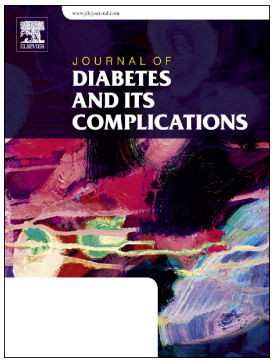


# Screening and identification of disordered eating in people with type 1 diabetes: A systematic review

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**Summary**

People with Type 1 diabetes (T1D) have been shown to be an at-risk group for the development of disordered eating behaviours, however, the validity of tools used to assess disordered eating behaviours in T1D is unclear. This review aimed to identify tools used to screen or identify disordered eating behaviours and eating disorders in people with T1D, and evaluate the validity and reliability of these tools. A systematic search strategy was conducted to October 2019 according to the PRISMA guidelines. The search strategy retrieved 3350 articles, with 100 articles describing 90 studies included in the review. Studies were predominantly conducted in adolescent females in clinical settings. Forty-eight individual tools were used across retrieved studies. Overall, the quality of tools reported in included articles was poor, with high risk of bias due to the use of non-validated tools (*n*=44 articles) and few studies comparing to the reference standard (*n*=10 articles) of a diagnostic interview. This review shows that a variety of tools have been used to screen and identify disordered eating behaviours and eating disorders in people with T1D. Future research including comparison to a gold standard diagnostic interview is warranted to further evaluate the validity and reliability of available tools.

**Keywords:** Eating Disorders, Type 1 diabetes, Disordered eating, Screening, Systematic review

## 1.0 Introduction

Eating disorders (ED) are complex mental health disorders that have one of the highest mortality and suicide rates of any mental illness [1, 2]. Eating disorders diagnosed according to the Diagnostic and Statistical Manual of Mental Disorders (DSM), as well as disordered eating behaviours, which do not meet thresholds for a DSM diagnosable eating disorder, have been shown to be significantly higher in people with Type 1 Diabetes (T1D) than their non-diabetic peers [3]. This may be attributable to several factors including the focus on diet and glycaemia, the increased emphasis on maintaining a healthy weight, risk of insulin-related weight gain and associated body dissatisfaction [4, 5]. In a recent meta-analysis, 7% of adolescents with T1D were classified as having a diagnosable eating disorder, compared to 2.8% of those without diabetes [3]. Moreover, the reported prevalence of sub-clinical disordered eating behaviours in T1D is up to 40% [3]. Insulin omission is a unique disordered eating behaviour in T1D, making it possible for weight control without the need for dietary restriction [6]. Eating disorders and disordered eating behaviour in T1D pose additional risks for early morbidity and mortality including diabetic ketoacidosis, as well as long-term complications such as retinopathy and neuropathy [7]. Given these serious complications, the secrecy associated with disordered eating behaviour and ubiquity of disordered eating and eating disorders in T1D, there is a need for consistent, early detection through routine screening in people with T1D.

A range of screening and assessment methods have been used to identify disordered eating and eating disorders in people with diabetes. However, the appropriateness and validity of these tools for use in individuals with T1D has been questioned [8], with items used to screen for disordered eating in the general population considered important management strategies in T1D due to the need for an increased focus on food [9]. Current guidelines suggest screening for disordered eating behaviour in people with T1D [10], however, evidence regarding the most valid and reliable tools to use across different age groups and different settings (e.g. primary versus tertiary care) is required. Identification of the most appropriate tools to screen for disordered eating and eating disorders in T1D is important given that timely identification and appropriate care provision may reduce morbidity and mortality and improve treatment outcomes (12).

Published reviews to date have assessed the prevalence of diagnosable eating disorders and disordered eating behaviours in T1D [3, 6]. While the psychometric properties of tools have been narratively reviewed [8] and implications of measurement tools according to diabetes-specific compared to general screening tools have been acknowledged [3], there is a paucity of systematic reviews to evaluate the validity and reliability of tools used to identify disordered eating behaviour and eating disorders in people with diabetes across the lifespan. Systematic evaluation of the validity and reliability of tools to screen and identify eating disorders and disordered eating behaviours in T1D in clinical practice is important and may inform future guidelines for standardised screening and assessment in this population. Further, reliable estimates of the extent of

disordered eating behaviours and eating disorders in T1D are needed to inform future interventions. Therefore, the aims of this review are to *(i)* identify all tools that have been used to screen or identify disordered eating behaviours and eating disorders in people with T1D; *(ii)* evaluate the validity and reliability of tools from those studies reporting detailed validation data; and *(iii)* explore the reported clinical utility of existing tools and discuss implications for clinical practice.

## 2.0 Methods

### *2.1 Search strategy*

A systematic search strategy was conducted up to May 2018, and an updated search conducted up to October 2019. Databases that were searched included MEDLINE, Embase, Web of Science, Scopus, PsycINFO, CINAHL, Cochrane Library, Proquest Nursing and Allied Health. The search strategy included the use of terms in three broad categories: *(i)* Type 1 diabetes, *(ii)* eating disorders or disordered eating behaviour and *(iii)* psychometric properties of tools. Key words used during the search included: diabetes mellitus, insulin dependent diabetes, type 1 diabetes, type 2 diabetes, gestational diabetes, feeding and eating disorders, eating disorder, restrictive eating, eating psychopathology, diabulimia, insulin omission, insulin misuse, body dysmorphic disorder, muscle dysmorphia, purge, vomit, laxative, binge, survey, questionnaire, tool, screen, validity, reliability, reproducibility, sensitivity, specificity, psychometrics, predictive value, decision support, likelihood, decision analysis, post-test probability, assessment, identification, clinical utility. A search of the grey literature was also conducted to identify any further relevant publications using Dissertations & Theses, Mednar, OpenGrey, and World Wide Sciences. The search was restricted to human studies and those published in the English language. While this review focuses on T1D, the search terms Type 2 diabetes and gestational diabetes were included in the search strategy to identify potentially mixed samples that reported eating disorder outcomes related to T1D. The search strategy was registered using Prospero (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=87046).

### *2.2 Inclusion criteria*

Titles and abstracts were screened by two independent reviewers. Following screening, full text articles were retrieved and assessed for inclusion in the review by the two independent reviewers. Studies were included if they used a tool to screen for or identify disordered eating behaviours or eating disorders in males and females aged ≥ 5 years with T1D, and reported outcomes of the tool. Studies were excluded if they reported on children < 5 years of age, did not use a screening or assessment tool, or did not report outcomes associated with the tool (e.g. prevalence of disordered eating behaviour or eating disorders, validity of tool). Two studies with >90% T1D participants were included [11, 12]. All study types were considered for inclusion in

the review including case studies. In any cases of uncertainty regarding the inclusion of a study in the review, a third independent reviewer was consulted until consensus was reached.

*2.3 Data extraction*

A data extraction table was developed specifically for the study, with data extracted by one reviewer and checked for accuracy by a second reviewer. Data that were extracted included: sample characteristics, tool characteristics and scoring, psychometric properties of tools, prevalence of disordered eating behaviour or eating disorders, clinical utility, and study limitations. Clinical utility as reported in the articles was evaluated using the criteria proposed by Smart and colleagues [13] including details of appropriateness, accessibility, practicability and acceptability. As previous reviews have comprehensively synthesised prevalence of disordered eating in T1D [3], this was not a primary focus of the current review and is not discussed in detail.

*2.4 Risk of bias*

Risk of bias of individual articles was assessed using the standardised tool, QUADAS-2 [14], by two independent reviewers. The QUADAS-2 tool assesses risk of bias in four key domains including patient selection, conduct and interpretation of the index test, comparison to a reference standard and patient flow and timing. Each of these criteria was classified as high risk of bias, low risk of bias, or unclear if there was insufficient information in the article to make an assessment. If there were any discrepancies in the quality assessment between the two reviewers, a third independent reviewer was consulted. Studies were not excluded from the review based on their assessed quality.

*2.5 Data synthesis*

Study characteristics were synthesised descriptively, with articles reporting validation data grouped by tool for analysis. To evaluate the validity and reliability reported in retrieved articles, the following criteria were used. For test-retest reliability, intraclass correlation coefficients (ICC) or Kappa >0.70 was considered acceptable, 0.60-0.69 was considered borderline, and unacceptable if <0.60. Pearson's correlation or Spearman's rank of >0.80 was considered acceptable, while >0.70 was considered borderline for test-retest reliability. Intra-rater and inter-rater reliability were considered acceptable if ICC or Kappa was above 0.70. Internal reliability ≥0.90 was considered excellent, ≥0.80- 0.89 considered good, ≥0.70- 0.79 acceptable, ≥0.60- 0.69 questionable, ≥0.50- 0.59 poor, and <0.50 unacceptable. Concurrent validity was evaluated using the extent to which results were consistent with other existing measures; criterion validity was evaluated via the relationship between results of the tool being assessed and the recognised measure or gold standard, such as a structured clinical interview or Eating Disorders Examination [15, 16]; and content validity was evaluated using the degree to which the content of an instrument adequately reflected the aspects of the outcome of interest (disordered eating). Validity was classified according to the area under the Receiver

Operating Characteristic (ROC) curve, with <0.5 classified as not useful, 0.5-0.6 as poor, 0.6-0.7 as sufficient, 0.7-0.8 as good, 0.8-0.9 as very good and 0.9-1.0 as excellent.

## 3.0 Results

The original search strategy retrieved 2461 articles and the updated search retrieved 253 articles. Following screening, 100 articles describing 90 studies up to October 2019 were included in the review (PRISMA Figure 1) [10-12, 17-113].

### *3.1 Descriptive synthesis of studies*

Study characteristics are reported in Table 1. A total of 33,526 participants were included across studies ranging from 14 to 9883 participants in individual studies. Fifty-eight studies were conducted in adolescents, 28 conducted in adults (18 years and older), one in children (<12 years), seven in a sample comprising both adolescents and adults, and six in a sample comprising both children and adolescents. Twenty-nine studies were conducted in females only and 70 in both males and females, while no studies were conducted in males exclusively. The majority of studies were cross sectional in design (n=65), while only four studies were randomised controlled trials. Studies were predominantly conducted in clinical settings (n=75), while fourteen studies were conducted in community-based settings. Only thirteen studies included follow up measures, with follow up duration ranging from six weeks to eleven years. Prevalence of disordered eating in the T1D samples is reported in Table 1. Briefly, the prevalence of disordered eating and eating disorders varied across studies, which may be due to the range of tools used, however, generally disordered eating behaviours were greater in those with T1D than the general population and females compared to males. No clear trends were observed according to age.

Descriptions of tools used to screen or identify disordered eating in people with T1D are reported in Table 1 and reported validity in Table 2. Forty-eight individual tools were used to screen or identify disordered eating or eating disorders across studies, and thirteen of these tools were modified versions of pre-existing tools for the general population to be specific to T1D [11, 18, 29, 41, 47, 48, 55, 56, 59, 81, 82, 113]. Only five of the 48 tools reported detailed validation data other than internal consistency. Tools that have reported detailed validation data (Diabetes Eating Problems Survey – Revised, Modified SCOFF, Eating Disorder Inventory – 3 Risk Composite, Youth Eating Disorders Examination Questionnaire, and the Screen for Early Eating Disorder Signs) are described below.

### *3.2 Risk of bias*

Risk of bias across all included articles is reported in Figure 2. Six of the 101 studies were deemed to be high risk due to the recruitment methods used in the studies [17, 57-59, 66, 73], while risk of bias in patient selection was

deemed unclear in fourteen studies due to a lack of adequate information regarding recruitment and sample characteristics [18, 20, 27, 29, 37, 40, 41, 50, 51, 60, 76, 89, 98]. There was deemed to be a high risk of bias for the index test in approximately half of the included studies (n=44) due to the use of non-validated tools for T1D [20, 22-27, 36-40, 42-46, 49, 51, 54, 60-62, 70-75, 78, 80, 83, 84, 87-91, 93, 94, 97, 101, 108]. In addition, the risk of bias of the index test in thirteen of the 100 studies [11, 18, 29, 41, 47, 48, 55, 56, 59, 81, 82, 113] was deemed unclear as the articles reported modifications of eating disorder tools designed for the general population to be specific to T1D, however, there were no details of the validation of the tools following these modifications. Modifications included the addition of diabetes-specific questions, such as insulin omission, and deletion of questions that may be affected by diabetes-specific management (e.g. food preoccupation question). Across studies, comparison to a reference tool was generally not conducted, with only ten studies [12, 29, 31, 53, 60, 78-80, 94, 98] comparing to a reference standard such as clinical interview, while five were deemed unclear [36, 38, 40, 49, 56].

*3.3 Tool validity of those studies reporting detailed validation data*

*3.3.1 Diabetes Eating Problems Survey-Revised (DEPS-R)*

Twenty-seven studies used the Diabetes Eating Problem Survey-Revised (DEPS-R) and eight of these reported detailed validation data [12, 19, 63, 85, 86, 95, 96, 103]. The DEPS-R is a 16-item tool that assesses general and diabetes-specific disordered eating behaviours including weight loss, food restriction, insulin misuse and vomiting [63]. The DEPS-R is scored on a six-point Likert scale ranging from never to always, with higher scores indicating the presence of more disordered eating behaviours. Detailed validation data for the DEPS-R tool is described in Table 2.

The English version of the DEPS-R has been shown to have satisfactory internal consistency in male and female adolescents [63]. Construct validity was demonstrated in female adolescents with positive correlations with body mass index z-score (BMIz), age and glycated haemoglobin (HbA1c); and negative correlations with blood glucose monitoring and quality of life (QoL) in female adolescents [63]. External validity was demonstrated in adolescents with correlations between DEPS-R scores and HbA1c and clinician reported insulin restriction [63]. The English version was found to have low specificity when compared to diagnostic interview, however, not all participants who were offered an interview participated, which may mean this value was falsely low [109].

