

Associations between disordered eating behaviour, diabetes distress and emotion regulation strategies in adults with type 1 diabetes: Results from a Dutch-Italian cross-sectional study

Jiska Embaye¹ | Giulia Bassi² | Alexandra E. Dingemans³ | Loes Doesborg³ | Frank J. Snoek¹ | Maartje de Wit¹

¹Amsterdam UMC, Vrije Universiteit Amsterdam, Medical Psychology, Amsterdam Public Health, Amsterdam, Netherlands

²University of Padova, Department of Developmental Psychology and Socialization, Padova, Italy

³GGZ Rivierduinen Eating Disorders Ursula, Leiden, Netherlands

Correspondence

Jiska Embaye, Amsterdam UMC, Vrije Universiteit Amsterdam, Medical Psychology, Amsterdam Public Health, 1081 HV, Amsterdam, Netherlands.
Email: j.embaye@amsterdamumc.nl

Abstract

Aims: Disordered eating behaviour (DEB) and diabetes distress are prevalent in adults with type 1 diabetes (T1D). Emotion regulation strategies, such as cognitive reappraisal and expressive suppression, are associated with DEB and managing stress in general. Here we examine the associations between DEB, diabetes distress, and emotion regulation strategies in the context of T1D.

Methods: Adults with T1D in The Netherlands and Italy completed an online survey, covering DEB (DEPS-R), diabetes distress (PAID-5), and emotion regulation strategies (ERQ). Associations between DEB, diabetes distress, and emotion regulation strategies were examined using path analysis.

Results: $N = 291$ participants completed the survey (78.9% women, 39 ± 13 years, HbA_{1c} : 55 ± 16 mmol/mol (7.2% [3.6%]); TIR: $66\% \pm 25$). $N = 79$ participants (27.1%) reported DEB ($DEPS-R \geq 20$) and $n = 159$ participants (54.6%) reported elevated diabetes distress ($PAID-5 \geq 8$). The path analysis, with small-to-medium effect sizes, revealed that more diabetes distress was associated with more DEB ($\beta = 0.23$, 95% CI [0.13, 0.34]). Less diabetes distress was associated with more use of cognitive reappraisal ($\beta = -0.24$, 95% CI [-0.36, -0.12]). More DEB was associated with more use of expressive suppression ($\beta = 0.14$, 95% CI [0.04, 0.24]).

Conclusions: This cross-sectional study suggests an association between DEB and diabetes distress, between cognitive reappraisal and less diabetes distress and between expressive suppression and more DEB. The results suggest that it may prove beneficial to prioritize strengthening emotion regulation strategies in interventions for people with T1D and DEB. Future research should help clarify causality with regard to emotion regulation and DEB in adults with T1D.

KEYWORDS

diabetes distress, disordered eating behaviour, emotion regulation, type 1 diabetes

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2023 The Authors. *Diabetic Medicine* published by John Wiley & Sons Ltd on behalf of Diabetes UK.

1 | INTRODUCTION

People with type 1 diabetes (T1D) are at higher risk of developing disordered eating behaviour (DEB) compared to those without diabetes.^{1,2} DEB is defined as a cluster of different symptoms and maladaptive behaviours including worrying about eating, restrictive eating, binge eating, and compensatory behaviours, such as fasting, vomiting, abuse of laxatives, excessive exercising, and insulin restriction in the case of diabetes.^{1,3-6} These behaviours are also described as subclinical eating disorder symptoms, that are not yet at the level of frequency or severity to merit a formal eating disorder diagnosis.⁷ The prevalence of DEB in T1D varies between 8.6% in male adolescents⁸ and 41.7% in female adolescents.⁹ Due to a higher prevalence of DEB in adolescents and women, studies have mostly focused on these groups, and data on DEB in adults with T1D in general and in adult men especially is lacking.

Several diabetes-related factors could explain the vulnerability of people with T1D to DEB. First, the ever-present need to be mindful of the effects of food intake on one's blood glucose can lead to rigid thinking about food, weight, body image and unhealthy dietary restrictions.¹⁰ Second, the experience of hypoglycaemia, during which the body naturally craves food intake to increase the blood sugar level, might result in an episode of binge eating.¹¹ Third, insulin therapy can lead to weight gain, which can induce feelings of body dissatisfaction and result in under-dosing of insulin.¹² Under-dosing or omission of insulin can be considered an inadequate but highly effective compensatory behaviour, adopted by 20% to 40% of people with T1D to control weight. Finally, living with and self-managing T1D can be challenging and a cause of emotional distress, which is reported by approximately 30% of people with T1D.¹³⁻¹⁵ Diabetes distress and negative affect may play a role in the development of DEB. Using ecological momentary assessment (EMA), Merwin and colleagues² found negative affect to be a predictor of pre-meal insulin restriction. Moreover, Moskovich and colleagues¹⁶ showed that people who tended to experience negative affect and diabetes distress before eating were at increased risk of binge eating at the upcoming meal. Conversely, engaging in binge eating resulted in greater negative affect.¹⁶

