Received: 14 December 2017 | Revised: 3 May 2018 | Accepted: 3 May 2018
DOI: 10.1002/eat.22889

WILEY
International Journal of
EATING DISORDERS

ORIGINAL ARTICLE

Disordered eating behaviors in adolescents with type 1 diabetes: A cross-sectional population-based study in Italy

Valentino Cherubini MD[1]* | Edlira Skrami PhD[2]* | Antonio Iannilli MD[1] | Alessandra Cesaretti RN[1] | Anna Maria Paparusso RN[1] | Maria Cristina Alessandrelli PsyD[1] | Flavia Carle PhD[2] | Lucia Ferrito MD[1] | Rosaria Gesuita PhD[2]

[1]Division of Paediatric Diabetes, Women's and Children's Health, AOU Ancona, Salesi Hospital, Ancona, Italy

[2]Centre of Epidemiology and Biostatistics, Università Politecnica delle Marche, Ancona, Italy

Correspondence
Rosaria Gesuita, Via Tronto, 10/A, 60120, Torrette di Ancona, Ancona, Italy.
Email: r.gesuita@univpm.it

Abstract

Objective: To evaluate the association of clinical, metabolic and socioeconomic factors with disordered eating behaviors (DEB) among adolescents with type 1 diabetes screened using the Diabetes Eating Problem Survey-Revised (DEPS-R).

Methods: A cross-sectional, population-based study involved 163 adolescents with type 1 diabetes, aged 11–20 years, recruited from the registry for type 1 diabetes of Marche Region, Italy, who completed the DEPS-R (response rate 74.4%). Clinical characteristics, lipid profile, HbA_{1c}, family profile of education and occupation were evaluated. The Italian version of DEPS-R was validated, and the prevalence of DEB estimated. The association of demographic, socioeconomic, and clinical factors with DEB was evaluated by multiple correspondence analysis and multiple logistic regression.

Results: The prevalence of DEPS-R-positive (score $\geq$20) was 27% (95% CI 17–38) in boys and 42% (95% CI 31–53) in girls. A clinical profile of DEPS-R-positive was identified: overweight, little time spent in physical activity, low socioeconomic status, poor metabolic control, skipping insulin injections. Furthermore, the probability of DEPS-R-positive increased 63% for every added unit of HbA_{1c}, 36% for every added number of insulin injections skipped in a week and decreased about 20% for every added hour/week spent in physical activity. Overweight youth were six times more likely to be DEPS-R-positive.

Discussion: A specific clinical profile of DEPS-R-positive was identified. A multidisciplinary clinical approach aimed to normalize eating behaviors and enhance self-esteem should be used to prevent the onset of these behaviors, and continuous educational programs are needed to promote healthy behaviors and lifestyles.

KEYWORDS
adolescent, body mass index, exercise, feeding and eating disorders, social class, type 1 diabetes mellitus

1 | INTRODUCTION

Type 1 diabetes in children and adolescents presents particular challenges beyond blood glucose control, including maintaining normal physical growth and dealing with family dynamics. There are conflicting results whether adolescents with type 1 diabetes are at higher risk of developing disordered eating and body image dissatisfaction than peers without diabetes (Ackard et al., 2008; Baechle et al., 2014; Colton et al., 2004; Jones, Lawson, Daneman, Olmsted, & Rodin, 2000; Young et al., 2013).

Baechle and colleagues defined disordered eating behaviors (DEB) as "a wide range of eating disorder pathologies including dieting for

Valentino Cherubini and Edlira Skrami contributed equally to this paper and should be considered joint first author.

weight control, binge eating and purging behaviors, to subthreshold and full syndrome eating disorders" (Baechle et al., 2014).The co-occurrence of type 1 diabetes and DEB is of high clinical relevance, often associated with worse glycemic control and higher rates of diabetes-related morbidity/mortality (Goebel-Fabbri et al., 2008; Nielsen, Emborg & Molbak, 2002; Scheuing et al., 2014). Therefore, it is essential to screen and detect adolescents at risk as early as possible (Cooper et al., 2016).

Estimates of the prevalence of DEB and eating disorders (EDs) among adolescents with type 1 diabetes showed high variability, ranging from 10% to 49%. This high variability may be related to the fact that some studies focused on females only (Colton, Olmsted, Daneman, Rydall, & Rodin, 2007; Hanlan, Griffith, Patel, & Jaser, 2013; Nielsen, 2002; Peveler et al., 2005) and others on both genders (Pinna et al., 2017; Wisting, Froisland, Skrivarhaug, Dahl-Jorgensen, & Ro, 2013a; Saßmann et al., 2015). In a recent 14-year prospective study (Colton et al., 2015), the probability of developing DEB and ED over the course of the study in adolescents with type 1 diabetes was found to be 79% and 60%, respectively.

Few studies on DEB have been population-based with response rates of 42.5% (Wisting et al., 2013a), 63% (Saßmann et al., 2015), 16% (Araia et al., 2017), and 42% (Baechle et al., 2014). The first three studies were based on the Diabetes Eating Problem Survey-Revised (DEPS-R), which is a diabetes-specific 16-item self-report screening measure for disordered eating in youth with diabetes (Markowitz et al., 2010). The 2014 study by Baechle and colleagues was based on the more generic SCOFF questionnaire (Morgan, Reid, & Lacey, 1999). Furthermore, no data on DEB in the Italian pediatric population with type 1 diabetes have been published to date.

This population-based study aimed to assess the prevalence of DEB in the region Marche Italy, using the Italian version of DEPS-R as a screening tool. Consistent with previous studies, we hypothesized that age, gender, BMI, physical activity, family socio-economic status, metabolic control, insulin restriction, insulin treatment modalities, are correlates of DEB in adolescents with type 1 diabetes.

2 | METHOD

2.1 | Participants and study design

This cross-sectional, population-based study was carried out in the Marche region, Italy, from November 2015 to May 2016. All 219 adolescents, aged 11–20 years with type 1 diabetes diagnosed at least 1 year before the beginning of the study, resident in Marche Region, and included in the Italian Insulin-Dependent Diabetes Registry (RIDI) (Carle et al., 2004) were invited to participate in this study. Exclusion criteria were diagnosed eating disorders and lack of willingness to provide signed informed consent. Two adolescents affected by autism were excluded from the study. No other psychiatric condition was diagnosed among the study population, as reported by the routine psychological evaluations.

