ORIGINAL ARTICLE

Assessing the clinical utility of the diabetes eating problem survey-revised (DEPS-R) in adolescents with type 1 diabetes

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Summary

Objective: Eating disorders are prevalent among adolescents with type 1 diabetes (T1D). We examined the clinical utility of the Diabetes Eating Problem Survey-Revised (DEPS-R), a brief self-report questionnaire developed for patients with T1D, to identify at-risk adolescents. We aimed to determine whether a positive DEPS-R screen was predictive of a formal diagnosis of an eating disorder as per the DSM-V. In addition, we assessed whether other variables including psychosocial characteristics and diabetes conflict were associated with an abnormal DEPS-R screen.

Methods: Cross-sectional study of 116 T1D adolescents aged 12-17 years. All participants completed the DEPS-R screening; both participants and parents completed a questionnaire addressing psychosocial characteristics/conflict around diabetes management. Clinical variables were obtained from participant charts. Differences were examined between positive and negative DEPS-R groups. Adolescents who screened positive were offered a referral to a specialized eating disorder team for further assessment.

Results: From 116 participants (mean age ± SD = 14.6 years ± 1.56), 21% (24/116) scored positive for DEPS-R More females than males had abnormal DEPS-R (75% vs 25%, $P = 0.001$). Those with positive DEPS-R score had higher HbA1c% (mean = 9.3 ± 1.3 vs 8.3 ± 1.2, $P = 0.001$). Positive DEPS-R group had higher conflict score for diabetes management in both parents' and children's assessments (both ps < 0.001). In regression analysis, being female (OR males = 0.07, 95%CI: 0.010-0.46, $P = 0.006$), older (OR = 2.01, 95%CI: 1.16-3.48, $P = 0.040$) and > child-reported conflict (OR = 1.78, 95%CI: 1.02-3.11, $P = 0.044$) were predictors of an abnormal DEPS-R score.

Conclusion: The DEPS-R score is a useful clinical tool for identifying T1D adolescents at risk for disordered eating behaviour, but has a low positive predictive value (PPV) for identifying adolescents who meet diagnostic criteria for an eating disorder. Female gender, suboptimal diabetes control and increased conflict in diabetes management are associated with an abnormal DEPS-R score.

KEYWORDS
adolescent, disordered eating, type 1 diabetes

1 | INTRODUCTION

Several studies have shown that disordered eating is more prevalent among adolescents with type 1 diabetes (T1D) compared to age-matched peers.[1-3] In 2013, a meta-analysis of 13 studies demonstrated that disordered eating behaviours were more common in adolescents with T1D.[4] In recent years, a number of studies have examined the prevalence, detection and optimal management of adolescents with T1D and disordered eating (DE) behaviours.[5-7]

Disordered eating in adolescents with T1D is especially concerning because it is associated with poor glycaemic control, which is linked to increased risk of developing diabetes-related complications.[8] For instance, Goebel-Fabbri et al[9] found that DE behaviours were associated with a threefold increase in mortality risk. Therefore, the early screening and management of DE in this at-risk population represents an imperative part of patient care.

