WILEY

International Journal of
EATING DISORDERS

Are children with chronic illnesses requiring dietary therapy at risk for disordered eating or eating disorders? A systematic review

Jenny H. Conviser PsyD[1] | Sheehan D. Fisher PhD[1] [ID] | Susanna A. McColley MD[2]

[1]Department of Psychiatry and Behavioral Sciences, Northwestern University Feinberg School of Medicine, 446 E Ontario St, Chicago, Illinois 60611

[2]Department of Pediatrics, Division of Pulmonary Medicine, Northwestern University Feinberg School of Medicine, 420 E. Superior Street, Chicago, Illinois 60611

Correspondence
Sheehan D. Fisher, Department of Psychiatry and Behavioral Sciences, Northwestern University's Feinberg School of Medicine, 676 North St Clair Street, Suite 1000, Chicago, IL 60611.
Email: sheehan.fisher@northwestern.edu

Abstract

Objective: Pediatric chronic illnesses (CI) can affect a child's mental health. Chronic illnesses with treatment regimens that specify a therapeutic diet may place the child at increased risk for disordered eating and specific eating disorders (ED). The aim of this review is to examine the relation between diet-treated CI and disordered eating and to determine the order of onset to infer directionality. Diet-treated CI is hypothesized to precede and to be associated with disordered eating.

Method: A comprehensive search of empirical articles that examine the relation between diet-treated CI (diabetes, cystic fibrosis, celiac disease, gastrointestinal disorders, and inflammatory bowel diseases) and disordered eating was conducted in Medline and PsycINFO using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. A table of the sample's characteristics, ED measures, major pertinent findings, and the onset of CI in relation to ED were provided.

Results: Diet-treated CI was associated with disordered eating and ED. Diet-treated CI had onset prior to disordered eating in most studies, except for inflammatory bowel diseases. Disordered eating and unhealthy weight management practices put children at risk for poor medical outcomes.

Discussion: Interventions for diet-treated CI require a focus on diet and weight, but may increase the risk for disordered eating. Future research is needed to elucidate the mechanisms that transform standard treatment practices into pathological eating, including characteristics and behaviors of the child, parents/care providers, family, and treatment providers.

KEYWORDS
chronic illness, cystic fibrosis, celiac disease, diabetes, eating disorders, gastrointestinal disorder, inflammatory bowel disease

Resumen

¿Los Niños con Enfermedades Crónicas que Requieren Terapia Dietética están en Riesgo de una Alimentación Disfuncional o un Trastorno de la Conducta Alimentaria? Una Revisión Sistemática

Objetivo: Las enfermedades crónicas (EC) pediátricas pueden afectar la salud mental de los niños. Las enfermedades crónicas con regímenes de tratamiento que especifican una terapéutica dietética pueden poner al niño en un mayor riesgo de alimentación disfuncional o de trastornos de la conducta alimentaria (TCA) específicos. El objetivo de esta revisión es examinar la relación entre EC tratadas con dieta y alimentación disfuncional y determinar el orden de inicio para inferir direccionalidad. Se hipotetiza que las EC tratadas con dieta preceden y están asociadas con alimentación disfuncional.

Jenny Conviser, PsyD, and Sheehan Fisher, PhD, should be considered joint first author.

Método: Se realizó una búsqueda exhaustiva de artículos empíricos que examinan la relación entre EC tratadas con dieta (diabetes, fibrosis quística, enfermedad celíaca, enfermedades gastrointestinales y enfermedad inflamatoria intestinal) y alimentación disfuncional en Medline y PsycINFO utilizando las guías de Preferred Reporting Items (Artículos de Informes Preferidos) para Revisiones Sistemáticas y de Metaanálisis. Se proporcionó una tabla de las características de la muestra, mediciones de TCA, hallazgos mayores pertinentes y el inicio de EC en relación al TCA.

Resultados: Las EC tratadas con dieta fueron asociadas con alimentación disfuncional y TCA. Las EC tratadas con dieta tuvieron un inicio previo a la alimentación disfuncional en la mayoría de los estudios, excepto para enfermedad inflamatoria intestinal. La alimentación disfuncional y las prácticas poco saludables de manejo de peso ponen a los niños en riesgo de resultados médicos pobres.

Discusión: Las intervenciones de EC tratadas con dieta requieren un foco en dieta y peso, pero pueden incrementar el riesgo para alimentación disfuncional. Se requieren investigaciones futuras para elucidar los mecanismos que transforman las prácticas de tratamiento estándar en alimentación patológica, incluyendo características y comportamientos del niño, padres/cuidadores, familia y proveedores de tratamiento.