Written consent was obtained from the participants, or their parents if the participant was younger than 18 years of age. The study protocol was approved by the Regional Ethics Committee.

2.2 | Measurements

2.2.1 | Anthropometry and other covariates

Within the Marche region, centers for adults and for children and adolescents with diabetes operate in a network sharing the same clinical records. Personal, clinical, and biochemical data are routinely recorded during the scheduled medical visit at the pediatric center and stored on an electronic database; adolescents who were transferred to adult centers were contacted through network adult diabetologists. The following data were extracted for each participant: date of birth and of diabetes diagnosis, gender, weight, height, number of episodes of severe hypoglycemia or ketoacidosis in the last 3 months, glycated hemoglobin (HbA_{1c}), lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides), weekly hours of physical activity, insulin therapy regimen multiple daily injections/continuous subcutaneous insulin infusion (MDI/CSII), average total daily insulin dose during the preceding week (U/kg/day), presence of celiac disease, and the use of a carbohydrate counting system, number of insulin shots/day and number of skipped insulin injections per week. In order to facilitate accurate reporting, the number of shots skipped per week is regularly assessed by physicians, in the presence of the parents, avoiding blaming of the adolescent and assuring her/him that it is something that can happen in the real life of people with type 1 diabetes.

Moreover, family characteristics such as parents' age, education and position of occupation, and history for diabetes were collected. Parents' education was categorized into three levels: a low education level (without a high school diploma; $<$13 years of schooling), a medium education level (a high school diploma; 13 years of schooling), a high education level (university studies; $>$13 years of schooling).

The classification of professions of the Italian Institute of Statistics (ISTAT, 2013) was used to classify parents' occupation according to nine major groups; occupational categories were considered in two skill levels: high (Manager, Legislators, Chief Executives Officials, Technicians and Associate Professionals, Science, Engineering, Health, Teaching, Business and Administration, Information and Communications Technology, Legal, Social, Cultural Professionals, Armed Forces Officers) and low (Elementary Occupations, Clerical Support Workers, Services and Sales Workers, Skilled Agricultural, Forestry and Fishery Workers, Craft and Related Trades Workers, Armed Forces Occupations, Other Ranks).

2.2.2 | DEB

A validated Italian version of the DEPS-R was used to identify adolescents with DEB. Two recent validation studies, respectively, conducted in Norway (Wisting, Froisland, Skrivarhaug, Dahl-Jorgensen, & Ro, 2013b) and in Germany (Saßmann et al., 2015), confirmed the good psychometric properties of this screening tool. The reliability and validity of the Italian version of DEPS-R were assessed in all study participants, as follows.

2.2.3 | Linguistic and cultural adaptation

Translation and crosscultural adaptation of the DEPS-R to the Italian language were carried out independently by two native language translators. A first Italian draft was obtained discussing the two translations by a group of experts that included two of the authors (VC, LF). An independent back-translation into English was carried out by a translator without knowledge of the study's objective.

2.2.4 | Reliability

The internal consistency of the DEPS-R was assessed by Cronbach's alpha coefficient. The overall internal consistency was evaluated considering all the items of the questionnaire, including the entire sample, as well as separately for girls and boys. Sixteen specific-item alpha coefficients were estimated removing one item at a time.

2.2.5 | Factor structure

This was explored by the exploratory factor analysis (EFA) using the principal axis factorial approach (PAF). The sample adequacy was evaluated by means of the Kaiser–Meier–Olkin test and the Bartlett test of sphericity.

2.2.6 | Construct validity

Spearman correlation analysis was carried out to evaluate relationships with other characteristics that could co-vary with the DEPS-R total score, such as *z*-BMI, HbA_{1c}, and age.

2.2.7 | Discriminant validity

This was performed to assess whether the questionnaire was able to discriminate between groups of individuals with the poorest (HbA_{1c} >8% [64 mmol/mol]) and the best (HbA_{1c} ≤7% [53 mmol/mol]) metabolic control, comparing the total score of DEPS-R of the two groups by means of Wilcoxon Mann–Whitney rank sum test.

2.2.8 | External validity

The association of DEPS-R score with the clinicians' assessment of insulin restriction was evaluated using Wilcoxon Mann–Whitney rank sum test. DEPS-R is a 16-item diabetes-specific self-report questionnaire; responses are scored on a 6-point Likert items scale (0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = usually, 5 = always). The resulting scale is scored by summing all 16 items and ranges from 0 to 80. The total score of DEPS-R was dichotomized at ≥20, indicating positive screening of DEB, as previously suggested (Markowitz et al., 2010). The validated Italian version of the questionnaire was distributed to the participants during their scheduled medical visit.

2.2.9 | Laboratory

HbA_{1c} was measured by point-of-care DCA Vantage (Siemens), standardized to the Diabetes Control and Complication Trial assay (Tamborlane et al., 2005). Total cholesterol, HDL cholesterol, and triglycerides were measured in stored plasma samples by an enzymatic method using a Beckman Coulter Olympus AU 480 (Beckman Coulter, Brea, CA). LDL was calculated using the Friedewald equation, which includes total cholesterol, HDL cholesterol, and triglycerides.

2.3 | Statistical analysis

Adolescents with HbA_{1c} ≥9% (75 mmol/mol) and reporting to skip at least one insulin shot per week were defined as "insulin-restrictors".

Age- and gender-specific percentiles of the Lipid Research Clinics Program Prevalence Study (Tamir et al., 1981) were used to classify patients by total cholesterol, triglycerides, LDL-C, and HDL-C concentrations.

Body mass index [BMI (kg/m^2)] was age and sex-standardized (*z*-BMI) according to the ISPED growth charts (Cacciari et al., 2006). Percentiles of *z*-BMI distribution were used to classify individuals as underweight, UW (BMI <3rd percentile), normal weight, NW (3rd ≤ BMI percentiles ≤ 85th), overweight, OW (85th < BMI percentiles ≤ 95th) and obese, O (BMI > the 95th percentile).

Family profile of education was obtained by combining parents' schooling as low (both parents without a high school diploma), medium (at least one parent with a high school diploma), and high (at least one parent with a university or higher degree). The skill levels of parents were combined to define a family profile of occupation as low, when both parents belonged to a low-skilled level, and high, when as at least one parent belonged to a high-skilled level of occupation.