The Norwegian version of the DEPS-R has shown good internal and good convergent validity with correlations with the Eating Attitudes Test (EAT-12) and BMIz scores in males and females aged 11-19 years [95, 96]. The Turkish version of the DEPS-R has shown good internal consistency and demonstrated criterion validity using HbA1c and BMI in males and females aged 9-18 years [19]. The Italian version of the DEPS-R has demonstrated high incremental validity in predicting eating disorder diagnosis when compared to a gold standard structured diagnostic clinical interview, substantial stability, a high degree of reproducibility, good

internal consistency and concurrent validity with significant correlations between the DEPS-R scores and the Eating Disorders Inventory (EDI), BMI, HbA1c in males and females aged 15-55 years [12] and construct, discriminant and external validity were supported in adolescents [103]. The Spanish translation of the DEPS-R displayed good internal consistency, excellent stability, and good agreement with the original DEPS tool in males and females aged 18-56 years [85]. In addition, content validity was confirmed by experts, construct validity was supported and there was good discriminate validity between genders for both tools. The German version of the DEPS-R demonstrated good internal consistency, construct validity with correlations with SCOFF and Eating Disorders Examination Questionnaire (EDE-Q) tools in males and females aged 11-19 years. Criterion validity was also confirmed using HbA1c, BMI and expert clinician report.

*3.3.2 SCOFF Questionnaire (Modified Version; mSCOFF)*

Two studies used a modified version of the SCOFF questionnaire (mSCOFF) and one reported validation data [98]. The original SCOFF tool is a five-item screening tool for disordered eating that has been validated in the general population [114]. Scores ≥2 on the SCOFF warrant further assessment for disordered eating. Validation data for the mSCOFF for T1D is reported in Table 2. Zuijdwijk et al. assessed the validity of the mSCOFF for T1D by replacing the food preoccupation question, which may be affected by diabetes management, with a question regarding insulin restriction [98]. When scoring was set to ≥2 positive answers, the sensitivity of the mSCOFF was 30%, specificity 100%, positive predictive value 100% and negative predictive value 83% compared to the modified Eating Disorder Inventory (mEDI) in adolescent females in a clinical setting. When scoring was set to ≥1 positive answer, the sensitivity of the mSCOFF was 80%, specificity 90% and positive predictive value 75% and negative predictive value 97% compared to the mEDI. Agreement between the mSCOFF and mEDI was borderline for ≥1 positive answer and unacceptable for ≥2 positive answers.

*3.3.3 Eating Disorders Inventory – 3 Risk Composite (EDI-3RC)*

Four studies used the Eating Disorders Inventory – 3 Risk Composite (EDI-3RC) and two reported validation data [31, 32]. The EDI-3RC is a 25-item tool that takes approximately five minutes to complete [115]. The tool uses ratings from Always to Never to assess the traits associated with eating disorders. The EDI-3RC includes three subscales relevant to diabetes – Body dissatisfaction, Drive for thinness, and Bulimia. The tool was modified for T1D by d'Emden et al. to include insulin misuse, with the original scoring of the tool retained [31, 32]. D'Emden et al. reported acceptable to excellent internal consistency for the EDI-3RC in adolescent boys and girls, which remained significant when analysed by sex and age [31, 32] (Table 2). When items related to diabetes management (item 7) were removed, internal consistency remained high. The tool demonstrated high concurrent validity, with significant bivariate correlations between the EDI risk composite score and the

child EDE subscales and global score, which remained significant for females and younger and older age groups [31, 32].

*3.3.4 Youth Eating Disorders Examination Questionnaire (YEDEQ)*

Two studies used the Youth Eating Disorders Questionnaire (YEDEQ) and reported validation data [31, 32]. The YEDEQ is the adolescent version of the EDE-Q and consists of 45-items assessing problematic eating behaviours over the past month [116]. The tool includes four subscales (Eating concern, Restraint, Shape Concern, Weight concern) as well as a global score. To modify the tool for a T1D population, questions regarding insulin misuse for the purpose of weight control were added by d'Emden et al., however, the original scoring of the YEDEQ was retained [31, 32]. D'Emden reported acceptable to excellent internal reliability of the YEDEQ subscales in adolescent males and females, which were retained when analysed according to sex and age [31, 32] (Table 2). When questions related to diabetes were excluded (items 1 and 5), internal consistency remained high. The YEDEQ demonstrated concurrent validity with significant intraclass correlations with the Child Eating Disorders Examination (chEDE) interview. These correlations remained significant for girls and by age, while correlations for boys were less consistent [31, 32].

*3.3.5 Screen for Early Eating Disorder Signs (SEEDS)*

One study used the Screen for Early Eating Disorder Signs (SEEDS) and reported validation data [76]. SEEDS is a 20-item tool that takes up to five minutes to complete that was developed to identify disordered eating in people with T1D [76]. Each item is scored on a seven-point Likert scale, with participants classified as having a probable eating disorder according to the DSM-5, a possible subthreshold eating disorder or no eating disorder. Powers et al. reported sound internal reliability for the SEEDS tool, high convergent validity with the Diabetes Distress Screening Scale, EDE-Q, and Rosenberg Self Esteem Scale in adolescent boy and girls [76]. Divergent validity was appropriately poor with values conceptually unrelated to the SEEDS tool (Table 2).

*3.4 Clinical Utility*

Information regarding clinical utility was reported in thirteen of the 100 studies only (using n=9 of the 48 tools) [12, 26, 31, 32, 63, 76, 82, 85, 95, 96, 98, 109, 111]. Information reported related to practicality of use including time required to complete the questionnaire and ease of use (Table 1). Reported time to complete tools ranged from 2-20 minutes [31, 32, 76]. Detailed information regarding accessibility, appropriateness and acceptability was not clearly reported in the retrieved manuscripts.

## 4.0 Discussion

To the authors' knowledge, this is the first systematic review to identify the tools used to screen or identify disordered eating in T1D, and to evaluate the validity and reliability of published tools. This review found

that there were 48 tools used across 100 studies with few tools (n=5) reporting detailed validation data. Many studies used non-validated tools for T1D (n=42) and only ten studies reported comparing the tool to a standardised clinical interview. In addition, risk of bias was unclear in a number of studies (n=13), as they reported modifying tools to be specific to T1D, however, did not test the validity of the modified tools. The variation in tools used across studies may contribute to discrepancies in the clinical identification of disordered eating behaviours in people with T1D and estimates in prevalence in the literature.

As shown in Tables 1 and 2, a range of tools have been used in adolescent samples; however, only five tools reported detailed validation data. In these studies, the DEPS-R was the most widely validated tool in adolescents with T1D, with high internal reliability, concurrent, criterion and convergent validity. The Italian translation of the DEPS-R was compared to a gold standard diagnostic interview; however, this requires replication in other languages. The English version was found to have low specificity, but this may be falsely low as only half of those offered an interview participated [109]. While the DEPS-R has been recommended for screening children with T1D from 10-12 years of age [10], further validation of the sensitivity and specificity of the tool via comparison against a gold standard clinical interview is warranted across a range of clinical settings and populations (e.g. different ages and ethnicities) to ensure the accurate clinical identification of these behaviours and appropriate referral to treatment pathways. With respect to other tools, the YEDE has demonstrated concurrent validity compared to a diagnostic interview and the EDI-3RC has been recommended for screening adolescents [8], however, further validation across broader demographic groups is recommended for these tools.

While disordered eating incidence has been reported to peak in adolescents aged 14-19 years [117], it can occur at any age and it is therefore important to screen across all age groups. Fewer studies reported detailed validation data for tools used in adult samples with T1D and these focused on the DEPS-R (Italian and Spanish versions) [12, 85]. In these studies, the DEPS-R demonstrated high internal reliability, high incremental validity, concurrent validity, content validity and substantial stability in adults aged up to 56 years [12, 85]; however comparison to a diagnostic interview is recommended in future research. The modified SCOFF for T1D has been recommended as a first step screening questionnaire for young adults in clinical practice [118], however, the primary validation of this tool was conducted in adolescents [98]. The validity of the tool for use in adult populations needs further exploration because of the developmental differences between adult and adolescent age groups. Further validation of the mSCOFF across broader adult samples would also be helpful to further inform the most appropriate tool for use in routine practice.

There was a trend towards greater disordered eating behaviours in those with T1D, which is consistent with previous reviews [119]. There was also a trend towards eating disorder symptoms being higher in female compared to males with T1D, however, it should be acknowledged that there was an overrepresentation of females across the included studies. The overrepresentation of females may be attributable to the higher

prevalence of disordered eating behaviours in females and convenience sampling across studies. Tool validity is therefore less clear in male T1D samples. Generally, there is a gender bias across eating disorder measures with measures frequently developed, used and evaluated in female participants. In addition, often tools are focused on eating disorder symptoms more frequently reported among females compared to males (e.g. drive for thinness). This is mirrored in the measures for people with T1D, with few studies including measures that may be more central to males, such as drive for muscularity. In addition, the majority of studies were cross-sectional in nature, which precludes inferences about cause and effect. This should be taken into consideration when interpreting the results. Further limitations of existing tools include the lack of incorporation of clinical indicators and technologies for T1D. Given the complexity of the condition, it is important to combine screening measures in a holistic framework alongside clinical indicators such as blood glucose levels, HbA1c and changes in these indicators over time. Future directions for the field include the development and implementation of clinical frameworks or processes incorporating both psychometrically sound screening tools as well as clinical indicators.

As most studies included in the review only used a self-reported screening tool, the reported prevalence of disordered eating may be inflated compared to those using a two-stage design including a diagnostic interview. The use of diagnostic interviews requires experienced clinicians who have a thorough understanding of both T1D and eating disorders to appropriately target the interview questions. It is imperative that the interviewer is knowledgeable regarding how the diagnosis and management of T1D affects eating behaviour, food and food choices. It is also important that the interviewer understands the cognitive changes present in clinical and sub-clinical disordered eating. By having a comprehensive understanding of the dual diagnosis in combination with clinical indicators, the interview may be framed to inform appropriate diagnosis. Collaboration between T1D and eating disorder clinicians is essential to ensure appropriate diagnosis and access to treatment pathways.

In order to improve the sensitivity and specificity of tools to detect disordered eating in T1D further research is recommended to evaluate this compared to a gold standard diagnostic interview. Screening tests should be highly sensitive to ensure people with T1D with disordered eating are not missed, particularly given the high morbidity and mortality associated with eating disorders [1]. However, this needs to be balanced against the specificity of the tool to minimise false positives. One way of assessing this is the area under the ROC curve, which measures the ability of the test to correctly classify those with or without the disease. Validation such as this is clinically important to ensure disordered eating behaviours are accurately screened as early identification and treatment is associated with more optimal treatment outcomes. This is also important in the research context to accurately determine the risk of disordered eating in people with T1D and inform appropriate intervention or prevention strategies.

Time to complete tools is an important consideration in clinical practice. Thirteen studies discussed time to complete the tools with this varying from 2-20 minutes (see Table 1), however, this was the only aspect of clinical utility assessed across studies. Further information is required regarding the clinical appropriateness, accessibility of the tool, practicalities of using the tool and perceived acceptability of the tool to determine if the tool can be incorporated as part of routine practice or is more suited to the research setting. Future research is also required to inform recommendations regarding timing and frequency of screening in clinical practice. In clinical care a tool that incorporates meal-time behaviours revealed by new technologies such as continuous glucose monitoring would be helpful alongside key questions regarding insulin omission, binge eating, hypoglycaemia treatment and body image perceptions.

This review is limited by the relatively small sample sizes of individual papers, overrepresentation of female adolescent samples and recruitment from clinical settings, which reduces generalisability to other populations. A further limitation is the restriction of the review to T1D only. While disordered eating has been identified in T2D, studies describing this population were not included in the current review due to the different mechanisms, aetiology, and management strategies compared to T1D. Future reviews should consider systematically evaluating tools for disordered eating in T2D. As the majority of studies were cross sectional, future studies should investigate the temporal stability of tools to determine if risk of disordered eating changes over time. Evaluating the stability of tools is also important in the context of interventions to determine if the tool is suitable to assess changes in disordered eating behaviours before and after the implementation of an intervention.

## 5.0 Conclusions

This review has shown that a wide variety of tools have been used to screen and identify disordered eating behaviours and eating disorders in people with T1D. Only five of the 48 tools used across studies reported detailed validation data reported, and risk of bias was unclear in a number of studies (n=13), as they reported modifying tools to be specific to T1D but did not report validity of the modified tools. The variation in tools used across studies may contribute to discrepancies in the clinical identification of disordered eating behaviours and eating disorders in people with T1D. Based on current literature, the DEPS-R appears to be the best validated tool for adolescents and adults, however, future research including comparison to a gold standard diagnostic interview is warranted to further evaluate the validity and reliability of currently available tools across broader demographic samples and settings.

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**Author contributions:** KMP, CS, MH and MM conceptualised the review, KMP and LJ screened articles and extracted data, KMP wrote the original draft and CS, MH, MM and LJ revised and edited the manuscript.