It has been suggested that eating behaviour is related to the regulation of emotions rather than to emotions themselves.¹⁷ For instance, consuming more "comfort foods" has been linked to suppressing negative emotions as opposed to reappraising or expressing them naturally.¹⁷ Emotion regulation is defined as the ability of an individual to modulate emotions by determining the emotional response to a specific situation.¹⁸ In the context of eating behaviour, cognitive reappraisal and

Novelty statement

- More diabetes distress is associated with more disordered eating behaviour (DEB) and ineffective emotion regulation strategies. Ineffective emotion regulation strategies are seen as a risk factor for DEB, but research in adults with T1D is scarce.
- The current study shows that expressive suppression (ineffective strategy) was associated with increased DEB. The use of more cognitive reappraisal strategies (effective strategy) was associated with a decrease in diabetes distress.
- These findings support the call for routine screening for DEB in adults with T1D and interventions promoting effective emotion regulation strategies.

expressive suppression are considered two important emotion regulation strategies, as they represent effective (cognitive reappraisal) and ineffective (expressive suppression) emotion regulation strategies.¹⁷ Cognitive reappraisal is defined as "*the attempt to reinterpret an emotion-eliciting situation in a way that alters its meaning and changes its emotional impact*",¹⁸ and expressive suppression as "*the attempt to inhibit or reduce ongoing emotion-expressive behaviour*".¹⁸ Studies find that cognitive reappraisal decreases emotional experience and behavioural expression. By contrast, expressive suppression decreases behavioural expression, but fails to decrease emotional experience. Cognitive reappraisal is therefore seen as a more effective strategy and is associated with more positive outcomes and with healthier behaviour than expressive suppression.¹⁹

In a recent study in people with diabetes, effective emotion regulation skills were found to be associated with decreased diabetes distress.²⁰ This is consistent with literature finding that in particular ineffective emotion regulation strategies are related to increased diabetes distress. Higher levels of effective emotion regulation can help people with diabetes cope effectively with the behavioural and emotional challenges of living with and self-managing diabetes, thereby reducing diabetes distress.²¹

Research on the association between emotion regulation and problematic eating behaviour in T1D is scarce. Kafali and colleagues²² found that DEB was associated with experiencing difficulty accessing emotion regulation strategies and regulating one's emotions. Young-Hyman and colleagues²³ highlighted that the association between depressive symptoms and bulimic symptoms was moderated by emotion dysregulation, such that the interaction

between higher depressive symptoms and more emotional dysregulation was related to more bulimic symptoms. Both studies were conducted in children and youth, indicating the lack of studies in adults with T1D.

While there is evidence to suggest an association between emotion regulation and diabetes distress, the role of emotion regulation and diabetes distress in the context of DEB has not yet been explored. Therefore, we made the first step by exploring the associations between DEB, diabetes distress, and emotion regulation strategies (expressive suppression and cognitive reappraisal) in a cross sectional study with a Dutch-Italian sample. As DEB warrants attention across all ages, we focused on the full age range of adults with T1D.

We hypothesized (1) a positive association between expressive suppression of emotions and diabetes distress as well as DEB and (2) cognitive reappraisal to be associated with less diabetes distress and less DEB.

2 | METHODS

2.1 | Participants and procedure

As part of an ongoing collaboration between Amsterdam UMC and the University of Padova in the topic of emotion regulation, a cross-sectional survey study was conducted in a sample of individuals aged 18 years or older with T1D in The Netherlands and Italy, between September to November 2021. A convenience sampling procedure was used for recruitment of participants: the study was broadly advertised as a study on 'eating and emotions' via websites of diabetes organizations, social media channels, such as Facebook community groups for people with T1D, and emails to interested participants of previous studies. A-priori sample size calculation was performed using the *semPower* package within the R environment, with a one-sided *p* value of <0.05 , a power equal to 0.80, and a RMSEA equal to 0.05. This resulted in a minimal sample size of 184 respondents.²⁴ Online survey platforms were used for data collection: *Survalyzer* was used in The Netherlands and *Google Forms* in Italy. The research protocol was approved by the ethics committees of Amsterdam University Medical Centres (2021.0452) and of the University of Padova, Italy (2021.4247). All participants provided online informed consent.