The Shapiro test showed that variables were not normally distributed. Therefore a nonparametric approach was used for the analysis.

The prevalence of DEPS-R ≥ 20 was evaluated as punctual and 95% confidence interval (CI) estimates using the binomial distribution. It was also evaluated according to gender, age, and BMI classes, the insulin delivery system used, family profile of education, and occupation.

The characteristics of the study sample were evaluated according to the DEPS-R levels (≥20 and <20). Quantitative variables were summarized using median and interquartile range (1st–3rd quartiles), and qualitative variables as absolute and percentage frequencies. Group comparisons between those with DEPS-*R* score ≥20 and those with DEPS-R score <20 were performed by means of the Wilcoxon–Mann–Whitney test in the case of quantitative variables and χ^2 test or Fisher test (when expected frequencies were <5) for qualitative variables. The rates for severe hypoglycemia and ketoacidosis during the 3 months before inclusion in the study were calculated for both groups and were compared using the exact conditional test for binomial distribution.

Multiple correspondence analysis (MCA) (Benzecri, 1973), an explorative statistical technique, was used to detect all the characteristics that are common in adolescents with DEPS-R ≥ 20. Metabolic control (HbA_{1c} grouped as <7% and ≥7% [53 mmol/mol]), individual and family sociodemographic characteristics (gender, family level of education attainment, parental profile of occupation), patients' clinical features (insulin delivery system, use of the carbohydrate counting system, insulin restriction, BMI classes, and time spent in physical activities grouped as ≤2 h per week and >2 h per week), lipid profile, and DEPS-R levels were analysed simultaneously. In this multivariate analysis, the modalities of all the categorical variables are organized in a multiple contingency table, and row and column frequencies were calculated. This statistical technique geometrically transforms the frequencies into a projection on a Cartesian plane; the associations between modalities are then evaluated in terms of distance between the points. The more the points are close to each other the more the modalities are shared by the same patients. The interpretation of the results is made on the relative position of the points and consists in looking for groupings of variables modalities as those with the closer distance between points. The ability of MCA to explain the whole data variability is showed by the inertia: when the inertia is close to 100%, all the variability is explained by the analysis.

A multiple logistic regression analysis was used to estimate the independent effect of patients' sociodemographic and clinical characteristics on the probability of having a DEPS-R $\geq$ 20. All estimates were obtained calculating 95% CIs. Likelihood ratio (LR) test and Hosmer–Lemeshow test were used to select the most parsimonious model and to evaluate the model's goodness of fit.

A level of probability lower than .05 was used to assess the statistical significance, and the statistical analyses were performed using R version 3.2.4 (R Core Team, 2016).

3 | RESULTS

Of the 219 adolescents invited to participate in the study, a total of 163 youth with type 1 diabetes (48.5% boys) completed the DEPS-R questionnaire (74.4% response rate).

Participants' median age was 15.4 years (1st–3rd quartiles: 13.2–17.7), median diabetes duration was 6.4 years (1st–3rd quartiles: 3.9–10.3) and median HbA_{1c} was 7.6% [60 mmol/mol] (1st–3rd quartiles: 7.1% [54 mmol/mol] – 8.2% [66 mmol/mol]). Most patients were on MDI (76%). Participants classified underweight were 4 (2.5%), those of normal weight 124 (76.1%), overweight 25 (15.3%), and obese 10 (6.1%). As only a few participants were underweight or obese, the first two classes (UW/NW) and the last (OW/O) were grouped.

Fifty-six patients did not participate in the study: 14 of them moved out the region, and no clinical data were available. Therefore, we were able to analyze clinical records of 42 nonparticipants. No significant differences between participants in the study and nonparticipants were found regarding gender, age at diagnosis, BMI, HbA_{1c}, total, and HDL cholesterol and triglycerides. Nonparticipants were older and had a longer diabetes duration than participants (Supporting Information Table S1).

3.1 | Reliability and validity analysis

The Italian version of DEPS-R showed good internal consistency and validity in our sample of children and adolescents with type 1 diabetes. The Cronbach's alpha coefficients for the DEPS-R were 0.81 (95% CI 0.76–0.85), 0.83 (95% CI 0.77–0.88), 0.78 (95% CI 0.71–0.85) for the entire sample, girls and boys, respectively (Supporting Information Tables S2–S4).

3.2 | Prevalence of disordered eating behaviors

The overall median DEPS-R score was 15 (1st–3rd quartiles: 10–23). Fifty-six adolescents reported a DEPS-R score $\geq$20 with a median score of 27 (1st–3rd quartiles: 23–31).

The prevalence of DEPS-R score $\geq$20 was 34.4% (95% CI 27.1–42.2), with no significant difference between boys [26.6% (95% CI 17.3–37.7)] and girls [41.7% (95% CI 31.0–52.9)] (p = .063). The prevalence was significantly higher in patients OW/O [65.7% (95% CI 47.8–80.9)] than in those UW/NW [25.8% (95% CI 18.5–34.3)] ($p < .001$).

The sociodemographic and clinical characteristics of the participants according to the DEPS-R score cutoff are shown in Table 1. Participants with DEPS-R score $\geq$20 had significant higher HbA_{1c} levels and used higher insulin doses, and spent significantly lower time in physical activity. No significant differences were found between the two groups in terms of other clinical and family characteristics.

The lipid profile of the participants according to the DEPS-R score levels was evaluated. Adolescents with DEPS-R score $\geq$20 had significantly higher median level of total cholesterol. No significant differences were found between the two groups when evaluating the percentiles of total cholesterol, HDL cholesterol, and LDL distributions. A significantly higher percentage of the participants with DEPS-R score $\geq$20 had triglycerides over the 95th percentile.

Figure 1 shows the results of the MCA. The two dimensions identified by the MCA explained about 64% of the total variability. It was possible to identify four groupings, as follows:

1. The first quadrant I) displayed participants with DEPS-R score <20, classified as nonrestrictors, more frequently boys, UW/NW, and that spent more than 2 h in physical activity per week. Their LDL and triglycerides values were more frequently under the 75th percentile, while their HDL levels were over the 50th percentile;
2. In the second quadrant II) were found participants that did not have a good metabolic control (HbA_{1c} >7% [53 mmol/mol]), used multiple daily injections, did not use the carbohydrate counting system and were classified as insulin restrictors. They had more frequently a medium or low family profile of education, low family profile of occupation;
3. The third quadrant III) referred to participants with DEPS-R score $\geq$20, that spent 2 h or less in physical activity per week, were more frequently girls, OW/O, with triglyceride, and LDL levels over the 75th percentile, and HDL levels under the 50th percentile;
4. In the fourth quadrant IV), participants were characterized by good metabolic control (HbA_{1c} $\leq$7% [53 mmol/mol]), the use of CSII, with a high family profile of education and occupation. Participants using the carbohydrate counting system were found in the extreme lower part of the quadrant.