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**Table 1:** Study characteristics of included studies

| Author, year, country | Study design | Participant number | Sample Characteristics | Setting | Tool; modifications; scoring | Clinical utility | Prevalence of disordered eating |
|---|---|---|---|---|---|---|---|
| Altinok, 2017, Turkey [19] | CS | N=200 | Female 55%<br>Mean age: 14 years<br>Mean BMI: SDS 0.64 (1.24)<br>HbA1c 8.05% (range 5.5-15.0); Multiple daily injections (≥4/day) 71.5% & pump 28.5%. | Clinical | **DEPS-R.** Translated into Turkish. Higher scores indicating more disordered eating behaviours & scores ≥20 indicating high risk for eating disorders. | NR | **DEPSR** Median scores Turkish total sample 11.0(0.55), females 11.5 (0-55) and males 10.5 (0-55). NS differences males and females.<br>29.1% females and 17.8% males met cut-off for needing further ED assessment |
| Antisdel, USA, 2000 [20] | CS | N=84<br>(n=54 T1D, n=30PKU) | Female 100%<br>Age 11-21, mean 16 (3)<br>BMI 23 (4) | Summer camp for diabetes or PKU | **Eating Attitudes Test 26** Higher scores indicate greater symptomatology, score ≥20 indicate eating problems<br>**Eating Disorder Inventory** | NR | **EAT** n=18 (33%) respondents with T1D reported symptoms of disordered eating |
| Araia 2017, Australia [21] | CS | N=477 | Adolescents<br>Female 62%<br>Age: 16 (2) years (range 13-19)<br>BMI percentile 0.68 (0.25).<br>Diabetes management : 47% insulin injection, 53% pump; HbA1c 66 (17) | Online survey for people on diabetes registry | **DEPSR** Scores ≥20 require further clinical evaluation.<br>Question from MIND Youth questionnaire to assess binge eating & insulin omission | NR | **DEPSR** mean scores for total sample 18.2 (14.4), females 22.2 (15.1), males 11.4 (10.0) p<.001.<br>38% above cut-off for further assessment. |
| Baechle, 2016, Germany [23] | CS | N=819<br>Response rate 37.5% | 49% female<br>Mean age 16.3 (2.3)<br>BMI female 22.9 (3.6), male 21.4 (2.9) (p<.001).<br>BMI SDS female 0.51 (0.93), male 0.19 (0.82) (p<.001).<br>Mean HbA1c 8.3(1.4)% ; 92% on intensified insulin treatment | Population based postal questionnaire | **SCOFF,** German version, ≥2 positive answers, ED is likely present<br>Insulin restriction. Self-reported frequency of IR in the previous week. Frequent IR defined as >5 times per week. | NR | **SCOFF** positive, non-insulin restricting - 28.2 (95%CI 23.8, 32.8)% females and 9.2% (95%CI 6.6, 12.4)% males (P<.001).<br>SCOFF negative, insulin restricting - 4.2 (95%CI 2.5, 6.6)% females and 5.3 (95% 3.4,7.9) % males (p=1.0).<br>SCOFF positive, Insulin restricting 2.7 (95%CI 1.4, 4.8) % female and 1.9 (95%CI 0.8, 3.8)% male (p=0.24).<br>SCOFF negative, not insulin restricting 83.6 (95%CI 79.6, 87.0)% males and 64.9 (95% CI 60.1, 69.6)% females |
| Baechle 2015, Germany [22] | CS | N=211<br>28% response rate | Female 60%<br>Mean age 19.4(1.0)<br>Mean HbA1c 8.6(1.7)%.<br>BMI males: normal weight 76.5%; females 69.8% healthy weight.<br>Insulin therapy male MDI 50.6%, continuous infusion 44.7%; females MDI 52.4%, continuous infusion 38.9% | Nationwide population based survey | **SCOFF questionnaire.** ≥2 questions answered yes, ED is suspected. | NR | **SCOFF** positive (≥2 symptoms) males 9.5%, females 30.2% (p<.001). |

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|---|---|---|---|---|---|---|---|
| Battaglia 2006, USA [25] | CS | N=69 | Adolescents<br>Female 100%<br>n=22 CSII group & n=47 MDI group.<br>Age CSII 14.09(1.85), MDI 14.49(1.74)<br>BMI CSII 23.41(3.31), MDI 23.47(3.41).<br>HbA1c CSII 7.84(1.29), MDI 9.11(1.81) (p<.05). | Clinical | **EDI-2 [MODIFIED VERSION]**- One item that could relate to dietary restrictions associated with T1D management excluded. Higher scores indicate more disordered eating<br>**EAT-26-** Higher scores indicate more disordered eating.<br>Two additional questions on IR added | NR | **EDI2 Drive for thinness** CSII 1.77(3.65), MDI 3.83(4.85) (NS). **EDI Bulimia** CSII 0.23(0.53, MDI 1.17(1.96) (NS). **EDI body dissatisfaction** CSII 5.55 (5.81), MDI 7.02 (5.77) (NS).<br>**EAT26 dietary restraint** CSII 3.14(3.45), MDI 4.13(4.45). (NS)<br>No CSII reported IR, 15% MDI reported insulin misuse |
| Bernstein 2013, USA [26] | CS | N=150 | Adolescents<br>Female 49%<br>Mean age 17.1 (range 11-25)<br>Mean HbA1c 8.6(1.9). | Clinical | **Eating Disorder Screen for Primary Care (ESP) [MODIFIED VERSION].** Scored positive if answer yes to >1 question.<br>Intentional insulin omission or reduction added | Easy to use | Disordered eating positive 20.7%<br>13.3% (n = 20) reported insulin misuse |
| Birk 1989, USA [27] | CS | N=385<br>70% response rate. | Female 100%<br>Mean age 28.2 (8.9), range 13-45 years.<br>Mean HbA1c 7.3(2.7) range 3-20. | Clinical | **Pyle Eating Behaviour Survey [MODIFIED VERSION].** Questions about diabetes management were added | NR | **Pyle Survey Eating disorder diagnosis:** AN 1.0%, Borderline AN 2.1%, Bulimia 9.9%, past bulimia 4.2%, mixed bulimia 2.1%.<br>N=70 reported reducing or omitting insulin |
| Broadly 2018, 2019, Australia [100, 101] | CS | N=275; n= 74 T1D, n=201 control | Study 1: Female 81%<br>Age 25.3 (6.6)<br>BMI 24.6 (6.3)<br>HbA1c 7.6 (1.5%)<br>Study 2: Female 100%<br>Mean age 26.2 (7.0)<br>BMI 22.7 ( 3.9)<br>HbA1c 7.8 (1.3)% | General community | **Eating Disorders Examination Questionnaire (EDE-Q)** Higher scores indicative of greater disordered eating behaviours<br>**Diabetes Eating Problem Survey Revised (DESP-R)** Score >20 high risk of disordered eating | NR | **Study 1: EDE-Q** 26.4 control and 24.3 diabetes group scored above clinical cut off for EDE-Q<br>**DEPS-R** 33.9% diabetes group at high risk according to DEPS-R.<br>**Study 2: EDE-Q** n=11 (26.8%) T1D above clinical cutoff, n=4 (7.1%) controls above clinical cutoff (p=0.013)<br>Objective binge eating higher in those with diabetes. |
| Caccavale 2015, USA [28] | CS | N=151 | Adolescents<br>Female 48%<br>Mean age 15.6(1.5)<br>Mean BMI z 0.71(0.76)<br>Mean HbA1c 8.8(1.6); 64.9% using insulin pump | Clinical | **Dietary eating problems survey revised (DEPSR)**. Higher scores indicating greater endorsement of DEB. | NR | **DEPSR** mean 12.6(10.1) |
| Cantwell 1996, UK [29] | CS | **Phase 1:** 215 (68% response rate)<br>**Phase 2 (interview):** n=48, (high EAT score | **Sample characteristics only reported for phase 2**<br>100% female<br>Age 17-30 years, Median age High EAT 24.4(4.4), low EAT 22.5(3.9).<br>Mean BMI high EAT 26.5(21-35), low EAT 23.5(19-34) (p<.05).<br>Mean HbA1c high EAT 11.3(2.7) low EAT | Postal survey | **EAT-40 [MODIFIED VERSION],** modified to remove questions that may be biased in those with diabetes. | NR | **EAT** Phase 1: 30/147 (20.4%) high EAT score. |

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| | | n=22, Low EAT score n=26) | 10.2(1.7). | | | | |
| Cecilia, Spain 2018 [102] | CS | N=178 | Adolescents<br>Female 48%<br>Age 14.9 (1.3)<br>HbA1c 8.5 (1.0) | Clinical | **Diabetes Eating Problem Survey Revised (DESP-R) SPANISH** Higher scores indicate more eating disorder behaviours, Score >20 high risk of disordered eating | | **DEPS-R** 59% low eating disorder behaviours (score<10), 26 moderate eating disorder behaviours (Score 10-19) and 15% high eating disorder behaviours (score >20). More girls than boys had high disordered eating behaviours (p=0.003) and higher DEPS-R score in girls than boys (p<.001) |
| Cherubuni, Italy, 2018 [103] | CS | N=163 (response rate 74%) | Adolescents<br>Female 51%<br>Median age 15.4 years<br>Median HbA1c 7.6, 76% MDI | Diabetes registry | **Diabetes Eating Problem Survey Revised (DESP-R) Italian version** Higher scores indicate more eating disorder behaviours, Score >20 high risk of disordered eating<br>Number of skipped insulin injections per week | NR | **DEPS-R** Score>20 27% boys and 42% girls (NS).<br>Higher HbA1c and BMI in those with higher DEPS-R scores |
| d'Emden 2012, 2013, Australia [31, 32] | CS | **Study 1:**<br>n=124 (88% response rate)<br>**Study 2:**<br>N= 124 participants (88% response rate)<br>n=51 completed the chEDE. | **Study 1 & 2:**<br>Female 53%<br>Age 13-18 years, Mean age 15.4(1.5) years.<br>Mean HbA1c 9.0(1.5). | Clinical | **Youth Eating Disorder Examination Questionnaire [MODIFIED VERSION]**-Included insulin misuse for weight control.<br>**Eating Disorder 3 Risk Composite [MODIFIED VERSION]-** Higher scores indicate higher symptom levels<br>YEDEQ & EDIRC adapted for diabetes to add additional questions pertaining to insulin misuse, which were endorsed by the authors of each tool. The insulin questions were analysed separately, with original scoring of tools retained | YEDEQ Takes approx. 15-20 mins, EDI 3RC takes approx. 5 mins to complete | **Study 1:**<br>**YEDEQ** disturbed eating behaviour 32.3% (37.9% female and 25.9% male).<br>**Global YEDEQ female** 1.69(1.36) (95%CI 1.35-2.02), males 0.52(0.77) (95% CI 0.32-0.72). Females sig higher than males on all subscales.<br>**EDI risk composite** females 34.03(9.90) (95%CI 31.58-36.48), males 25.06 (5.92) (95%CI 23.33-26.67). Higher EDI in females compared to males.<br>**Study 2:** Insulin misuse was 5.6% (7.6% females and 3.4% males) |
| d'Emden 2017, Australia [11] | CS | N=164<br>96% participation rate. | 98.7% T1D<br>56% female<br>Age 18-25 years, median 21 (IQR 3)<br>BMI median 23.9 (IQR 4.2).<br>74.2% MDI, 22.5% insulin pump therapy;<br>HbA1c median 8.0(IQR 1.8), | Clinical | **Eating Disorder Inventory Risk Composite EDI 3RC-** score of ≥46 & a score in the typical or elevated clinical range on any scale is indicative of disordered eating behaviours<br>**The Eating Disorders Compensatory Behaviour Questions** | NR | **EDI-3RC** mean(SD) 31.6(9.8) (Females sig higher than males; p<.001).<br>**EDCBQ** 38.7% disordered eating behaviours (NS differences male and female). |
| Eilander 2017, Netherlands [34] | CS | n=103 adolescents 87.3% response rate. | 11-16 years, mean Age 13.5(1.49)<br>51.5% girls<br>BMIz 0.64(1.0)<br>80.4% treatment pump; HbA1c 8.0(3.5) | Clinical | **MIND Youth Questionnaire**- (dieting frequency)<br>**AHEAD** study weight loss behaviours<br>**Diabetes eating Problems Scale Revised DEPSR [MODIFIED VERSION]** - translated into Dutch in the current study. Cut-off of ≥20 for | NR | **MY-Q body/shape** Answers of 45.6% adolescents were flagged and completed DEPSR.<br>**DEPSR** Mean DEPSR 10.4(7.59). 7.8% had scores above DEPSR cut-off.<br>N=16 adolescents reported |

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| | | | | | risk of DEB. Question on ketones, which are not familiar to Dutch youth, deleted & new cut-off of ≥18 defined (range 0-75, with original 0-80). Higher scores indicate more weight loss activities | | intentional insulin omission. |
| Engstrom 1999, Sweden [36] | CS | N=178 (n=89 IDDM, n=89 controls, n=7 non participants) 92% participation | Female 100%<br>Age IDDM group 16.3(1.4) range 14-18, control 16.4(1.4).<br>BMI IDDM 23.7(2.9), control 21.1(3.0) (p<.001).<br>HbA1c 8.4(2.0). | Clinical | **Eating Disorders Inventory Children's version**. Cut-off of 14 in order to obtain high specificity according to Swedish norms proceeded to interview | NR | **EDI** N= 17 girls scored above the cut off in EDI drive for thinness to proceed to interview.<br>N=15 diabetic patients (16.9%) compared with 2 control girls (2.2%), p<0.01, had disturbed eating behaviour according to the questionnaire. |
| Falcao 2017, Portugal [37] | CS | n=128 (n=55 with diabetes, n=73 without diabetes) | **Diabetes group** n=37 female, age 18-30 years, mean 24.78 (4.18), years, BMI 24.13(3.90).<br>**Non diabetes group n**=62 females, mean age 22.67(3.11), BMI 22.03(3.48).<br>Age (p=0.001) & BMI (p=0.002) sig different between groups. | Online survey | **EDEQ-** Portuguese version. Higher scores indicate more disordered eating.<br>**Questionnaire on personal experience about food & body image**- questionnaire developed for this study & included questions on insulin omission | NR | According to EDEQ cut-off, 25.8% showed clinical level of disordered eating (29.1% diabetes, 23.3% non diabetes; p=0.46).<br>**EDEQ global score** diabetes 1.37(1.37), non diabetes 1.48(1.23) (p=0.63).<br>20.8% reported stopping taking insulin intentionally, 7.3% of which did so to reduce weight |
| Friedman 1998, France [38] | CS | N=168 (n=69 IDDM, n=45 non diabetic outpatients & n=54 students) | **Diabetes sample:** Mean age 26.7(8.2), n=35 females. Mean HbA1c 8.6(1.7).<br>**Outpatient sample:** age 28.9(6.8), n=25 females.<br>**Student sample**: age 22.7(2.8), 100% female. | Clinical | **Eating Attitudes test** - French version. Cut-off score of 30 for eating disorder<br>**Bulimic Inventory Test of Edinburgh (BITE)**- French version with probable bulimia being diagnosed with score >19. | NR | **EAT** Restrictive behaviours (EAT>30) IDDM females 8.5%, non diabetic females 5%, IDDM males 0%, non diabetic males 8%.<br>**BITE** Bulimic behaviours (10-19) IDDM females 2.9% non diabetic females 0%, IDDM males 2.9%, non diabetic males 0%. Minor bulimic behaviours diabetic females 14.3%, non diabetic females 5%, diabetic males 5.9%, non diabetic males 16%. |
| Gagnon 2017, Canada [39] | CS | N=140 (n=93 T1D, n=46) | Mean age T1D without ED 38.6(15.1), T1D+ED 29.1(10.3).<br>Sex NR | Online survey | **Eating disorders examination questionnaire (EDEQ6**)- Reports ED diagnoses were based on the presence & frequency of specific disordered eating behaviours in the EDEQ as per the DSM5. | NR | **EDEQ6** ED- type 1 diabetes- n=39 (42%).<br>50% of patients with ED+T1D reported insulin omission, compared to 8% T1D. |
| Garcia Reyna 2003, Spain [40] | CS | N=673 (n=98 diabetic, n=575 non diabetic) | **Diabetic** n=60 male, n=38 female. Age 13.78(1.05), range 12-16.<br>**Non diabetic** age 13.73(0.63), range 12-16. | Not described. Authors affiliated with hospital | **Spanish version of the Eating Attitudes Test (EAT-40).** Cut-off EAT-40 >30 | NR | **EAT-40** n=13 Diabetic participants EAT>30, n=57 non diabetic EAT>30. |
| Gimenez | CS | N=74 | Age 17.4(1.4) | Clinical | **Eating Attitudes Test (EAT-26)** | NR | **EAT 26** 20% girls scored >20 on the |