2.2 | Measures

DEB was assessed with the *Diabetes Eating Problem Survey-Revised* (DEPS-R²⁵), which is a diabetes-specific measure of problematic diabetes eating behaviour

designed for people with T1D. The DEPS-R measures disordered eating in people with diabetes with questions related to maladaptive eating, preoccupation with thinness, and the concept of maintaining high blood glucose levels to lose weight. It is the only screening tool that has been validated for DEB in T1D for use in a clinical population.²⁵ Participants rate the frequency of a specific behaviour on a 6-point Likert scale (from 0 "never" to 5 "always"), where higher scores indicate greater pathology. A recommended cut-off score of ≥ 20 has been empirically established as a threshold, indicating the need for further clinical assessment of eating pathology.²⁵ Item 10 (the item concerning ketones) was excluded from the present study, as ketones are rarely measured in Dutch diabetes care. However, we still adopted the cut-off score of ≥ 20 , as the item on ketones has little contribution to the total sum score.²⁶ The DEPS-R was translated with the forward-backward method and the final version was approved by the original authors.^{26,27} The Italian DEPS-R has been validated.²⁶

Diabetes distress was measured with the 5-item *Problem Areas in Diabetes Scale-Short Form-5* (PAID-SF-5²⁸). Participants rate their problems on a 5-point Likert scale (from 0 "not a problem" to 4 "serious problem"). Total scores range from 0 to 20, with higher scores indicating greater diabetes distress. The PAID-5 presents good psychometric properties and is able to assess diabetes distress as well as the PAID-20 with less burden to the participants.²⁸ A PAID-5 score ≥ 8 indicates elevated diabetes distress and was used as cut-off.

Emotion regulation strategies were measured with the *Emotion Regulation Questionnaire* (ERQ¹⁸). The ERQ is a validated, 10-item questionnaire, that is often used in eating behaviour studies.¹⁷ The ERQ consists of two subscales corresponding to two emotion regulation strategies: cognitive reappraisal (6 items) and expressive suppression (4 items). The items can be answered on a 7-point-Likert scale (from 1 "strongly disagree" to 7 "strongly agree"), where higher scores indicate more use of the emotion regulation strategy.

Prior studies have demonstrated adequate to good reliability and validity for the DEPS-R,²⁹ PAID-5,¹⁴ and ERQ.¹⁸ In the present study, the PAID-5 and DEPS-R showed a Cronbach's alpha of 0.85. The cognitive reappraisal scale of the ERQ showed a Cronbach's alpha of 0.80 and the expressive suppression scale of the ERQ showed a Cronbach's alpha of 0.76.

Demographic and diabetes-related data (i.e., age, gender, education, living status), most recent HbA_{1c}, TIR over the past 7 days (if available from glucose sensor), and diabetes complications (dichotomized in yes/no), were collected by self-report (see Data S1).

2.3 | Statistical analysis

Baseline measures were summarized using mean and standard deviation, or frequencies and percentages in the case of categorical data. Chi-square tests and Mann-Whitney U tests were performed to investigate differences in baseline characteristics between Dutch and Italian participants, and between participants who presented scores below and above the DEPS-R cut-off of ≥ 20 .

Spearman correlations (ρ) and path analysis were conducted to examine the associations between DEPS-R, PAID-5, ERQ expressive suppression, and ERQ cognitive reappraisal. The models were adjusted for age, gender, BMI, country and TIR. Despite not anticipating that the associations would change with age,³⁰ we did correct for age in our analyses. Interaction effects with gender were included to investigate the influence of gender on the associations between emotion regulation, DEPS-R, and PAID-5. Cohen's guidelines were used for effect size interpretation. Correlation coefficients between 0.10 and 0.29 represent a small association, values

between 0.30 and 0.49 represent a medium association, values of 0.50 and above represent a large association.³¹ Stata/SE was used to conduct the path analysis. SPSS version 26.0 was used to conduct all other analyses.

3 | RESULTS

3.1 | Characteristics of participants

The online questionnaires were completed by $N=291$ participants, of which $n=229$ (78.7%) were women. Participants showed a mean age of 39.6 (SD \pm 13.4) years, a mean diabetes duration of 19.3 (SD \pm 13.3) years, a mean HbA_{1c} of 55 ± 16 mmol/mol (7.2% [3.6%]), and a mean TIR of 65.7% (SD \pm 25). Table 1 illustrates sociodemographic and clinical characteristics of the total sample.