The II and the III quadrants of the graph identified a factorial plane in which patients with a poor metabolic control and positively screened for DEB were counter-posed to the patients characterized by optimal metabolic control who were found negative to DEPS-R screening (I and IV quadrants).

Table 2 shows the results of the multiple logistic regression analysis. A DEPS-R score $\geq$20 was significantly associated with HbA_{1c}, the number of skipped or forgotten insulin injections per week, BMI levels, and the time spent in physical activity. In particular, the probability of having a DEPS-R score $\geq$20 increased about 63% for every added unit of HbA_{1c} and about 36% for every added number of insulin injections skipped or forgotten in a week; OW/O youth were more than six times

TABLE 1 Sociodemographic and clinical characteristics according to DEPS-R score cutoff in children and adolescents with type 1 diabetes

Variables	DEPS-R score <20 (*n* = 107)	DEPS-R score ≥20 (*n* = 56)	Effect size[a]	*p*
Sociodemographic characteristics				
Gender, boys [*n* (%)]	58 (54.2)	21 (37.5)	−0.08 (−0.16;0)	.063*
Age at visit, years [median (1st–3rd quartiles)]	15.1 (13.2;17.5)	15.7 (13.3;17.9)	−0.05 (−0.37;0.28)	.612**
Age at diagnosis, years [median (1st–3rd quartiles)]	8.8 (5;11.5)	8.2 (4.7;10.7)	0.08 (−0.25;0.4)	.535**
BMI classes [*n* (%)]				<.001*
UW/NW	95 (88.8)	33 (58.9)	—	
OW/O	12 (11.2)	23 (41.1)	0.22 (0.13;0.31)	
Physical activity (h/week) [median (1st–3rd quartiles)]	5 (2;8)	2 (1;5)	0.7 (0.37;1.04)	<.001
Clinical characteristics				
Diabetes duration, years [median (1st–3rd quartiles)]	6 (3.3;10.3)	8.3 (4.6;10.1)	−0.1 (−0.43;0.22)	.307**
HbA_{1c}, % [median (1st–3rd quartiles)]	7.4 (7;7.9)	8 (7.5;8.6)	−0.68 (−1.01; −0.35)	<.001**
Insulin restriction[b] [*n* (%)]				.125
Nonrestrictors	104 (97.2)	51 (91.1)	—	
Restrictors	3 (2.8)	5 (8.9)	0.16 (−0.02;0.35)	
Insulin delivery system (CSII) [*n* (%)]	26 (24.3)	13 (23.2)	−0.01 (−0.1;0.09)	1*
Insulin dose (U/kg/day) [median (1st–3rd quartiles)]	0.9 (0.7;1)	1 (0.8;1.1)	−0.24 (−0.57;0.08)	.018**
Carbohydrate counting system (yes) [*n* (%)]	13 (12.1)	2 (3.6)	−0.13 (−0.27;0.01)	.130*
Celiac disease (yes) [*n* (%)]	5 (4.7)	5 (8.9)	0.09 (−0.08;0.26)	.314*
Severe hypoglycemia rate in the last 3 months[c]	3.7	10.7	0.09 (−0.1;0.28)	.088†
Ketoacidosis rate in the last 3 months[c]	0.9	0	−0.19 (−0.71;0.33)	.344†
Family characteristics				
Father's age (years) [median (1st–3rd quartiles)]	50.8 (47.7;53.8)	50.4 (46;55.3)	−0.21 (−0.54;0.12)	.853**
Mother's age (years) [median (1st–3rd quartiles]	46.5 (43.6;50)	46 (42.7;49.8)	−0.03 (−0.35;0.3)	1**
Family level of education [*n* (%)]				.244*
Low	23 (22.3)	10 (18.5)	—	
Medium	49 (47.6)	34 (63.0)	0.06 (−0.04;0.17)	
High	30 (29.1)	11 (20.4)	−0.01 (−0.13;0.11)	
Family's profile of occupation [*n* (%)]				0.549
Low	74 (69.2)	42 (75)	—	
High	33 (30.8)	14 (25)	−0.04 (−0.12;0.05)	
Family history of type 2 diabetes [*n* (%)]	40 (37.4)	27 (48.2)	0.06 (−0.03;0.14)	.247*
Family history for type 1 diabetes [*n* (%)]	16 (15)	8 (14.3)	−0.01 (−0.12;0.11)	1*

Note. CSII = continuous subcutaneous insulin infusion; DEPS-R = Diabetes Eating Problem Survey-Revised; NW = normal weight; O = obese; OW = overweight; UW = underweight.
[a]Estimates are Cohen's effect sizes (Cohen J. Statistical Power Analysis for the Behavioral Sciences. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988); *p* values refer to: χ^2 test.
[b]Patients answering to skip at least one insulin shot per week and having an HbA_{1c} equal or higher than 9% were categorized as restrictors.
[c]Rates (events/patients) within 3 months prior to the beginning of the study.
*Fisher exact test.
**Wilcoxon–Mann–Whitney test.
†Conditional exact test for binomial distribution.

more likely to have DEPS-R score ≥20 than those UW/NW. Moreover, the probability to have a score ≥20 on DEPS-R decreased about 20% for every added hour per week spent in physical activity.

4 | DISCUSSION

To the best of our knowledge, this is the first population-based study focusing on DEB in youth with type 1 diabetes in Italy. By validating the DEPS-R questionnaire in the Italian language in adolescents with type 1 diabetes, this study provides a useful clinical practice tool for screening DEB. Recently, an Italian version of DEPS-R was validated in a population with median age of 38 years of insulin-treated patients with type 1 or type 2 diabetes (Pinna et al., 2017). The Italian version of DEPS-R showed a high level of internal consistency and validity, consistent with the original version (Markowitz et al., 2010). The prevalence of DEB in this population of Central Italy was high, and patients positive to the screening had a distinctive clinical profile, as shown by the MCA. They were overweight or obese, with a worse lipid profile and metabolic control, prone to skipping insulin injections, not using the carbohydrate counting system and on MDI treatment. Also, most of them were girls who spent little time in physical activity, with a low family profile of education and occupation. Among those features, number of skipped shots, HbA_{1c}, BMI categories, and physical activity were found to have an independent effect on the probability to be positive for DEPS-R.