Although there have been studies that have attempted to delineate clinical characteristics that place individuals with T1D at risk for developing DE behaviours, findings have been inconsistent in relation to psychosocial and familial factors.[10-12] In addition, studies have used different methods to detect disordered eating behaviours, which are often labour intensive and do not translate into clinical practice. For example, the Eating Disorder Examination is a diagnostic instrument which consists of a semi-structured clinical interview and is considered to be the gold standard for diagnosing an eating disorder. However, reports have indicated that using this diagnostic instrument takes an average of one hour to be administered.[13] Hence, other screening tools have been applied such as the Eating Disorder Inventory 3, a commonly used screening tool which still consists of a lengthy questionnaire with 91 items.[14] Therefore, reports are variable in terms of how DE is diagnosed, with some using a screening tool and others using the criteria from the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V). The DSM-V recognizes several subtypes of eating disorders and classifies insulin misuse as a purging behaviour.[15] However, adolescents with T1D and DE behaviours present a diagnostic challenge, as they often engage in behaviours that are not captured by standard screening tools. Previous studies have found that standard DE screening tools, such as the SCOFF questionnaire, detect a similar prevalence of DE between adolescents with T1D and age-matched peers.[16,17] Still, a substantial number of youth with T1D engage in insulin omission and/or restriction, which is not accounted for in these studies. Furthermore, screening tools aimed at diagnosing DE within the general population often focus on behaviours that are inherent to diabetes management, such as reading food labels and monitoring intake of macronutrients. Studies have demonstrated that generic screening tools cannot accurately detect the presence of eating disorders in patients with T1D, compared to screening tools designed specifically for T1D individuals.[6] Furthermore, deliberate insulin omission was found to be the most common behaviour to promote weight loss after dieting in adolescents with T1D.[2] Therefore, any screening tool that does not explicitly assess these behaviours may result in an underestimate of disordered eating practices.

We aimed to assess the clinical utility of the DEPS-R survey in detecting DE behaviours in adolescents with T1D and to examine the clinical and psychosocial factors associated with a positive DEPS-R screen. We hypothesized that a positive DEPS-R screen was associated with disordered eating and warranted referral to a specialized eating disorder team for further evaluation and assessment of an eating disorder as defined by the DSM-V.

2 | METHODS

This was a cross-sectional study. Inclusion criteria were that participants were 12 to 17 years old with a diagnosis of T1D from this tertiary centre. All patients who attended the outpatient diabetes clinic meeting, the inclusion criteria over a 6-month period, were invited to participate in the study. From a total of 198 approached patients, 116 patients accepted to participate with a response rate of close to 59% (Figure 1). Study packages explaining the study and objectives were distributed to patients and their primary caregiver(s) upon arrival to their regular clinic visit. Participants had to read and complete the survey questions independently from their parents; parents completed a separate questionnaire. Patients were informed when the results of the DEPS-R screening were positive, and were offered a referral to the eating disorder team for further evaluation and management. The study was approved by the ethics committee at Western University.
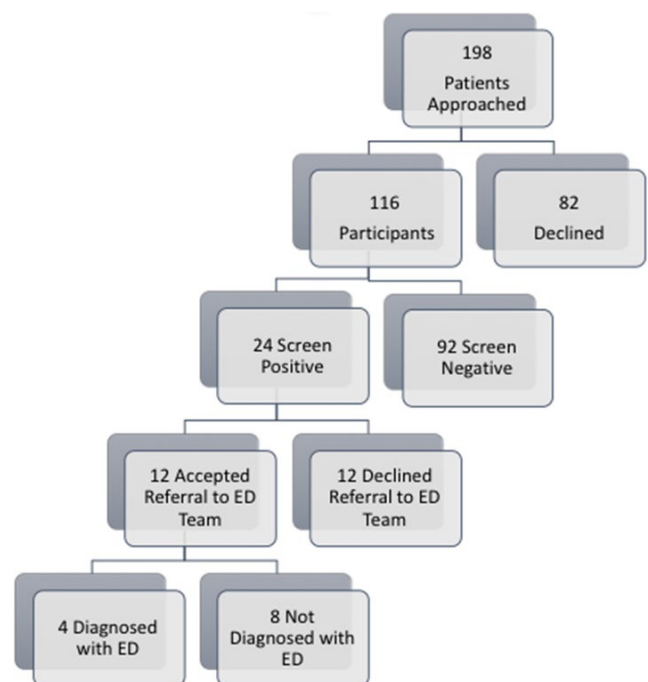
FIGURE 1 Flow of participants through study. ED, eating disorder

2.1 | Measures

Clinical variables including age, anthropometric measurements, duration of diabetes and HbA1c were obtained from electronic medical records.