Overall, $n=159$ participants (54.6%) reported elevated diabetes distress (PAID-5 ≥ 8). As to the ERQ, the frequency of using cognitive reappraisal and expressive suppression

TABLE 1 Demographic, psychological and diabetes-related characteristics of participants ($N=291$), stratified by DEPS-R cut-off score ≥ 20 .

Characteristics mean (SD) or %	Total $N=291$	DEPS-R score		p	U/X^2
		<20 $n=212$ (72.9%)	≥ 20 $n=79$ (27.1%)		
Age (years)	39.6 (13.4)	40.4 (13.6)	37.47 (12.8)	0.117	$U=7374.00$
Women (%)	229 (78.7)	163 (76.9)	66 (83.5)	0.171	$X^2=1.88$
Education level (%)				0.210	$X^2=4.53$
Primary education	2 (0.7)	1 (0.5)	1 (1)		
Secondary education	24 (8.2)	14 (6.6)	10 (12.7)		
Secondary vocational education	106 (36.4)	75 (35.4)	31 (39.2)		
Tertiary education (bachelor, master or equivalent)	159 (54.6)	122 (57.5)	37 (46.8)		
Living status (%)				0.695	$X^2=3.03$
Living alone	41 (14.1)	27 (12.7)	14 (17.7)		
With parents/family	61 (21)	47 (22.2)	15 (19)		
Student house/with friends	8 (2.7)	7 (3.6)	1 (1)		
With partner and no children	98 (33.7)	72 (34)	26 (32.9)		
With partner and children	73 (25.1)	51 (24.1)	22 (27.8)		
Diabetes duration (years)	19.3 (13.3)	19.9 (13.8)	17.8 (11.6)	0.422	$U=7824.00$
BMI (Body Mass Index)	24.9 (4.9)	23.8 (4.1)	27.8 (5.4)	<0.001	$U=4338.00$
HbA _{1c} (mmol/mol) and %	55 (16) (7.2% (3.6%))	53 (13) (7% (3.3%))	62 (20) (7.8% (4%))	<0.001	$U=4954.50$
TIR (%)	65.7 (25.4)	67.7 (26.2)	60.5 (22.3)	0.002	$U=4720.00$
Diabetes complications; yes, (%)	62 (21.3)	25 (11.8)	37 (46.8)	0.011	$X^2=6.491$
Scores of baseline questionnaires, mean (SD)					
PAID-5 total score	8.2 (4.6)	7.5 (4.4)	10.1 (4.6)	<0.001	$U=5700.00$
DEPS-R total score	14.1 (10.4)	8.9 (5.6)	27.9 (7)	<0.001	$U=0.000$
ERQ reappraisal	4.4 (1.2)	4.5 (1.2)	4.2 (1.3)	0.069	$U=7215.00$
ERQ suppression	3.4 (1.3)	3.3 (1.2)	3.7 (1.4)	0.021	$U=6906.500$

strategies was comparable to normative data from the general population.¹⁸ Based on DEPS-R score ≥ 20 , $n = 79$ participants (27.1%) presented with DEB (see Table 1). Participants with DEPS-R score ≥ 20 , reported a younger age, higher BMI, higher HbA_{1c}, lower TIR, and a higher PAID-5 total score. More specifically, $n = 57$ (72.2%) of the participants who scored above the DEPS-R cut-off ≥ 20 also reported elevated diabetes distress (PAID-5 ≥ 8). In the age category 18–30 ($n = 90$), 38.9% presented with DEB. In the age category 31 or older ($n = 201$), 31.1% presented with DEB.

Dutch participants reported a significantly lower TIR, more diabetes complications, and a higher DEPS-R total score, than Italian participants (see Data S2). Based on DEPS-R score ≥ 20 , $n = 35$ Italian participants (20.8%) reported DEB versus $n = 44$ of the Dutch participants (35.8%). Other demographic and clinical characteristics between the samples were similar (see Data S2); therefore data from both samples were merged for the subsequent analyses.

3.2 | Associations between PAID-5, DEPS-R and ERQ

The Spearman correlations between diabetes distress, DEB, and the use of emotion regulation strategies are reported in Table 2, showing small to medium effect size according to Cohen's guidelines. The results of the path analysis are reported in Table 3 and visualized in Figure 1. Small to medium effect sizes (semi-partial correlations) were detected in the path analysis. More diabetes distress was significantly associated with more DEB ($\beta = 0.23$, 95% CI [0.13, 0.34]). Less diabetes distress was significantly associated with more use of cognitive reappraisal ($\beta = -0.24$, 95% CI [-0.36, -0.12]). More DEB was significantly associated with more use of expressive suppression ($\beta = 0.14$, 95% CI [0.04, 0.24]), and not to the use of cognitive reappraisal. Gender did not significantly moderate these associations.