In our study, more than onethird of adolescents scored above the cutoff on the DEPS-R, highlighting the very high prevalence of DEB in boys that was about three times higher than the prevalence reported in Norway (Wisting et al., 2013a) and Germany (Saßmann et al., 2015).

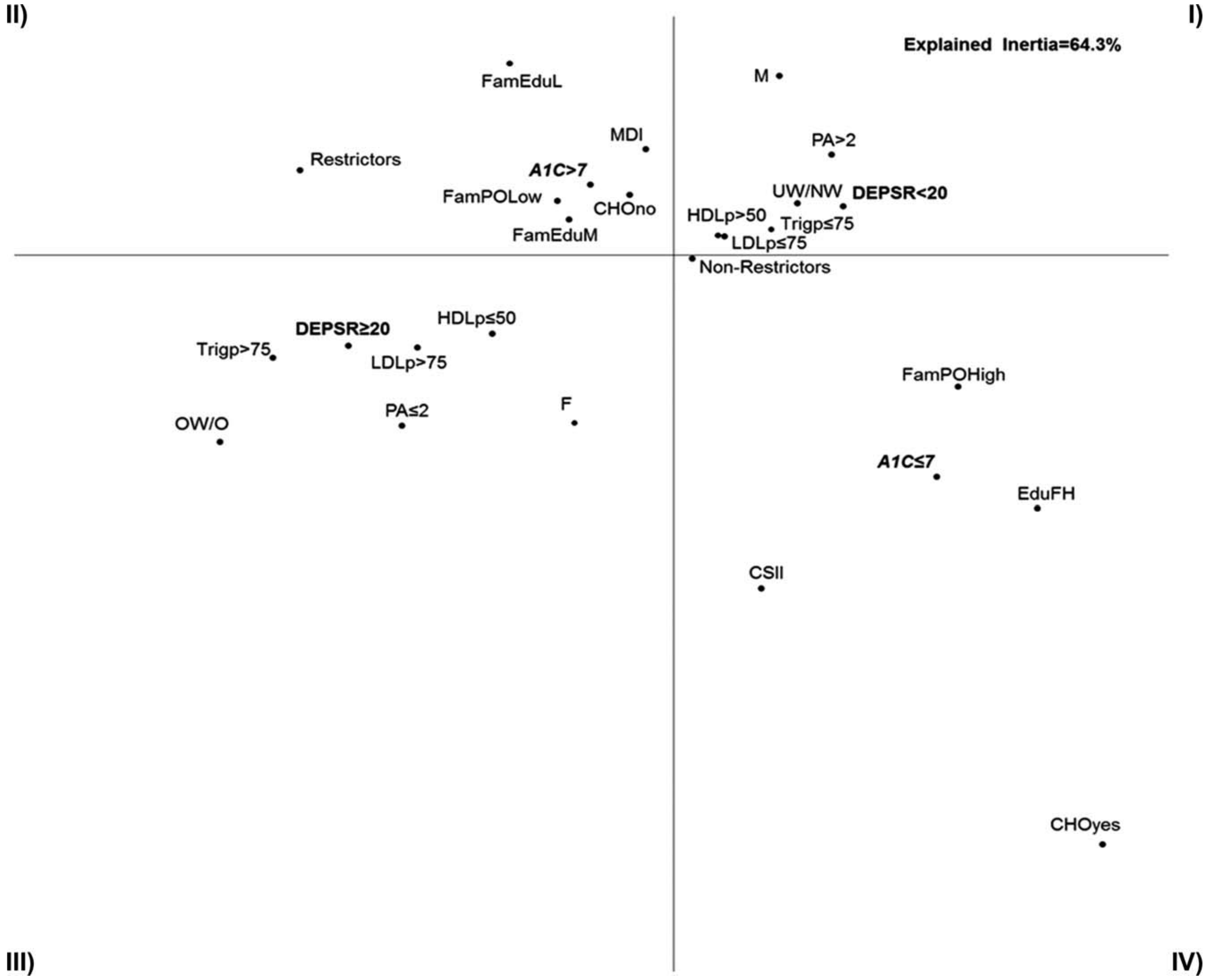

FIGURE 1 Association between DEPS-R levels, metabolic control, individual and family sociodemographic characteristics, and clinical features. Results of the multiple correspondence analysis. A1c >7 HbA1c more than 7% (53 mmol/mol) F Girls A1c ≤7 HbA1c up to 7% (53 mmol/mol) M Boys CHOyes Carbohydrate counting system: Yes Non-Restrictors Non-insulin restrictors CHOno Carbohydrate counting system: No Restrictors Insulin restrictors CSII Insulin delivery system: CSII UW/NW BMI UW/NW MDI Insulin delivery system: MDI OW/O BMI OW/O DEPS-R<20 DEPS-R score<20 LDLp≤75 LDL-C percentiles ≤75th DEPS-R≥20 DEPS-R score<20 LDLp>75 LDL-C percentiles >75th Family Profile of Education: HDLp≤50 HDL-C percentiles ≤50th EduFH High: University diploma HDLp>50 HDL-C percentiles >50th FamEduM Medium: High school diploma Trigp ≤75 Triglycerides percentiles ≤75th FamEduL Low: Middle school diploma Trigp>75 Triglycerides percentiles >75th FamPOHigh Family Profile of Occupation: High PA>2 Physical activity >2 hours/week FamPOLow Family Profile of Occupation: Low PA≤2 Physical activity ≤2 hours/week CSII, continuous subcutaneous insulin infusion; DEPS-R, Diabetes Eating Problem Survey-Revised; HbA1c, glycated hemoglobin; MDI, multiple daily injections; O, obese; OR, OW, overweight; NW, normal weight; UW, underweight

It is possible to speculate that a modification of social behaviors involving youth of both genders is occurring in Italy. In fact, the design of our study allows assessment of the entity of this phenomenon, not the detection of the determinants. Therefore, further studies are required to investigate the reasons for the higher number of male adolescents with type 1 diabetes and DEB. DEB were also a typical feature of girls in our study, with a prevalence that was higher than some previous studies (Doyle et al., 2017; Saßmann et al., 2015; Wisting et al., 2013a) but lower than the study reported by Araia et al. (2017).