1 | INTRODUCTION

Pediatric chronic illness (CI) increases the risk for mental health disorders (Chapman, Perry, & Strine, 2005; Pinquart & Shen, 2011), which in turn exacerbates medical symptoms (Katon, Lin, & Kroenke, 2007). Diabetes, cystic fibrosis, celiac disease, inflammatory bowel disease, and gastrointestinal disorders (e.g., irritable bowel syndrome) are unique illnesses with treatments that require adherence to strict dietary regimens, which are referred to as diet-treated CIs in this text. Diabetes (Lawrence et al., 2006), cystic fibrosis (Quittner et al., 2008), celiac disease (Mazzone et al., 2011), and gastrointestinal disorders/inflammatory bowel disease (Greenley et al., 2010; Lee et al., 2009) are diet-treated CIs that increase the risk of disordered eating and eating disorders (ED) (Quick, Byrd-Bredbenner, & Neumark-Sztainer, 2013). Disordered eating is pathological eating behaviors (e.g., overly restrictive dieting, binge eating) that are abnormal but not sufficient to meet criteria for an ED, whereas EDs are a cluster of symptoms that meet diagnostic criteria for anorexia nervosa (AN), bulimia nervosa (BN), binge-eating disorder (BED), or avoidant restrictive food intake disorder (ARFID). In general, strict control of one's diet (i.e., dieting) is a risk factor for the development of an ED and disordered eating behaviors and related cognitions (Bulik et al., 2006; Polivy & Herman, 2002; Tanofsky-Kraff, Faden, Yanovski, Wilfley, & Yanovski, 2005), as does exposure to parents and peers who diet (Haynos, Watts, Loth, Pearson, & Neumark-Stzainer, 2016). Although following a strict dietary regimen is essential for survival and the ability to thrive for children with diet-treated CI, there may be an inherent risk of disordered eating or EDs that have their own serious medical consequences in this population (Quick et al., 2013).

Diet-treated CIs are usually lifelong health conditions that have a significant impact on specific biological systems, global functioning, and longevity. While CI management usually includes a combination of medication, therapies, and testing, diet-treated CIs require additional disease-specific changes in diet to improve health. These recommended dietary strategies extend beyond the norms of the U.S. Dietary Guidelines (2015–2020)

for healthy individuals to address the pertinent concerns of each CI (Hu, Neuhouser, Perez-Escamilla, Martinez-Gonzalez, & Willett, 2016).

Parents are integral to the implementation of medical recommendations for children with diet-treated CI, including ensuring that their children follow the prescribed dietary guidelines. However, there are inherent dangers in parental overcontrol of feeding. For example, overcontrol of child feeding may disrupt the child's development of self-regulation over their appetite and eating, including internal cues of hunger and satiety, and self-control (Birch & Fisher, 1998; Birch, Fisher, & Davison, 2003; Haycraft & Blissett, 2012). In the general population, parents' motivation to overcontrol feeding may be to limit or increase a child's food intake, or control the child's behavior (e.g., reward or punishment), but a child's lack of control over feeding is associated with risk for disordered eating (Birch & Fisher, 1998; Brown & Ogden, 2004). Parental control of child feeding is related to child dietary restriction and disinhibition (Brown & Ogden, 2004; Carper, Orlet Fisher, & Birch, 2000; Matheson et al., 2015), eating in the absence of hunger (Birch et al., 2003), body dissatisfaction (Brown & Ogden, 2004), and weight control behaviors (Cromley, Neumark-Sztainer, Story, & Boutelle, 2010), which are risk factors for EDs (Stice, Marti, & Durant, 2011).

Quick et al. (2013) provided an introductory discussion of the prevalence of EDs and disordered eating in children with diabetes, cystic fibrosis, celiac disease, and inflammatory bowel disease and preliminary evidence of an association between diet-treated CI and disordered eating (Quick et al., 2013), but a systematic review of the literature has not previously been conducted. The purpose of this review is to examine the association between diet-treated CIs and disordered eating by systematically examining the literature until June 2016 based on the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009) and providing critical summaries of each article (description of the sample, measures of ED, major findings, order of onset for CI vs. ED). We aimed to infer the directionality of the relationship between the CI and disordered eating by: (a) presenting the association between CI and disordered eating and (b) comparing the order of onset. First,

we hypothesize that diet-treated CI is positively associated with disordered eating and ED diagnosis. Second, we hypothesize that diet-treated CI precedes disordered eating.