TABLE 2 Spearman correlations ($N = 291$).

Variables	1	2	3	4	5	6	7	8	9
1. Diabetes duration	—								
2. Age	0.43**	—							
3. BMI	0.31**	0.14*	—						
4. HbA _{1c}	0.03	-0.04	0.15*	—					
5. TIR	-0.05	0.15*	-0.18**	-0.37**	—				
6. ERQ cognitive reappraisal	0.10	0.11	-0.13*	-0.01	0.05	—			
7. ERQ expressive suppression	-0.02	-0.09	0.05	-0.03	-0.05	0.21**	—		
8. PAID-5 total score	-0.16**	-0.07	0.03	0.08	-0.14*	-0.19**	0.09	—	
9. DEPS-R total score	-0.03	-0.20**	0.43**	0.26**	-0.27**	-0.10	0.18**	0.29**	—

Abbreviations: BMI, Body Mass Index; HbA_{1c}, Haemoglobin A1c; TIR, Time In Range.

* $p < 0.05$; ** $p < 0.01$.

TABLE 3 Associations between disordered eating behaviour (DEPS-R), diabetes distress (PAID-5), and the use of cognitive reappraisal and expressive suppression (ERQ).

		β	95% CI		p
			LL	UL	
PAID-5	DEPS-R	0.23	-0.13	0.34	<0.001
ERQ cognitive reappraisal	PAID-5	-0.24	-0.36	-0.12	<0.001
ERQ expressive suppression	PAID-5	0.10	-0.02	0.22	0.092
ERQ expressive suppression	DEPS-R	0.14	0.04	0.24	0.005
ERQ cognitive reappraisal	DEPS-R	0.00	-0.10	0.11	0.984
PAID-5 * gender	DEPS-R	0.06	-0.18	0.29	0.640
ERQ cognitive reappraisal * gender	DEPS-R	-0.22	-0.49	0.05	0.112
ERQ expressive suppression * gender	DEPS-R	-0.12	-0.36	0.12	0.329
ERQ cognitive reappraisal * gender	PAID-5	-0.14	-0.46	0.18	0.392
ERQ expressive suppression * gender	PAID-5	0.07	-0.21	0.35	0.616

Note: $N = 291$; all models were adjusted for country, age, gender, BMI and TIR.

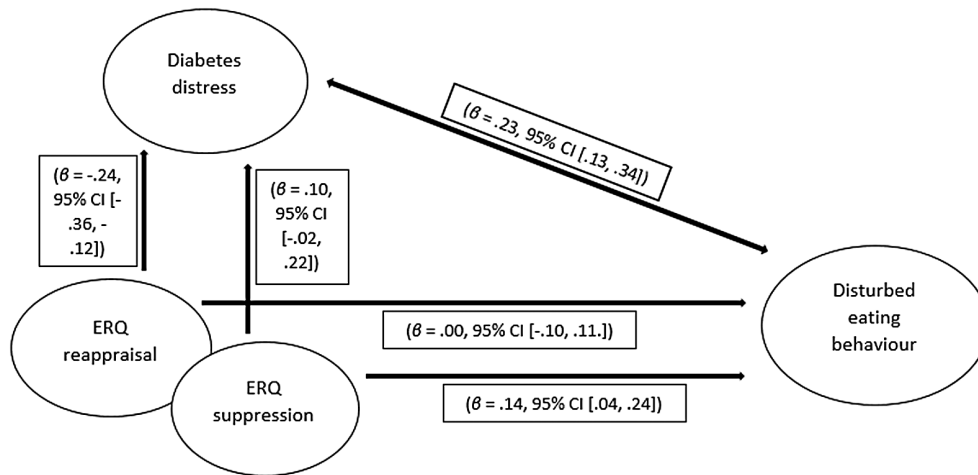


FIGURE 1 Associations between emotion regulation strategies (ERQ), diabetes distress (PAID-5) and disordered eating behaviour (DEPS-R), with standardized regression coefficients (β) and confidence intervals (CI).

4 | DISCUSSION

To the best of our knowledge, this is the first study among adults with T1D that examines the associations between disordered eating behaviour (DEB), diabetes distress, and two emotion regulation strategies: cognitive reappraisal and expressive suppression. Our main findings confirmed the hypotheses of the present study, namely that diabetes distress was associated with more DEB. The use of cognitive reappraisal was associated with less diabetes distress and the use of expressive suppression was associated with more DEB. We did not find an association between expressive suppression and diabetes distress.