The results of MCA showed that boys and girls belonged to two different groups, characterized by the different amount of time spent in physical activity. This result suggests that girls and boys may use different ways to control their body weight. Furthermore, our study suggests the importance of applying DEPS-R to both genders as a screening tool in clinical practice, as has been previously reported by Doyle et al. (2017).

The MCA allowed the identification of a group of socioeconomic and clinical factors useful in identifying those adolescents with type 1 diabetes vulnerable to DEB. Low and medium family profile of education and a low family profile of occupation were associated with a DEPS-R score ≥20. Other studies evaluated the association between DEB and clinical and social characteristics in adolescents with type 1 diabetes using different questionnaires, which makes comparisons with our results difficult. Colton and colleagues explored the relationship

TABLE 2 Effect estimate of factors associated to the DEPS-R levels

Independent variables	OR	95% CI	p
HbA_{1c} (%)	1.63	1.05; 2.58	.031
Insulin delivery system (CSII vs. MDI)	0.72	0.27; 1.88	.513
Insulin dose (U/kg/day)	2.91	0.60; 14.52	.185
Insulin shots skipped (nr per week)	1.36	1.04; 1.81	.027
BMI level: OW/O vs. UW/NW	6.32	2.36; 18.13	<.001
Triglycerides—percentiles (>75th vs. ≤75th)	0.99	0.33; 2.83	.983
LDL cholesterol—percentiles (>75th vs. ≤75th)	0.96	0.32; 2.78	.939
Physical activity (h/week)	0.80	0.69; 0.91	.001
Family level of education (medium vs. low)	2.01	0.72; 6.00	.192
Family level of education (high vs. low)	1.75	0.50; 6.40	.384

Note. CSII = continuous subcutaneous insulin infusion; DEPS-R = Diabetes Eating Problem Survey-Revised; HbA_{1c} = glycated hemoglobin; MDI = multiple daily injections; O = obese; OR = odds ratio; OW = overweight; NW = normal weight; UW = underweight. Results of the multiple logistic regression analysis.
LR test: χ^2 with 10 *df*, $\chi^2 = 52.7$, $p < .001$; Hosmer and Lemeshow goodness of fit test: χ^2 with 8 *df*, $\chi^2 = 2.82$, $p = .945$.

between DEB and family sociodemographic status and did not find any association (Colton et al., 2004; Neumark-Sztainer et al., 2002). On the other hand, a low family socioeconomic status has been reported to be associated with poor metabolic control and higher body weight (Gesuita et al., 2017). In accordance with previous studies (Colton et al., 2007, Saßmann et al., 2015; Tse, Nansel, Haynie, Mehta, & Laffel, 2012), individuals with high BMI were more frequently positive for DEB, and a longitudinal study found that higher BMI predicted the onset of DEB among patients with type 1 diabetes (Olmsted, Colton, Daneman, Rydall, & Rodin, 2008). In clinical practice, body weight is always a major concern in youth with type 1 diabetes, since there is a strong relationship between food intake, insulin therapy, and metabolic control. Moreover, food preoccupation imposed by carbohydrate-counting systems, weight fluctuations associated with variable use of insulin and subsequent body and blood glucose fluctuations associated with mismatched insulin dose, and excessive caloric intake secondary to hypoglycemia (Peterson, Fischer, & Young-Hyman, 2015) can work as a burden for people with type 1 diabetes and may increase vulnerability to the development of DEB. Dietary limitation helps in maintaining body weight within normal range; on the other hand, this limitation could change into restriction, becoming a risk factor for the onset of DEB. In this context, other nondiabetes related factors could be involved, such as quality of relationship with parents and peers, and self-concept deficit.

A common feature of patients with type 1 diabetes with DEB is skipping insulin shots as an attempt to lose weight (Araia et al., 2017; Baechle et al., 2014; De Paoli & Rogers, 2017; Saßmann et al., 2015). Since the definition of insulin restrictors was based both on reporting by the patients and on clinical evaluation, few of them classified as restrictors were found in our study. Therefore, by not declaring skipped insulin shots some patients, who should have been included as insulin restrictors, could have been excluded. Nevertheless, when the number of skipped shots was evaluated in the multiple logistic analysis, an independent effect on the probability of having DEB was found, suggesting the importance of regularly inquiring about missed insulin injections in clinical practice.

Children and adolescents with type 1 diabetes generally spend less time in physical activities than their peers without diabetes (Maggio et al., 2010; Valerio et al., 2007). This behavior may be connected with a fear of hypoglycemia, which can be avoided by following basic recommendations, including insulin dose adjustment, frequent glucose monitoring, and careful management of food intake before, during, and after physical activity. These recommendations might represent a burden that limits youth with diabetes spending time in physical exercise and sports. We found that adolescents with DEB spent less than half the time in physical exercise than peers without DEB, suggesting a potentially protective role of physical activity on DEB, for which further studies are warranted.

Our study has some limitations. Firstly, it is not a longitudinal study, so does not allow estimation of the age at onset of eating disorders. Moreover, DEPS-R includes items that do not describe eating disorder behaviors but rather attitudes toward diabetes management and weight. However, it is an accepted screening tool for DEB in adolescents with diabetes that is easy to use in clinical practice. The level of precision of estimates was not very high, above all when analyzing the effect of factors associated with DEPS-R. Nevertheless, the sample size was adequate to validate the questionnaire in the Italian language. Furthermore, this study represents a part of the DEPS-R validation process, since we were not able to estimate its sensitivity and specificity. For this reason, a study aimed at confirming the validity of DEPS-R is ongoing within the Italian Society for Pediatric Endocrinology and Diabetes (ISPED), to involve all Italian Centers for type 1 diabetes.

This study has a number of strengths. It is a population-based study, including adolescents recruited from the regional registry for diabetes. To the best of our knowledge, it has the highest participation rate of similar studies. Moreover, the use of electronic medical records increases the accuracy of diabetes-related data.

