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SYSTEMATIC REVIEW

# Body Image Problems in Individuals with Type 1 Diabetes: A Review of the Literature

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## Abstract

Despite type 1 diabetes' (T1D) potential influence on adolescents' physical development, the occurrence of body image problems of adolescents with diabetes remains unclear. No research synthesis has yet addressed this issue. This study aims to systematically evaluate the empirical evidence concerning body image in individuals with T1D in order to provide an overview of the existing literature. Using PRISMA methodology, 51 relevant studies that fulfilled the eligibility criteria were found, the majority of them (N = 48) involving youth. The findings varied across studies: 17 studies indicated that in youth with T1D, body dissatisfaction was common and that body concerns were generally greater in youth with T1D than in controls; nine studies did not find any differences in body image problems between participants with and without T1D; three studies described higher body satisfaction in youth with diabetes than in controls; and three studies reported mixed results. Body concerns in individuals with T1D were often found to be associated with negative medical and psychological functioning. The variability and limits in assessment tools across studies, the overrepresentation of female subjects, and the fact that most research in this field is based on cross-sectional data are stressed in the interpretation of these mixed findings. Future research directions that could improve the understanding of body image concerns and clinical implications are discussed.

**Keywords** Adolescents · Youth · Body image · Type 1 diabetes · Systematic review

## Introduction

For individuals with type 1 diabetes (T1D), specific features of the illness and its management—such as dietary restrictions, weight variation, perception of living in an unhealthy body, and focus and attention on the body—are thought to contribute to the development of a negative body image (Colton et al., 1999; Shaban, 2010). Concerns and lack of satisfaction with their body, especially during adolescence, may lead to the development of unhealthy eating attitudes that could seriously increase the risk of poor glycemic control and long-term complications (Hanlan et al., 2013; Young et al., 2013). However, no general agreement has been reached as to whether body image problems are always found in individuals with T1D and whether significant differences exist between individuals with and without T1D in terms of body image. To date, no research synthesis has addressed this issue; therefore, this study aims to offer a systematic review that summarizes and analyzes the peer-reviewed literature over time on this topic.

It is worth noting that a great deal of literature has reported that body image is significantly associated with psychological functioning in general. In particular, body image has been found to meaningfully affect quality of life, self-esteem, sexual functioning (Grossbard et al., 2009; Nayir et al., 2016; O'Dea, 2012; Weaver & Byers, 2006; Woertman and van den Brink 2012). Additionally, some authors argue that negative body image has a negative effect on mood and on social anxiety and interpersonal/psychosocial functioning (Cash et al., 2004; Choi & Choi, 2016; Davison & McCabe, 2006; Holsen et al., 2001; Pawijit et al., 2017), in addition to promoting health-compromising behaviors (e.g., dieting, binge eating, lower levels of physical activity, unhealthy weight control behaviors), particularly during a time of difficult transition such as adolescence (Neumark-Sztainer et al., 2006). The generally-demanding

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process of maturation toward adulthood, the changes in the body due to pubertal development and growth, and the growing importance of appearance may favor a tendency toward problematic perceptions and dissatisfaction with their body size and shape during this critical time (Davison & McCabe, 2006; Paxton et al., 2006; Wertheim & Paxton, 2011). Several studies have identified the key role of body dissatisfaction in the development of disordered eating behaviors (DEBs), both in youth from the general population and in adolescents with T1D (Amaral & Ferreira, 2017; Araia et al., 2020; Girard et al., 2018; Striegel-Moore & Bulik, 2007). Recently, a meta-analysis was conducted of the results of 479 samples from 330 studies comparing body image in children and adolescents with chronic conditions to that in healthy controls (Pinquart, 2013). However, while this review examined a broad range of conditions (e.g., arthritis, cerebral palsy, visual impairment, cancer, epilepsy, spina bifida, hearing impairment, cystic fibrosis, inflammatory bowel disease), its focus on individuals suffering from T1D was limited (approximately 34[1]/330 studies).

## Current Study

Given the relevance of body image problems to the psychological functioning of youth, including those with T1D, and in order to obtain a more comprehensive understanding and a systematic evaluation of this issue, the present study seeks to identify existing main findings on body image in youth with T1D, along with current gaps in the literature that may serve as a guide for future investigations. In particular, this review attempts to answer the following research questions: what are the general demographics (e.g., gender, age), sample composition, and research design of the studies? What measures are used to assess body image problems? Which studies examining youth with T1D describe body image problems, and what demographic-/anthropometric-related differences are reported? How frequently are body image concerns reported as being related to eating problems? What other (illness-related and psychological) factors were described as being associated with body image problems? Critical summaries of each article (description of the study's design, aims, sample, measures of body image, major findings and limitations) are provided in Table 1. Studies explicitly comparing adolescents with adults, as well as those focusing solely on adults, are summarized at the end of Table 1.

[1] It was difficult to define the exact number of studies, because unpublished studies were also included and some were unavailable; therefore, it was not possible for the authors to verify the inclusion of diabetes patients.

# Methods

## Search Strategy and Study Selection

A systematic search was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009; Moher et al., 2009). A search for relevant literature was conducted in December 2020 and January 2021 to identify peer-reviewed articles evaluating body image in individuals with T1D. In order to detect all potential publications, no date ranges or limits were established. The following electronic databases were used in this search: PsycInfo, PsycArticles, PsycCRITIQUES, Pubmed, and Scopus. The search strategy utilized search terms for diabetes (i.e., "type 1 diabetes", "diabetic", "insulin dependent diabetes mellitus") combined with terms for body image (i.e., "body image", "body shape", "body dissatisfaction", "body concerns", "body image disturbances", "body image attitudes"). In addition, a manual search of relevant journals was carried out. Specifically, a carefully examination of the reference sections of articles was conducted to identify additional, potentially relevant records. Additionally, just before this paper was submitted, the searches were repeated in order to identify any new studies published in the relevant literature after the initial search.

The initial database search identified 635 articles (plus 10 articles identified through other sources) (Fig. 1). After duplicates (N = 361) were removed, 284 articles were then further considered and screened by their titles. Through title screening, articles reporting qualitative, case report, or treatment studies were excluded, along with commentaries, letters to editors, editorials, non-original studies (e.g., reviews and meta-analyses), books chapters, and study protocols (N = 52). The title screening step identified 232 full-text articles, which were retrieved and assessed for inclusion in this review based on the following inclusion criteria: (1) the original research was in English; (2) the study examined body image (and related aspects) in individuals with T1D; (3) the study presented quantitative data; (4) the full text was published in English.

Studies were excluded if they: (1) only measured body image in type 2 diabetes (T2D); (2) were not fully relevant (e.g., studies that focused exclusively on weight loss or nutrition and not on body image aspects). Titles and full texts were screened by two independent reviewers (AB, CC). A third independent reviewer (AT) was consulted in cases of uncertainty in order to reach agreement on the eligibility of the study. After an examination of 232 full texts, 181 studies were excluded because they did not include T1D samples (N = 116), did not focus on psychological dimensions (N = 8) or on body image (N = 11), had an inadequate design (N = 1), were not in English (N = 24),