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| 2008, Spain [41] | | | n=40 female<br>Mean HbA1c 8.7(1.6). | | **Diagnostic Survey for Eating Disorders (DSED)** modified for diabetes (modifications NR). | | EAT-26.<br>**DSED** n=10 (n=9 girls) scored moderate to high in DSED. |
| Goncalves 2016, Portugal [44] | CS | N=79 | n=46 females<br>Mean age 15.71(2.23) range 12-19 years. | Adolescents with diabetes registered with local diabetes association | **Eating Disorder Examination Questionnaire (EDEQ).** Higher scores indicate greater pathology. | NR | **EDEQ global score** lower weight 57.42 (20.15), same or higher weight 31.34(15.19) p<.001. |
| Grylli 2004, 2005, Austria [45, 46] | CS | N=199<br>79% participation rate | Female 48%<br>Age 14.1(2.5).<br>BMI 20.4(3.3).<br>HbA1c 8.4(1.8)%. | Part of larger study identified from clinical setting | **Eating attitudes test (EAT-26**)- German version. Total score used to determine cut-off<br>**Eating Disorders inventory (EDI2).** German version.<br>Cut offs according to Jones study- EDI drive for thinness ≥9, EDI bulimia ≥5, body dissatisfaction ≥15, total score of ≥20 on EAT6 or BMI ≤5th percentile or ≥91st percentile. | NR | **EDI2** n=35 scored above predetermined cut-off for EDI2 (n=30 female, n=5 male). |
| Howe 2007, USA [50] | CS | n=295<br>38% response rate. | N=158 males.<br>Mean age 14.9(2.5) range 11-20 years.<br>Mean BMI 23.3.<br>34% insulin pump. | Clinical | **Diabetes Eating Problem Survey (DEPS)-** No scoring described<br>**Project EAT survey** | NR | **DEPS** scores ranged from 32-81, mean 48(8.4). |
| Iafusco 2004, Italy [51] | CS | N=324 (n=193 diabetic, n=131 controls) | **Diabetes group**<br>8-18 years, mean age 13.6(2.7).<br>N=92 female.<br>Mean BMI 21.45(3.45).<br>Insulin 43% 3/day 54.8% 4/day<br>**Controls** matched for age & sex (data NR). | Clinical | **Eating Disorders Examination Questionnaire [MODIFIED VERSION]**, modified for diabetes (modifications not described) | NR | **EDEQ** No major eating disorders identified in people with diabetes or healthy controls.<br>Subclinical disordered eating higher in diabetes n=9 compared to controls n=1 (p=0.09). |
| Johnson 2014, UK [52] | CS | N=96<br>81% repose rate | 59% female<br>Age 16-21 years, mean 18.1(1.3)<br>BMI 23.3 (3.2).<br>HbA1c 10.0(2.1)%. 76% multiple daily injections<br>Compered to reference group from previous study | Clinical | **Diabetes Eating Problem Survey Revised (DEPS R)** mean item score of ≥2.5 used to identify those needing further assessment following advice from scale developers | NR | **DEPSR** 35.1% met cut offs for disordered eating behaviours |
| Jones 2000, Canada [53] | CS | N=1454 (n=356 T1D, n=1098 non diabetic controls) (84% response rate) | Female 100%<br>Age 12-19 years, mean age diabetic 14.9(2.0), non-diabetics 14.8(1.9).<br>Mean BMI diabetes 22.7(3.8), non diabetes 20.6(3.3) p<.001.<br>HbA1c 8.8(1.7). | Clinical | **Eating Disorders Inventory**<br>**Eating Attitudes Test** Scores corrected for EAT & EDI for items affected by diabetes treatment<br>**Diagnostic survey for eating disorders [MODIFIED VERSION]**. Modified to include intentional insulin omission for weight loss.<br>Screening cut-offs to progress to EDE interview: 1. Score of >15 on EDI drive for thinness; 2. Score of >5 on EDI bulimia subscale; 3. Score of >20 on EDI body | NR | 48% controls and 52% diabetic subjects scored above survey screening cut-offs.<br>**DSED** omission or under dosing of insulin 11%. |

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| | | | | | dissatisfaction subscale; 4. Total score of >20 on the EAT; 5. Current or past history of binge eating, self-induced vomiting, use of laxatives or diuretics, insulin omission for weight loss, or current dietary restriction on DSED; 6. History of eating disorder diagnosis or treatment on DSED; 7. <5th BMI percentile | | |
| Kaminsky 2013, Canada [54] | CS | N=73 (n=46 T1D, n=27 controls) | **Diabete**s- n=27 girls, age 15(1.62) range 12-18, BMI 22.42(3.95). **Controls**- n=13 girls, mean age 14.9(1.64) range 12-18, BMI 21.74(3.37). | Clinical | **Eating Disorders Inventory III** | NR | **EDI 111 Body dissatisfaction** diabetes 9.34(8.60), control 8.0(8.13) NS. **Drive for thinness** diabetes 5.13(6.52), control 2.73(4.05) NS. **Bulimia** diabetes 3.09(3.84), control 1.92(2.15) NS. |
| Keane, 2018, Ireland [108] | CS | n=51 (T1D), n=236 (control) | Young adults 18-30 years old. Mean age of diabetes group 21.4 (2.5), female 41% | Clinical | **Eating Disorder Examination Questionnaire (EDE-Q)** A cut-off score ≥4 indicates clinical significance | NR | **EDE-Q** Mean global score for diabetes group was 0.82 (1.1). No individuals in diabetes group had a score in clinical range |
| Khan 1996, UK [55] | CS | N=96 (n=48 IDDM, n=48 control) | Female 100% Aged between 13-20 years. | Clinical; Controls friends of diabetic participants. | **Eating Disorder Inventory [MODIFIED VERSION] -** Amended to minimise confounding effects of diabetes treatment- amendments made by consumers & professionals. **Dutch Eating Behaviours Questionnaire** External eating **Insulin questionnaire**- insulin omission | NR | **EDI** Diabetes scored higher than controls on the body dissatisfaction, bulimia and desire for thinness subscales. 22.9% omitting insulin more than once per month. |
| Kichler 2008, USA [56] | CS | n=75 83.3% response rate. | Female 100% 11-17 years. Mean age 14.1(1.88). BMI SD 0.74(0.65). | Clinical | **Eating Disorder Inventory-** Higher scores indicating more body dissatisfaction. **Eating Attitudes Test 26 [MODIFIED VERSION]**- Excluded 6 medically related items to minimise false positives as a result of diabetes diagnosis. Higher scores indicate more eating pathology. | NR | **EDI** BD mean 28.11(10.5) **EAT** 26- 4.76(5.92). |
| Latzer, Israel, 2018 [104] | CS | N=403; n=97 T1D, n=39 coeliac + T1D, n=267 coeliac | Adolescents and young adults 10-30 years Female 65% Mean age 16 years | Clinical | **Eating Attitudes Test 26 (EAT-26)** score >20 considered pathological **Diabetes Eating Problems Survey Revised (DEPS-R)** Score ≥20 identifies DEB | NR | **EAT-26** identified 8.2% of T1D group with DEB **DEPS-R** identified 26% of T1D group with DEB |
| Maharaj, 1998, 2001, 2003, Canada [57-59] | CS | **Study 1 & 2:** n=88 77% response rate **STUDY 3:** n=113 | **Study 1:** Female 100%; Adolescents, Mean age 14.9(2.2) y; Mean BMI 22.6 (3.7) ; Mean HbA1c 9 (1.6)% **Study 2:** Female 100% ; Age 15.0 (2.2) **Study 3:** Female 100% ; Adolescents, Mean age 15.2(2.2) ; HbA1c mean 8.8(1.4)% | Clinical | **Eating Disorder Inventory Diagnostic Survey for Eating Disorders [MODIFIED VERSION]** Modified to include DM-specific items- Insulin omission & under dosing. **EDI & DESD** Classified as Frequent (≥9 drive for thinness, ≥5 bulimia or >15 body dissatisfaction & DEB 2-3 times/mth) Mild (≥9 drive for thinness, ≥5 bulimia or >15 body | NR | **Study 1:** Frequent eating problems n=18 (20.5%); moderate eating problems=30 (34.1%); no eating problems n=40 (45.5%) **Study 2:** Non-disturbed n=56 (49.6%); mildly disturbed n=37 (32.7%); highly disturbed n=20 (17.7%) **Study 3**: Highly eating disturbed (HD) n=18 (20.5%); mildly eating disturbed |

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| | | | | | dissatisfaction & DEB ≤1/mth) or No Eating problems (absence of DEB) | | (MD) n=30 (34.1%); non-eating disturbed (ND) n=40 (45.5%). **DSED-M** Insulin underdosing ND 0%, MD 20.7%, HD 50.0% (p<.001). |
| Marcus, 1991, USA [61] | CS | n=188 84% response rate | Female: 100% Mean age: 30.7 (8.2) y Mean BMI: 23.9 (3.6) Mean HbA1c 10.8 (1.8)% | Clinical | **Bulimia Test [MODIFIED VERSION]** with 2 diabetes-specific questions added (insulin manipulation / omission). Score of ≥88 for screening for subclinical ED. **Eating Disorder Inventory** | NR | **BULIT:** mean BULIT 54.6(14.5). 4.7% met clinical cutoff for further clinical evaluation. Insulin manipulation in 21.6% and insulin omission 3.3%. **EDI:** Drive for thinness 5.5(5.1), bulimia 1.3(2.9), body dissatisfaction 10.2(8.2). |
| Markowitz, 2010, USA [63] | CS | n=112 | Female 56% Adolescents, Mean age 15.1 (1.2) y Mean zBMI 0.8 (0.7) Mean HbA1c 8.7 (1.7)%, 26% pump, 62% ≥3 injections/day | Clinical | **Diabetes-specific Eating Problem Survey-Revised-** development of the revised version from the original Diabetes Eating Problem Survey. Higher scores indicate more disordered eating behaviours | Completion <10 minutes | **DEPSR** females 14.1(11.0), males 9.3(8.7) p=0.02 Missing or restricting insulin 27% (24% males, 29% females). 41% insulin restrictors scored ≥20 on DEPSR compared to 14% non restrictors (p=0.002) |
| Meltzer, 2001, USA [65] | CS | n=152 | Adolescents Female: 54% Mean age 14.5 (1.99) y Mean HbA1c 9.04 (1.67) Mean BMI 22.02 (4.36) kg/m2. | Clinical | **Eating Disorders Inventory [MODIFIED VERSION]**. Two diabetes-specific questions added (insulin under dosing / omission) Clinical cut-off of >5 on bulimia subscale | NR | **EDI:** n=7 (4.6%) clinically significant on the Bulimia subscale (score 5+) 6% skipping/manipulating insulin dose for weight loss |
| Merwin, 2014, USA [66] | CS | n=276 | Female: 68.5% Mean age 43.5 (13.7) y 89.5% Caucasian 69.6% insulin pump, Self-reported HbA1c range 4.9-15% | Clinical | **Diabetes-specific Eating Problem Survey-Revised** - Higher scores indicating more symptomatology, scores >20 suggest clinically significant ED. Three of five items to assess manipulation of diabetic treatment regime used. Questions around eating behaviour developed by authors | NR | **DEPS-R** 22% (n=61) score >20 |
| Nansel, 2012, USA [67] | CS | n=151 | Adolescents Female 48.3% Mean age 15.6 (1.5) BMI 35.8% overweight/obese 64.9% pump | Clinical | **Diabetes Eating Problem Survey** DEPS developed for adult sample so cut-offs for current youth sample based on sample distribution (>1SD mean classified as at risk, <1SD mean were classified as low risk) | NR | **DEPS** n=129 (85.4%) low risk, n=22 (14.6%) at risk (score 39+ at risk). Mean DEPS score 24.9(14.0). |
| Neumark-Sztainer, 2002, USA [68] | CS | n=143 Response rate 58%. | Adolescents Mean age 15.3 (2.3)y Female 51% Mean BMI 23.8 (4.2); 41% overweight | Clinical | **Diabetes Eating Problem Survey [MODIFIED VERSION];** two questions regarding insulin omission/ reduction added to the original DEPS. | NR | **DEPS** DEPS score females 44.8(10.7), males 41.7(8.0) p=0.07. 10.3% females and 1.4% males skipping insulin and 7.4% females and 1.4% males using less insulin for weight control |
| Nip, USA, 2019 [112] | CS | n=2156 T1D | Female 50% Mean age 17.1 (4.3) | Enrolled in larger cohort | **Diabetes Eating Problem Survey Revised (DEPS-R)** Cut-off score for disordered eating | NR | **DEPS-R** 21.2% of T1D had DEB, mean score 12.7 (10.3). Highest scores in |