The Diabetes Eating Problem Survey-Revised (DEPS-R) is a screening tool that was designed for use in adolescents with T1D and has been validated in several different populations.[3,18-20] The DEPS-R is a 16-item questionnaire, with each item being scored in agreement on a 6-point Likert scale and higher scores indicating increased symptom severity. The DEPS-R takes <5 minutes to complete and it represents a practical way to screen for DE in a clinical setting. The DEPS-R was the primary method used to screen for DE behaviours. Patients with a score ≥20 were categorized as positive. A threshold of 20 was selected based on previous studies that have demonstrated that scores >20 are associated with poorer glycaemic control requiring further evaluation from a specialized eating disorder team.[18]

Patients were also provided with a de novo questionnaire that captured exercise frequency, past medical diagnoses (including anxiety and depression) and conflict around diabetes management at home. All information was based on self-report. The conflict around diabetes management scale included four items: the frequency of conflict around administration of insulin, blood sugar checks, blood sugar readings and meals/snacks. Items were scored in a 3-point Likert scale of never, sometimes or always. Higher scores indicated greater levels of conflict. Since the study was designed for clinical practicality, conflict items were selected as a subset of questions from the previously validated Diabetes Family Conflict Scale.[21] These items were selected based on the expert opinion of the multidisciplinary diabetes team and the most common conflicts routinely described in clinic visits.

Parents received a separate questionnaire with additional items about annual household income, marital status and caregiver medical history, including diagnoses of anxiety and depression. Other studies have found a relationship between low socioeconomic status, parental health problems, and comorbid medical conditions and the development of psychosocial issues in adolescents with TIDM. We searched for a correlation between any these variables and disordered eating behaviours. Parents were asked the same questions as patients about conflict around diabetes management, which were scored in the same manner.

2.2 | Statistical analysis

Independent two-tailed Student's *t* tests assessed differences in mean values between the DEPS-R-positive and DEPS-R-negative groups. Mann-Whitney U tests were used for assessing differences in values for variables that were not normally distributed. Chi-squared tests were used to assess differences in proportions between groups. Logistic regression analyses were used to identify predictors of a positive DEPS-R screen. Variables significant at the bivariate level were entered into the regression model and subsequently removed at $P > 0.20$ in a backward elimination strategy; the Hosmer-Lemeshow statistic was used to determine model fit. All results were analysed using SPSS v.25 statistical software (IBM Corp., Armonk, NY).

3 | RESULTS

Figure 1 shows the flow of subjects that were approached and the number of participants who had accepted to enrol at this study. From the 198 adolescents approached, a total of 116 (53 females, 63 males) were enrolled, yielding a response rate of 59%. Out of 116 participants, 24 adolescents (18 females, six males) had a positive DEPS-R screen, giving an overall prevalence of 21%. Among the 24 participants who screened positive on the DEPS-R survey, 12 accepted a referral to the eating disorder service for further assessment, and four of these participants (25%) met DSM-V criteria for any eating disorder.

Clinical characteristics of participants are summarized in Table 1. There were no significant differences in age, body mass index (BMI)-Z scores, history of anxiety or depression, household income, parental mental health history, duration of diabetes diagnosis or level of physical activity between patients with positive and negative DEPS-R The prevalence of positive DEPS-R was higher among females compared to males (34% for females; 10% for males). The positive DEPS-R group (mean [SD] = 9.31 [1.29]) had higher A1C% levels compared to the negative group (8.34 [1.23], $P = 0.001$). In addition, a higher child-reported conflict score was associated with a positive DEPS-R screen (median [IQR] for DEPS-R-positive 4 [3.0-5.5] and 2 [0-3] for DEPS-R-negative, $P < 0.001$).