**Table 1** Characteristics of the studies (N = 51) included in the review

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| *Studies focusing on youth* | | | | | | |
| 1. Ackard et al. (2008, USA) | Cross-sectional study | To compare the prevalence of DE and body dissatisfaction between adolescents with T1D and a population-based sample of youth | 143 (70) adolescents with T1D (15.3, 12–21 years) compared to 4746 (2357) controls from Project EAT (14.9, 11 or younger –18 or older years) | Items drawn from the project EAT survey, assessing body weight perception and satisfaction | Adolescents (both genders) with T1D reported higher levels of body satisfaction than controls (test value NR, m: p = 0.008, f: $p < 0.001$) | Small sample size<br>Absence of a control group<br>Due to the cross-sectional nature of the study, it is not possible to infer a causal relationship/temporal order between body dissatisfaction and the variables of interest<br>Low participants' response rate |
| 2. Araia et al. (2017, Australia) | Cross-sectional study | To examine gender differences in DEBs and body dissatisfaction in adolescents with T1D | 477 (295) adolescents with T1D (16, 13–19 years) | The Body Mass Index Silhouette Matching Test (BMI-SMT), assessing body dissatisfaction (differences between perceived actual and ideal size) | 88% of girls with T1D wanted to be thinner; 76% of boys reported body dissatisfaction (43% expressed a desire for thinness, 33% for a larger body size)<br>In both genders, body dissatisfaction correlated with eating binges (f: r = 0.45, $p < 0.001$; m: r = 0.26, $p < 0.01$), BMI (f: r = 0.39, $p < 0.001$; m: r = 0.42, $p < 0.001$), and DEBs (f: r = 0.67, $p < 0.001$; m: r = 0.42, $p < 0.001$), but not with diabetes duration (test value NR, $p$ = NR), or it differed by mode of management (injections vs. pumps) (test value NR, $p$ = NR)<br>For girls, body dissatisfaction also correlated with age (r = 0.20, $p < 0.01$) and insulin omission (r = 0.23, $p < 0.001$) | Low participant response rate<br>Limited representativeness of the sample (due to voluntary self-selection, variables assessed only by measures in English, overrepresentation of female adolescents and pump users, heterogeneity in sociodemographic background)<br>Single-item measures to assess eating binges and insulin omission do not provide underlying reasons |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 3. Araia et al. (2020, Australia) | Cross-sectional study | To examine the relationship between DE, body dissatisfaction, and psychological variables; to identify correlates of DE in youth with T1D | 477 (297) adolescents with T1D (15.7, 13–19 years) | Body Mass Index Silhouette Matching Test (BMISMT), assessing body dissatisfaction (differences between perceived actual and ideal size) | The magnitude of body dissatisfaction was almost five times higher in girls with T1D than in boys<br>In girls, only body dissatisfaction correlated (moderately) with diabetes distress, emotional well-being, diabetes-related resilience, quality of life, anxiety symptoms, depressive symptoms ($\pm 0.34 < r < \pm 0.43$, all $p < 0.001$)<br>For both genders, body dissatisfaction (along with diabetes distress) were the strongest predictors of disordered eating ($b = 0.36$, $p < 0.001$, additional 7% of unique variance) | Low participant response rate<br>Self-reported nature of clinical variables<br>Use of a single item to assess variables of interest (e.g., general quality of life) |
| 4. Bachmeier et al. (2020, Australia) | Cross-sectional study | To profile the clinical and psychosocial characteristics of young people with diabetes; to assess the use and acceptance of a diabetes psychosocial assessment tool | 155 (87) adolescents and young adults (149 with T1D, 4 with T2D, 2 other) (20.7, 18–25 years) | 2 items evaluating current body weight/shape concerns developed for this study | T1D individuals (both genders) reported significant weight (27.1%) and shape (26.6%) concerns<br>Body weight (test value NR, $p = 0.007$) and shape (test value NR, $p < 0.001$) concerns were significantly higher in female participants than in male participants | The assessment measures (i.e., DPAT form) were not offered to all eligible participants (only to 64.6%)<br>Poor discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 5. Baechle et al. (2014, Germany) | Case-control study | To compare prevalence of DEBs in intensely-treated youth with early-onset T1D and peers from the general population | 629 (289) adolescents with early onset T1D (15.3, 11–17 years) compared to 6813 (2218) peers (14.6, 11–17 years) | 1 item from SCOFF assessing satisfaction with body weight | Female and male participants with T1D reported lower body dissatisfaction than peers (f: 22.9% vs. 31.9%, $\chi^2=0.632$, $p=0.002$; m: 8.3% vs. 15.7%, $\chi^2=0.521$, $p<0.001$) | Methodological differences (e.g., procedure in questionnaires' completion and differences in some items) and time-related differences between the diabetes and the comparison groups (participants in a nationwide survey, KiGGS); may have biased the comparison between the two study groups |
| 6. Benioudakis (2020, Greece) | Cross-sectional study | To evaluate the illness perceptions in individuals with T1D using an insulin pump (CSII) and those using MDI | 109 (76) adolescents and adults with T1D (32.6 years, 18–46 and older) | 1 item to assess the representation of body image with the insulin pump developed for this study (added to a modified version of Brief IPQ) | Participants with T1D in the CSII group reported higher negative impact on body image due to insulin pump use than that reported by participants in the MDI group ($U=2363$, $p<0.0001$) | Only volunteers with T1D were invited to participate<br>No questions about HbA1c or dangerous medical conditions (hypoglycemia/hyperglycemia)<br>The survey was only conducted in Greek |
| 7. Blicke et al. (2015, Germany) | Cross-sectional study | To examine whether awareness of personal resources (positive beliefs, social support) affects metabolic control in children and adolescents with T1D | 78 (37) adolescents with T1D (13.88, 11–17 years) | Self-perception and Body Awareness subscale (8 items) of Essen Resource Inventory for Children and Adolescents (ERI-KJ), assessing self-perception and body awareness | Body awareness was inversely correlated with HbA1c values ($r=-0.28$, $p=0.016$) | No discussion of limitations |
| 8. de Wit et al. (2012, Holland) | Cross-sectional study | To describe the development and psychometric evaluation of the Monitoring Individual Needs in Diabetes Youth Questionnaire (MY-Q) self-report measure, which assesses health-related quality of life in adolescents with T1D | 84 (44) adolescents with T1D (14.4, 10–18 years) | 1 item specifically assessing body satisfaction from Monitoring Individual Needs in Diabetes Youth Questionnaire (MY-Q) | Lower score on body image item was negatively associated with higher HbA1c values ($r=-0.26$, $p=0.019$) and with younger age ($r=-0.23$, $p=0.038$)<br>Girls reported more body image problems than boys (76.49 vs. 83.50, $p=0.021$, $d=0.52$) | No discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 9. Eilander et al. (2017, Holland) | Cross-sectional study | To explore the prevalence of DEBs and associated psychological and clinical factors; to establish concordance between adolescents–parents and adolescents–clinicians with respect to DEBs | 103 (53) adolescents with T1D (13.5, 11–16 years) and their parents | Items of MIND Youth Questionnaire (MY-Q), assessing body satisfaction | Half of the adolescents with T1D reported body concerns<br>In the T1D sample, there were no gender differences in body satisfaction ($t = 1.96$, $p = 0.053$); concern about body image was higher in those with DEBs (test value NR, $p < 0.001$)<br>Adolescents with T1D and parents showed slight agreement ($k = 0.126$, $N = 94$) with regard to adolescents' body satisfaction | Due to cross-sectional data, it is not possible to infer causality<br>Validity, sensitivity, and specificity of assessment measures (e.g., DEB measures) not sufficiently studied<br>Methodological differences in questionnaire completion procedure |
| 10. Engström et al. (1999, Sweden) | Case-control study | To evaluate the prevalence of EDs in adolescent girls with T1D compared to matched healthy controls; to study relationships between eating behavior, body proportions, insulin treatment, and metabolic control in diabetic patients | 89 female participants with T1D (mean age: 16.3, 14–18 years) compared to 89 healthy female controls (mean age: 16.4 years, NR) | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | Adolescents with T1D reported higher body dissatisfaction than controls (test value NR, $p = 0.019$) | No discussion of limitations |
| 11. Erkolahti and Ilonen (2005, Finland) | Case-control study | To find differences in the school achievement of adolescents with 2 different kinds of chronic illnesses compared to healthy adolescents; to analyze correlation between self-image and school grades | 21 (12) adolescents with T1D (17.9 years, NR)<br>24 (13) adolescents with rheumatoid arthritis (17.9 years, NR)<br>24 (13) control adolescents (17.6 years, NR) | Body Image scale from the Offer Self-Image Questionnaire (OSIQ), assessing the extent to which adolescents feel positively or negatively about their bodies | Adolescents with T1D (as well as those with RA) did not differ in Body Image scores from healthy adolescents (test value NR, $p = $NR)<br>Body image did not correlate with scholastic grades (all $p > 0.05$) in the T1D ($r = 0.32$), rheumatoid arthritis ($r = 0.08$), or control ($r = 0.23$) groups | Small sample size<br>No information about the direction of the relationship between self-image and the variables of interest |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 12. Erkolahti et al. (2003, Finland) | Case-control study | To determine differences in self-concept between chronically ill (T1D and rheumatoid arthritis) and healthy adolescents | 23 (12) adolescents with T1D (17.8 years, NR)<br>25 (13) adolescents with rheumatoid arthritis (17.9 years, NR)<br>26 (14) control adolescents (17.6 years, NR) | Body Image scale from the Offer Self-Image Questionnaire (OSIQ), assessing the extent to which adolescents feel positively or negatively about their bodies | Adolescents with T1D (as well as those with rheumatoid arthritis) did not differ in Body Image scores from the healthy adolescents (test value NR, $p$ = NR)<br>In the whole sample, no differences were found between girls and boys (test value NR, $p$ = NR) | No discussion of limitations |
| 13. Falcão and Francisco (2017, Portugal) | Case-control study | To compare DE and body image dissatisfaction among adolescents and young adults with T1D and their peers without T1D; to investigate the consequences of diabetes for food, body image, and weight; to identify the use of insulin omission as a weight loss strategy | 55 (37) adolescents and young adults with T1D (24.78, 18–30 years)<br>compared to 73 (62) youth and young adults without T1D (22.67, 18–30 years) | Shape and Weight Concern subscales from Eating Disorder Examination-Questionnaire (EDE-Q), assessing shape and weight concerns<br>Contour Drawing Rating Scale (CDRS), assessing body image dissatisfaction<br>Items formed a 20-item self-report questionnaire developed specifically for this research to evaluate T1D participants' perceptions about body image | Participants with T1D did not differ from controls on shape ($t = -0.979$, $p = 0.330$) or weight ($t = -0.909$, $p = 0.365$) concerns<br>Body image dissatisfaction significantly predicted DE in participants with T1D ($b = -0.751$, $p < 0.001$) but not in controls ($b = -0.157$, $p > 0.05$) | Differences between participants with T1D and without T1D (e.g., unequal distribution with respect to the gender and the age of participants)<br>Presence of health problems (not identified as chronic diseases) was not controlled in the control group<br>Self-reported nature of psychological variables may have favored responses given as a result of social desirability or at random<br>Limited exploration of insulin omission behavior<br>Variables of interest were assessed by measures not specific for individuals with T1D; may have affected the comparison between the two study groups |
| 14. Fällström and Vegelius (1978, Sweden) | Case-control study | To analyze the validity of the Rorschach test in clinical assessment | 16 girls with T1D (mean age: NR, 7–15 years)<br>compared to 16 healthy girls (mean age: NR, 7–15 years) | Rorschach items devoted to identifying body image problems | Children with T1D showed higher indicators of body image disturbances than controls (penetration item D-estimate = −0.7500) | No discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 15. Gawlik et al. (2016, Australia) | Cross-sectional study | To evaluate associations between the appearance investment component of body image and diabetes adjustment (as quality of life, metabolic control, and insulin misuse) | 177 girls and women with T1D (36.32, 18–68 years) | The Appearance Schemas Inventory to assess Self-evaluative salience (the extent to which individuals define self-worth by their physical appearance) and Motivational salience (actual engagement in appearance management behaviors) | Body image perception was associated with all diabetes adjustment indicators: Self-evaluative salience correlated with diabetes quality of life ($r=-0.40$, $p<0.001$), HbA1c values ($r=0.28$, $p<0.001$), and age ($r=-0.35$, $p<0.001$). Self-evaluative salience was higher among those who reported higher HbA1c values ($F=6.80$, $p<0.01$) and those who restricted insulin for weight control ($F=7.86$, $p<0.001$) | No discussion of limitations |
| 16. Grylli et al. (2010, Austria) | Cross-sectional study | To explore differences in self-regulation in adolescent girls with T1D with and without EDs | 76 adolescent girls (17.2 years, NR) with T1D compared to 23 adolescent girls with T1D and ED (mean age: NR, NR) | Negative body self subscale from The Narcissism Inventory–90, assessing an experience of the body as repulsive and ugly | Girls with T1D and an ED showed higher negative body self than girls with T1D without an ED ($t=-3.4$, $p=0.001$) | Small sample size (low number of adolescent girls with T1D diagnosed for EDs)<br>Due to the cross-sectional nature of the study, it is not possible to infer a causal relationship between the variables of interest<br>Absence of a control group |
| 17. Hartl et al. (2015, Germany) | Longitudinal study | To test whether body image mediates the association between perceived family climate and changes in glycemic control | 109 (51) adolescents with T1D (15.84, 13–19 years) | Frankfurter Scales of Body Concept (FKKS), assessing body image (as body strength and competence, attractiveness, and feelings) | For single adolescents with T1D, body image mediated associations between family climate and changes in glycemic control ($b=-0.24$, $p=0.007$)<br>For dating adolescents with T1D, body image did not mediate the association between family climate and changes in glycemic control ($b=0.00$, $p>0.05$) | Limited representativeness of the sample (sample composed primarily of German adolescents)<br>Defects in the assessments of confounding variables (e.g., BMI, glycemic control) and of family climate<br>Study design limits (half-longitudinal) may have influenced the results |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 18. Kaminsky and Dewey (2013, Canada) | Case-control study | To examine ED symptoms and body image in adolescents with T1D, along with the related variables of social support, self-esteem, health locus of control | 46 (27) adolescents with T1D (15, 12–18 years) compared to 27 (13) adolescents seen for bone fracture at an orthopedic clinic (14.9, 12–18 years) as control group | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction<br>Body Esteem Scale for Adolescents and Adults (BESAA), assessing body esteem regarding appearance, weight, and attribution | Adolescents with T1D showed a healthy body image, which did not differ from the control group ($F=0.00$, $p=0.99$) nor the reported greater body dissatisfaction ($F=0.42$, $p=0.52$)<br>In T1D adolescents, a higher powerful others external locus of control was significantly correlated with a more positive body image ($r=0.41$, $p=0.01$)<br>In both the T1D and control groups, positive body image correlated with EDs (as drive for thinness $r=-0.58$, $p<0.01$; bulimia $r=-0.51$, $p<0.01$); being male, higher levels of social support, and a powerful other's locus of control were associated with lower body dissatisfaction ($R^2=0.34$, $p=-0.003$) and a more positive body image ($R^2=0.50$, $p<0.001$) | Low response rate (16% adolescents with T1D, 7% comparison peers)<br>Small sample size<br>A lack of data about diabetes control (i.e., A1C levels)<br>Use of self-report measures for variables of interest (e.g., weight and height)<br>Due to the cross-sectional nature of the data, it is not possible to infer causality or directional relationships between variables |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 19. Kaminsky and Dewey (2014, Canada) | Case-control study | To examine the associations between BMI and physical activity with body image, self-esteem, and social support in adolescents with T1D | 46 (27) adolescents with T1D (15, 12–18 years) compared to 27 (13) adolescents seen for bone fracture at an orthopedic clinic (14.9, 12–18 years) as control group | The Body Esteem Scale for Adolescents and Adults (BESAA), assessing body esteem regarding appearance, weight, and attribution | Adolescents with T1D showed a healthy body image, which did not differ from the control group ($F=0.00$, $p=0.99$)<br>In girls with T1D (but not in boys, $p=$NR), those with higher BMI had less positive body image ($t=-0.46$, $p=0.03$)<br>In both the T1D and control groups, a more positive body image did not correlate with higher levels of physical activity (test value=NR, $p=$NR) | Low response rate (16% adolescents with T1D, 7% comparison peers)<br>Small sample size<br>A lack of data about diabetes control (i.e., A1C levels) and mode of insulin delivery<br>Use of self-report measures for variables of interest (e.g., weight and height)<br>Due to the cross-sectional nature of the data, it is not possible to infer causality or directional relationships between variables |