2 | METHOD

2.1 | Search and study selection

A systematic search was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009). The Medline and PsycINFO electronic databases were searched for relevant studies up to June 2016. Search terms for CIs with treatments that require an augmentation of one's diet including, "cystic fibrosis," "celiac," "diabetes," "diabetic," "IDDM," "Crohn's disease," "inflammatory bowel disease," "irritable bowel syndrome," "gastrointestinal disorder," and "chronic illness" were combined with terms for EDs, including "eating disorder," "bulimia," "binge eating," "disordered eating," and "anorexia nervosa."

2.2 | Eligibility criteria and data collection

Articles eligible for inclusion were required to present a research study that: (a) examined subjects with a history of both a CI and an ED/disordered eating, (b) subjects had an average age between 0 and 21 based on the National Institute of Health's "Inclusion of Children as Participants" guidelines at the start of the study, or subjects were adults with retrospective data on symptoms of ED and CI that both occurred during childhood, (c) presented quantitative data on the relation between an ED/disordered eating and a CI, and (d) the full text was published in English. Articles of qualitative, case report, or treatment studies were excluded, along with commentaries, letters to editors, dissertations, and not original studies (e.g., reviews). An explanation of the inclusion rationale was provided for several studies with unique methodological designs (e.g., retrospective report) to demonstrate that the data fit the review's purpose.

Data relevant to the purpose of this review were extracted from each study and summarized in a table based on CI type (see Table 1). Studies of inflammatory bowel disease and gastrointestinal disorders were included in one table due to their similar symptomology. Unless otherwise specified, ED refers to any diagnosis or symptomatology of AN, BN, BED, eating disorder not otherwise specified (EDNOS), or disordered eating. Table 1 includes the sample's characteristic and average age, measures of the ED, and the major pertinent findings. In addition, the onset of CI in relation to ED symptoms was indicated in the table (e.g., prior, after) for studies that provided this information directly or when this information can be inferred based on the etiology of the disease (e.g., cystic fibrosis exists from birth). For studies that did not provide precise data on the age of onset of EDs, inferences were made based on epidemiological data of the age of onset for EDs. The average age of onset for EDs is in late adolescence (approximately 18 years old), with the lower end the of age of onset starting after 10 years old (Favaro, Caregaro, Tenconi, Bosello, & Santonastaso, 2009). Therefore, the conservative estimate of 10 years old was used as a cutoff of the onset of ED to estimate the temporal order of CI and ED onset. The onset of a CI prior to the earliest likely onset of an ED (older than 10 years old) would support the hypothesis that a CI started prior to an ED.

3 | REVIEW STRUCTURE

This review is structured to provide an overview of the relationship between CI and ED. First, we provide a brief description of the medical disorder. Second, we summarize the results of the relation between diet-treated CI and EDs in children, and link the results to the table. Finally, a discussion of the key findings and implications for future research and clinical practice is provided. A critical analysis of risk of bias was conducted using the Fowkes and Fulton (1991) method.

4 | RESULTS

A total of 86 studies met criteria for inclusion based on the inclusion and exclusion criteria (see Figure 1). The number of articles with relevant data varied for each diet-treated CI, with some articles providing data for multiple CIs: 69 for diabetes, 9 for cystic fibrosis, 5 for celiac, and 7 for gastrointestinal disorders and inflammatory bowel disease. In most cases where relevant data were presented, CI had an age of onset prior to the age of initial disordered eating or ED diagnosis. The majority of studies were cross-sectional and used validated measures of ED, but did not provide sufficient evidence of proper sampling of subjects (i.e., representativeness of sample, sufficient power, inclusion/exclusion criteria, accounting for nonrespondents). Studies that compared children with CI versus controls showed that children with CI had higher rates of disordered eating than controls (see Table 2). Rates of ED diagnoses varied throughout studies, with most studies of AN, BED, and EDNOS reporting rates in the single digits: .3–16% with AN, 10–40% with BN, 3–13% with BED, and .5–9% with EDNOS (see Supporting Information Table 1). Elevated levels of disordered eating were most common in children with CI, with rates between 11 and 70% of subjects.