Higher parent-reported conflict scores were also associated with a positive DEPS-R screen (median [IQR] for DEPS-R-positive 4 [2.25-4] and for DEPS-R-negative 2 [0-3.5], $P = 0.001$). Adolescents who reported higher conflict scores categorized from 0 to 2, 3 to 5 and above 5, presented with a higher median [IQR] DEPS scores of 8 [4-11.7], 16 [9-22] and 28 [17-36], respectively, as shown in Figure 2.

In the final logistic regression model, female gender, older age and a higher child-reported conflict score remained as independent risk factors for a positive DEPS-R screen. Other variables included in the model were HbA1C and parent conflict score (Table 2).

4 | DISCUSSION

Identifying T1D youth at risk for developing DE can be very challenging as the standard criteria for the general population may not apply to patients with diabetes. The DEPS-R screening tool has been previously validated in T1D adolescents. However, it is currently not used as a standard screening assessment in practice guidelines. By using the DEPS-R, the prevalence of DE behaviours detected among our T1D youth was similar to that of other reported studies among

TABLE 1 Clinical characteristics between participants with positive and negative DEPS-R scores

	Total	DEPS-R Positive	DEPS-R Negative	P Value
N (%)				
Male	63 (45.7%)	6 (25.0%)	57 (62.0%)	0.001
Female	53 (54.3%)	18 (75.0%)	35 (38.0%)	
Mean (SD)				
Age	14.6 (1.56)	14.92 (1.28)	14.52 (1.62)	0.271
BMI (z score)	0.77 (0.86)	1.02 (0.84)	0.70 (0.85)	0.107
HbA1C (%)	8.54 (1.30)	9.31 (1.29)	8.34 (1.23)	0.001
Time from diagnosis (y)	6.26 (3.85)	6.29 (4.12)	5.50 (3.79)	0.963
Median (IQR)				
Conflict score				
Child	2.0 (0.00, 4.00)	4.0 (3.00, 5.50)	2.0 (0.00, 3.00)	<0.001
Parent	2.0 (1.00, 4.00)	4.0 (2.25, 4.00)	2.0 (0.00, 3.50)	0.001
N (%)				
Anxiety				
Child	10 (8.6%)	4 (17.4%)	6 (6.6%)	0.114
Parent	6 (5.2%)	3 (15.0%)	3 (3.9%)	0.100
Depression				
Child	7 (6.0%)	3 (13.0%)	4 (4.4%)	0.145
Parent	11 (9.5%)	3 (15.0%)	8 (10.4%)	0.692
Physical activity				
<30 min	52 (27.6%)	8 (33.3%)	24 (26.1%)	0.50
30-59	33 (28.4%)	6 (25.0%)	27 (29.3%)	
60-89	23 (19.8%)	4 (16.7)	19 (20.7%)	
90-120	10 (8.6%)		10 (10.9%)	
>120	8 (6.9%)	3 (12.5%)	5 (5.4%)	
Marital status				
Married	64 (66.0%)	10 (50.0%)	54 (70.1%)	0.358
Divorced, remarried	4 (4.1%)	1 (5.0%)	3 (3.9%)	
Divorced, single	24 (24.7%)	7 (35.0%)	17 (22.1%)	
Single, never married	5 (5.2%)	2 (10.0%)	3 (3.9%)	
Income				
<25 000	7 (6.0%)	3 (12.5%)	4 (4.3%)	0.142
25 000-49 000	10 (8.6%)	2 (8.3%)	8 (8.7%)	
50 000-79 000	15 (12.9%)	4 (16.7%)	11 (12.0%)	
80 000-100 000	15 (12.9%)	4 (16.7%)	11 (12%)	
>100 000	35 (30.2%)	5 (20.8%)	30 (32.6%)	

the diabetic population.[22,23] Variable prevalence rates have been reported in the literature, and this is likely due to the heterogeneity of screening tools that are used to detect disordered eating in patients with T1D.