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| | | | Mean HbA1c 9.2 (1.8)<br>Receiving insulin therapy | study | ≥20 for further clinical assessment | | 15-19 years. |
| Peterson, 2018, USA [10] | CS | n=43 | Youth (10-17 years) with T1DM transitioning from multiple daily injections to insulin pump therapy<br>Female 54%<br>Mean age 12.9(1.8) | Clinical | **Eating Disorders Inventory III:** Higher scores indicative of more symptoms | NR | **EDI:** Body dissatisfaction mean 6.4 (8.5), Bulimia symptoms 1.5(3.5) |
| Philippi, 2013, Brazil [71] | CS | n=189 | Female 75%<br>Mean age 26.0(9.8)<br>Insulin units/day 0.8(0.4) | Clinical | **Bulimic Investigation Test**<br>**Eating Attitude Test**<br>**Binge Eating Scale**<br>Considered to have risk behaviour for ED if ≥21 in EAT26, ≥1 BITE, ≥17 in BES | NR | Overall: 58.7% at risk of eating disorder across all three tests<br>**EAT:** 45% (score of 21+)<br>**BITE**: 40% (score 10+)<br>**BES:** 16% (score 17+) |
| Pinna, 2017, Italy [12] | CS | n=211 | N= 192 T1D (91%), 19 T2D (9%),<br>Female 51%<br>Mean age 38 (range 13-55)<br>Median BMI 24. | Clinical | **Diabetes Eating Problem Survey-Revised** (Italian version)- Higher scores indicate more DEB.<br>**Eating Disorders Inventory III**<br>CUTOFF: 75th-85th percentile indicates clinical risk & >85th percentile indicates high clinical risk. Eating Disorder Risk Composite derived from composite of 3 EDI scales | Completed <10 min. | **DEPS-R** median score 12; females 14, males 10 p<0.05.<br>**EDI-III** clinical risk of ED in 13.3% of the sample using EDRC |
| Pollock- Barziv, 2005, Canada [73] | CS | n=51 | Female 100%<br>Mean age 21.5 years | Community | **Diagnostic Survey for Eating Disorders [MODIFIED VERSION]**- including diabetes compliance (e.g. insulin)<br>**Eating Disorder Inventory** | NR | **DSED**: 14 (27%) had ED symptoms at least twice a month for the past 3 months<br>Total ED symptom score participants with ED symptoms 7.9(3.1), without ED symptoms 5.0(1.3) p<.01 |
| Polonsky, 1994 USA [74] | CS | n=341<br>91% response rate | Females 100%<br>Mean age 33.1 (12.4) y<br>BMI 24.2(4.4)<br>Insulin injection frequency 2.2(0.7) | Clinical | **Bulimia Test Revised**- higher scores indicate greater pathology<br>**Insulin use:** 5 items constructed by authors re insulin use, weight concerns & eating concerns. | NR | **Self-reported insulin misuse** n=104 (30.5%) insulin omitters, with n=45 omitting insulin for weight control, 8.8% frequent insulin omission<br>**BUILT-R** total 53.2( 22.6), insulin omitters 66.7(26.9), non omitters 47.0(17.7) p<.001 |
| Powers, 1990, USA [75] | CS | n=97 | Paediatric patients<br>Female 47%<br>Mean age 15.7 y male, 15.5 y female | Clinical | **Eating Habits Questionnaire [MODIFIED VERSION]** with additional items specific to diabetes mellitus. | NR | **Eating Habits Questionnaire:** DSM-III diagnostic criteria n=0 male, n=2 (BN) females met criteria for ED. DSM-III-R diagnostic criteria n=0 male and n=1 (BN) females met criteria for eating ED.<br>14% females and 4.1% males self-reported withholding insulin |

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| | | | | | | | p=0<.004 |
| Powers, 2016, USA [76] | CS | n=268 38.2% response rate | Female 57% 91% Caucasian Mean age 19.2(9.2) y HbA1c 8.4(1.6) | Postal survey identified from diabetes centre electronic medical record | **The Screen for Early Eating Disorder Signs.** Cut-off scores low risk ≤68, moderate risk 69-84, High risk ≥85 **EDE-Q** used for convergent validity | 2–5 minutes to complete | **SEEDS** n=174 (64.9%) participants with Low Risk, n=42 (15.7%) with Moderate Risk and n=52 (19.4%) with High Risk of an eating disorder. Average SEEDS score 63.2(22.4) range 23-135, median 58.0. |
| Quinn, 2016, USA [77] | CS | n=43 | Female 53% Young adults, Median age 19 years Median BMI 24.4 Median HbA1c 8% | Clinical | **Diabetes Eating Problem Survey-Revised-** Higher scores indicating greater pathology. Cut-off score >20 | NR | **DEPSR** n=10 (23.5%) screened positive for eating problems (score >20) |
| Rancourt, USA, 2019 [105] | CS | n= 818 | N=313 adolescents, n=307 young adults, n=198 adults Mean age adolescents 15.7 (1.3), young adults 21.1 (2.1), adults (30.5 (2.8) Female adolescents 47%, young adults 63%, adults 69% | Diabetes registry | **Diabetes Eating Problems Survey Revised (DEPS-R)** Score ≥20 identifies those at risk of eating disorder | NR | **DEPS-R** 31% at risk of an eating disorder (30% adolescents, 35% young adults, 28% adults). DEPS-R higher in females. Insulin restriction adolescents 18%, young adults 16%, adults 9%. |
| Rodin, 1985, Canada [79] | CS | n=46 | Adolescents Female 100% Mean age 17.2 | Clinical | **Eating Disorder Inventory Eating Attitudes Test-26-** cut-off point >20 | NR | **EAT 26** n=9 (19.6%) above the cut-off point (>20) on the EAT-26 **EDI** n=10 (21.7%) elevated scores on the Drive for Thinness, Bulimia or Body Dissatisfaction subscales of the EDI. |
| Rodin, 1987, Canada [80] | CS | n=58 | 100% Female 15-22 years old; Mean age 17.6 | Clinical | **Eating Disorder Inventory-** cut-off point ≥10 drive for thinness, ≥5 bulimia **Eating Attitudes Test-**26- cut off >20 | NR | **EDI and EAT**- 27 (46.6%) scored above the cut-off points on at least one of the EDI and EAT-26. |
| Rodin, 1991, Canada [81] | CS | n=103 85% response rate | Adolescents 100% Female Mean age 15.1(1.4) years | Clinical | **Diagnostic survey for Eating Disorders [MODIFIED VERSION]**, revised to include questions regarding insulin manipulation | NR | **DSED-** ED diagnosis 13% of the sample based on DSM-III criteria (anorexia nervosa in 1% and bulimia in 12%), and in 5% of the sample based on DSM-III-R criteria (all bulimia nervosa) Insulin omission in those with an ED n=7 (54%), without ED n=5 (6%) p=0.001. |
| Ryan, 2008, France [83] | CS | N=94 (n=43 T1D, n=51 T2D) | T1D 37% female 18-70 years | Clinical | **Questionnaire of Eating & Weight Patterns-Revised.** BED diagnostic criteria: ≥2 BE episodes/wk for 6 mths; ≥3 BED symptoms; significant distress associated with eating; no regular compensatory behaviours. **Three Factor Eating Questionnaire** (French-translated)- higher scores indicating higher eating disordered behaviour | NR | **Questionnaire of Eating and Weight Patterns-Revised.** No T1D patient of either gender with BED diagnosis. However, males with T1D (26%) and 11% T2DM females displayed overeating or binge eating behaviour. |

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| Ryman, 2019, Canada [109] | CS | n=116 | Youth 12-17 years with T1DM. 54.3% female, mean age 14.6 (1.56), mean HbA1c 8.54% (1.30) | Clinical | **Diabetes Eating Problem Survey Revised (DEPS-R)** Scores of ≥20 categorised as positive | Takes <5 minutes to complete | **DEPS-R** 21% scored positive to DEB |
| Sancanuto, 2017, Spain [85] | CS | n=112 | Adults<br>Female 58%<br>Age 18-56 years<br>Mean BMI 24.8 (7.2) | Community | **Diabetes Eating Problem Survey & revised version,** Spanish translation. Higher scores indicate higher risk of developing an eating disorder. DEPSR cut off point >20<br>**Eating Attitude Test-26,** translated into Spanish. Cut off point of >20 to determine risk of ED. | Mean time of completion was 4-7.5 min which represents an affordable time for completion in clinical practice. | **DEPSR** 19.44% met clinical cutoff<br>**EAT-26** detected 11.11% of sample had disordered eating |
| Saßmann, 2015, Germany [86] | CS | n=246<br>63% response rate | Young people<br>Female 49%<br>Mean age 15.8(1.8)<br>HbA1c 8.2(1.6),<br>BMI SD score 0.34(0.89)<br>Insulin pump therapy 33%. | Clinical | **Diabetes Eating Problem Survey–Revised** translated into German. Score of ≥20 indicates high risk for eating disorders.<br>**SCOFF**- ≥2 positive answers indicate disordered eating behaviour.<br>**Eating Disorders Examination Questionnaire**-German version higher scores indicating more psychopathology. | NR | **DEPSR** n=38 score >20 (15.4%; boys 8.8%, girls 22.3%) p=0.003<br>**DEPSR** total score 12.0(9.6), boys 9.4(7.0), girls 14.8(11.0) p<.001.<br>**SCOFF** n=40 score>2 (16.3%; boys 8.8%, girls 24.2%) p=0.001<br>**EDEQ** n=20 with ED pathology (8.1%; boys 1.6%, girls 14.9%) p<.001. |
| Schwartz, 2002, USA [87] | CS | n=45<br>42% response rate | Adolescents<br>Female 100%<br>Age 14.4(1.72)<br>Mean HbA1c 9.57(1.81) | Clinical | **Eating Disorder Examination Questionnaire** | NR | **EDEQ** Average score 2.03 (1.51). No clinical cutoff for specified |
| Stancin, 1989, USA [89] | CS | n=59 | Females 100%<br>Mean age 21.5 (2.7)y<br>91.5% white | Community | **Bulimia screening form**<br>**Eating Disorder Inventory** | NR | **Bulimia screening form:** 12% bulimic, 10% "bulimia-like", 36% binge eating<br>**EDI:** None of the total sample mean subscale scores were in the clinically significant range |
| Tokatly Latzer, 2018, Israel [92] | CS | N=403 (n=97 T1D, n=267 coeliac disease (CD), n=39 T1D + CD) | Female 65%<br>Age T1+CD 16.5(3.7), T1 16.7(4.6), CD 17.0(5.8)<br>BMI % (10-17) T1D +CD 50.5(28.8), T1D 57.5(26.7), CD 41.6(28.9) p=0.001.<br>BMI kg/m2 (18-30) T1D+CD 23.3(2.9), T1D 22.5(3.3), CD 22.2(3.1). | Clinical | **Eating Attitude Test-26**- EAT≥20 considered pathological.<br>**Diabetes Eating Problem Survey-Revised**-DEBs defined as score ≥20 | NR | **EAT-26**: 8 T1DM subjects (8%), n=10 (26%) CD+T1DM, scored 20+<br>**DEPS-R:** 25 T1DM subjects (26%), n=17 (45%) CD+T1DM scored 20 or more |
| Troncone, 2019, Italy [106] | CS | n=200 | Adolescents with T1DM. Mean age 15.24 (1.45), female 49%, mean HbA1c 7.94% (1.48) | Clinical | **Diabetes Eating Problems Survey Revised (DEPS-R) Italian** Scores ≥20 indicate a level of DEB warranting further attention | NR | **DEPS-R** 36.5% scored DEPS-R positive, mean score 19.02 (12.84) |
| Wisting, 2013 a & b, Norway [95, 96] | CS | n=770<br>42% response rate. | Children & adolescents<br>Female 50.6%<br>Mean age 14.6 (2.1) y<br>Mean HbA1c 8.5(1.4)%<br>Mean BMIz 0.3(0.9) | Nationwide population based survey via diabetes registry | **Diabetes Eating Problem Survey–Revised**-Norwegian. higher scores indicate greater eating pathology; score of ≥20 require further assessment.<br>**Eating Attitudes Test-** higher scores indicating | Completed in less than 10 min | **Study 1:**<br>**DEPS-R** The mean scores were 11.0(10.7) for the total sample and 7.7(7.4) and 14.2(12.4) for males and females, respectively. No clinical cut- |