This is the first Italian study providing estimates of DEPS-R $\geq$ 20 prevalence in both genders. Moreover, the validation of the DEPS-R questionnaire in the Italian language allows the comparison of our results with those of other countries. Additionally, many factors have been analyzed, including sociodemographic and clinical features, identifying the profile of the adolescent with type 1 diabetes positive for DEB screening.

In summary, our study suggests that skipping insulin shots and spending little time engaging in physical activity, having elevated BMI and a low family profile of education and occupation should be considered a warning sign for DEB in preteen and adolescents with type 1 diabetes. Intervention should be made to promote physical activity, using sensitivity and caution so as not to unintentionally promote or worsen DEB. Such interventions should also take into consideration challenges related to obesity and disadvantaged socioeconomic conditions.

ACKNOWLEDGMENTS

We thank Ray Hill and Melanie Gatt (PhD), independent medical writers, acting on behalf of Springer Healthcare Communications, who provided English-language editing and journal styling prior to submission. This support was funded by A.F.A.I.D. Marche Onlus (Associazione Famiglie con Adolescenti e Infanti con Diabete della Regione Marche).

CONFLICT OF INTEREST

The authors declare no competing financial interests.

ORCID

Rosaria Gesuita PhD http://orcid.org/0000-0002-6943-0602

REFERENCES

Ackard, D. M., Vik, N., Neumark-Sztainer, D., Schmitz, K. H., Hannan, P., & Jacobs, D. R. Jr. (2008). Disordered eating and body dissatisfaction in adolescents with type 1 diabetes and a population-based comparison sample: Comparative prevalence and clinical implications. *Pediatric Diabetes*, *9*(4pt1), 312–319. https://doi.org/10.1111/j.1399-5448.2008.00392.x

Araia, E., Hendrieckx, C., Skinner, T., Pouwer, F., Speight, J., & King, R. M. (2017). Gender differences in disordered eating behaviors and body dissatisfaction among adolescents with type 1 diabetes: Results from diabetes MILES youth-Australia. *International Journal of Eating Disorders*, *50*(10), 1183–1193. https://doi.org/10.1002/eat.22746

Baechle, C., Castillo, K., Straßburger, K., Stahl-Pehe, A., Meissner, T., Holl, R. W., … Rosenbauer, J. (2014). Is disordered eating behavior more prevalent in adolescents with early-onset type 1 diabetes than in their representative peers? *International Journal of Eating Disorders*, *47*(4), 342–352. https://doi.org/10.1002/eat.22238

Benzecri, J. P. (1973). *L'analyse des donnees. Tome 1: La taxinomie. Tome 2: L'analyse des correspondances*. Paris, France: Dunod.

Cacciari, E., Milani, S., Balsamo, A., Spada, E., Bona, G., Cavallo, L., … Cicognani, A. (2006). Italian cross-sectional growth charts for height, weight and BMI (2 to 20 yr). *Journal of Endocrinological Investigation*, *29*(7), 581–593. https://doi.org/10.1007/BF03344156

Carle, F., Gesuita, R., Bruno, G., Coppa, G. V., Falorni, A., Lorini, R., … Group, R. S. (2004). Diabetes incidence in 0- to 14-year age-group in Italy: A 10-year prospective study. *Diabetes Care*, *27*(12), 2790–2796.

Colton, P., Olmsted, M., Daneman, D., Rydall, A., & Rodin, G. (2004). Disturbed eating behavior and eating disorders in preteen and early teenage girls with type 1 diabetes: A case-controlled study. *Diabetes Care*, *27*(7), 1654–1659.

Colton, P. A., Olmsted, M. P., Daneman, D., Farquhar, J. C., Wong, H., Muskat, S., & Rodin, G. M. (2015). Eating disorders in girls and women with type 1 diabetes: A longitudinal study of prevalence, onset, remission, and recurrence. *Diabetes Care*, *38*(7), 1212–1217. https://doi.org/10.2337/dc14-2646

Colton, P. A., Olmsted, M. P., Daneman, D., Rydall, A. C., & Rodin, G. M. (2007). Five-year prevalence and persistence of disturbed eating behavior and eating disorders in girls with type 1 diabetes. *Diabetes Care*, *30*(11), 2861–2862. https://doi.org/10.2337/dc07-1057

Cooper, M. N., Lin, A., Alvares, G. A., de Klerk, N. H., Jones, T. W., & Davis, E. A. (2017). Psychiatric disorders during early adulthood in those with childhood onset type 1 diabetes: Rates and clinical risk factors from population-based follow-up. *Pediatric Diabetes*, *18*(7), 599–606. https://doi.org/10.1111/pedi.12469

De Paoli, T., & Rogers, P. J. (2017). Disordered eating and insulin restriction in type 1 diabetes: A systematic review and testable model. *Eating Disorders*, *28*, 1–18. https://doi.org/10.1080/10640266.2017.1405651

Doyle, E. A., Quinn, S. M., Ambrosino, J. M., Weyman, K., Tamborlane, W. V., & Jastreboff, A. M. (2017). Disordered eating behaviors in emerging adults with type 1 diabetes: A common problem for both men and women. *Journal of Pediatric Health Care*, *31*(3), 327–333. https://doi.org/10.1016/j.pedhc.2016.10.004

Gesuita, R., Skrami, E., Bonfanti, R., Cipriano, P., Ferrito, L., Frongia, P., … Cherubini, V. (2017). The role of socio-economic and clinical factors on HbA1c in children and adolescents with type 1 diabetes: An Italian multicentre survey. *Pediatric Diabetes*, *18*(3), 241–248. https://doi.org/10.1111/pedi.12378

Goebel-Fabbri, A. E., Fikkan, J., Franko, D. L., Pearson, K., Anderson, B. J., & Weinger, K. (2008). Insulin restriction and associated morbidity and mortality in women with type 1 diabetes. *Diabetes Care*, *31*(3), 415–419. https://doi.org/10.2337/dc07-2026

Hanlan, M. E., Griffith, J., Patel, N., & Jaser, S. S. (2013). Eating disorders and disordered eating in type 1 diabetes: Prevalence, screening, and treatment options. *Current Diabetes Reports*, *13*(6), 909–916. https://doi.org/10.1007/s11892-013-0418-4

ISTAT Classificazione delle professioni (2013). Retrieved from https://www.istat.it/it/archivio/18132

Jones, J. M., Lawson, M. L., Daneman, D., Olmsted, M. P., & Rodin, G. (2000). Eating disorders in adolescent females with and without type 1 diabetes: Cross sectional study. *British Medical Journal*, *320*(7249), 1563–1566.