4.1 | Diabetes

The most extensive literature on diet-treated CI and disordered eating exists for type 1 diabetes mellitus (see Table 1). Individuals with diabetes are at increased risk for disordered eating attitudes and behaviors, including drive for thinness, body dissatisfaction, dieting, and excessive exercise and diet pill usage for weight control (Antisdel & Chrisler, 2000; Bernstein, Stockwell, Gallagher, Rosenthal, & Soren, 2013; Colton, Olmsted, Daneman, Rydall, & Rodin, 2004; d'Emden et al., 2013; Engström et al., 1999; Grylli, Hafferl-Gattermayer, Schober, & Karwautz, 2004; Grylli, Hafferl-Gattermayer, Wagner, Schober, & Karwautz, 2005; Howe, Jawad, Kelly, & Lipman, 2008; Khan & Montgomery, 1996; Lloyd, Steel, & Young, 1987; Mellin, Neumark-Sztainer, Patterson, & Sockalosky, 2004; Neumark-Sztainer et al., 1996; Palladino et al., 2013; Pinar, 2005). The rate of individuals meeting criteria for EDs (AN, BN, EDNOS) varied across studies (Colton, Olmsted, Daneman, & Rodin, 2013; Hudson, Wentworth, Hudson, & Pope, 1985; Jones, Lawson, Daneman, Olmsted, & Rodin, 2000; Peveler

TABLE 1 Studies of children with diet-treated chronic illness and disordered eating/eating disorders

Study	Sample	ED measure(s)	Findings	CI onset
Ackard et al. (2008)	Subjects with type 1 diabetes (n = 143; age=15.3)	Disordered eating and body dissatisfaction items from QEW-R, AHEAD, and P-EAT	Subjects with diabetes had better body satisfaction, lower levels of dieting, and lower usage of extreme, unhealthy weight control. However, subjects with diabetes skipped using insulin (10.3% female; 1.4% male) or reduced recommended amount of insulin (7.4% female; 1.4% male) to control weight	N/A
Antisdel and Chrisler (2000)	Female subjects with type I diabetes (n = 54; age=16) and phenylketonuria (n = 30; age=19)	EAT-26; EDI; BCS	Thirty-three percent of subjects with diabetes had marked disordered eating and 23% of subjects with phenylketonuria. Subjects with diabetes scored higher on dieting and drive for thinness, and lower on oral control than subjects with phenylketonuria. Subjects with diabetes and elevated ED problems were less likely to monitor their blood sugar levels, follow a meal plan, maintaining appropriate blood sugar levels, and appropriately treat hypoglycemia than those without elevated ED problems	Prior: (CI duration: 10 years)
Bächle, Stahl, Pehe, and Rosenbauer (2016)	Subjects with type 1 diabetes for at least 10 years (n = 819; age=16.3)	SCOFF	28.2% of the female subjects and 9.2% of the male subjects scored positive for disordered eating on the SCOFF and 4.3% of females and 5.3% of males reported frequent insulin restriction without disordered eating. Males with disordered eating were more at risk for insulin restriction than males without disordered eating, but this difference was not found for females. Glycated hemoglobin values were highest in the insulin restricting males and females, followed by those with insulin restriction and disordered eating	Prior: (CI duration: 15.7 years)
Baechle et al. (2014)	Subjects in Germany with early-onset type 1 diabetes (at least 10 years duration) (n = 629; age = 15.3) compared to representative peers (n = 6,813; age=14.6)	SCOFF	Female subjects with diabetes were slightly more likely to have elevated disordered eating (31.2%) than the female comparison group (28.9%), whereas males with diabetes were less likely to have elevated disordered eating (11.7%) than the male comparison group (15.2%). Both female and male subjects with diabetes were more satisfied with their body weight, but had more food-intrusive thoughts. Subjects with diabetes engaged in insulin restriction at least three times per week (18.5% of males, 20.5% of females). Insulin restriction was related to worse average glycated hemoglobin values compared to subjects without insulin restriction	Prior: (CI onset: 2.7 years old)
Battaglia, Alemzadeh, Katte, Hall, and Perlmuter (2006)	Female subjects with type 1 diabetes who use continuous subcutaneous insulin infusion (n = 22; age = 14.09) or multiple daily injections (n = 47; age = 14.49)	EDI-2; EAT-26	Disordered eating and glycemic values were similar for each group. Insulin omission was uncommon in the continuous subcutaneous insulin infusion group (0%) and 15% in the multiple daily injections group. The continuous subcutaneous insulin infusion group had the lower glycated hemoglobin values	Prior: (CI duration: 6.8 years [subcutaneous insulin infusion]; 7.4 years [Multiple daily injections])