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| | | | | | greater pathology | | offs given.<br>**Study 2:**<br>**DEPS-R** 18.3% total sample, 27.7% of the females and 8.6% of the males scored above the cutoff (20+)<br>A total of 31.6% of the participants reported insulin restriction and 6.9% reported insulin omission after overeating. |
| Wisting, 2018, 2019, Norway [110, 111] | CS | n=282 | 18-79 year olds with T1DM. Mean age 42.1 (15.19). 56.3% insulin pen, 43.4% insulin pump. Mean HbA1c 7.8% Mean self-report BMI 26.0 (4.1) | Clinical | **Diabetes Eating Problem Survey Revised (DEPS-R) Norwegian** Cut-off score ≥20 indicates need for further clinical assessment | Typically completed in <10 minutes | **Study 1: DEPS-R** 20.3% scored above cut-off for DEB (13.3% of males, 24.8% females)<br>**Study 2: DEPS-R** Mean score 13.83 (9.2), males 11.18 (7.8), females 15.57 (9.6). |
| Young- Hyman, 2016, USA [97] | CS | n=101 | Children & adolescents<br>n= 58 newly diagnosed (New) participants, n= 45 transitioning to pump (Pump) participants<br>Female 54.4%<br>Mean age 12.8 (2.1)<br>HbA1c New 11.4(2.2), pump 8.3(1.3)<br>BMIz New -0.14(1.4), pump 0.6(0.9)<br>p<.001. | Clinical | **Eating Disorder Inventory III.** Higher scores indicating more DEB. | NR | **EDI:** Newly diagnosed bulimia score 2.7 (4.7), Pump: bulimia score 1.5(3.5). No clinical cut-offs given |
| Zuijdwijk, 2014, Canada [120] | CS | n=43 | Adolescent<br>Female 100%<br>Mean age 15.8 (1.7) y<br>BMI 25.5 (3.5)<br>HbA1c 8.4 (1.4)% | Clinical | **mSCOFF** original SCOFF ED screening questionnaire modified for diabetes by replacing food preoccupation question with question re insulin restriction<br>**Eating Disorder Inventory III [MODIFIED VERSION]** modified to eliminate questions related to diabetes-imposed dietary restrictions. Cut-offs consistent with those proposed by Jones et al. | mSCOFF can be quickly administered during a routine clinic visit. mEDI is not practical to administer given its length, cost, & scoring | **mEDI:** n=10 (23.2%) high risk for an ED.<br>**mSCOFF:** n=12 (27.9%) participants answered positively to one or more questions and n=3 answered positively to two questions. |
| Alice Hsu 2009, Taiwan [17] | Case control | n=142 (n=71 T1D, n=71 non DM) 93% response rate | Adolescents<br>Female: 58%<br>Age: T1D 15.9 (3.1), non DM 15.9 (3.1)<br>BMI: T1D (20.6 (2.9), non DM 20.7 (3.5)<br>HbA1c: 9.08 (1.96) ; Insulin treatment traditional (BD) 60.6%, intensive 38% | Clinical; Control: community | **Eating Attitudes Test 26** Higher scores indicating greater disturbed eating behaviours. Score of ≥20 identify subthreshold eating disorders.<br>**Bulimic Inventory Test Edinburgh (BITE)** Cut-off scores for subthreshold eating disorders: symptoms=20, severity=5, total score=26 | NR | **Female BITE total** 10.93 (6.47) non DM 6.62 (4.71) p<.001. **Total EAT** T1DM 15.02 (8.45) non DM 11.55 (8.74) NS. **Males BITE total** t1dm 7.97 (6.39) non DM 5.41 (3.66) NS. **Total EAT** T1DM 11.76 (8.02) non DM 8.83 (5.39) NS. |
| Baechle 2014, Germany [24] | Case control | n=629 diabetes survey | Adolescents<br>Female diabetes 46%, KiGGS 49% (NS).<br>Mean age diabetes 15.3 (1.7), KiGGS | Nationwide population based survey | **SCOFF questionnaire [MODIFIED VERSION]**.<br>≥2 questions answered yes, ED is suspected.<br>Additional insulin misuse question added. | NR | **SCOFF** 31.2% female diabetic group SCOFF positive, 28.9% KiGGS SCOFF positive (NS). |

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| | | cohort, n=6813 KiGGS study Response rate 42% diabetes survey, 67% KiGGS study. | 14.6(2.0) (P<.001). HbA1c mean 8.3(1.3); Insulin infusion 48.8%, intensified conventional therapy 43.3% | | Analyses conducted removing question 5 (Food dominates life) as this is a strategy in diabetes management | | **Modified SCOFF** After excluding question 5, 2.7% diabetic boys and 16.6% diabetic girls SCOFF positive, compared to 9.4% and 20.4% KiGGS males (p<.001) and females (NS). 18.5% males and 20.5% females reported insulin restriction ≥ 3 times per week, with 6.0% males and 7.4% females restricted insulin > 5 times per week. |
| Mannucci, 1995, Italy [60] | Case control | N=381 (n=118 IDDM, n=263 control) | **IDDM** Female: 52.5% Mean age: 34.4 (11.7) y Mean HbA1c: 7.5 (1.7)% **CONTROL** 56.3% female | IDDM: Clinical CONTROL: nominated by IDDM participants | **Bulimic Investigation Test Edinburgh (BITE)** Subclinical eating disorders BITE scores > 10 or > 8 + severity score of 2+. **Diabetes-adapted Eating Attitude Test-36** (adaptations not specified) | NR | **BITE:** Subclinical eating disorders: 33% IDDM and 22.5% control. Manipulation of insulin therapy to control body weight n=8 (12.9%). |
| Markowitz, 2009, USA [62] | Case control | n=90 95% response rate | Female: 100% Adolescents, Mean age 14.3 (2.0) Mean zBMI 0.9 (0.7) Mean HbA1c 8.6 (1.9)% 56% pump therapy, 44% injection therapy | Clinical | **Eating Disorder Examination Questionnaire**- Clinically significant disordered eating ≥4 on the subscales & global EDEQ. **Three Factor Eating Questionnaire** **Power of Food Scale** | NR | **EDEQ:** 20% scored above cutoff for 1+ subscale.7.8% scored within the clinical range for the global scale. |
| Pinar, 2005, Turkey [72] | Case control | N=100 (n=45 diabetes, n=55 non-diabetes) | Adolescents Female: 50% Mean age 15.5 (1.4) y Mean BMI 20.3 (2.8) Mean HbA1c 8.5 (2.7)% | Clinical ; Control subjects from high school | **Eating Attitudes Test** | NR | **EAT:** 68.9% of diabetes and 21.8% of non-diabetes subjects had DEB (score 30+) EAT score diabetic patients 33.6(9.5), control 21.8(12.2) p<.001. 40% of diabetic patients reported skipping insulin or taking less insulin for weight control. |
| Robertson, 1990, Norway [78] | Case control | N=116 (n=56 IDDM, n=60 non-diabetic) | **IDDM** Female 100% Age 26.2(1.0) Mean BMI 23.0 (0.4). **Control** Female 100% Age 29.5(0.9) BMI 22.4(0.3) | Community | **Eating Attitudes Test-40 [MODIFIED VERSION]** four items omitted that may be affected by diabetes. Scores of 19-29 indicate subclinical ED, while >30 indicates severe eating pathology **Bulimic Investigatory Test Edinburgh.** Score of 10-19 subclinical eating disorder, & ≥20 indicate BN | NR | Subclinical cases was almost equal in the IDDM and non-IDDM groups (10 (17.8%) and 11 (18.3%) respectively, for anorexia nervosa and 7 (12.5%) and 8 (13.3%), respectively, for bulimia nervosa) **EAT:** Median score EAT 40 IDDM 16, control 13 (p=0.03), EAT-36 IDDM 12.5, control 12.0 (NS). **BITE:** Median score BITE symptoms IDDM 5.0, control 5.0, BITE severity IDDM 0.0, control 1.0 (p=0.02) |
| Rosmark, 1986, Sweden [82] | Case control | N=179 (n=86 IDDM, n=93 control) | **Diabetes group:** Female 48% Mean age females 28.3 (6.8) years, males 28.4 (6.6) years | Clinical; Control university students | **Eating Attitudes Test [MODIFIED VERSION]** with four diabetes-related questions omitted. Score of 30 discriminates between AN & non-AN | Easily administered & requires little time to | **EAT** Three (3.5%) of IDDM patients scored above diagnostic cut-off of 30 (1 male, 2 female). No control subjects scored above 30. |

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| | | | **Control**<br>Female 65%<br>Age female 29.2(6.7), male 29.2(6.7), 64.5% female. | | | complete | |
| Sivertsen, 2014, Norway [88] | Case control | N=9883 (n=40 T1D, n=9843 non T1D) Response rate 51% | Prevalence of T1D in sample 0.4% Young people<br>Mean age 17.9 y<br>Female 53% | Community population sample | **Eating Disturbance Scale** | NR | **Eating disturbance scale:** Mean score 3.6(2.8) for T1DM subjects, 3.2(2.3) no diabetes. No clinical cutoff for disordered eating reported. |
| Steel, 1989, Scotland [90] | Case control | N=484 (n=273 IDDM, n=211 control) | Female 52%<br>**Female IDDM** (medians)<br>Age 22, BMI 23.3, HbA1c 11%<br>**Female control**<br>Age 21, BMI 21.6<br>**Male IDDM** (medians):<br>Age 22, BMI 23.2, HbA1c 10%<br>**Male Control**<br>Age 21, BMI 21.8 | Clinical; Control nominated by IDDM | **Eating Attitudes Test**<br>**Eating Disorders Inventory**<br>Removed diabetes questions | NR | n=15 (7%) had clinically apparent eating disorder.<br>**EAT** total score female diabetic 15.4, control 8.0; male diabetic 10.3, control 6.2. EAT total (diabetes-biased Qs omitted): female 9.4 (6.0 control), male 5.3 (4.1 control)<br>**EDI** drive for thinness female diabetic 0.57, control 0.29, male diabetic 0.14, control 0. EDI Drive for thinness (Diabetes Qs omitted) female diabetic 0.25, control 0, diabetic male 0, control 0.<br>**EDI** bulimia female diabetic 0, control 0, male diabetic 0, control 0.<br>**EDI** body dissatisfaction female diabetic 1.7, control 1.0, male diabetic 0.44, control 0.33 |
| Striegel- Moore, 1992, USA [91] | Case control | N=92 (n=46 IDDM, n=46 control) | Children & adolescents<br>Female 100%<br>Age IDDM 13.0(0.5), control 13.0(0.5)<br>BMI IDDM 21.2(0.7), control 19.7(0.6).<br>HbA1c 12.2(0.5) | Clinical; Control from schools | **Eating Disorder Inventory & children's version** (< 12 years) | NR | **EDI:** body dissatisfaction IDDM 0.8(0.9), control 0.9(0.9), drive for thinness IDDM 0.7(0.9), control 0.5(0.6), bulimia IDDM 0.1(0.3), control 0.2(0.4). NS difference between groups. |
| Wing, 1986, USA [94] | Case control | n=202 (IDDM) 90% response rate | Adolescents<br>Female 50%<br>**Males:** Mean BMI 20.7 (0.2); Age 15.1 (0.2) years; HbA1c 10.7 (0.2)<br>**Females:** Mean BMI 21.5 (0.3) ; Age 14.5 (0.2) years ; HbA1c 11.6 (0.2)<br>Control reference group: n=2000 from a previous community survey, n=142 from reference group with T1D | Clinical | **Eating Attitudes Test- 26-** Higher scores indicate greater disturbances in eating behaviour<br>**Binge Eating Scale-** higher scores indicating more bulimic behaviours | NR | **BES**: Mean total score males 5.5(0.5), females 9.8(0.7), p<.001). No clinical cut-offs reported<br>**EAT-26:** Mean total score males 11.1 (0.8), females 13.0 (0.8) (NS). Scored as low, medium or high, but prevalence NR for whole sample |
| Baechle, 2019, Germany [99] | Cohort | N= 1318 | Female 56%<br>Mean age 17.8 (3.4) years | Register-based | **mSCOFF [MODIFIED for diabetes]** question 5 on food replaced with insulin restriction | Brief tool | **mSCOFF** 10.8% sample screened positive for DEB. Age related |

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| | | | Mean HbA1c 8.0 (1.3)%<br>60% CSII | | question. 2+ answers screened positive | | differences in DEB. Those with previous DEB had 26.7% probability of DEB at follow up over 3 years. Females more likely to develop and have persistent DEB over time. |
| Doyle 2017, USA [33] | Cohort | N=60 | 45% female.<br>Age 18-28 years, Mean age 21 (2.5) years.<br>HbA1c mean 8.4(1.8); Insulin pump 71.7% | Clinical | **Diabetes Eating Problems Survey Revised** - Higher scores indicate greater pathology, Score of ≥20 threshold for further evaluation. | NR | **DEPSR** 23.3% were DEPSR positive, 29.6% females and 18.2% males (NS). DEPSR score males 13.6(15.3) and females 15.0(10.2) (NS). |
| Luyckx, Belgium, 2019 [113] | Cohort | n=300 | Female 57%<br>Age 20.8 (3.3)<br>75% insulin injection | Recruited from diabetes registry | **Diabetes Eating Problem Survey Revised (DEPS-R) [MODIFIED]** Modified by removing references to ketones. Higher scores indicating more DEB | NR | **DEPS-R** Baseline scores 13.2 (10.5). At baseline, 26% had a score ≥18, which was relatively stable at 1 year follow up (27%). Within this group, 19% had persistent DEB, 8% increased and 7% decreased DEB over time. |
| Markowitz, 2013, USA [64] | Cohort | n=43 | Female: 45%<br>Young people, Mean age 13.3 (1.9) y<br>84% on basal-bolus regimen<br>HbA1c 8.3 (1.3)%<br>Mean zBMI 0.7(0.9) | Clinical | **Diabetes-specific Eating Problem Survey-Revised**-<br>Higher scores indicate greater disordered eating behaviours & ≥20 indicates high risk for disordered eating. | NR | **DEPSR** Two patients at baseline (4.7%) had a score of ≥20, indicating high risk for ED, 3 additional people had score ≥20 at follow up. |
| Palladinol, 2012, USA [70] | Cohort | N=244 (n=121 diabetes group, n=123 group without diabetes. 66-77% response rate | **Diabetes subjects:**<br>Female 53%<br>Adolescents, Mean age 18.2 (0.4)<br>Mean BMI 25.7 (4.0)<br>57.5% insulin pump,<br>Mean HbA1c 8.9 (1,8)%<br>**CONTROL**<br>Female 54%<br>Age 18.0 (0.5)<br>BMI 24.1 (4.7) | Clinical ; Control subjects from malls & physicians | **Eating Disorders Inventory [MODIFIED VERSION]:**<br>Three items of the drive for thinness subscale were removed as diabetes care artificially inflates ED presence | NR | **EDI:** Mean drive for thinness females 2.35(0.1), males 1.34 (0.09) p<.001. Mean bulimic symptoms females 1.61(0.06), males 1.33 (0.06) p<.001. |
| Rydall, 1997, Canada [84] | Cohort | n=107 88% response rate | Adolescents<br>Female 100%<br>Mean age 15(2)<br>BMI 22.3(3.1)<br>HbA1c 9.0(1.7)<br>78% 2 insulin injections/day. | Clinical | **Diagnostic Survey for Eating Disorders [MODIFIED VERSION]**- Modified to include insulin omission & under dosing. Highly disordered eating - ≥ 2x per week over previous 3 months; moderate disordered eating - ≥2x per week for 3 months; non-disordered eating for <2x per month for 3 months. | NR | **DSED** at baseline 29% had highly (n=9) or moderately (n=17) disordered eating behaviour. DEB persisted in 18% (n=16) with DEB at baseline at 4-5 year follow-up. Insulin misuse n=12 (14%) baseline, n=30 (34%) at follow up. |
| Troncone, 2018, Italy [93] | Cohort | n=81 | Female 48%<br>Mean age 7.9(1.5)<br>Mean HbA1c 8.16 (0.9)<br>Mean zBMI -0.19 (1.3), 31.4% overweight/ obese. | Clinical | **Problematic Eating Behaviours Examination Questionnaire (PEBEQ)** - Italian version. No Italian validated child measure available, therefore parental reported measure was used. Total score >8 classified as problematic | NR | n=32 (47.8%) with problematic eating behaviours (cut-off value of >8). |
| Goebel-Fabbri 2011, 2008, | Longitudinal | **Study 1:** n= 207. (57% | **Study 1:**<br>Female 100% | Clinical, 11 year follow | **Insulin misuse Screening statement** Any participants restricting insulin categorised as | NR | **Study 1:** n=60 insulin restricting at baseline, of these n=40 continued |