| 20. Kichler et al. (2008, USA) | Cross-sectional study | To investigate correlation of maladaptive eating attitudes and behaviors in female adolescents with T1D and its relationship with treatment adherence and glycemic control | 75 female adolescents with T1D (14.1, 11–17 years) | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | Body dissatisfaction correlated with BMI ($r=0.42$, $p<0.01$) and with adolescents' negative perception of familial and peer communication ($r=0.62$, $p<0.01$)<br>Body dissatisfaction predicted maladaptive eating behaviors ($b=0.57$, $p<0.01$) and moderated the relationship between negative communication and maladaptive eating attitudes and behaviors ($b=0.48$, $t=4.24$, $p<0.01$) | Use of self-report measures for variables of interest completed only by parents and adolescents<br>Measures used were not exhaustive in evaluating all facets of the variables under examination<br>The context in which variables were assessed may have limited the participants' disclosure (e.g., about their endorsement of unhealthy weight control behaviors such as insulin misuse)<br>Due to the cross-sectional nature of the data, it is not possible to infer causal relationships between variables |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 21. Maharaj et al. (2003, Canada) | Cross-sectional study | To examine the contribution of adolescent self-concept, maternal weight and shape concerns, and mother–daughter relationships to eating disturbances among girls with T1D | 88 adolescent girls with T1D (15.0, 11–19 years) and their mothers | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction<br>Items from Self-Perception Profile for Adolescents, assessing self-concept in the area of physical appearance | Adolescents with T1D and DE showed higher body dissatisfaction ($F=60.42$, $p=0.0005$) and poorer self-concept about their physical appearance ($F=19.45$, $p=0.0005$) than non-DE participants<br>Adolescents' perceived physical appearance was a significant independent predictor of eating disturbances (23% of the variance, $F=24.43$, $p=0.00005$)<br>Adolescents' self-concept in the area of physical appearance mediated the link between maternal weight and shape concerns and adolescent eating disturbances ($pr=0.42$, $p=0.00005$), and partially mediated the link between mother–daughter relationships and adolescent DE status ($pr=0.25$, $p=0.003$) | Due to the cross-sectional nature of the data, it is not possible to infer causality or directional relationships between variables<br>Some potentially salient variables/relevant risk factors (e.g., the role of father–daughter relationships and paternal weight concerns, genetic predisposition for weight and shape concerns, the role of maternal depression, poor family relationship) were overlooked<br>Limited representativeness of the sample (composed solely of girls with T1D) |
| 22. Markowitz et al. (2009, North America) | Cross-sectional study | To identify a rapid screening approach to detect DEBs in adolescent girls with T1D and to examine the relationship between DEBs and body weight | 90 adolescent girls with T1D (14.3, 12–19 years) | Shape and Weight Concern subscales from Eating Disorder Examination-Questionnaire (EDE-Q), assessing shape and weight concerns | Majority of participants (50% more of the study sample) had Shape and Weight Concerns scores within the clinical (pathological) range, compared to a normative sample | Use of self-report measures for variables of interest (e.g., weight and height, HbA1c)<br>Limited representativeness of the sample (partly composed of self-selected participants, with over-representation of pump users) |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 23. McCraw and Tuma (1977, USA) | Case-control study | To examine differences between youth with and without T1D on Rorschach content categories | 25 (15) youth with T1D (10.9, 8–16 years) compared to 25 (15) youth without T1D (10.9, 8–16 years) | Rorschach items devoted to identifying body image problems | Children with T1D did not show impaired body image compared to controls (test value NR, $p$ = NR) | No discussion of limitations |
| 24. Meltzer et al. (2001, North American) | Cross-sectional study | To examine the relationship between disordered eating attitudes and behaviors, BMI, and glycemic control in adolescents with T1D | 152 (70) adolescents with T1D (14.45, ages 11–19 years) | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | Girls (not boys, $t = -0.498$, $p > 0.05$) with T1D reported significantly less body dissatisfaction ($t = -3.097$, $p < 0.05$) compared to a normative healthy sample<br>A higher BMI was a significant predictor of greater body dissatisfaction, more so for female ($R^2 = 0.271$ $p < 0.0001$) than male ($R^2 = 0.103$, $p < 0.03$) participants<br>Body dissatisfaction was a significant predictor of EDs (drive for thinness), more so for female ($R^2 = 0.484$, $p < 0.0001$) than male ($R^2 = 0.185$, $p < 0.001$) participants | No discussion of limitations |
| 25. Neumark-Sztainer et al. (1995, North American) | Case-control study | To compare body dissatisfaction and unhealthy weight-loss practice among adolescents with and without a chronic illness | 2149 adolescents and young adults, 210 (NR) with T1D (14.9, 12–20 years) compared to 1381 adolescents and young adults without chronic illness (mean age: NR, NR) | 3 items developed for this study assessing weight dissatisfaction, body pride, concern with body development | Girls ($11.20 < \chi^2 < 32.33$, $.001 < p < 0.05$) and boys (although less pronounced for the latter) ($17.91 < \chi^2 < 34.78$, $.001 < p < 0.003$) with a chronic illness (including those with T1D) reported higher body image problems (as weight dissatisfaction, body pride, concern with body development) than those without a chronic illness | Use of self-report measures for variables of interest (e.g., eating practices, height and weight, etc.)<br>Recruitment procedure may have generated sample selection biases |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 26. Neumark-Sztainer et al. (1996, USA) | Case-control study | To compare dieting, binge eating, and purging behaviors among adolescents with and without T1D | 310 (158) adolescents with T1D (14.9, 12–18 years) compared to 850 (409) adolescents without chronic illness (mean age: NR, NR) | 3 items developed for this study assessing weight dissatisfaction, concern with body development, weight perception | Female participants with T1D (but not male, $\chi^2 = 0.4$, $p > 0.05$) showed higher weight concerns, dissatisfaction (test value NR, all $p < 0.01$), and concerns with body development (perceiving themselves as overweight) ($\chi^2 = 11.8$, $p < 0.01$) than female participants without T1D<br>In female (but not in male) participants with T1D ($B = 0.32$, $p < 0.001$) and without T1D ($B = 0.11$, $p < 0.05$), weight dissatisfaction predicted binge eating and purging behaviors | Use of self-report measures for variables of interest (e.g., presence of chronic condition)<br>Poor discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 27. Neumark-Sztainer et al. (2002, North American) | Cross-sectional study | To examines the prevalence of specific weight control practices/DEBs and their associations with sociodemographic characteristics, BMI and weight perceptions, family functioning, and metabolic control among adolescents and young adults with T1D | 143 (70) adolescents and young adults with T1D (15.3, 12–21 years) | Items assessing weight perceptions and weight control behaviors drawn from the Project EAT (Eating Among Teens) Survey | In both genders, weight dissatisfaction was associated with DEBs (f: $r=0.40$, $p=0.001$; m: $r=0.31$, $p=0.013$)<br>Boys (test value NR, $p<0.001$) and girls (test value NR, $p=0.013$) who perceived their weight as heavier reported more frequent unhealthy weight control behaviors than those without such a perception<br>Girls (test value NR, $p=0.005$) (but not boys, test value NR, $p=0.314$) reporting higher rates of body dissatisfaction were more likely to engage in unhealthy weight control behaviors than those with lower rates of body dissatisfaction | Low response rate (58%)<br>Due to the cross-sectional study design, it is not possible to infer or discuss causality<br>Small sample size<br>Limited representativeness of the sample (due to homogeneity in sociodemographic background) |
| 28. O'Brien et al. (2011, England) | Cross- sectional study | To examine the extent to which adolescents' perceptions of their mother's weight loss and eating attitudes and behaviors explained the adolescents' DEBs | 82 female adolescents with T1D (15.8 years, NR) and their mothers | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body image dissatisfaction | T1D adolescents' body dissatisfaction was predicted by their perceptions of their mother's frequency of dieting behavior ($b=0.522$, $p<0.001$), lack of family cohesion ($b=-0.247$, $p=0.036$), and mother's belief that self/daughter is heavier than ideal ($b=0.275/.313$, $p=0.020/.009$) | Small sample size<br>Methodological limits in questionnaire completion procedure may reduce the generalizability of the results |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 29. Olmsted et al. (2008, Canada) | Longitudinal study | To identify predictors of the onset of DEBs in adolescent girls with T1D | 126 girls with T1D (11.9, 9–13 years) | Shape and weight concern subscales from (Children and Adult) Eating Disorder Examination, assessing shape and weight concerns<br>Items from Self-Perception Profile for Adolescents, assessing self-concept in the area of physical appearance | Weight and shape concerns (21.0% of the variance, $\chi^2 = 22.09$, $p < 0.0001$) and perceived poor self-concept about physical appearance (20.0% of the variance, $\chi^2 = 20.80$, $p < 0.0001$) were among the strongest predictors of DEB<br>Weight and shape concerns and perceived physical appearance scores were in the normal range and did not differ from those observed in an age-matched group of school-aged girls collected in a parallel study (test value NR, $p$ = NR) | Small sample size<br>Some potentially relevant risk factors to the prediction of variables of interest (e.g., DEB) were overlooked<br>Limited representativeness of the sample (composed solely of girls with T1D) may reduce the generalizability of the findings |
| 30. Peducci et al. (2019, Italy) | Cross-sectional study | To investigate disturbed eating behavior and eating patterns in an adolescent population with T1D | 85 (51) children and adolescents with T1D (13.4, 8–14 years) | Shape and Weight Concern subscales from Eating Disorder Examination-Questionnaire (EDE-Q), assessing weight and shape concerns | Children with T1D scored higher in the Shape and Weight concern subscales than in the Restraint and Eating concern subscales ($F = 9.289$, $p = 0.021$)<br>Girls reported higher shape ($t = 3.36$, $p < 0.001$) and weight ($t = 3.24$, $p < 0.001$) concern than boys<br>Adolescents reported higher shape ($t = 6.11$, $p < 0.00001$) and weight ($t = 5.72$, $p < 0.00001$) concern than preteens | Absence of a control group<br>Not fully validated Italian version of DEB assessment measure |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 31. Peterson et al. (2018, North America) | Cross-sectional study | To examine whether disease-related factors (disease- and treatment-based disruption in hunger and satiety) contribute to bulimic symptoms in youth with T1D | 43 (23) adolescents with T1D (12.86, 10–17 years) | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | Female participants with T1D had higher body image dissatisfaction than male participants ($t = -2.19$, $p < 0.05$)<br>Body dissatisfaction correlated with bulimic symptoms ($r = 0.32$, $p < 0.05$), HbA1c values ($r = 0.32$, $p < 0.05$), and depressive symptoms ($r = 0.71$, $p < 0.01$) | DEB assessment measure does not evaluate T1D-specific form of purging (insulin manipulation); dietary restraint assessed by a single item<br>Due to the cross-sectional design, it is not possible to determine the causal or directional nature of the relationship between variables<br>Small sample size<br>A lack of data about diabetes control (e.g., mode of insulin delivery and dosing, hypoglycemia experience or meter download)<br>Inconsistency across participants in the method of measuring some variables (e.g., height and weight) |
| 32. Pinar (2005 Turkey) | Case-control study | To determine the prevalence of DEBs and the relationship between DEBs and body image and metabolic control | 45 (23) adolescents with T1D (15.49, 12–18 years) compared to 55 (27) non-diabetic healthy control participants (15.49, 12–18 years) | The Body Image Scale (BIS), assessing level of concern about body shape and body dissatisfaction | Adolescents with T1D showed no higher body dissatisfaction than healthy peers ($t = -1.86$, $p > 0.05$)<br>In the T1D sample, girls had higher body dissatisfaction than boys ($t = 3.64$, $p < 0.001$)<br>In both the T1D ($r = -0.155$) and controls ($r = -0.080$) groups, body dissatisfaction did not correlate with ED ($p > 0.05$)<br>In the T1D group, body dissatisfaction did not correlate with BMI ($r = -0.192$, $p > 0.05$) | Small sample size<br>Poor discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 33. Powers et al. (2012, USA) | Case-control study | To describe characteristics of patients with ED and T1D and compare them with those with an ED and no T1D | 48 (47) adolescents and adults with T1D diagnosed with an ED (mean age: 26.2 years, NR) compared to 96 (94) adolescents and adults with ED and no-diabetes in a matched comparison sample (mean age: NR, NR) | The Body Image Assessment (BIA), assessing body distortion as differences between perception of current and ideal body size<br>Shape and weight concerns subscales from the Eating Disorders Examination—Questionnaire (EDE-Q), assessing shape and weight concerns<br>Body dissatisfaction subscale from Eating Disorders Inventory-3 (EDI-3), assessing body dissatisfaction | Individuals with an ED and T1D did not differ in body distortion (test value NR, $p = 0.097$), weight concerns (test value NR, $p > 0.05$), or body dissatisfaction (test value NR, $p > 0.05$) from individuals with an ED and no diabetes<br>Individuals with an ED and T1D reported fewer shape concerns than individuals with ED and no diabetes (test value NR, $p = 0.047$) | No discussion of limitations |
| 34. Powers et al. (2017, USA) | Cross-sectional study | To evaluate associations between diabetes distress and a range of psychological health concerns among adolescents and adults with T1D | 268 (153) adolescents and adults with T1D (mean age: NR, > 12 years) | Shape and weight concerns subscales from the Eating Disorders Examination—Questionnaire (EDE-Q), assessing weight and shape concerns<br>Body Shape Rating Scale, assessing current and ideal body shape | T1D individuals with high diabetes distress reported greater shape (test value NR, $p < 0.001$) and weight concerns (test value NR, $p < 0.001$) than those with low or moderate distress, regardless of age<br>T1D individuals aged < 18 years with high diabetes distress perceived a larger current body shape than those with low or moderate distress (test value NR, $p < 0.001$) | Due to the cross-sectional study design, it is not possible to infer temporal order or causality between variables<br>DEB assessment measures were designed for the general population, which may lead to confusion and/or misinterpretation of some items |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 35. Robertson et al. (2020, Australia) | Cross-sectional study | To explore the impact of externally-worn diabetes technologies on sexual behavior and activity, body image, and anxiety in adopters and non-adopters of these devices | 285 (152) adolescents and adults with T1D (34.5, 16–60 years) | Stunkard figure rating scales assessing body dissatisfaction (as difference between current perceived and ideal body size) | There were no differences in body image dissatisfaction between technology users (CSII, CGM) and nonusers (CGM/CSII $z = -0.68/0.10$, $p > 0.05$) | Limited representativeness of the sample (due to low response rate, overrepresentation of technology users, and heterogeneity in sociodemographic background) reduce the generalizability of the results |