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Bernstein et al. (2013)	Subjects with type 1 diabetes (*n* = 150; age = 17.1)	ESP	20.7% of subjects reported disordered eating and 13.3% took less insulin than recommended. 46% of subjects met criteria for uncontrolled diabetes (glycated hemoglobin levels at or above 8.5%)	Prior: (CI onset: 10.0 years old)
Bryden et al. (1999)	Adolescent subjects with type 1 diabetes at baseline (*n* = 76; age = 15) who were followed up with 8 years later	EDE	Concern about weight and shape worsened in women and men from adolescence to adulthood. No subjects met criteria for AN or BN; 3 met criteria for EDNOS at baseline and 3 at follow-up. Deliberate underuse or omission of insulin to control weight was only endorsed by female subjects during adolescence (*n* = 10). Mean glycated hemoglobin was nonsignificantly lower for females who misused their insulin	Prior: (CI duration: 8.0 years (male); 7.1 years (female)
Caccavale et al. (2015)	Subjects with type 1 diabetes (*n* = 151; age = 15.6) and their parents	DiEPS-R	Lower priority placed on family meals, less parental modeling of healthy eating, and greater food restrictions in the home based on adolescent-report were associated with greater disordered eating. Both adolescent- and parent-report of greater family conflict about diabetes was associated with disordered eating	Prior: (CI duration: 7.7 years)
Cantwell and Steel (1996)	Adult subjects with high negative eating attitudes and low negative eating attitudes that had an adolescence-onset of insulin-dependent diabetes (*n* = 22; age at onset = 11.3; *n* = 26, age at onset=12.6, respectively)	EAT-40; Psychiatric diagnosis (DSM-III)	The onset of diabetes preceded the diagnosis of an ED for all subjects with an ED	Prior: (CI duration: 13.1 years (high negative eating); 9.8 years (low negative eating)
Colton et al. (2004)	Female subjects with type 1 diabetes (*n* = 101; age = 11.8) and age-matched control subjects (*n* = 303; age=11.8)	cEDE	Equivalent percentages of female subjects with diabetes and without diabetes had at least one disturbed eating behavior in the previous month (16%), but subjects with diabetes were more likely to have 2 or more disturbed behaviors, use excessive exercise for weight control, and engage in binge eating. 2% of subjects with diabetes omitted their insulin to lose weight in the past month	Prior: (CI duration: 4.7 years)
Colton et al. (2007)	Female subjects with type 1 diabetes (Time 1: *n* = 126; age=11.8; Time 2: *n* = 106; age=12.9)	cEDE	The number of subjects with disturbed eating varied at each time point (Time 1 only: *n* = 7; Time 2 only: *n* = 10; Time 1 a 2: *n* = 8), but did not increase in prevalence over the 1 year. Maternal eating attitudes, along with child self-worth and BMI, predicted disordered eating behaviors and attitudes	Prior: (CI duration: 3.7 years)
Colton et al. (2013)	Female subjects with type 1 diabetes (Time 1: *n* = 98; age=11.7; Time 2: *n* = 98; age = 16.5)	EDE	At Time 2, 51.0% of subjects had no current disordered eating, 35.7% with disordered eating but no ED, and 13.3% had an ED. Depression was associated with ED and disordered eating. Glycated hemoglobin values were not differentiated by the presence of disordered eating	Prior: (CI duration: 4.8 years)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
d'Emden et al. (2013)	Subjects with type 1 diabetes (n = 124; age = 15.4)	YEDE-Q; EDI-3	Male and female subjects had elevated disordered eating behaviors (32.3%), but most males had only one disordered eating behavior whereas 48% of females had 2 or more disordered eating behaviors. Higher levels of disordered eating were associated with elevated glycated hemoglobin	Prior: (CI duration: 5.0 years)
Engström et al. (1999)	Female subjects with type 1 diabetes (n = 89; age = 16.3) compared to healthy controls (n = 89; age = 16.4)	EDI-C; BAB-T	The group with diabetes significantly differed from the control group on the drive for thinness and body dissatisfaction subscales. Subjects with diabetes did not meet criteria for AN or BN but 6.9% had EDNOS. The girls with elevated ED symptomatology had a higher BMI, but no difference in glycated hemoglobin, insulin treatment or frequency of hypoglycemia and diabetic ketoacidosis	Prior: (CI duration: 7.7 years)
Grylli et al. (2004)	Subjects with type 1 diabetes (n = 199; age=14.1)	EAT-26; EDI-2; EDE	Only female subjects met criteria for an ED (11.5%), while 13.5% of females and 1% of males had a subsyndromal ED. Excessive exercising (30.4%), dieting (30.4%), and insulin manipulation (26.1%) were the most common weight-loss behaviors	Prior: (CI duration: 5.4 years [ED]; 7.8 years [sub-ED]; 5.4 years [no ED])