In our study, we defined a positive screen as threshold score >20, as previous studies have demonstrated that this correlated well with a higher HbA1c and, thus, was clinically relevant as potentially increasing the risk for diabetes complications. However, whether this threshold value is specific for detecting DE is unknown as this has not been previously studied. Only one other study by Pinna et al have attempted to delineate how well the DEPS-R correlates with a formal DE diagnosis. They found that subjects who met DSM-V criteria for any DE had a median DEPS-R score of 22.[24] In our study, all participants who screened positive were offered a referral to the DE service for a comprehensive assessment. Of the 24 participants who screened positive, only 12 accepted a formal assessment by the DE
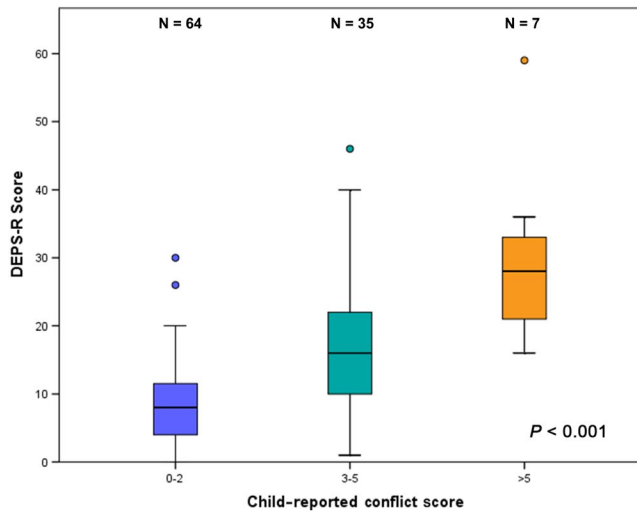
FIGURE 2 Box plot depicting that the relationship between child reported conflict score and DEPS-R scores

TABLE 2 Proportional contribution of gender, age and child's conflict score as predictors for an abnormal DEPS-R screen using multivariate analysis

	OR (95%CI)	P
Female gender	0.069 (0.010-0.461)	0.006
Age (y)	2.006 (1.157-3.478)	0.013
HbA1c (%)	1.348 (0.644-2.820)	0.428
Conflict score (child)	1.778 (1.015-3.114)	0.044
Conflict score (parent)	1.555 (0.887-2.727)	0.123

service; and from those, four participants met the DSM-V criteria for a DE diagnosis. This gives a low specificity of 25% and a PPV of 0.33. The higher the PPV, the better is the screening tool. Nevertheless, as half of participants refused the formal assessment ED, this value may be falsely low. It is possible that the participants who declined the referral are the ones with a confirmed DE. Despite the fact that our findings did not demonstrate high specificity using the score DEPS-R ≥20, a positive screen provided an excellent for detecting at-risk participants who require closer monitoring along with the allied health team in the routine clinical setting.

In our study, a prior diagnosis of depression or anxiety was not associated with DE behaviours. Other studies have shown that young adults with T1D who screened positive for DE have more severe depressive symptoms.[25,26] Neither of these studies used screening tools that were specific to the T1D population when looking at the prevalence of DE. Bachle et al, found that a minority of young adults with depressive symptoms met DSM-V criteria for depression, which may account for why no association was seen in our study.[27]

Interestingly, our findings showed a strong correlation between the degree of parent- and child-reported conflict around diabetes management and a positive DEPS-R screen. This relationship had been demonstrated by others who used the Diabetes Family Conflict Scale to assess the degree of conflict.[18] Others have found that family cohesion is associated with healthy weight control practices within the T1D population.[10] Eilander et al[11] found that parental distress around diabetes care was associated with higher HbA1c levels. The questions selected to assess for conflict in our study were a small subset of questions taken from the Family and Diabetes Conflict Scale and therefore have not been validated and should be interpreted with caution. However, since our measure of conflict was relatively brief, it may be a practically useful tool to identify family conflict.