In accordance with the literature, our findings demonstrated an association between effective emotion regulation (cognitive reappraisal) and less diabetes distress. It should be noted that in previous literature²⁰ effective emotion regulation was defined as the perceived understanding of one's emotional state and the perceived ability to regulate one's emotional state, which differs from the concept of cognitive reappraisal. Emotion dysregulation has been measured as a broad concept containing elements of emotional awareness, clarity of responses, and limited access to effective emotion regulation strategies, in prior studies.^{22,23} This demonstrates the various conceptualizations of emotion regulation and challenges comparisons between study results.

Our results are furthermore in line with previous EMA studies finding an association between increased diabetes distress and increased DEB, in which DEB was measured as insulin restriction and as binge eating during upcoming meals.^{2,16} Negative affect (e.g., diabetes distress) increased the odds of insulin restriction² and people with T1D with higher levels of diabetes distress were more likely to engage in binge eating as a way to cope with negative feelings.¹⁶

These studies' findings suggest that a decrease in diabetes distress might result in less act of insulin restriction, as well as in less binge eating, both of which are associated with better glycaemic outcomes. The results of the present study contribute to findings of the previous studies by indicating that effective emotion regulation (cognitive reappraisal) could play a role in the experience of less diabetes distress, as well as in less DEB. Numerous therapies for eating disorders currently focus on effective emotion regulation,^{32,33} but additional research is required to develop intervention strategies and treatment recommendations for DEB in T1D. This study emphasizes the significance of addressing efficient emotion regulation in DEB treatments for people with T1D, such as the use of cognitive reappraisal. DEB was furthermore associated with a younger age, a higher BMI, a higher HbA_{1c}, and a lower TIR, which corresponds with previous studies conducted in adolescents and adults.^{5,6,8,9,34,35} Nevertheless, by including a wide age range, our results show that DEB is not only prevalent in young adults but warrants attention across all ages.

This study has strengths and limitations. The use of the DEPS-R, a validated, diabetes-specific measure to detect DEB in people with T1D, was a significant strength of our study. The DEPS-R is a self-report measure however, and like the other instruments used in this study, it may be subject to self-report bias and recall bias. To eliminate the risk of bias in future research, it would be advisable to use EMA and to let participants report eating behaviour and psychological outcomes several times throughout the day. Furthermore, we used the commonly used clinical cut-off of ≥ 20 to describe our sample. Previous studies have found a three-factor structure, making a distinction between maladaptive eating, preoccupation with thinness, and the concept of maintaining high blood glucose levels to lose weight.²⁹ For clinical practice, further examination of these subscales might be helpful when scores are above the cut-off.

The point prevalence of diabetes distress in our total sample (54.6%) was relatively high compared to prior studies (approx. 30%¹³⁻¹⁵). This may be due to selection bias as people with a specific interest and perhaps experience in the topic of eating and emotions selected themselves for this study. Further, women were over-represented in our sample. They tend to report higher distress scores compared to men.¹⁵ This selection bias might impact the generalizability of our results. Also, the time of data collection (the COVID-19 pandemic) may have impacted distress levels; lockdown measures taken during the pandemic were related to increased levels of perceived stress in people with diabetes,³⁶ although a positive effect of lockdown measures on diabetes distress has also been reported.³⁷

The point prevalence of 27.1% DEB in our total sample was comparable to previous research in adults with T1D.⁵ However, differences between Dutch and Italian participants were observed, such that Dutch participants reported higher DEB (35.8%) than Italian participants (20.8%).^{9,38} Different strategies of study advertisement between countries could have contributed to this varying point prevalence of DEB. Whereas in Italy social media was mainly used to recruit participants; in the Netherlands, diabetes organizations and eating disorder clinics were involved in recruitment of participants. This may have attracted Dutch participants with an affinity to DEB. We are moreover aware that the cross-sectional design of the study does not allow inference regarding the directionality of the associations between the study variables, therefore prospective studies are warranted.

This study underlines the importance of identifying and addressing DEB in T1D, and confirms risk factors, such as younger age, higher BMI, higher HbA_{1c} and lower TIR, in research and clinical practice. Our results furthermore suggest that it may prove beneficial to prioritize strengthening emotion regulation strategies as a key component of interventions for people with T1D and DEB.

ACKNOWLEDGEMENTS

We would like to thank Prof. Dr. Jos Twisk for his statistical advice in conducting the path analysis.

CONFLICT OF INTEREST STATEMENT

None.

FUNDING INFORMATION

None.