Grylli, Wagner, Hafferl-Gattermayer, Schober, and Karwautz (2005)	Subjects with type 1 diabetes (n = 199; age = 14.1)	EAT-26; EDI-2; EDE	Thirty-five subjects had elevated negative eating attitudes, of which 2 had BN, 9 had EDNOS, and 13 had a subthreshold ED. Subjects with disordered eating tended to use wishful thinking and emotional regulation as coping mechanisms, and were less likely to blame others as a coping strategy. Subjects with disordered eating had lower quality of life	Prior: (CI duration: 5.6 years)
Grylli et al. (2005)	Subjects with type 1 diabetes (n = 199; age = 14.1)	EAT-26; EDI-2; EDE	None of the males and 11.5% of the females had an ED, but no cases of AN. 1% of the males and 13.5% of the females had subthreshold eating problems. Females with type 1 diabetes and clinical or subthreshold disordered eating had higher harm avoidance and lower self-directedness than females with no eating pathology	Prior: (CI duration: 5.4 years)
Helgeson, Escobar, Siminerio, and Becker (2007)	Subjects with type I diabetes (n = 132) and healthy subjects (n = 131) with an average age of 12.08 followed over a 1 year period	EDI	A focus on others to the exclusion of oneself was longitudinally associated with drive for thinness in subjects with diabetes. A focus on others to the exclusion of oneself in all subjects was associated with bulimic symptoms at Time 1	Prior: (CI duration: 4.91 years)
Helgeson, Snyder, et al. (2007)	Subjects with type I diabetes (n = 132) and healthy subjects (n = 131) with an average age of 12.08 followed over a 3-year period	EDI	The difference between females and males drive for thinness increased at each of the three time points, with females having higher scores. Adolescents with diabetes had a longitudinal increase in drive for thinness and healthy adolescents experienced a decrease over time	Prior: (CI duration: 4.91 years)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Helgeson et al. (2009)	Subjects with diabetes (n = 132) with an average age of 12.10 followed over a 3-year period	EDI	Drive for thinness was cross-sectionally associated with worse metabolic control for males, but not females. Parent-child relationship quality predicted better metabolic control for females and not males. Bulimic symptoms, and not drive for thinness, predicted longitudinal changes in metabolic control	Prior: (CI duration: 4.91 years)
Howe et al. (2008)	Subjects with type 1 diabetes (n = 295; age = 14.9)	DEPS; P-EAT	Subjects who felt overweight and dissatisfied with their weight had increased disordered eating behaviors. A minority of subjects used very unhealthy weight-control behaviors (e.g., diet pills, skipping insulin). Skipping meals and insulin were associated with higher glycated hemoglobin	Prior: (CI duration: 8.4 years)
Hsu, Chen, Huang, Lin, and Lin (2009)	Subjects with type 1 diabetes (n = 42; age = 15.9) and without diabetes (n = 42; age = 15.9)	EAT-26; BITE	Females with type 1 diabetes had higher BITE symptom subscale and total scores and negative bulimic-type eating attitudes than those without diabetes. Males with type 1 diabetes had higher BITE symptoms subscale scores and bulimic-type eating attitudes. Glycated hemoglobin predicted the BITE severity subscale	Prior: (CI duration: 6.02 years)
Hudson et al. (1985)	Two samples (n = 100; n = 164) of subjects with insulin-dependent diabetes with an average age of 19.3 years	AN/BN Questionnaire created for study based on DSM-III	None of the subjects met criteria for AN, but 2 from each sample met all criteria except weight below 75% (subjects' weight was below 80%). The first sample had 39.5% of subjects with history of BN and the second sample had 30.9%. Of those with a history of BN, 60.1% met current criteria for BN	Prior: (CI duration: 8.6 years)
Johnson, Elliott, Scott, Heller, and Eiser (2014)	Subjects with type 1 diabetes (n = 96; age = 18.1)	DEPS-R	Elevated levels of disordered eating occurred in 35.1% of subjects. Glycated hemoglobin did not differ significantly between those with high or low disordered eating	Prior: (CI duration: 8.1 years)
Jones et al. (2000)	Subjects with type 1 diabetes (n = 356; age = 14.9) and age matched controls without diabetes (n = 1,098; age=14.8)	EDI; EAT; EDE; DSED	Subjects with diabetes endorsed more binge eating and less dieting for the purpose of losing weight than controls. Subjects with diabetes were 2.4 times more likely to have an ED (10%) than subjects without an ED (4%), with EDNOS being the most common diagnosis. Insulin omission was the most common weight loss method after dieting in subjects with diabetes, and subjects with diabetes and an ED had higher average glycated hemoglobin compared to those without an ED	Prior: (CI duration: 6.7 years)
Kaminsky and Dewey (2014)	Subjects with type 1 diabetes (n = 46; age = 15) and controls (n = 27; age = 14.8)	BESAA	Higher BMI was associated with poorer body image, self-esteem, and social support in girls with diabetes, but not in boys with diabetes	N/A