Maggio, A. B., Hofer, M. F., Martin, X. E., Marchand, L. M., Beghetti, M., & Farpour-Lambert, N. J. (2010). Reduced physical activity level and cardiorespiratory fitness in children with chronic diseases. *European Journal of Pediatrics*, *169*(10), 1187–1193. https://doi.org/10.1007/s00431-010-1199-2

Markowitz, J. T., Butler, D. A., Volkening, L. K., Antisdel, J. E., Anderson, B. J., & Laffel, L. M. (2010). 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*, *33*(3), 495–500. https://doi.org/10.2337/dc09-1890

Morgan, J. F., Reid, F., & Lacey, H. (1999). The SCOFF questionnaire: Assessment of a new screening tool for eating disorders. *British Medical Journal*, *319*(7223), 1467–1468.

Neumark-Sztainer, D., Patterson, J., Mellin, A., Ackard, D. M., Utter, J., Story, M., & Sockalosky, J. (2002). Weight control practices and disordered eating behaviors among adolescent females and males with type 1 diabetes: Associations with sociodemographics, weight concerns, familial factors, and metabolic outcomes. *Diabetes Care*, *25*(8), 1289–1296.

Nielsen, S. (2002). Eating disorders in females with type 1 diabetes: An update of a meta-analysis. *European Eating Disorders Review*, *10*(4), 241–254.

Nielsen, S., Emborg, C., & Molbak, A. G. (2002). Mortality in concurrent type 1 diabetes and anorexia nervosa. *Diabetes Care*, *25*(2), 309–312.

Olmsted, M. P., Colton, P. A., Daneman, D., Rydall, A. C., & Rodin, G. M. (2008). Prediction of the onset of disturbed eating behavior in adolescent girls with type 1 diabetes. *Diabetes Care*, *31*(10), 1978–1982. https://doi.org/10.2337/dc08-0333

Peterson, C. M., Fischer, S., & Young-Hyman, D. (2015). Topical review: A comprehensive risk model for disordered eating in youth with type 1 diabetes. *Journal of Pediatric Psychology*, *40*(4), 385–390. https://doi.org/10.1093/jpepsy/jsu106

Peveler, R. C., Bryden, K. S., Neil, H. A., Fairburn, C. G., Mayou, R. A., Dunger, D. B., & Turner, H. M. (2005). The relationship of disordered eating habits and attitudes to clinical outcomes in young adult females with type 1 diabetes. *Diabetes Care*, *28*(1), 84–88.

Pinna, F., Diana, E., Sanna, L., Deiana, V., Manchia, M., Nicotra, E., … Carpiniello, B. (2017). 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*, *17*(1), 262. https://doi.org/10.1186/s12888-017-1434-8

R Core Team (2016). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/.

Saßmann, H., Albrecht, C., Busse-Widmann, P., Hevelke, L. K., Kranz, J., Markowitz, J. T., … Lange, K. (2015). Psychometric properties of the German version of the Diabetes Eating Problem Survey-Revised: Additional benefit of disease-specific screening in adolescents with type 1 diabetes. *Diabetic Medicine*, *32*(12), 1641–1647. https://doi.org/10.1111/dme.12788

Scheuing, N., Bartus, B., Berger, G., Haberland, H., Icks, A., Knauth, B., … DPV Initiative; German BMBF Competence Network Diabetes Melitus (2014). Clinical characteristics and outcome of 467 patients with a clinically recognized eating disorder identified among 52,215 patients with type 1 diabetes: A multicenter German/Austrian study. *Diabetes Care*, *37*(6), 1581–1589. https://doi.org/10.2337/dc13-2156

Tamborlane, W. V., Kollman, C., Steffes, M. W., Ruedy, K. J., Dongyuan, X., Beck, R. W., … Diabetes Research in Children Network Study Group (2005). Comparison of fingerstick hemoglobin A1c levels assayed by DCA 2000 with the DCCT/EDIC central laboratory assay: Results of a Diabetes Research in Children Network (DirecNet) Study. *Pediatric Diabetes*, *6*(1), 13–16. https://doi.org/10.1111/j.1399-543X.2005.00088.x

Tamir, I., Heiss, G., Glueck, C. J., Christensen, B., Kwiterovich, P., & Rifkind, B. M. (1981). Lipid and lipoprotein distributions in white children ages 6–19 yr. The lipid research clinics program prevalence study. *Journal of Chronic Diseases*, *34*(1), 27–39.

Tse, J., Nansel, T. R., Haynie, D. L., Mehta, S. N., & Laffel, L. M. (2012). Disordered eating behaviors are associated with poorer diet quality in adolescents with type 1 diabetes. *Journal of Academic Nutrition & Dietetics*, *112*(11), 1810–1814. https://doi.org/10.1016/j.jand.2012.06.359

Valerio, G., Spagnuolo, M. I., Lombardi, F., Spadaro, R., Siano, M., & Franzese, A. (2007). Physical activity and sports participation in children and adolescents with type 1 diabetes mellitus. *Nutrition, Metabolism, & Cardiovascular Diseases*, *17*(5), 376–382. https://doi.org/10.1016/j.numecd.2005.10.012

Wisting, L., Froisland, D. H., Skrivarhaug, T., Dahl-Jorgensen, K., & Ro, O. (2013a). Disturbed eating behavior and omission of insulin in adolescents receiving intensified insulin treatment: A nationwide population-based study. *Diabetes Care*, *36*(11), 3382–3387. https://doi.org/10.2337/dc13-0431

Wisting, L., Froisland, D. H., Skrivarhaug, T., Dahl-Jorgensen, K., & Ro, O. (2013b). Psychometric properties, norms, and factor structure of the diabetes eating problem survey-revised in a large sample of children and adolescents with type 1 diabetes. *Diabetes Care*, *36*(8), 2198–2202. https://doi.org/10.2337/dc12-2282

Young, V., Eiser, C., Johnson, B., Brierley, S., Epton, T., Elliott, J., & Heller, S. (2013). Eating problems in adolescents with type 1 diabetes: A systematic review with meta-analysis. *Diabetic Medicine*, *30*(2), 189–198. https://doi.org/10.1111/j.1464-5491.2012.03771.x

How to cite this article: 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;00:1–9. https://doi.org/10.1002/eat.22889