REFERENCES

- Broadley M, Zaremba N, Andrew B, et al. 25 years of psychological research investigating disordered eating in people with diabetes: what have we learnt? *Diabet Med*. 2020;37(3):401-408.
- Merwin RM, Dmitrieva NO, Honeycutt LK, et al. Momentary predictors of insulin restriction among adults with type 1 diabetes and eating disorder symptomatology. *Diabetes Care*. 2015;38(11):2025-2032.
- Coleman SE, Caswell N. Diabetes and eating disorders: an exploration of 'Diabulimia'. *BMC Psychol*. 2020;8(1):1-7.
- De Paoli T, Rogers PJ. Disordered eating and insulin restriction in type 1 diabetes: a systematic review and testable model. *Eat Disord*. 2018;26(4):343-360.
- Watt A, Ng AH, Sandison A, Fourlanos S, Bramley A. Prevalence of disordered eating in adults with type 1 diabetes in an Australian metropolitan hospital. *Health Soc Care Community*. 2022;30(4):e974-e980.
- Wisting L, Skriverhaug T, Dahl-Jørgensen K, Rø Ø. Prevalence of disturbed eating behavior and associated symptoms of anxiety and depression among adult males and females with type 1 diabetes. *J Eat Disord*. 2018;6(1):1-10.
- Olmsted MP, Colton PA, Daneman D, Rydall AC, Rodin GM. Prediction of the onset of disturbed eating behavior in adolescent girls with type 1 diabetes. *Diabetes Care*. 2008;31(10):1978-1982.
- Wisting L, Frøisland DH, Skriverhaug T, Dahl-Jørgensen K, Rø Ø. Disturbed eating behavior and omission of insulin in adolescents receiving intensified insulin treatment: a nationwide population-based study. *Diabetes Care*. 2013;36(11):3382-3387.
- Cherubini V, Skrami E, Iannilli A, et al. Disordered eating behaviors in adolescents with type 1 diabetes: a cross-sectional population-based study in Italy. *Int J Eat Disord*. 2018;51(8):890-898.
- Goebel-Fabri AE. Disturbed eating behaviors and eating disorders in type 1 diabetes: clinical significance and treatment recommendations. *Curr Diab Rep*. 2009;9(2):133-139.
- Merwin RM, Moskovich AA, Dmitrieva NO, et al. Disinhibited eating and weight-related insulin mismanagement among individuals with type 1 diabetes. *Appetite*. 2014;81:123-130.
- Gagnon C, Aimé A, Bélanger C. Predictors of comorbid eating disorders and diabetes in people with type 1 and type 2 diabetes. *Can J Diabetes*. 2017;41(1):52-57.
- Skinner TC, Joensen L, Parkin T. Twenty-five years of diabetes distress research. *Diabet Med*. 2020;37(3):393-400.
- Snoek FJ, Pouwer F, Welch GW, Polonsky WH. Diabetes-related emotional distress in Dutch and US diabetic patients: cross-cultural validity of the problem areas in diabetes scale. *Diabetes Care*. 2000;23(9):1305-1309.
- Fisher L, Polonsky WH, Hessler DM, et al. Understanding the sources of diabetes distress in adults with type 1 diabetes. *J Diabetes Complications*. 2015;29(4):572-577.
- Moskovich AA, Dmitrieva NO, Babyak MA, et al. Real-time predictors and consequences of binge eating among adults with type 1 diabetes. *J Eat Disord*. 2019;7(1):1-9.
- Evers C, Marijn Stok F, de Ridder DT. Feeding your feelings: emotion regulation strategies and emotional eating. *Pers Soc Psychol Bull*. 2010;36:792-804.
- Gross JJ, John OP. Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *J Pers Soc Psychol*. 2003;85(2):348-362.
- Cutuli D. Cognitive reappraisal and expressive suppression strategies role in the emotion regulation: an overview on their