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Khan and Montgomery (1996)	Female subjects with insulin-dependent diabetes and matched controls in 4 sets of age groups with 12 individuals per group: 13/14 (age = 14.1), 15/16 (age = 16.4), 17/18 (age = 18.0), 19/20 (age = 19.6)	EDI; DEBQ	Subjects with diabetes scored in the pathological range of drive for thinness, bulimia, and body dissatisfaction. Subjects with diabetes and age 13/14 had higher body dissatisfaction than their controls, but by age 19/20, controls have increased their body dissatisfaction to a pathological range. Body dissatisfaction increased with age despite health status. Subjects with diabetes were less able to control eating when faced with external cues. Subjects who omitted their insulin had higher scores for bulimic symptoms and responsiveness to external eating cues, and had lower desire to have control of diabetes	Prior for age groups 13/14 and 19/20; after for age groups 15/16 and 17/18: (CI duration, respectively: 6.6, 10.5, 5.7, 6.6 years)
Kichler, Foster, and Opipari-Arrigan (2008)	Female subjects with type 1 diabetes (n = 75; age = 14.1) and their mothers	EDI; EAT; EDE-D	Body image dissatisfaction moderated the relation between negative communication by family toward the adolescent about physical appearance/diet and maladaptive eating attitudes and behaviors. Treatment adherence mediated the relation between maladaptive eating attitudes/behaviors and glycemic control. Only 77.3% of females always took the prescribed amount of insulin	N/A
Lloyd et al. (1987)	Female (n = 147) and male subjects (n = 126) with insulin-dependent diabetes and controls for each gender (n = 138; n = 73, respectively)	EDI; EAT	Female subjects with diabetes had worse overall eating attitudes and higher drive for thinness, interceptive awareness, ineffectiveness, and interpersonal distrust than controls. Male subjects with diabetes had higher total EAT scores, diet factor subscale of the EAT, drive for thinness, and ineffectiveness than controls. Glycated hemoglobin was associated with total EAT scores	Prior: (CI onset: 12 years old; ED onset 19 years old)
Maharaj et al. (2003)	Female subjects with type 1 diabetes (n = 88; age = 15) and their mothers	EDI; DSED-M	Subjects with mild and more severe disordered eating had poorer self-concepts in physical appearance, global self-worth, and behavioral conduct than girls without disordered eating; they also had mothers who weighed more, more likely to be on a diet, and binge eat. Mothers of girls with mild disordered eating expressed more weight dissatisfaction and mothers of girls with high disordered eating exercised more frequently for weight control. Subjects with disordered eating had poorer communication, less trust, and greater alienation in their relationship with their mother and given less autonomy. The relation between maternal weight/shape concerns and child eating disturbances were partially mediated by the quality of the mother–daughter relationship. Self-concept also fully mediated mother–daughter relationship and child eating disturbance status	Prior: (CI onset: 6.3 years (noneating disturbed), 8.1 years (mildly disturbed eating), 10.3 years (highly disturbed eating)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Markowitz, Lowe, Volkening, and Laffel (2009)	Female subjects with type 1 diabetes (n = 43; age = 14.3)	EDE-Q; TFEQ; PFS	Subjects who were overweight had more disturbed eating, and were 8 times more likely to score in the clinical range of at least one subscale of the EDE-Q. Twenty percent of the total sample had clinical significant disordered eating.	Prior: (CI duration: 6.4 years)
Markowitz et al. (2010)	Subjects with type 1 diabetes (n = 112; age = 15.1)	DEPS	Subjects with high levels of disordered eating were more likely to miss or restrict their insulin. Glycated hemoglobin was highest and the BMI was lowest among subjects with elevated disordered eating and insulin restriction	Prior: (CI duration: 6.8 years)
Markowitz et al. (2013)	Subjects with type 1 diabetes (n = 43; age = 13.3) assessed at three time points (baseline, 1, 6 months)	DEPS	Subjects who were overweight or obese had higher disordered eating scores than those with normal weight. Diabetes duration was associated with disordered eating at baseline and 6 months and BMI was associated at all time points. Hemoglobin A1c was positively associated with disordered eating at follow-up time points	After: (CI duration: 2.1 years)
Mellin et al. (2004)	Female subjects with type 1 diabetes (n = 30; age = 17.3)	EATS; AHEAD	Subjects with disordered eating were most likely to binge eat and skip/reduce insulin. Girls with disordered eating were more likely to perceive themselves as overweight, have low weight satisfaction, try to lose weight currently, engage in unhealthy weight-loss behaviors, have a low level of family mealtime structure, have parents who were trying to lose weight, and have parents who make negative comments about the subject's weight	Prior: (CI duration: 7.7 years)
Weltzer et al. (2001)	Subjects with type 1 diabetes (n = 152; age = 14.45)	EDI	BMI was a stronger predictor of body dissatisfaction for females than males. Likewise, body dissatisfaction was a stronger predictor of drive for thinness for females than males. Female subjects had higher bulimia scores than males prior to the age of 15. The worst glycemic control was found in overweight subjects with clinically significant bulimia symptoms and had a longer duration of diabetes.	Prior: (CI duration: 6.08 years)
Neumark-Sztainer, Story, Resnick, Garwick, and Blum (1995)	Subjects with CI including insulin-dependent diabetes, asthma, attention deficit disorder, physical disabilities, or seizure disorders (n = 2,149; age = 14.9) and a control group (n = 1,381)	Items assessing ED symptoms created for this study	Both female and male subjects with CI had higher levels of body dissatisfaction, frequency of dieting, and purging than subjects without a CI, with a greater difference in females. Females with diabetes had more frequent vomiting and use of laxatives/diuretics for weight loss	N/A
Neumark-Sztainer et al. (1996)	Subjects with diabetes (n = 310; age = 14.9) and a comparison group (n = 850)	Items of ED behaviors developed for this study	The clinical sample had more frequent binge eating, purging, and frequent dieting and lower emotional well-being. Perception of being overweight, weight dissatisfaction, and concerns with physical development were higher and family connectedness was lower in females with diabetes. Younger females with sexual attraction to other females and had body dissatisfaction were most likely to binge eat and purge; boys with sexual attraction to males had more binge eating and purging	N/A