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| USA [42, 43] | | original cohort).<br>**Study 2:**<br>**n=**234<br>60% of the original cohort. | Age 13-60 years, Mean age 44(12) years<br>Mean BMI 25(5).<br>Mean HbA1c 7.9(1.3).<br>**Study 2:**<br>Mean age follow up 45(12) range 24-72.<br>BMI 25(5), mean HbA1c 7.9(1.3). | up | inappropriate insulin users.<br>**Bulimia test revised**<br>**Self-reported eating & weight concerns** designed for project.<br>**Eating disorders inventory** | | insulin restriction at follow up.<br>**Bulimia test revised** score participants continuing insulin restriction baseline 63.6(23.3), follow up 64.6(23.7); those who stopped insulin restriction baseline 62.6(28), follow up 46.2(16.9) (p<.05).<br>**Study 2:** n=71 reported insulin restriction at baseline (30%). **Bulimia test revised** symptoms IR 66.8 vs non IR 45.6 (p<.001). **EDI** symptoms IR 37.9 non IR 22.3(p<.001). |
| Helgeson 2007, 2009, USA [47, 48] | Longitudinal | **Study 1:**<br>n=263 (n=132 with diabetes, n=131 without diabetes)<br>66-77% response rate<br>**Study 2:**<br>diabetes only (n=132) | Adolescents<br>Diabetes n=70 girls, non diabetes n=67 girls.<br>Age 12.08(0.73) range 10.70-14.21 years.<br>BMI diabetes 22.05(4.36), non-diabetes 20.63(4.37) p<.01.<br>Mean HbA1c 8.04(1.31). | Clinical; Control health fairs & paediatric physician network | **Eating Disorder Inventory [MODIFIED VERSION]-** 3 items for drive for thinness subscale removed as they may be biased by diabetes- previous research has shown inclusion of these questions artificially inflated the presence of eating disturbances in diabetes | NR | **Study 1: Drive for thinness** T1 Diabetes Male 1.58, female 2.12, Healthy male 1.61, female 2.12.<br>**Bulimia** T1 Diabetes Male 1.66, female 1.66, Healthy male 1.63, Female 1.75.<br>**Study 2:** Baseline drive for thinness 1.86(0.97), Bulimic symptoms 1.66 (0.55). |
| Herpetz 2001, Germany [49] | Longitudinal | n=38.<br>(N=13 T1D, n=23 T2D) | **At 2 year follow up T1D**<br>Age 34.7(6.3), % male 23.1<br>BMI 27.0(6.0). Relative HbA1c 1.6(0.5) | Clinical | **Eating Disorder inventory** | NR | **EDI Drive for thinness** baseline 25.7(8.6), follow up 24.8(7.5) (NS)<br>**Bulimia** baseline 19.2(9.0), follow up 18.6(7.7) (NS) **Body dissatisfaction** baseline 33.3(15.3), follow up 41.1(6.9). (NS)<br>n=5 T1DM deliberately omitting insulin for weight loss. |
| Eisenberg Colman, 2018, US [107] | RCT | n=42 (treatment), n=48 (control) | Youth with T1DM. Mean age 13.8 (1.6), female 51%, mean HbA1c 8.2% (1.1) | Clinical | **Diabetes Eating Problems Survey Revised (DEPS-R)** Higher scores indicate greater endorsement of DEB | NR | **DEPS-R** Mean score at baseline 12.4 (10.1). No clinical cut-off reported. |
| Olmstead, 2002, Canada [69] | RCT | n=212 (phase 1 screening); 73% response rate<br>n=85 (phase | **Phase 1:**<br>Adolescent; Female 100%<br>**Phase 2**: age 16(2.0)<br>BMI 23.4(3.5)<br>HbA1c 9.1(1.5). | Diabetes clinic registry | **Eating Disorder Inventory**<br>**Diagnostic Survey for Eating Disorders [MODIFIED VERSION]** modified to include intentional insulin omission. DEB classified as score of ≥9 drive for thinness, ≥5 on the bulimia subscale or ≥15 on the body dissatisfaction on the EDI, or DEB using the | NR | **EDI/DSED**: 61.3% (n=130) screened as having disturbed eating attitudes or behaviours |

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| | | 2) | | | DSED | | |
| Colman 2018, USA [30] | Secondary analysis of RCT | n=148 (24% response rate), DEPS-R completed by n=90 (≥13 years) | 51.1% female<br>Age 8-16 years, Mean age 13.8 (1.6) years.<br>BMI 65.5% normal weight, 22.2% overweight, 12.2% obese.<br>Insulin regime 63.3% pump or both, 6.7% injections; mean HbA1c 8.2 (1.1) | Clinical | **Diabetes Eating Problems Survey Revised-**. Higher scores indicating more DEB. | NR | **DEPSR** mean score 12.4 (10.1); treatment 10.1 (7.6), control 14.59(11.7) (NS) |
| Eisenberg 2016, USA [35] | Secondary analysis of RCT | n=90 (N=42 treatment, n=48 control) | Age 13-16 years, mean age 13.8(1.6).<br>48.9% male.<br>BMI 22.7(4.0). | Clinical | **Diabetes Eating problem Survey Revised-** Higher scores indicating greater DEB. | NR | **DEPSR** Baseline DEB 12.4(10.1) |
| Alloway, 2001, USA [18] | Non randomised trial | n= 14 (n=8 treatment, n=6 wait list control) | Female: 100%<br>Age: treatment 3.25 (9.3), control 31.0 (10.3).<br>BMI treatment 29.4(2.2) control 27.8(6.4). | Clinical | **Eating attitudes test, Eating Disorder Inventory [MODIFIED VERSIONS]** 2 questions added on omitted insulin. Tools adapted for people with diabetes- removing questions that could result in an overestimation of eating disorder symptoms.<br>Criteria for sub-clinical disordered eating: EDI score 40+, Elevated score on at least one EDI symptom subscale, EAT score 17+ | NR | **Subclinical ED:** 14/91 (15.4%)<br>**Baseline EAT** treatment group 22.5(5.3) control group 30.8 (10.6)<br>**Eating disorder symptoms** treatment group 35.4(7.8) control 32.0(11.9)<br>**Insulin omission** treatment group 2.0(2.1) control 2.3 (2.1). |

CS= cross sectional, NR= Not reported, WC= weight concern, SC= shape concern, EC= eating concern, DFT= drive for thinness, BD= body dissatisfaction; unless otherwise specified, data is presented as mean(SD)

**Table 2:** Validity and reliability of tools to screen and identify disordered eating or eating disorders as reported in retrieved studies

| TOOL | Internal consistency | Test-retest reliability | Inter-rater and Intra-rater reliability | Criterion and concurrent validity | Construct validity | Content validity | Sensitivity and specificity |
|---|---|---|---|---|---|---|---|
| **AHEAD study questions** [34] | NR | NR | NR | NR | NR | NR | NR |
| **Binge Eating Scale** [71, 94] | NR | NR | NR | NR | NR | NR | NR |
| **Bulimia Screening Form** [89] | NR | NR | NR | NR | NR | NR | NR |
| **Bulimia Test (a modified version)** [61] | NR | NR | NR | NR | NR | NR | NR |
| **Bulimia Test Revised** [42, 43, 74] | Cronbach's α 0.95 [74] | NR | NR | NR | NR | NR | NR |
| **Bulimic Inventory Test of Edinburgh** [17, 38, 60, 78] | **Chinese** Good Cronbach's α 0.83 [17] | NR | NR | NR | NR | NR | 1 false negative compared to clinical interview [78] |
| **Bulimic Investigation Test** [71] | NR | NR | NR | NR | NR | NR | NR |
| **Diabetes Eating Problems Survey** [50, 52, 67, 85] | **Spanish** Good Cronbach's α 0.816 [85] | NR | NR | NR | **Spanish** agreement with DEPS-R kappa 0.8 (p<.001), correlation with DEPS-R 0.956 (p<.001). Good discriminate validity between genders [85] | NR | NR |
| **Diabetes Eating Problems Survey (a modified version)** [68] | NR | NR | NR | NR | NR | NR | NR |
| **Diabetes Eating Problems Survey Revised** [19, 21, 28, 30, 33, 35, 63, 64, 77, 85, 86, 92, 95, 96, 100-102, 104, 105, 107, 109-112, 121] | **English** Good Cronbach's α 0.86 adults 0.86 [122], acceptable 0.87 adolescents [105]. **Turkish** Good Cronbach α 0.847 (females 0.857, males 0.83) [19]. **Italian** good Cronbach's α = 0.81 - 0.83 [12, 103]. **Spanish** Good Cronbach's α 0.840 [85] **German** Good (Cronbach's a = 0.84 total sample, 0.87 girls & 0.76 boys). **Norwegian** Good 0.89 (0.81 males & 0.90 females) [95, 96] Adequate- | **Italian** High reproducibility ICC = 0.950 and substantial stability [12] **Spanish** acceptable stability ICC 95.8 (95%CI 91.8-97.9 p<.001), Spearman coefficient 0.861 [85] | NR | **Italian** Correlation between total score DEPS-R, EDI-3 (subscales and EDRC) , BMI, and HbA1C [12] **German** Criterion validity confirmed against HbA1c value, BMI & expert (clinician) report [86]. **Italian** Those with ED diagnosis using interview had higher DEPS-R scores compared to no diagnosis (p < 0.0001) [12] | **English** Correlated positively with zBMI, age, HbA1c and clinician reported insulin restriction. Neg correlation QoL and frequency of BG monitoring [63]. Correlated with the EAT-12 (0.65; P < 0.01). **German** Correlation with SCOFF & EDEQ (r=0.54 p<.001, r=0.70 p<.001 total sample; r = 0.37, P ≤ 0.000 & r = 0.50, P ≤ 0.000 for boys & r = 0.62, P ≤ 0.000 & r = 0.79, P ≤ 0.000 for girls). [86] **Turkish** confirmatory factor analysis X2/df 1.824 (good fit), RMSEA 0.064 (moderate fit), PCLOSE 0.057 (less than good fit), CFI 0.907 (traditional fit), GFI (Good fit), AGFI 0.855 (good fit), NFI 0.819 less than good fit [19]. **Italian** Confirmatory factor analysis- latent structure of subscales conformed with validation of original tool, incremental validity high in predicting a diagnosis of ED.[121] Construct, discriminant and external validity supported. [103] **Spanish** good discriminate validity between | **Spanish** content validity confirmed by experts [85] | **English:** Low specificity (25%), however only half of those screened agreed to formal diagnostic interview [109] |

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| | Cronbach's α 0.84 (0.84 females, 0.81 males)[111] | | | | genders. Kaiser Meyer Olkin test 0.798 & Bartlett sphericity test reached p<.001 which supports validity of the factor model. Agreement with DEPS kappa 0.8 (p<.001), correlation DEPS 0.956 (p<.001). Significant relationship with EAT-26 [85]<br>**Norwegian** Participants scoring above cutoff on DEPS-R had higher scores on the EAT-12 (P =.001), higher HbA1c (P=0.001), higher zBMI (P=0.001), older age (P=0.001), & greater consultations with the diabetes team (P = 0.01) [95, 96] Factor analysis- Kaiser Meyer Olkin value 0.92 & Bartlett test of sphericity reached statistical significance supporting the favourability of the correlation matrix; 3 components identified explaining 55% of variance [95, 96] | | |
| **Diabetes Eating Problems Survey Revised (a modified version)** [34, 66, 113] | **Belgium:** Cronbach α 0.87 baseline, 0.86 at follow up [113] | NR | NR | NR | NR | NR | NR |
| **Diagnostic Survey for Eating Disorders (a modified version)** [41, 53, 57-59, 69, 73, 81, 84] | NR | NR | NR | NR | NR | NR | NR |
| **Dutch Eating Behaviours Questionnaire** [55] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Attitudes Test 12** [95, 96] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Attitudes Test 26** [17, 20, 41, 45, 46, 79, 80, 85, 92, 94, 104] | **Chinese** Cronbach's α 0.76 [17] | NR | NR | NR | NR | NR | NR |
| **Eating Attitudes Test 26 (a modified version)** [25, 56] | Cronbach's α 0.80 [56] | NR | NR | NR | NR | NR | NR |
| **Eating Attitudes Test 40** [29, 38, 40, 53, 71, 72, 90] | **Turkish** Cronbach's α 0.89 [72] | NR | NR | NR | NR | NR | Sensitivity 75% & a specificity 60%, predictive value 27% [29] |
| **Eating Attitudes Test 40 (a modified version) (EAT 36)** [18, 29, 60, 78, 82] | NR | NR | NR | NR | NR | NR | EAT-36 produced 7 false positives AN & 1 false negative AN [78] |
| **Eating Disorder Examination Questionnaire** [37, 39, 44, 62, 86, 87, 100, 108] | **Portuguese** Cronbach's α global 0.91-0.95, restraint 0.82-0.84, eating concern 0.82-0.86, weight concern 0.80-0.82, shape concern 0.76-0.92 [37, 44] | NR | NR | NR | NR | NR | NR |

