 (79.5%)	78 (62.9%)	
Physician Distress (n, %)				
Early Adolescent	15 (32.6%)	31 (67.4%)	46 (37.1%)	
Late Adolescent	24 (30.8%)	54 (69.2%)	78 (62.9%)	0.84
Regimen Distress (n, %)				
Early Adolescent	9 (19.6%)	37 (80.4%)	46 (37.1%)	
Late Adolescent	14 (17.9%)	64 (82.1%)	78 (62.9%)	0.82
Interpersonal Distress (n, %)				
Early Adolescent	12 (26.1%)	34 (73.9%)	46 (37.1%)	
Late Adolescent	18 (23.1%)	60 (76.9%)	78 (62.9%)	0.83

*DDS: Diabetes Distress Scale

Table 3. Comparison of HbA1c groups and DDS score classification

Characteristics	HbA1c <8	HbA1c ≥8	Overall	P value
Total DDS Score (n, %)				
Group 1	7 (21.2%)	20 (22%)	(21.8%)	1
Group 2	26 (78.8%)	71 (78%)	97 (78.2%)	
Emotional Burden (n, %)				
Group 1	6 (18.2%)	19 (20.9%)	(20.9%)	0.80
Group 2	27 (81.8%)	72 (79.1%)	99 (79.8%)	
Physician Distress (n, %)				
Group 1	9 (27.3%)	30 (33%)	(31.5%)	
Group 2	24 (72.7%)	61 (67%)	85 (68.5%)	0.066
Regimen Distress (n, %)				
Group 1	8 (24.2%)	15 (16.5%)	(18.5%)	0.043
Group 2	25 (16.5%)	76 (83.5%)	101 (81.5%)	
Interpersonal Distress (n, %)				
Group 1	10 (30.3%)	20 (22%)	30 (24.2%)	0.35
Group 2	23 (69.7%)	71 (78%)	97 (78.2%)	

*DDS: Diabetes Distress Scale

Table 4. Spearman correlations between HbA1c and DDS scores

DDS Subscale	Spearman's r	p-value
Total DDS Score	0.216	0.016
Emotional Burden	0.229	0.011
Physician Distress	0.128	0.155
Regimen Distress	0.216	0.016
Interpersonal Distress	0.177	0.049

DDS: Diabetes Distress Scale.

DISCUSSION

DRD comprises negative emotions (such as frustration, hopelessness, anger, guilt, and fear) that arise from living with and managing diabetes. Unlike depression and anxiety, DRD is not a psychiatric disorder but an illness-specific affective response; nevertheless, these constructs are related and may co-occur[4,5,9].

Several studies suggest that, in both type 1 and type 2 diabetes, glycemic control is more strongly affected by DRD than by depression[9-11]. High DRD is associated with unfavorable clinical and psychosocial outcomes. Fisher et al. have argued that depression like presentations in diabetes may in fact reflect clinically significant DRD and reducing DRD has been associated with improvements in HbA1c among individuals with T1DM[10].

Adolescence is a particularly vulnerable developmental window. Teens with T1DM report higher anxiety and depressive symptoms than their peers as they learn self-management while navigating social, physical, and emotional transitions to independence. Prior reports suggested that 22–36% of adolescents with T1DM experience clinically significant DRD[11]. More recent cohorts confirm that DRD remains highly prevalent in this age group, with reported prevalence rates of 42% in large U.S. samples, 38% in Chinese populations, and 34% in South Asian adolescents[12,13]. Even higher rates have been noted in specific subgroups, such as ~49% in urban Black youth and 40% with routine single-item screening[14,15]. In our cohort, the prevalence of clinically significant DRD was 78.2%, exceeding most prior estimates (generally 34–49% in recent pediatric studies)[16].

Several contextual and methodological factors may account for this discrepancy. First, single-center tertiary recruitment may enrich for complex or higher-risk patients. Second, differences in patient demographics, cultural context, and healthcare delivery systems could contribute to the higher observed rates in our sample. In addition, survey conduct factors may have played a role: the questionnaire was clinician-administered face-to-face in a clinical setting, which could heighten social desirability influences on adolescents' responses. Finally, the timing of data collection coincided with the ongoing effects of the COVID-19 pandemic, a period reported to exacerbate psychosocial stress in adolescents with chronic illnesses, including diabetes[18]. Thus, our higher prevalence likely reflects a combination of setting, population, and timing, as well as measurement context.

Contemporary pediatric evidence indicates that DRD is common and clinically meaningful in adolescents with T1DM, but age-related gradients within adolescence have not been consistently observed. In a multi-site U.S. cohort, after multivariable adjustment for relevant covariates, age was not independently associated with elevated DRD, whereas higher HbA1c and female sex remained significantly associated with greater distress[12].