| 36. Sullivan (1979, North America) | Cross-sectional study | To report on the development of a scale for assessment of life adjustment (i.e., Diabetic Adjustment Scale) | 150 female adolescents with T1D (13.8, 12–16 years) | Items from Diabetes Adjustment Scale (DAS), evaluating body image concerns | Higher adjustment in body image areas correlated with positive attitude toward diabetes ($r = 0.29$, $p < 0.01$), dependence/independence issues ($r = 0.27$, $p < 0.01$), and general adjustment to diabetes ($r = 0.77$, $p < 0.05$) | Limited representativeness of the sample (composed solely of female participants studying at a camp for girls with T1D, with homogeneous socioeconomic features) |
| 37. Svensson et al. (2003, Sweden) | Case-control study | To investigate eating behavior in male adolescents with T1D | 109 male adolescents with T1D (16.6, 14–18 years) compared to 139 male controls without T1D (16.4, 14–18 years) | Body Dissatisfaction subscale from Eating Disorder Inventory for children (EDI-C), assessing body dissatisfaction | Male adolescents with T1D did not show higher body dissatisfaction than control participants (test value NR, $p > 0.05$) | Poor discussion of limitations (only one reference to small sample size) |
| 38. Swift and Seidman (1964, North America) | Case-control study | To investigate psychological differences (personality, general adjustment, family characteristics) between youth with and without T1D | 50 (25) youth with T1D (11.66, 7–17 years) compared to 50 (25) youth without T1D (11.7, 7–15 years) | Items assessing body image concerns from drawings tests (drawing of opposite sex person, House-tree-person/HTP) and Rorschach items | 8 of the 11 measures (HTP and Rorschach, e.g., mutilated/damage body, body concerns) indicated a greater pathological body image in youth with T1D than in controls<br>Self-perception (as damaged and mutilated person) was positively associated with unsatisfactory diabetes control ($r = NR$, $p = 0.03$) and with dependence–independence ($r = NR$, $p = 0.001$) | Poor discussion of limitations (only one reference to limits on the representativeness of the sample) |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 39. Swift et al. (1967, North America) | Cross-sectional study | To evaluate personality, general adjustment, family characteristics, and relationships with the diabetes control of youth with T1D | 40 (15) youth with T1D (11, 2–20 years) | Items assessing body image concerns from drawings tests (drawing of opposite sex person, House-tree-person/ HTP) and Rorschach items | 20% of youth with T1D perceived damaged, mutilated body image; 35% perceived being inadequate, inept<br>The better the body image, the better the control (r = NR, $p = 0.001$) | Absence of a control group<br>Recruitment procedure may have generated sample selection biases<br>Limited representativeness of the sample (due to homogeneity in socioeconomic features) |
| 40. Troncone et al. (2018, Italy) | Longitudinal study | To examine changes over a 5-year period in body image accuracy and dissatisfaction, as well as relationships with DEBs, in young patients with T1D | 67 (33) children with T1D (first assessment: 7.86, 5.1–10.06 years; at follow-up: 12.7, 10.07–15.08 years) | Collins's body image silhouette chart, assessing body size perception and satisfaction | Children with T1D perceived themselves as thinner than their real weight (t = 16.046, $p < 0.001$) and showed a desire to be thinner than their real body size (t = 15.893, $p < 0.001$)<br>The general tendency towards body size underestimation (i.e., perceiving the body to be smaller than it is) (F = 1.415, $p = 0.24$) and dissatisfaction (F = 1.499, $p = 0.22$) were found to be unchanged at follow-up<br>Degree of body dissatisfaction predicted DEBs (b = 0.272, $p < 0.05$) | Small sample size<br>Absence of a control group<br>Lack of causal and directional inferences between the variables of interest (e.g., DEBs and body image features)<br>Limits on the accuracy of the measurement method and instruments (e.g., self-report questionnaires filled in by parents) |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 41. Troncone et al. (2016, Italy) | Case – control study | To evaluate body image perception and satisfaction in children with T1D | 81 (39) children with T1D (8.11, 5–10 years) compared to 219 (109) healthy control participants (mean age: NR, NR) | Truby and Paxton's Children's Body Image Scale, assessing the perception and satisfaction of body size | Children ($t = 5.603$, $p < 0.001$) with T1D and controls ($t = 11.140$, $p < 0.001$) showed underestimation and dissatisfaction ($t = -0.962$, $p < 0.01$) with their body size<br>Children with T1D, especially girls, were more accurate in their perception of body size than the control group ($F = 4.654$, $p < 0.05$)<br>In both the T1D and control groups, those with higher weight underestimated their body size more ($F = 30.238$, $p < 0.001$) and were more dissatisfied ($F = 25.766$, $p < 0.001$) than those with lower weight | Limited representativeness of the sample (small sample with all participants from the same geographical area)<br>Need for longitudinal observations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 42. Troncone et al. (2020a, Italy) | Case-control study | To examine body image problems and their associations with DEBs in adolescents with T1D and in healthy peers | 183 (98) adolescents with T1D (15.29, 13.02–18.05 years) compared to 183 (98) control participants (15.35, 13.05–18.06 years) | Sociocultural Attitudes Towards Appearance Questionnaire-4R (SATAQ-4R), assessing body image problems as internalization of the thin ideal and perceived sociocultural appearance-related pressures<br>The Body Dissatisfaction subscale from Eating Disorder Inventory – 3 Referral Form, assessing body dissatisfaction | Participants with T1D reported higher body dissatisfaction than controls ($t=4.219$, $p<0.0001$); in both groups, girls reported higher body dissatisfaction than boys (T1D: $t=-4.150$, $p<0.0001$, controls: $t=-4.591$, $p<0.0001$)<br>Adolescents (both genders) with T1D did not display more body image problems (as thin ideal internalization and appearance pressure) than controls (test value NR, $p>0.05$)<br>Girls with T1D were found to be more pressured by family ($t=2.258$, $p=0.025$) but less by media ($t=-2.308$, $p=0.022$) to improve their appearance and to attain a thin body than were girls in the control group<br>Body image problems predicted DEBs in boys and girls with T1D (internalization of thin m: $b=0.372$, $p<0.001$; pressure from significant others m: $b=0.418$, $p=0.001$; pressure from media f: $b=0.243$, $p=0.029$) and in controls | Limited representativeness of the sample (due to voluntary self-selection and participants recruited all from the same diabetic center)<br>Limits on the accuracy of the measures (e.g., self-report questionnaires)<br>Due to the cross-sectional nature of the study, it is not possible to infer a causal relationship between the variables of interest |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 43. Troncone et al. (2020b, Italy) | Cross-sectional study | To examine associations of DEBs with body image problems, parents' eating disorder symptoms, and emotional and behavioral problems among adolescents with T1D | 200 (98) adolescents with T1D (15.24, 13–18 years) and their parents | Sociocultural Attitudes Towards Appearance Questionnaire-4R (SATAQ-4R), assessing body image problems as internalization of the thin ideal and perceived sociocultural appearance-related pressures<br>The Body Dissatisfaction subscale from Eating Disorder Inventory – 3 Referral Form, assessing body dissatisfaction | Adolescents (male and female) with T1D had higher body dissatisfaction and body image problems (as thin ideal internalization and appearance pressure) than did a normative sample ($-84.708 \leq t \leq -14.360$, all $p < 0.005$)<br>Girls with T1D showed higher body dissatisfaction ($t = -4.852$, $p < 0.001$) than boys<br>Adolescents with T1D and DEBs showed higher levels of body dissatisfaction ($t = 2.578$, $p = 0.011$) and body image problems ($2.703 \leq t \leq 4.603$, $.001 \leq p \leq 0.010$) than adolescents with T1D but no DEBs<br>In both genders (m: $b = 0.307$, $p < 0.01$; f: $b = 0.440$, $p < 0.001$), pressure to conform to societal norms about body image predicted DEBs | Limited representativeness of the sample (due to small sample size, voluntary self-selection, participants recruited all from the same geographical area)<br>Due to the cross-sectional nature of the study, it is not possible to infer a causal relationship between the variables of interest<br>Absence of a control group<br>Limits on the accuracy of the measurement method and instruments (e.g., self-report questionnaires filled in by parents) |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 44. Wilson et al. (2015, England) | Cross-sectional study | To examine risk factors for EDs in young people with T1D | 50 (30) adolescents with T1D (mean age: NR, 14–16 years) | Shape and weight concerns subscales from Child Eating Disorder Examination (cEDE), assessing shape and weight concerns | Female participants with T1D showed higher weight and shape concerns than male participants (test value NR, $p < 0.05$)<br>Higher shape and weight concerns were seen among adolescents with T1D who reported any ED behaviors (test value NR, $p < 0.003$)<br>Preliminary evidence indicated that BMI was higher in girls with T1D with shape and eating concerns ($F = 3.47$, $p = 0.046$) than in boys with T1D but no concerns ($F = 0.24$, $p = 0.79$) | Small sample size<br>Limits on the accuracy of the measures (e.g., interview)<br>Sample selection biases limited the representativeness of the sample (e.g., inclusion of boys, girls, mothers, and fathers) |
| *Studies explicitly comparing adolescents with adults* | | | | | | |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 45. Khan and Montgomery (1996, England) | Case-control study | To investigate age-related differences between adolescents with T1D and age-matched controls in eating attitudes and disorders | 48 girls with T1D (17.02, 13–20 years) compared to 48 healthy girls (17.02, 13–20 years) | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | Participants with T1D showed higher body dissatisfaction than controls ($F = 9.18$, $p < 0.005$). At age 13–14 years, girls with T1D scored higher than control participants on body dissatisfaction ($F = 2.86$, $p < 0.05$); by age 19–20 years, they scored within the same pathological range as control participants ($F = 6.7$, $p < 0.001$). In both T1D and control participants, 13–14 year old girls showed lower body dissatisfaction than other age groups (data NR)<br>Body dissatisfaction did not correlate with attitudes around restricting eating (test value NR, $p > 0.05$.) and did not differ between those who omitted insulin and those who did not (test value NR, $p > 0.05$) | No discussion of limitations |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 46. Philippi et al. (2013, Brazil) | Cross-sectional study | To evaluate the frequency of risk behaviors for EDs in patients with T1D and their association with gender, nutritional status, and variables related to T1D and body satisfaction | 189 (141) adolescents and adults with T1D (26, 12–56 years) | Stunkard's Figure Rating Scale assessing body dissatisfaction (as difference between perceived and ideal body size) | 76.2% (n = 144) of the individuals with T1D were dissatisfied with their bodies<br>Body dissatisfaction was higher in those at risk of ED (test value NR; $p < 0.001$) than those not at risk of ED, in those who were overweight than those at normal weight (they want to be thinner, test value NR, $p < 0.001$), among female participants than male participants (77.8 vs. 22.2%; test value NR, $p = 0.001$), and in those who omitted insulin (want to be thinner, $p < 0.001$); body dissatisfaction was the same between adults and adolescents (test value NR, $p = 0.755$) | The assessment measure (e.g., DEB measures) was not fully validated for the Brazilian version<br>DEB assessment measures designed for the general population, which may increase false positive rates<br>Limited representativeness of the sample (due to heterogeneity in sociodemographic and clinical features)<br>Absence of a control group |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 47. Rancourt et al. (2019, North American) | Cross-sectional study | To examine associations among constructs included in the T1D-modified dual pathway model; to examine age as a moderator of these associations | 818 individuals with T1D: 307 (144) adolescents (15.71, 13–17 years), 313 (196) young adults (21.20, 18–25 years), and 198 (135) adults (30.51, 26–35 years) | The Body Image subscale from the Screen for Early Eating Disorder Signs (SEEDS), assessing body dissatisfaction | Young adults and adults with T1D showed higher body dissatisfaction than adolescents ($p < 0.001$, $n^2 = 0.05$)<br>Across all age cohorts, greater body dissatisfaction was significantly associated with DEBs ($r = 0.64$, $p < 0.01$), dietary restraints ($r = 0.39$, $p < 0.01$), greater diabetes-specific negative affect ($r = 0.48$, $p < 0.01$), zBMI ($r = 0.20$, $p < 0.01$), and HbA1c values ($r = 0.08$, $p < 0.05$)<br>The associations between body dissatisfaction and DEBs ($b = 0.41$, $p < 0.05$) and body dissatisfaction and dietary restraints ($b = 0.37$, $p < 0.05$) were strongest for young adults | Methodological limits in participant enrollment procedure and significant differences between responders and non-responders may reduce the generalizability of the results<br>Some potentially salient variables (e.g., gender, age, blood glucose data from CGM) were not examined<br>Poor psychometric properties of the hunger/satiety disruption measure<br>Due to the cross-sectional nature of the study design, it is not possible to infer causal relationships between the study variables and DEBs |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 48. Verbist and Condon (2019, United Kingdom) | Cross-sectional study (and qualitative analysis) | To examine predictors of DEBs and body image dissatisfaction among the T1D population; to qualitatively explore the relationship between T1D management and body image concerns | 121 (106) adolescents and adults with T1D (36, 18–60 years) | Body Image States Scale (BISS), assessing satisfaction with perception of body image<br>Two open-ended questions assessing personal experience on body image concerns | Body image-dissatisfied participants were more likely to be frequent social network users ($\chi^2 = 5.58$, $p = 0.02$), with no differences detected between age groups (test value = NR, $p = 0.026$). Age was found to not be significantly associated with body image satisfaction (test value = NR, $p$ = NR)<br>Body image satisfaction negatively correlated with DEBs (rho = − 0.710, $p < 0.001$), BMI (rho = − 0.467, $p < 0.001$), and social network use (rho = − 0.291, $p = 0.001$)<br>Body image satisfaction uniquely predicted 27.5% of DEBs' occurrence (b = − 0.619, $p < 0.01$)<br>Body image satisfaction was predicted by BMI ($R^2 = 0.232$; b = − 0.466, $p < 0.01$) and social network use ($R^2 = 0.299$; b = − 0.26, $p < 0.01$)<br>The lack of control over body weight gain, limitation in clothing options, and discomfort around medical equipment were the most frequent factors reported as a cause for body image dissatisfaction | Due to the cross-sectional nature of the study, it is not possible to infer a causal relationship between the variables of interest<br>Absence of a control group<br>Some potentially salient variables (e.g., metabolic control and comorbidity data) were not examined<br>Limits on the accuracy of the measures (e.g., self-report online questionnaires, uncertainty in questionnaire scoring procedure, variables only assessed by measures in English)<br>Limited representativeness of the sample (e.g., gender bias with low male response rate) |
| *Studies focusing solely on adults* | | | | | | |