- modulatory effects and neural correlates. *Front Syst Neurosci.* 2014;8:175.
20. Coccaro EF, Lazarus S, Joseph J, et al. Emotional regulation and diabetes distress in adults with type 1 and type 2 diabetes. *Diabetes Care.* 2021;44(1):20-25.
 21. Fisher L, Hessler D, Polonsky W, et al. Emotion regulation contributes to the development of diabetes distress among adults with type 1 diabetes. *Patient Educ Couns.* 2018;101(1):124-131.
 22. Kafali HY, Altinok YA, Ozbaran B, et al. Exploring emotional dysregulation characteristics and comorbid psychiatric disorders in type 1 diabetic children with disordered eating behavior risk. *J Psychosom Res.* 2020;131:109960.
 23. Young-Hyman DL, Peterson CM, Fischer S, Markowitz JT, Muir AB, Laffel LM. Depressive symptoms, emotion dysregulation, and bulimic symptoms in youth with type 1 diabetes: varying interactions at diagnosis and during transition to insulin pump therapy. *J Diabetes Sci Technol.* 2016;10(4):845-851.
 24. Moshagen M, Erdfelder E. A new strategy for testing structural equation models. *Struct Equ Model Multidiscip J.* 2016;23(1):54-60.
 25. Markowitz JT, Butler DA, Volkening LK, Antisdel JE, Anderson BJ, Laffel LM. Brief screening tool for disordered eating in diabetes: internal consistency and external validity in a contemporary sample of pediatric patients with type 1 diabetes. *Diabetes Care.* 2010;33(3):495-500.
 26. Pinna F, Diana E, Sanna L, et al. Assessment of eating disorders with the diabetes eating problems survey–revised (DEPS-R) in a representative sample of insulin-treated diabetic patients: a validation study in Italy. *BMC Psychiatry.* 2017;17(1):1-11.
 27. Eilander MM, de Wit M, Rotteveel J, et al. Disturbed eating behaviors in adolescents with type 1 diabetes. How to screen for yellow flags in clinical practice? *Pediatr Diabetes.* 2017;18(5):376-383.
 28. McGuire B, Morrison T, Hermanns N, et al. Short-form measures of diabetes-related emotional distress: the problem areas in diabetes scale (PAID)-5 and PAID-1. *Diabetologia.* 2010;53(1):66-69.
 29. Wisting L, Wonderlich J, Skriverhaug T, Dahl-Jørgensen K, Rø Ø. Psychometric properties and factor structure of the diabetes eating problem survey–revised (DEPS-R) among adult males and females with type 1 diabetes. *J Eat Disord.* 2019;7(1):1-7.
 30. Leppanen J, Brown D, McLinden H, Williams S, Tchanturia K. The role of emotion regulation in eating disorders: a network meta-analysis approach. *Front Psychiatry.* 2022;13:793094.
 31. Cohen J. *Statistical Power Analysis for the Behavioral sciences—second edition.* 12 Lawrence Erlbaum Associates Inc.; 1988:13.
 32. Wildes JE, Marcus MD, Cheng Y, McCabe EB, Gaskill JA. Emotion acceptance behavior therapy for anorexia nervosa: a pilot study. *Int J Eat Disord.* 2014;47(8):870-873.
 33. Wallace LM, Masson PC, Safer DL, von Ranson KM. Change in emotion regulation during the course of treatment predicts binge abstinence in guided self-help dialectical behavior therapy for binge eating disorder. *J Eat Disord.* 2014;2(1):1-9.
 34. Araia E, Hendrieckx C, Skinner T, Pouwer F, Speight J, King RM. Gender differences in disordered eating behaviors and body dissatisfaction among adolescents with type 1 diabetes: results from diabetes MILES youth—Australia. *Int J Eat Disord.* 2017;50(10):1183-1193.
 35. Nip AS, Reboussin BA, Dabelea D, et al. Disordered eating behaviors in youth and young adults with type 1 or type 2 diabetes receiving insulin therapy: the SEARCH for diabetes in youth study. *Diabetes Care.* 2019;42(5):859-866.
 36. Ruissen MM, Regeer H, Landstra CP, et al. Increased stress, weight gain and less exercise in relation to glycemic control in people with type 1 and type 2 diabetes during the COVID-19 pandemic. *BMJ Open Diabetes Res Care.* 2021;9(1):e002035.
 37. Sacre JW, Holmes-Truscott E, Salim A, et al. Impact of the COVID-19 pandemic and lockdown restrictions on psychosocial and behavioural outcomes among Australian adults with type 2 diabetes: findings from the PREDICT cohort study. *Diabet Med.* 2021;38(9):e14611.
 38. Troncone A, Affuso G, Cascella C, et al. Prevalence of disordered eating behaviors in adolescents with type 1 diabetes: results of multicenter Italian Nationwide study. *Int J Eat Disord.* 2022;55(8):1108-1119.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Embaye J, Bassi G, Dingemans AE, Doesborg L, Snoek FJ, de Wit M. Associations between disordered eating behaviour, diabetes distress and emotion regulation strategies in adults with type 1 diabetes: Results from a Dutch-Italian cross-sectional study. *Diabet Med.* 2023;40:e15122. doi:[10.1111/dme.15122](https://doi.org/10.1111/dme.15122)