Multicenter European registry data collected during routine care further underscore substantial psychosocial burden in adolescents (12–20 y) and its associations with metabolic control, but do not establish a uniform increase in distress across adolescent age bands[19]. Additional pediatric samples around the transition to adult care similarly highlight DRD as a key correlate of poorer well-being and readiness, without defining a consistent intra-adolescent age gradient[20,21]. In our cohort, 62% of adolescents with clinically significant DRD were in late adolescence and 38% in early adolescence; nevertheless, DDS-17 total and subscale scores did not differ significantly between age groups, aligning with the mixed age-effect signal reported in recent pediatric studies. These patterns likely reflect developmental heterogeneity, measurement context, and limited power for between band contrasts.

Sex-related differences in DRD have been documented in adolescents with T1DM, although the magnitude and direction of these differences vary across studies. In a large multi-site U.S. cohort, female sex was independently associated with greater DRD, higher mean glucose levels, and a lower percentage of time in range[12]. Similar findings were observed, with higher distress scores reported in female adolescents compared with males[14]. Family and social factors may further influence these patterns, as intrusive parenting behaviors have been shown to be more strongly associated with higher DRD among girls than boys[22].

In contrast, studying adolescents preparing to transition to adult care, confirmed the clinical significance of DRD but did not identify a consistent or large gender effect[20]. In our cohort, although the prevalence of clinically significant DRD was slightly higher among females (79%) than males (77.4%), the

difference was not statistically significant, consistent with the heterogeneous gender effects reported in recent pediatric studies.

While female sex often shows higher DRD, cross-cohort inconsistency likely reflects variation in instruments, thresholds, adjustment sets, and context (e.g., family dynamics). Given small to moderate effect sizes and possible power limitations, our non-significant difference is compatible with prior literature. Practically, these data support universal DRD screening while considering sex-sensitive, family-engaged interventions when indicated.

Recent pediatric studies consistently show that higher DRD is linked with less favorable glycemic outcomes in youth with T1DM most commonly reflected in elevated HbA1c. In a routine-care screening cohort, DRD scores were positively associated with HbA1c and DRD statistically mediated the relationship between depressive symptoms and glycemia[16]. Similarly, in an urban U.S. cohort, greater youth (and caregiver) DRD correlated with higher HbA1c and poorer day-to-day diabetes self-management[15]. Cross sectional data from a tertiary pediatric sample also report substantial DRD in adolescents, with higher burden in subgroups at risk for suboptimal metabolic control[14].

In our study, consistent with the literature, HbA1c was significantly higher in patients with clinically significant distress. However, while mean HbA1c values were significantly higher among adolescents with clinically significant DRD, a categorical analysis using an HbA1c cut-off of 8% was not statistically significant. This discrepancy may be explained by the loss of statistical power when continuous variables are dichotomized, as well as by clustering of patients around the threshold. To further delineate the glycemia–distress relationship, we performed Spearman rank-order correlations: HbA1c correlated positively with the total DDS-17 score. These findings suggest that DRD is more consistently associated with higher average HbA1c levels rather than strict categorical cut-offs.

The DDS-17 yields a total score and four domain subscores (Emotional Burden, Regimen-Related Distress, Interpersonal Distress, and Physician-Related Distress)[15]. In pediatric cohorts, higher DRD is generally associated with less favorable glycemic indices; nonetheless, differences in measurement tools and reporting conventions mean that DDS-17 subscale findings have not been consistently reproduced across the literature.

By contrast, adult analyses that model DDS-17 domains more explicitly often identify regimen-related distress as the domain most closely linked with higher HbA1c, whereas associations for the other subscales tend to be more variable[23,24]. Consistent with this evidence, we performed Spearman rank-order correlations in our cohort: HbA1c correlated positively with the Emotional Burden, Regimen-Related and Interpersonal Distress subscales, whereas the correlation with Physician Distress was not significant. Taken together, these results indicate that, in adolescents, elevations in HbA1c are most reliably associated with Emotional and Regimen-Related distress (with a smaller contribution from interpersonal distress) while physician related distress shows no clear link.

Self-monitoring of blood glucose is an essential component of glycemic control in patients with T1DM. Adolescents often fall short of optimal monitoring owing to psychosocial factors, family communication challenges, and the emotional volatility of adolescence[12,25]. In a Sudanese clinic cohort, less frequent SMBG was independently associated with higher HbA1c and poorer overall glycemic control in children and adolescents[26]. An examination of 275 Iranian children and adolescents showed that SMBG frequency is strongly influenced by strip cost and availability as well as consistent parental participation, highlighting structural and family determinants of testing behavior[27]. In one study, approximately one-third of young people were reported to avoid blood glucose monitoring because they wished to ignore their diabetes[28]. Finally, in a large Egyptian clinic sample, decreased SMBG frequency was found to predict insulin non-adherence, underscoring how low testing often co-occurs with broader self-care barriers[29]. In our study, adolescents with clinically significant DRD displayed significantly more irregular monitoring, consistent with these observations.