**Table 1** (continued)

| Author (year, country) | Study design | Aims | N participants (female), (mean age, age range) | Body image measure(s) | Results | Limitations |
|---|---|---|---|---|---|---|
| 49. Herpertz et al. (2001, Germany) | Longitudinal study | To determine the course of EDs over a period of 2 years, along with the related variables of body- and self-acceptance, BMI, glycemic control, and psychiatric symptomatology | 13 (10) adults with T1D (34.7 years, NR) and an ED<br>23 (16) adults with T2D (49.9 years, NR) and an ED | Body Dissatisfaction subscale from Eating Disorder Inventory (EDI), assessing body dissatisfaction | At the 2-year follow-up, body dissatisfaction did not increase in the T1D group (test value NR, $p > 0.05$) but it did increase in the average obese T2D sample (test value NR, $p < 0.01$) | Small sample size<br>The duration of the follow-up period was short<br>Limited representativeness of the recruited type-2 diabetes patients |
| 50. Mcdonald et al. (2021, Australia) | Cross-sectional study | To test the relationship between body image disturbances and psychosocial outcomes (quality of life, anxiety, depression) in individuals with diabetes and individuals with an amputation | 212 adults (85) with diabetes (46 with T1D) (64.4, 21–89 years)<br>227 (68) adults with an amputation (58.54, 20–91 years) | Body Image Disturbance Questionnaire (BIDQ), assessing subjective body image disturbance<br>The Appearance Schemas Inventory, assessing an individual's psychological investment in their physical appearance (as Self-evaluative salience, the extent to which individuals define self-worth by their physical appearance; and as Motivational salience, actual engagement in appearance management behaviors)<br>The Body Image Ideals Questionnaire (BIQ) to assess actual-ideal discrepancy appearance | For individuals with diabetes (and with an amputation), body image experience, psychological investment in physical appearance, and self-ideal discrepancy all predicted psychosocial outcomes.<br>Body image disturbances mediated the relationship between personal investment in appearance and psychosocial outcome (estimate = 0.102) and partially mediated the relationship between self-ideal discrepancy and psychosocial outcome (estimate = 0.185) ($\chi^2 = 48.80$, $p = 0.003$) | Due to the cross-sectional design and data, it is not possible to infer causal relationships between variables<br>Convenience samples, which limit the representativeness of the results<br>Use of self-report measures for variables of interest (e.g., BMI)<br>Some potentially relevant variables (e.g., illness-specific constructs, such as diabetes-related distress or fear of hypoglycemia) were overlooked |
| 51. Rockliffe-Fidler and Kiemle (2003, United Kingdom) | Cross-sectional study | To examine psychological factors (adjustment to diabetes, depression, anxiety, sexual self-esteem, body satisfaction, expectations/satisfaction with sexual functioning) relevant to sexual functioning in women with diabetes | 18 women with T1D (43.7, 24–64 years)<br>25 women with T2D (56.3, 35–83 years) | 5-point body-satisfaction scale designed for this study, assessing body dissatisfaction | Approximately half of the women reported being dissatisfied with their body<br>Body satisfaction significantly correlated with BMI ($r = -70.51$, $p = 0.001$)<br>Body satisfaction was not significantly correlated with sexual functioning (r = NR, $p$ = NR) | Recruitment procedure shortcomings and self-selection for participation may have favored low response rates and sample selection biases and may have limited the representativeness of the sample |

did not report quantitative data (N = 18) or relevant evidence (N = 2), or the full text was not available (N = 1) (Fig. 1). (All excluded studies are listed in Online Appendix 1.) Consequently, a total of 51 articles met all of the selection criteria and were included in the review (Fig. 1).

## Results

### Synthesis of Study Characteristics

The number of participants with T1D across studies ranges from 13 (Herpertz et al., 2001) to 629 (Baechle et al., 2014). Of the 51 papers included in this literature review, three studies were conducted with adults (19 years and older) (Herpertz et al., 2001; Mcdonald et al., 2021; Rockliffe-Fidler & Kiemle, 2003); 14 had samples comprising both adolescents [according to the WHO's (1986) definition from ages 10 to 19] and adults (e.g., Bachmeier et al. 2020; Rancourt et al., 2019; Robertson et al., 2020); 27 studies were conducted with adolescents only (e.g., Araia et al., 2020; Hartl et al., 2015; Peterson et al., 2018; Wilson et al., 2015); six studies used a sample comprising both children and adolescents (e.g., Olmsted et al., 2008; Peducci et al., 2019); and one study sample consisted exclusively of children (Troncone et al., 2016). In terms of gender, 12 studies were conducted with only female participants (e.g., Gawlik et al., 2016; O'Brien et al., 2011), and 38 with both male and female participants (e.g., Benioudakis, 2020; Verbist & Condon, 2019; Wilson et al., 2015). Only one study (Svensson et al., 2003) was conducted exclusively with male participants. The majority of the studies (n = 29) were cross sectional in design (e.g., O'Brien et al., 2011; Philippi et al., 2013; Powers et al., 2017); 18 were case–control studies (e.g., Falcão & Francisco, 2017; Troncone et al., 2020a) and four were longitudinal studies (e.g., Hartl et al., 2015; Troncone et al., 2018). In terms of sample composition, 24 studies had a sample consisting only of individuals with T1D (e.g., Blicke et al., 2015; de Wit et al., 2012); 14 studies had samples with both T1D and control participants (e.g., Baechle et al., 2014; Falcão & Francisco, 2017); four studies had samples of T1D adolescents and their parents (e.g., Eilander et al., 2017; Troncone et al. 2020b); three studies had participants with T1D and T2D (Bachmeier et al. 2020; Herpertz et al., 2001; Rockliffe-Fidler & Kiemle, 2003); and six studies had participants with T1D and other illnesses (e.g., individuals with rheumatic arthritis, bone-fracture patients, individuals with an amputation, individuals with an eating disorder -ED) (e.g., Kaminsky & Dewey, 2013, 2014; Mcdonald et al., 2021).