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| | **English** Adequate to high Cronbach's α 0.78-0.95 [62, 101] | | | | | | |
| **Eating Disorder Examination Questionnaire (a modified version)** [51] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory** [20, 42, 43, 49, 53, 56-59, 61, 69, 73, 79, 80, 89, 91] | Cronbach's α 0.82-0.90 [56, 57, 73] | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory (a modified version)** [18, 47, 48, 55, 65, 70, 90] | Cronbach's α bulimia subscale 0.72-0.77, drive for thinness 0.77-0.89 body dissatisfaction 0.89 [48, 65] | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory 2** [45, 46] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory 2 (a modified version)** [25] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory 3** [10, 54, 97, 121 10] | Cronbach's α body dissatisfaction subscale 0.76-0.83, drive for thinness 0.71, bulimia 0.79-0.83 [10, 54, 97] | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory 3 (a modified version)** [120] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Inventory 3 Risk Composite (a modified version)** [11, 31, 32] | High Cronbach α DT 0.88, bulimia α 0.77, BD α 0.94. DT high when diabetes related items removed (Cronbach α 0.87) [31, 32] | | | Correlations EDI-3RC scale scores & Risk Composite score with chEDE subscales ($p < 0.01$) & Global score ($p < 0.01$) [31, 32] | | NR | NR |
| **Eating Disorder Inventory Children's Version** [36, 91] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disorder Screen for Primary Practice (a modified version to include insulin restriction)** [26] | NR | NR | NR | NR | NR | NR | Insulin restriction question high specificity 96.3%, low sensitivity 24.6% [26] |
| **Eating Disorders Compensatory Behaviours Questions** [11] | NR | NR | NR | NR | NR | NR | NR |
| **Eating Disturbance Scale** [88] | Cronbach's α EDS-5 0.75 [88] | NR | NR | NR | NR | NR | NR |
| **Eating Habits Questionnaire (a modified version)** [75] | NR | NR | NR | NR | NR | NR | NR |

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|---|---|---|---|---|---|---|---|
| **Food and body image questionnaire (created by authors)** [37] | NR | NR | NR | NR | NR | NR | NR |
| **Insulin Misuse Screening Statement (created)** [42, 43] | NR | NR | NR | NR | NR | NR | NR |
| **Insulin Questionnaire (created by authors)** [55] | NR | NR | NR | NR | NR | NR | NR |
| **Insulin use 5 questions (created by authors)** [74] | NR | NR | NR | NR | NR | NR | NR |
| **mSCOFF** [99, 120] | NR | NR | NR | *Cut-off 1+ positive answer* Agreement mSCOFF & mEDI k=0.68 [95% CI 0.43–0.94]; *Cut-off 2+ positive answer* Agreement mSCOFF & mEDI k=0.40 [0.07–0.72] | NR | NR | *Cut-off 1+ positive answer* sensitivity 80% (95% CI 44–97%) & specificity 90% (76–98%); positive predictive value 75% (37–94%), negative predictive value 97% (76–100%) compared to modified EDI. *Cut-off 2+ positive answers* sensitivity 30% (7–65%), specificity 100% (89–100%); positive predictive value 100% (30–100%), negative predictive value 83% (67–93%) compared to modified EDI. [98] |
| **Power of Food Scale** [62] | NR | NR | NR | NR | NR | NR | NR |
| **Problematic Eating Behaviours Examination Questionnaire** [93] | **Italian** Cronbach's α 0.71 [93] | NR | NR | NR | NR | NR | NR |
| **Project EAT survey** [50] | NR | NR | NR | NR | NR | NR | NR |
| **Pyle Eating Behaviour Survey (a modified version)** [27] | NR | NR | NR | NR | NR | NR | NR |
| **Question from MIND Youth Questionnaire** [21, 34] | NR | NR | NR | NR | NR | NR | NR |
| **Questionnaire of Eating and Weight Patterns Revised** [83] | **French** Cronbach's α 0.71[83] | NR | NR | NR | NR | NR | NR |
| **SCOFF** [22-24, 86] | NR | NR | NR | NR | NR | NR | NR |
| **Screen for Early Eating Disorder Signs** [76] | Sound Cronbach's α overall 0.95, body image 0.92, feelings 0.90 [76] | NR | NR | NR | Convergent validity: correlated with similar factors (+0.47 SEEDS QoL & the Diabetes Distress Screening Scale; +0.86 SEEDS Body Image factor & EDE-Q SCs subscale; −0.73 SEEDS Feelings factor & the Rosenberg Self- | NR | NR |

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| | | | | | Esteem scale −0.82 SEEDS QoL factor & the Rosenberg Self-Esteem scale). Divergent validity: appropriately poorly correlated (all < \|0.30\|; range from 0.09 to 0.28) with values conceptually unrelated to SEEDS factors. [76] | | |
| **Insulin restriction question (created)** [23] | NR | NR | NR | NR | NR | NR | NR |
| **Eating/weight questions designed for project (created)** [42, 43] | NR | NR | NR | NR | NR | NR | NR |
| **Three Factor Eating Questionnaire** [62, 83] | Cronbach's α 0.80-0.91 [62] | NR | NR | NR | NR | NR | NR |
| **Youth Eating Disorder Examination Questionnaire (a modified version)** [31, 32] | High Cronbach α restraint 0.78, EC 0.75, WC 0.91, SC 0.95. [31, 32] | NR | NR | Concurrent validity with chEDE (n = 51) with sig ICC (p < 0.001): Restraint ICC 0.86 (95% CI 0.77–0.92), EC 0.76 (0.55–0.87), WC 0.78 (0.64–0.87) SC 0.76 (0.55–0.87) Global score 0.85 (0.75–0.91) [31, 32] | NR | NR | NR |

**Figure 1:** PRISMA flow diagram of studies included in the review

**Figure 2:** Risk of bias of studies included in the review

Highlights

- This review evaluates the reliability and validity of tools to assess disordered eating in T1D
- 48 individual tools have been used to assess disordered eating in people with T1D
- Many studies were deemed high risk of bias due to the use of non-validated tools
- Further validation including comparison to a diagnostic interview is needed

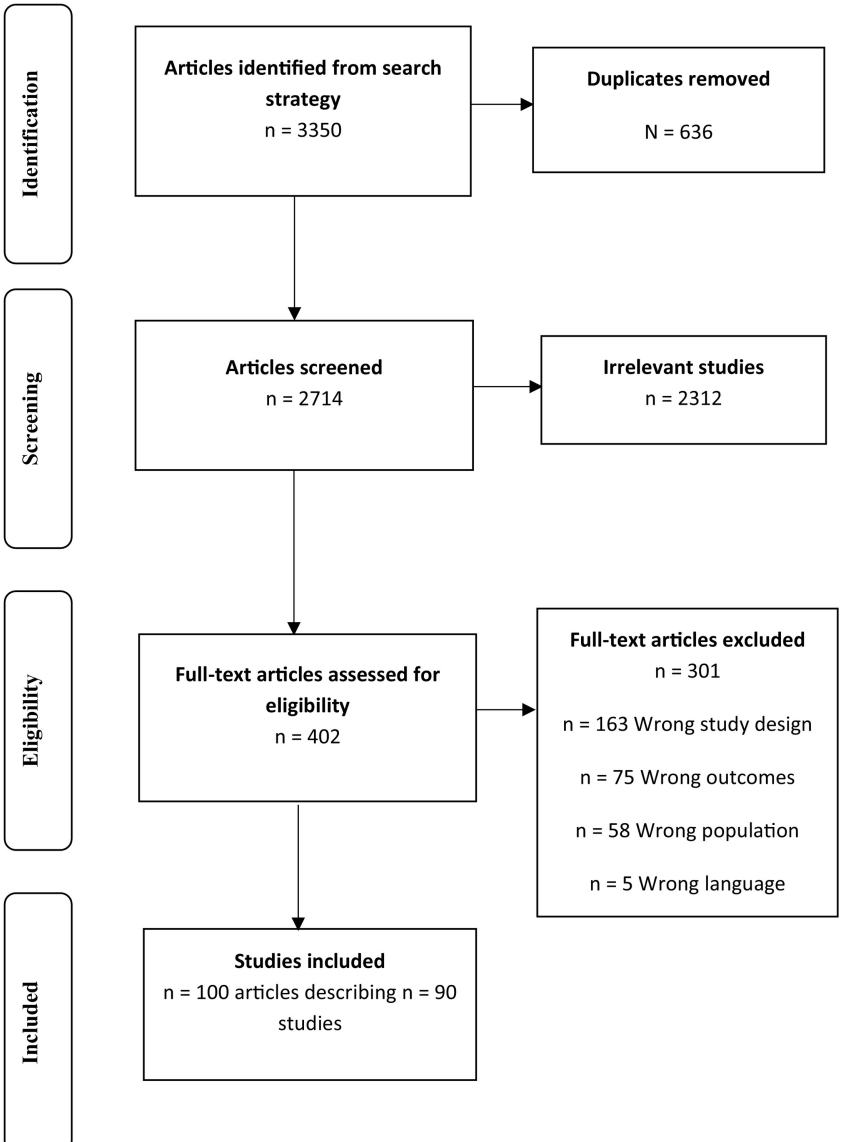
Identification
Articles identified from search strategy
n = 3350
Duplicates removed
N = 636
Screening
Articles screened
n = 2714
Irrelevant studies
n = 2312
Eligibility
Full-text articles assessed for eligibility
n = 402
Full-text articles excluded
n = 301
n = 163 Wrong study design
n = 75 Wrong outcomes
n = 58 Wrong population
n = 5 Wrong language
Included
Studies included
n = 100 articles describing n = 90 studies

Figure 1

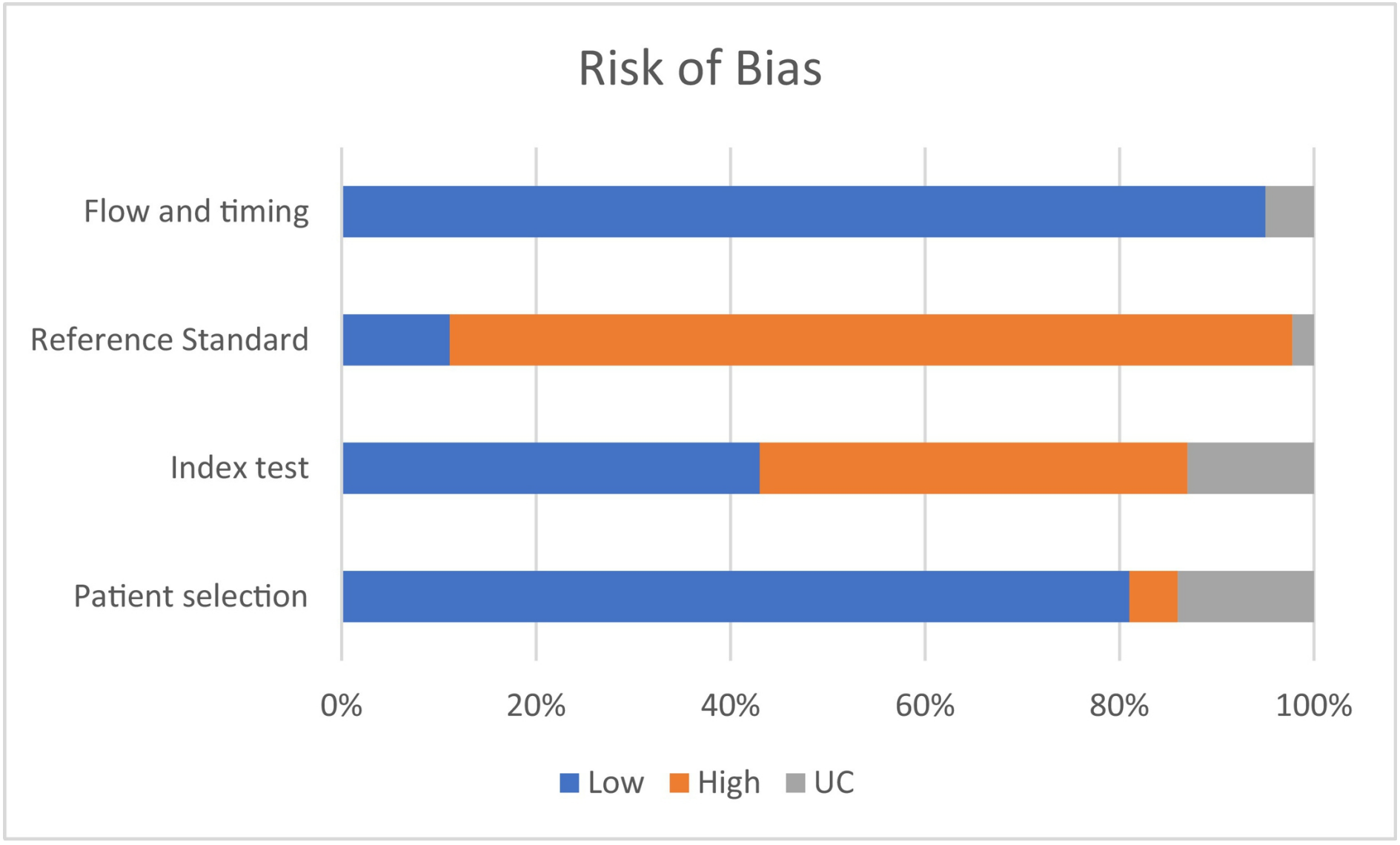
Risk of Bias
Flow and timing
Reference Standard
Index test
Patient selection
0%
20%
40%
60%
80%
100%
Low
High
UC

Figure 2