Achieving pediatric glycemic targets lowers the risk of microvascular complications and justifies early identification and management of DRD. Recent youth data directly linking DRD to complications are limited; however, a contemporary systematic review shows that psychosocial/mental health factors (most pronounced from adolescence into young adulthood) are consistently associated with repeat diabetic

ketoacidosis (DKA), implicating distress related mechanisms in acute adverse events[30].

In our cohort, we did not observe significant associations between DDS scores and hypoglycemia, microalbuminuria, or retinopathy. This null finding is biologically and epidemiologically plausible in adolescence, when clinically evident microvascular complications are relatively uncommon and when screening for albuminuria and retinopathy is recommended to begin at puberty or from age 11 years after 2–5 years of diabetes duration. These factors lower event rates and reduce statistical power in pediatric samples[31,32]. Collectively, current evidence favors routine DRD screening and focused psychosocial interventions to optimize daily management and long-term glycemic exposure, although definitive pediatric data connecting DRD to overt complications remain limited and are still accruing.

Evidence directly linking DRD to hospitalization in adolescents with T1DM is scarce, yet recent pediatric data point to meaningful psychosocial contributions to acute care use. Markedly higher hospitalization risks have been reported in youth with T1DM compared with the general population, with more than 60% of admissions related to diabetes and nearly half due to DKA, while mental-health diagnoses are also over-represented[32]. Evidence on recurrent DKA has consistently identified psychosocial factors as key correlates[30]. Complementing these findings, a review of stigma in T1DM reported associations in adolescents and young adults between higher stigma, higher HbA1c, and greater frequency of DKA and severe hypoglycemia, reinforcing the link between psychosocial burden and acute complications[33].

In a single-center adolescent series, more than half of hospitalizations were preceded by diabetes deterioration attributed to emotional distress, a pattern not observed before the pandemic[34]. In our cohort**,** the number of hospitalizations was significantly higher among adolescents with clinically significant DRD than among those with little or no distress, aligning with these contemporary observations and supporting the premise that psychosocial load and acute metabolic instability are closely intertwined during adolescence.

This study is one of the few to investigate DRD in adolescents with T1DM in Turkey, using a validated scale. The focus on adolescents is particularly important, as this age group faces unique psychosocial and developmental challenges that complicate diabetes management. The use of the DDS-17, a well-validated and widely applied instrument, enhances the reliability and comparability of our results with international research. Another strength is the relatively large sample size, which increases the statistical power and generalizability of the findings. In addition, the study did not only examine glycemic control but also hospitalization patterns, thereby providing a multidimensional understanding of the impact of DRD on both clinical and psychosocial outcomes. Together, these strengths highlight the novelty and contribution of the study to the limited body of literature on DRD in adolescents.

Several limitations merit attention. First, the cross-sectional design does not allow causal inference between DRD and glycemic control. Second, the study was conducted in a single tertiary center, which may limit the generalizability of the findings to broader populations. Third, although the sample size is relatively large for a single-center adolescent study, it remains modest compared with international multicenter cohorts. In addition, data collection relied on self-reported measures, which may have introduced recall or social desirability bias, particularly in adolescents. HbA1c relied on the average within the prior year or a single enrollment value when only one result was available, which may not fully capture long-term glycemic control. Finally, pandemic-related contextual stressors could have influenced responses and outcomes. Despite these limitations, the validated Turkish DDS-17 and a comparatively large adolescent sample are notable strengths. Future work should delineate longitudinal DRD trajectories across adolescence and into young adulthood, ideally using multicenter designs.

The most important treatment goal in type 1 diabetes is to achieve normal glycemic control with minimal risk of hypoglycemia. However, DRD is recognized as one of the most common and important psychosocial barriers to good glycemic control and effective diabetes management. In this single-center adolescent cohort, clinically significant DRD was common and co-occurred with higher mean HbA1c, greater hospitalization burden, and less regular self-monitoring of blood glucose.

Associations were strongest when glycemia was modeled continuously; domains reflecting emotional burden, regimen demands, and interpersonal strain paralleled HbA1c, underscoring the clinical salience

of affective and day-to-day management pressures in adolescence. Taken together, the findings support routine DRD screening as a standard component of pediatric T1DM visits and the integration of brief, scalable psychosocial supports (such as emotion-regulation/problem-solving modules and structured family-engagement strategies) delivered within multidisciplinary care pathways and attentive to practical barriers (e.g., monitoring supplies, language access).

Future studies should evaluate mechanism-informed interventions in randomized or pragmatic trials, examine the durability of effects on metabolic and utilization outcomes, and test potential moderators (e.g., sex, developmental stage). Longitudinal, multicenter cohorts that bridge the transition to adult care and use validated multilingual tools are warranted to map distress trajectories and to establish whether lowering DRD reduces hospitalizations and yields durable improvements in glycemic control. Collectively, these findings support routine DRD screening at pediatric T1DM visits and the integration of brief, scalable psychosocial supports within multidisciplinary care pathways, with standardized referral mechanisms for adolescents screening positive.

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