**Table 1** (continued)

*T1D* type 1 diabetes, *BMI* body mass index, *EDs* eating disorders, *DEBs* disordered eating behaviors, *DE* disordered eating, *HTP* House-tree-person, *MDI* multiple daily injection, *CSII* continuous subcutaneous insulin infusion, *CGM* continuous glucose monitoring, *NR* not reported

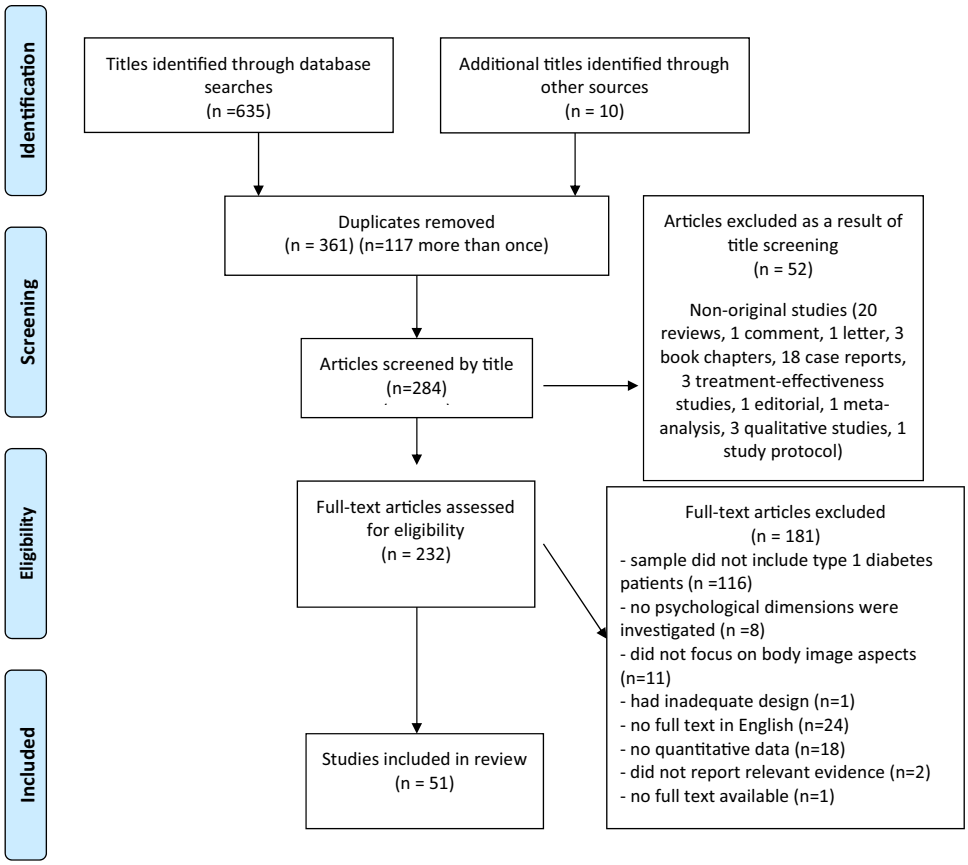


**Fig. 1** PRISMA flow chart describing the study selection process

## Measurement of Body Image

A range of screening and assessment methods have been developed and used to identify body image perception and to measure several aspects of body image problems. Therefore, the ways in which body image was conceptualized and assessed varies across studies. Of the 51 studies included in this literature review, the majority (n = 30) used subscales and items from existing tools (e.g., Body Dissatisfaction subscale from the Eating Disorder Inventory; Shape and Weight Concern subscales from the Eating Disorder Examination-Questionnaire) (e.g., Eilander et al., 2017; Peducci et al., 2019; Peterson et al., 2018) or used individual self-report tools (n = 10) designed for the general population (e.g., Body Image Scale; Body Image Disturbance Questionnaire; Sociocultural Attitudes Towards Appearance Questionnaire) (e.g., Gawlik et al., 2016; Troncone et al. 2020a, b). Additionally, six studies developed questionnaires/items specifically for the study (e.g., Bachmeier et al. 2020; Benioudakis, 2020). Overall, in these studies, body image problems were mainly defined—and therefore assessed—as thoughts or judgments about one's body (or body parts) or evaluations and perceptions of one's general appearance (i.e., body shape/weight concerns, body dissatisfaction, body image disturbances/distortions, weight perception and satisfaction, concern with body development, body pride); as facets of self-concept (i.e., body image concept, physical self-evaluative and motivational salience, physical self-concept, negative body self, body esteem, self-perception and body awareness); or as the internalization of the thin ideal and the perceived sociocultural appearance-related pressures or positive/negative feelings about their body.

Additionally, eight studies used body silhouette charts (e.g., Body Image Assessment, Stunkard figure rating scales, Collins's body image silhouette chart) (e.g., Araia et al., 2017, 2020; Falcão & Francisco, 2017) designed to generally measure size accuracy (perception of current body size and own weight category) and body satisfaction (difference between perceived body size and ideal body size); four studies used projective tests (e.g., drawing tests, Rorschach) or items evaluating general body image impairment and disturbances (e.g., Fällström & Vegelius, 1978; McCraw & Tuma, 1977); and one study used two open-ended questions exploring personal experience of body image concerns along with a self-reported body image measure (Verbist & Condon, 2019).

## Body Image Problems

Thirty-three studies (out of 51) sought either to directly evaluate the presence of body image problems or to subsequently measure other variables. Of these 33 studies, 18 (one of which focused on adults) reported body concerns in diabetes patients, while 12 did not and three reported mixed results. Specifically, 11 studies described significant body image problems—viewed as body image dissatisfaction (e.g., Eilander et al. 2017; Philippi et al., 2013), weight and shape concerns (Bachmeier et al., 2020; Peducci et al., 2019), perceived damaged/inadequate body image (Swift et al., 1967), and body size misperception (Troncone et al., 2018)—in adolescents with T1D. Shape and weight concerns were especially present in adolescents and adults with T1D with high diabetes distress compared to those with low/moderate distress (test values NR, $p < 0.001$) (Powers et al., 2017). Of these 11 studies, one was conducted with adults with T1D and similarly indicated that participants were dissatisfied with their body (Rockliffe-Fidler & Kiemle, 2003). Moreover, seven case–control studies reported greater body dissatisfaction, shape concerns, and an attitude of negative body image in individuals with T1D (mainly samples of female children and adolescents) than in healthy peers or controls without T1D (e.g., Markowitz et al., 2009; Troncone et al. 2020b).

Conversely, nine studies found no significant differences in body image problems between participants (mainly adolescents of both genders) with and without T1D (e.g., Falcão & Francisco, 2017; Kaminsky & Dewey, 2013, 2014). Particularly, in one study, male adolescents with T1D did not show higher body dissatisfaction than control participants (test value NR, $p > 0.05$) (Svensson et al., 2003). Three studies (Ackard et al., 2008; Baechle et al., 2014; Meltzer et al., 2001) reported that adolescents with T1D of both genders (in Meltzer et al., 2001, only girls) even had a higher body level of body satisfaction than controls without T1D. In terms of the three studies reporting mixed results, one study indicated that female adolescent participants with T1D showed higher weight concerns, dissatisfaction (test value NR, all $p < 0.01$), and concerns-body development (perceiving themselves as overweight, $\chi^2 = 11.8$, $p < 0.01$) than female participants without T1D, while male participants with T1D did not differ from male controls ($\chi^2 = 0.4$, $p > 0.05$) (Neumark-Sztainer et al., 1996). In another study, children with T1D ($t = 5.603$, $p < 0.001$) and controls ($t = 11.140$, $p < 0.001$) showed similar levels of underestimation and dissatisfaction ($t = -0.962$, $p < 0.01$) with body size; additionally, girls with T1D were more accurate in their perception of body size than the control group ($F = 4.654$, $p < 0.05$) (Troncone et al., 2016). In another study, while adolescents with T1D reported higher body dissatisfaction than controls ($t = 4.219$, $p < 0.0001$), they did not display more body image problems (as thin ideal internalization and appearance pressure) (test value NR, $p > 0.05$) than controls did; female participants with T1D were found to be more pressured than female controls by family ($t = 2.258$, $p = 0.025$) but less by media ($t = -2.308$, $p = 0.022$) to improve their appearance and to attain a thin body (Troncone et al., 2020a).

The 18 studies (out of 51) that did not directly evaluate the presence of body image problems mainly: explored body image so as to identify any association with other variables (HbA1c values, diabetes adjustment, family climate, maladaptive eating behaviors, BMI, quality of life, etc.) (e.g., Blicke et al., 2015; O'Brien et al., 2011); carried out comparisons among youth with T1D grouped by gender, presence of EDs, type of insulin therapy, etc. (e.g., Powers et al., 2012; Wilson et al., 2015); evaluated body image as a mediator of psychological outcomes (Hartl et al., 2015); or assessed changes in body image dissatisfaction in adults with T1D (Herpertz et al., 2001). It is worth noting that among these, two studies focused on the impact of diabetes insulin devices in adolescents and adults with T1D, describing higher negative body representation (as insulin pump use effect) in multiple daily injection users than in continuous subcutaneous insulin infusion (CSII) users ($U = 2363$, $p < 0.0001$) (Benioudakis, 2020) or finding no differences in body image dissatisfaction between technology (CSII, continuous glucose monitoring—CGM) users and nonusers (CGM/CSII $z = -0.68/0.10$, $p > 0.05$) (Robertson et al., 2020).

### Gender Differences

Of the 12 studies looking at gender differences and clearly comparing male and female individuals with T1D, most ($n = 11$) showed that girls/women had significantly higher rates of body image dissatisfaction and body weight and shape concerns than boys/men (e.g., Araia et al., 2017, 2020; Bachmeier et al. 2020). Although no direct mean comparisons were carried out, in other studies, dissatisfaction with weight means reported by girls with T1D ($13.9 \pm 4.0$) were higher than those reported by boys with T1D ($5.4 \pm 2.7$) (Ackard et al., 2008); girls reported higher body dissatisfaction (22.9%) than boys (8.3%) (Baechle et al., 2014); both girls ($11.20 < \chi^2 < 32.33$, $0.001 < p < 0.05$) and boys (although less pronounced) ($17.91 < \chi^2 < 34.78$, $0.001 < p < 0.003$) with chronic illness (including T1D) reported higher body image problems—as weight dissatisfaction, body pride, and concern with body development—than those without chronic illness (Neumark-Sztainer et al., 1995). In contrast, another study found no gender differences in body satisfaction ($t = 1.96$, $p = 0.053$) in a sample of 103 Dutch adolescents with T1D (Eilander et al. 2017), as well as in a sample of 23 Finnish adolescents with T1D ($p = \text{NR}$) (Erkolahti et al., 2003).