Our findings did not identify a relationship between BMI-Z scores and DE behaviours in this cohort. There is conflicting

evidence regarding the relationship between BMI and DE in the literature. Some studies have found that increased BMI is associated with the onset of DE and persistence of DE behaviours over time.[12,28] Others have demonstrated that increased BMI was not associated with DE; however, associations were found between negative attitudes about body shape and the desire to lose weight.[29] Our findings support the idea that BMI-Z scores are a less important predictor for DE among youth with T1D, and that clinical assessments should focus more on adolescents' perceptions about their weight.

With respect to diabetes control, several reports have looked at the association between DE and HbA1c as a surrogate for diabetes control, and results have been inconsistent. A meta-analysis performed by Young et al showed that worse glycaemic control was associated with DE behaviours. Our results confirmed a significant association between DE and suboptimal glycaemic control, which has only been observed in studies using diabetes adapted screening tools in comparison with those using screening tools for a general population.[4] We found that a higher HbA1c was an independent predictor of a positive DEPS-R screen and, therefore, more DE behaviours. These results highlight the importance of recognizing DE behaviours and providing immediate intervention among patients with suboptimal diabetes control. Others have shown that women with DE behaviours, especially insulin restriction, are at higher risk of early development of diabetes-related complications such as nephropathy and foot problems.[9]

One of the main objectives of this study was to establish a practical means of detecting DE behaviours in T1D adolescents in a clinical setting. Surveys were administered during regular clinic hours and did not significantly affect patient flow or result in longer clinic duration. Furthermore, a referral mechanism was put in place, which helped to identify patients who needed further support in managing their DE in a timely manner.

This study is not without limitations. Firstly, administration of the DEPS-R survey is not a part of routine clinical practice. Therefore, patients had the opportunity to decline participation in the study. This may have led to a selection bias, where adolescents with DE behaviours preferentially opted out of the study. In addition, the nature of the survey is based on self-report. As such, participants could misreport the answers on both the DEPS-R and questionnaires. For instance, a history of depression or anxiety may have not been reported and therefore could impact the results of our study. It would

be interesting to see whether an interview-based assessment tool produces different prevalence rates. Another limitation of the study is that the DEPS-R questionnaire has not been validated in this cohort of patients. The DEPS-R has been validated in other European populations, but further studies would be required for its use to be accepted as a routine screening tool in Canadian adolescents.

Our findings demonstrated that the DEPS-R screening tool is a clinically useful method that can be utilized as a part of routine practice. Our data provide evidence that suboptimal diabetes control and increasing conflict around diabetes management are associated with DE behaviour. We could not identify an association between DE and elevated BMI.

Our study is one of the first studies to assess whether higher DEPS-R scores are predictive of meeting DSM-V criteria for an eating disorder. Despite identifying T1D youth at risk of DE, a DEPS-R score ≥20 was not specific for a DSM-V diagnosis of an eating disorder. Future research should evaluate the DEPS-R threshold scores that are predictive of meeting the DSM-V criteria for any eating disorder. This is important clinically, as adolescents who are identified as having DSM-V diagnoses can be appropriately managed by an eating disorder team. Follow-up studies are needed to further assess whether early identification and specialized management of eating disorders lead to a lower DEPS-R score and improved glycaemic control.

ACKNOWLEDGMENT

CONFLICT OF INTEREST

None of the authors have any of conflicts of interests to declare.

AUTHOR CONTRIBUTIONS

B Ryman contributed in the study design, ethics submission, review of literature, data collection and analysis; interpretation of results and elaboration of manuscript, review and submission. J MacIssac assisted with study design, data collection, analysis and interpretation of results. T Robinson had a crucial role in ethics submission. MR Miller guided through statistical analysis and interpretation. PH Gallego has mentored B Ryman in all steps from study design, ethics submission, data collection, literature review, interpretation, writing and reviewing the manuscript.

DATA AVAILABILITY

All data generated or analysed during this study are included in this published article.

ETHICS STATEMENT

This study was approved by the Research Ethics Board from Western Research, London Ontario (Project ID 108133).

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