### Age Differences

Of the 14 studies with samples comprising both adolescents and adults with T1D, only four directly compared adolescents with adults. Of these four studies, two did not detect differences between age groups (test value NR, $p = 0.755$, Philippi et al., 2013) (test value NR, $p =$ NR, Verbist & Condon, 2019), one found body image dissatisfaction to be higher in adults than in adolescents ($p < 0.001$, $n^2 = 0.05$) (Rancourt et al., 2019), and one indicated that 13–14 year old girls' body dissatisfaction was lower than that of the other age groups (older adolescents and young adults), regardless of diabetes (data NR) (Khan & Montgomery, 1996). Similarly, when different age groups of adolescents with T1D were directly compared, teens reported higher shape ($t = 6.11$, $p < 0.00001$) and weight ($t = 5.72$, $p < 0.00001$) concerns than preteen participants (Peducci et al., 2019). Of the three studies conducted with adults with T1D (19 years and older), two focused directly on the presence of body image problems, finding high frequency of dissatisfaction with their body (Rockliffe-Fidler & Kiemle, 2003) and no worsening of body dissatisfaction after 2 years (test value NR, $p > 0.05$) (Herpertz et al., 2001). The remaining study focused less on the occurrence of body image problems, instead evaluating body image as a mediator and a predictor of psychological outcomes (Mcdonald et al., 2021).

### BMI

Researchers have shown that body dissatisfaction (or body image satisfaction) was positively (or negatively) correlated with higher BMI in both girls and women with T1D (e.g., Kichler et al., 2008) and in youth of both genders (Rancourt et al., 2019). In fact, BMI was described as higher in girls with T1D with shape and eating concerns ($F = 3.47$, $p = 0.046$) and less positive body image ($t = -0.46$, $p = 0.03$) (Kaminsky & Dewey, 2014; Wilson et al., 2015). Similarly, in both genders (although more so for female than male participants), a higher BMI was found to be a significant predictor of greater body dissatisfaction (female: $R^2 = 0.271$ $p < 0.0001$; male: $R^2 = 0.103$, $p < 0.03$) (Meltzer et al., 2001), and body image satisfaction was also predicted by BMI ($R^2 = 0.232$; $b = -0.466$, $p < 0.01$) (Verbist & Condon, 2019). In line with these findings, other evidence indicated higher body dissatisfaction in overweight adolescents and adults with T1D compared to those with normal weight (test value NR, $p < 0.001$) (Philippi et al., 2013); similarly, it was found that in children with T1D and in control participants, those with higher weight underestimated their body size more ($F = 30.238$, $p < 0.001$) and are more dissatisfied than those with lower weight ($F = 25.766$, $p < 0.001$) (Troncone et al., 2016). Only one study, evaluating a sample of Turkish adolescents with T1D, found no significant body dissatisfaction correlation with BMI ($r = -0.192$, $p > 0.05$) (Pinar, 2005); additionally, another study found a lack of correlation in boys (but not in girls) (Kaminsky & Dewey, 2014).

## Body Image Problems and Disordered Eating Behaviors

Several studies (n = 12) clearly described body image problems (defined as body image dissatisfaction, perceived physical appearance, weight and shape concerns, and pressure to conform to societal norms about body image) in youth with T1D as one of the main predictor of DEBs, both in female-only samples (e.g., Falcão & Francisco, 2017; Verbist & Condon, 2019) and in samples of both genders (e.g., Araia et al., 2017, 2020). One study described weight dissatisfaction as a predictor of binge eating and purging behaviors in female (but not male) adolescent participants with T1D ($B = 0.32$, $p < 0.001$) and without T1D ($B = 0.11$, $p < 0.05$) (Neumark-Sztainer et al., 1996). Similarly, concerns about body image/weight dissatisfaction were found to be higher in adolescents with T1D and DEBs (Eilander et al., 2017) and positively correlated to DEBs (Neumark-Sztainer et al., 2002; Rancourt et al., 2019), EDs (Kaminsky & Dewey, 2013), bulimic symptoms in both genders (Peterson et al., 2018) and dietary restraints (Rancourt et al., 2019). Girls reporting higher rates of body dissatisfaction were more likely to engage in unhealthy weight control behaviors than those with lower rates of body dissatisfaction (test value NR, $p = 0.005$) (Neumark-Sztainer et al., 2002).

Two studies found higher negative body image (Grylli $t = -3.4$, $p < 0.001$; Maharaj $F = 60.42$, $p = 0.0005$) and poorer self-concept about their physical appearance (Maharaj $F = 19.45$, $p = 0.0005$) in adolescent girls with T1D and a diagnosed ED than in girls with T1D but no ED. Another study reported greater shape and weight concerns among male and female adolescents with T1D with any ED than those with no ED (test value NR, $p < 0.003$) (Wilson et al., 2015). Adolescents with T1D and DEBs were found to show higher levels of body dissatisfaction ($t = 2.578$, $p = 0.011$) and body image problems conceptualized as thin ideal internalization and appearance pressure problems ($2.703 \leq t \leq 4.603$, $0.001 \leq p \leq 0.010$), than adolescents with T1D but no DEBs (Troncone et al. 2020b). Further evidence indicated higher body dissatisfaction in adolescents and adults with T1D at risk of ED compared to those not at risk of ED (test value NR, $p < 0.001$)—as well as being higher in those who omitted insulin (test value NR, $p < 0.001$) (Philippi et al., 2013).

One study reported that participants (adolescents and adults) with an ED and T1D did not differ in body distortion (test value NR, $p = 0.097$), weight concerns (test value NR, $p > 0.05$), and body dissatisfaction (test value NR, $p > 0.05$)

from patients with an ED and no diabetes, but they saw themselves as heavier and desired a thinner physique less frequently and reported fewer shape concerns than patients with an ED and no diabetes (test value NR, $p = 0.047$) (Powers et al., 2012). Conversely, another study reported that body dissatisfaction did not correlate with attitudes to restricting eating (when faced with external cues that prompt eating) (test value NR, $p > 0.05$) and did not differ between those who omitted insulin and those who did not (test value NR, $p > 0.05$) (Khan & Montgomery, 1996). Similarly, no significant body dissatisfaction correlation with EDs in Turkish adolescents with T1D ($r = -0.155$, $p > 0.05$) and in controls ($r = -0.080$, $p > 0.05$) was found (Pinar, 2005).

## Other Factors Associated with Body Image Problems

Other factors that have been found to be associated with body image concerns in youth with T1D include both diabetes-related aspects (e.g., glycemic control) and general psychological dimensions (e.g., self-esteem, comorbidity, illness adjustment, quality of life).

### Diabetes Management

The results of the systematic review suggest that body image problems are correlated with diabetes control. More specifically, body awareness (Blicke et al., 2015) and satisfaction (de Wit et al., 2012; Peterson et al., 2018; Rancourt et al., 2019) were found to be inversely correlated with HbA1c values, suggesting that youth who felt satisfied and comfortable in their bodies had significantly better metabolic control. Similarly, previous evidence revealed that the more damaged the self-perception, the worse the diabetes control (r = NR, $p = 0.03$)—and conversely, the better the body image, the better the control (r = NR, $p = 0.001$) (Swift & Seidman, 1964; Swift et al., 1967). Another study indicated that for single (not involved in a romantic relationship) adolescents, a negative family climate was positively associated with poorer body image ($r = 0.56$, $p < 0.001$), which in turn predicted worse glycemic control (beta = −0.24, $p = 0.007$) (Hartl et al., 2015). Body image perception was found to be generally related to diabetes management as well. In particular, one study found that the extent to which girls and women with T1D define their self-worth by their physical appearance was positively related to disease control ($r = 0.28$, $p < 0.001$) and negatively to diabetes quality of life ($r = -0.40$, $p < 0.001$), particularly for younger individuals (Gawlick et al. 2016). Other evidence indicated that higher adjustment in body image areas is positively correlated with a positive attitude toward diabetes ($r = 0.29$, $p < 0.01$), a dependence/independence attitude ($r = 0.27$, $p < 0.01$), and general adjustment to diabetes ($r = 0.77$, $p < 0.05$) (Sullivan, 1979).

### Psychological Dimensions

Body image concerns have been found to be associated with several psychological variables. In female adolescents with T1D, body dissatisfaction was found to be positively (moderately) correlated with diabetes distress, anxiety symptoms, and depressive symptoms, and negatively correlated with emotional well-being, diabetes-related resilience, and quality of life ($\pm 0.34 < r < \pm 0.43$, all $p < 0.001$) (Araia et al., 2020). Similarly, in youth and young adults of both genders with T1D, body dissatisfaction was described as positively correlated with depressive symptoms ($r = 0.71$, $p < 0.01$) (Peterson et al., 2018) and with greater diabetes-specific negative affect ($b = 0.05$, $p < 0.01$) (Rancourt et al., 2019). For adults with diabetes (T1 and T2), body image experience, psychological investment in physical appearance, and self-ideal discrepancy predicted psychosocial outcomes such as anxiety, depression, and quality of life ($\chi^2 = 48.80$, $p = 0.003$; estimate = 0.102) (McDonald et al., 2021). Individuals with T1D with high diabetes distress reported greater shape (test value NR, $p < 0.001$) and weight (test value NR, $p < 0.001$) concerns than those with low or moderate distress, regardless of age; among these individuals, those younger than 18 years with high distress perceived a larger current body shape than those with low or moderate distress (test value NR, $p < 0.001$) (Powers et al., 2017).

Other significant associations were also described. In children with T1D, self-perception (as damaged and mutilated person) was positively associated with a dependence–independence attitude (test value NR, $p = 0.001$) (Swift & Seidman, 1964). A more positive adolescent body image positively correlated to a higher powerful external locus of control ($r = 0.41$, $p = 0.01$) (Kaminsky & Dewey, 2013). Body dissatisfaction was positively associated with female adolescents' perceptions of their mother's frequency of dieting behavior ($b = 0.522$, $p < 0.001$) and their mother's belief that she/her daughter is heavier than ideal ($b = 0.275/0.313$, $p = 0.020/0.009$, respectively), and it was negatively associated with family cohesion ($b = -0.247$, $p = 0.036$) (O'Brien et al., 2011). In a sample of adolescents and adults with T1D, participants with body image dissatisfaction were more likely to be frequent social network users ($\chi^2 = 5.58$, $p = 0.02$), and body image dissatisfaction was found to be predicted by social network use ($b = -0.266$, $p < 0.01$) (Verbist & Condon, 2019).

Other studies described body image as a mediator of the relationship between psychological and diabetes-related variables. In particular, one study found that, in girls with T1D, body dissatisfaction was positively correlated with negative perceptions of familial and peer communication ($r = 0.62$, $p < 0.01$) and moderated the relationship between negative communication and maladaptive eating attitudes and behaviors ($z = 2.64$, $p < 0.01$) (Kichler et al., 2008). Other evidence

indicated that adolescents' self-concept in the area of physical appearance mediated both the link between maternal weight and shape concerns and adolescent eating disturbances (pr = 0.42, $p = 0.00005$) as well as the link between mother–daughter relationships and adolescent eating disturbance status (pr = 0.25, $p = 0.003$) (Maharaj et al., 2003). For adult individuals with diabetes, body image disturbances mediated the relationship between personal investment in appearance and psychosocial outcomes (estimate = 0.102) and partially mediated the relationship between self-ideal discrepancy and psychosocial outcomes (estimate = 0.185) ($\chi^2 = 48.80$, $p = 0.003$) (McDonald et al., 2021). For single (not involved in a romantic relationship) adolescents, body image was found to mediate the association between family climate and changes in glycemic control (b = 0.24, $p = 0.007$) (Hartl et al., 2015).

## Discussion

No general agreement has been reached that body image problems are always reported in youth with T1D. Despite the role of body image problems in increasing unhealthy eating behaviors and in affecting general well-being in individuals with T1D, especially during adolescence, little attention has been paid to understanding and synthetizing the existing findings on this issue from the current body of literature. Drawing from PRISMA guidelines, the present study systematically and comprehensively evaluated the empirical literature on body image problems in individuals with T1D up to January 2021 and summarized the principal findings. As the large majority of results came from studies involving youth, this study is able to provide a valuable contribution to the developmental literature on this issue. A good deal of evidence was beyond the scope of the present review and thus was excluded.

Overall, this systematic review replicates and expands the results of a previous meta-analysis (Pinquart, 2013), which included a lower number of studies (34 vs. 51 in the current study) and indicated that young individuals with chronic physical diseases (especially those with scoliosis, cystic fibrosis, growth hormone deficits, asthma, spina bifida, cancer, and diabetes) had generally less positive body image then their healthy peers. In the current review, the findings on body image problems are somewhat mixed, and the occurrence of such problems varied across studies. In line with this previous meta-analysis (Pinquart, (2013), a number of studies (n = 17) described here indicated that in youth with T1D, body dissatisfaction was commonly experienced and body concerns were generally greater in those with T1D than in the general population; however, several studies (n = 9) did not find any difference in body image problems between adolescents with and without T1D. In addition, some studies (n = 3) even described higher body satisfaction in adolescents with T1D than in healthy peers.

In terms of gender differences, studies that differentiated male and female individuals with T1D revealed a higher likelihood of girls/women having a body image problems than boys/men, mirroring the findings of the general literature across different age groups (Bearman et al., 2006; Phares et al., 2004). When assessed, boys/men with T1D reported higher dissatisfaction with their bodies than controls without T1D, which is also in line with evidence from general population (Cohane & Pope, 2001). Few studies directly compared different T1D age groups, and these provided mixed results, showing older participants with greater body image problems than younger ones or no differences at all. With respect to problems that are frequently found to be associated with body image disturbance, this literature review indicated that the primary issue can result in adverse physical and psychological health effects. Body image problems were found to be associated with negative medical outcomes—such as elevated glycosylated hemoglobin, poorer diabetes management, and higher BMI—as well as with psychological variables—such as anxiety, depression, poorer quality of life, and higher distress. Furthermore, body image concerns have also been frequently found to be associated with DEBs, confirming the key role of body dissatisfaction in the development of DEBs, as largely supported by studies with the general population as well as with adolescents with chronic illness (Amaral & Ferreira, 2017; Girard et al., 2018; Neumark-Sztainer et al., 2002; Striegel-Moore & Bulik, 2007).

Interpretations of these findings—especially the results on the occurrence of body image problems and on gender differences—require that two general methodological issues be taken into account. First, the variation in tools used across studies may contribute to discrepancies in findings on body image problems. As shown in Table 1, a range of tools has been used in samples with T1D individuals; therefore some differences—or lack thereof—may be the result of the measures adopted. For example, it was reported that adolescents with T1D showed greater body dissatisfaction than controls on the EDI[2] Body Dissatisfaction subscale, but in the same study, no differences were found when the body image problems of thin ideal internalization and appearance pressure were measured (Troncone et al., 2020a). Consequently, with regard to findings supporting the presence body image problems, it could be hypothesized that diabetes-related factors and difficulties—e.g., recurring weight variation, perception of living in an unhealthy body, focus on body functioning, dietary restrictions, daily need for injections, etc.—may explain the development of a negative body image (Colton

[2] Eating Disorder Inventory.

et al., 1999; Shaban, 2010). At the same time, inconsistencies in the results lead us to wonder the extent to which the findings directly stem from differences in and the limits of the measures adopted.

Second, it should be acknowledged that girls/women (and youth) were overrepresented across the included studies. Given that several studies measured body image and subsequently measured eating problems, this overrepresentation of female participants may be attributable to the largely-recognized higher prevalence of DEBs in girls and women in general and in the T1D population (Colton et al., 2015; Neumark-Sztainer et al., 2011; Wisting et al., 2013), as well as to convenience sampling across studies. In this regard, it should be noted that all studies finding no differences between adolescents with T1D and control participants in terms of body image problems were conducted with samples composed of male and female—or, in one study, only male—adolescent participants (e.g., Baechle et al., 2014; Falcão & Francisco, 2017; Svensson et al., 2003). In contrast, all studies conducted with exclusively-female samples reported higher body image problems in the T1D group than the control group, giving the impression that body image problems are a specifically women's or girls' issue (e.g., Markowitz et al., 2009).

Limitations across body image measures due to gender bias should also be taken into consideration when interpreting such results. Existing tools often focus on body image concerns that are salient to women and girls (e.g., belief of being fat, concerns about specific aspect/shape of body parts such as thighs or hips) and focus less on symptoms recognized as more central to men and boys (e.g., desire for a muscular and athletic physique, concern about muscle mass and shoulder width) (Cafri & Thompson, 2004). Therefore, it cannot be ruled out that because of these methodological issues, the true levels of body dissatisfaction among boys with T1D are probably not well estimated.

## Strengths

The present review has a number of strengths. One main strength is that it undertakes a systematic review of all existing studies that address body image problems in T1D samples and then summarizes the state of research and provides a comprehensive picture of the main findings and of the methods used in investigations of this topic. The structured search and analysis procedure, along with the predefined inclusion and exclusion criteria to ensure the scientific relevance of the studies under examination, strengthen the overall quality of the review. It is worth noting that a quite extensive body of literature—composed of a relatively high number of studies with more-or-less sophisticated research designs—attempted to collect evidence about the presence and features of body image problems in individuals (mostly youth) with T1D, revealing a certain amount of attention paid to this topic. Several factors (gender, BMI, DEBs, etc.) were also frequently analyzed as potential salient variables. Nevertheless, the understanding of the development of body image problems in individuals with T1D is restricted by the limitations of the present review and of the field.

## Limitations and Implications for Future Directions

Several limitations in this systematic review should be noted. To start, the results of this review are limited by the study's inclusion criteria; thus, they are limited to English peer-reviewed journal articles indexed in electronic database resources, and the gray literature was not consulted. It may be possible that some studies could have been missed; for example, non-original studies (e.g., comments, book chapters, case reports, etc.) published in other languages were ignored, and potential additional insight on the topic could have been missed. Furthermore, another limitation is related to the search terms used in this review: it is possible that they did not capture all relevant studies. For example, the use of search terms for T1D might have overlooked some studies on chronic illness that also included participants with diabetes. This limitation was partially accounted for by a hand search of the included reference lists. In addition, the research in this review was of a quantitative nature; future research could adopt a qualitative or mixed-method approach to more deeply investigate how body image problems in youth with T1D develop and how they manifest.

Similarly, several limitations can be found within the studies examined in the current review, which need to be addressed in order to obtain a more comprehensive picture of body image concerns in people with T1D. To start with, future research should strive to accurately measure body image: to date, the majority of measures adopted consist of self-report instruments assessing body image as a single and undifferentiated construct, ranging from dissatisfaction with body shape and weight, shape concerns, and level of satisfaction with (or significance of) their physical appearance to body image disturbances or facets of self-concept. Fewer studies adopted measures based on body silhouettes evaluating the level of body size accuracy and the satisfaction with one's physical appearance as the difference between actual and ideal size. Multidimensional assessment should start from the assumption that body image is a multifaceted construct consisting of self-perceptions, attitudes, beliefs, feelings, and behaviors related to one's body and is dynamically related to the social environment (Calogero & Thompson, 2010; Cash & Pruzinsky, 1990), and such assessments should be more frequently adopted as a measurement approach that can recognize the multiple aspects of body image.

Additionally, as already argued for ED pathology (Murray et al., 2017), a more gender-sensitive approach to examining body image problems is needed—one that includes constructs that resonate more with the male experience. Therefore, future studies should ensure they consider gender differences when assessing body image ideals and body image dissatisfaction (i.e., desire for thinness in women vs. desire for a muscular physique in men; girls typically wanting to be thinner vs. boys frequently wanting to be bigger). In particular, they should address body image concerns that may be more pertinent to boys and take into account guidelines and methods that are purposely designed to more effectively assess male body image (Cafri & Thompson, 2004). Moreover, given the cross-sectional nature of the results and the dearth of follow-up studies, longitudinal research is needed to further explore the relationship between body image issues and clinical and psychological variables.

Given the other limitations in studies' designs (e.g., limits in the representativeness of the samples, potentially salient/confounding variables not examined, frequent absence of control group), additional research on this topic that is more methodologically robust is needed to draw more solid conclusions. Future work should also focus on identifying key predictors of body image problems in youth with T1D, should more deeply explore differences between adolescents and adults, between different adolescent age groups (i.e., early, middle, late), and should address body image concerns in children.

### Clinical Implications

Given the well-known associations between body image problems and EDs/DEBs and between body image problems and negative psychological outcomes—as well as the higher vulnerability of youth with T1D to psychological problems—continuous psychological monitoring is needed to periodically evaluate adolescents' overall psychosocial well-being, diabetes-specific quality of life and distress, psychosocial and mental health problems, and developmental adjustment to diabetes management (ADA, 2018; Buchberger et al., 2016; Delamater et al., 2018; Hagger et al., 2016). For such psychological evaluations, dedicated screenings and specific assessments of body image problems can be incorporated into routine practice. Specifically, given the harmful effects of DEBs on health and diabetes management (Goebel-Fabbri, 2009; Nielsen, 2002; Starkey & Wade, 2010), such unhealthy eating behaviors need particular attention. An accurate evaluation of the onset and characteristics of the body image problems is a crucial first step in realizing appropriate intervention or prevention strategies. Therefore, it is important to combine screening measures with the use of diagnostic interviews, carried out by experienced clinicians, to appropriately target the interview questions in order to ensure that body image problems (and related issues, such as DEBs) are accurately screened. Once assessed, the body image concerns of individuals with T1D need to be addressed through educational and intervention programs before the problems become more severe. Collecting and analyzing such data can significantly enrich knowledge and the progress of research in this area.

## Conclusion

Body image problems in individuals with T1D have been associated with a number of negative psychosocial and behavioral outcomes. Despite the scholarly attention that has been paid to the presence of body image problems in youth with T1D, no summary of either the state of current research or its gaps had been performed. The present study addresses the need for a systematic review of the existing empirical evidence on body image problems in individuals with T1D. This review reveals evidence both for and against the idea that body image problems are more frequently found in youth with T1D than in healthy peers. Overall, studies indicating that body dissatisfaction is more common and generally greater in youth with T1D than in controls outnumber studies that do not find differences between these groups. In addition, body concerns are often found to be associated with negative medical and psychological functioning. Taken together, the available empirical data indicate that, given the major issues that adolescents face in general (i.e., rapid and dynamic cognitive, developmental, and emotional changes, impact of body changes, searching for acceptance by peers, etc.) combined with the burden of the illness, its management, and the relative adaptation to emerging development needs, psychological care should be integrated into diabetes care in order to periodically monitor for psychological conditions and possible problematic signs (such as body image concerns). However, this topic needs to be examined further, with the methodological limits that characterize existing research especially taken into account, in order to expand the existing knowledge on body image problems in diabetes patients during such a critical developmental phase as adolescence. An important next step is conducting empirical studies in which different and age/gender-specific aspects of body image problems are investigated, as well as longitudinal studies that verify causal relationships between body image and psychological and medical variables.

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## Declarations

**Conflict of interest** The authors report no conflict of interests.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.



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