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Neumark-Sztainer et al. (2002)	Subjects with type 1 diabetes (n = 143; age = 15.3)	DEPS; EATS	Disordered eating and weight control behaviors were higher in females than males. Subjects who viewed their weight as heavier were more likely to use unhealthy weight control behaviors. For males and females, weight dissatisfaction was associated with worse eating attitudes and behaviors, but not BMI and weight perception. Females who used unhealthy weight control behaviors were in families with the lowest cohesion, which in turn was negatively correlated with eating attitudes and behaviors for females and males. Disordered eating behaviors were associated with higher glycated hemoglobin in females and males, whereas healthy weight control was associated with lower glycated hemoglobin than unhealthy weight control in females only	N/A
O'Dell and DuPaul (2012)	Subjects with diabetes (n = 779; age = 12.7)	NS-CSHCN	Eating disorders, depression, anxiety, and other emotional problems were grouped into the study's main outcome of "emotional problems." Emotional problems were more likely in adolescents than younger children (2.0 times), to occur if the symptoms of diabetes often interfere with daily activity (3.4 times) and the family has had financial problems due to the child's health care costs (1.92 times)	N/A
Olmsted, Colton, Daneman, Rydall, and Rodin (2008)	Female subjects with type 1 diabetes (n = 101; age = 11.9) at baseline and 4 follow-up assessments over 5 years	cEDE	The new onset of disturbed eating behaviors was predicted by BMI, weight and shape concern, physical appearance and self-worth (indicators of self-esteem), and depressed mood	Prior: (based on study design)
Palladino et al. (2013)	Subjects with type 1 diabetes (n = 117; age = 18.15) and without diabetes (n = 122; age=18.02) assessed at senior year of high school and 1 year later	EDI	Female subjects had a stronger drive for thinness and bulimic symptoms than males. Drive for thinness decreased over time for subjects with diabetes and not in college full time, whereas it increased for those without diabetes who were not in college full time	Prior: (CI duration: 11.12 years)
Peveler, Fairburn, Boller, and Dunger (1992)	Subjects with insulin-dependent diabetes (n = 76; age=15.3) and matched controls (n = 76; age = 15.3)	EDE; EAT-26	Adolescent female subjects with diabetes had higher BMIs and worse eating attitudes than those without diabetes. None met criteria for AN or BN but 5 had EDNOS (3 diabetic, 2 nondiabetic). Negative eating attitudes were higher among boys with diabetes than those without diabetes. Females with diabetes had a higher BMI than males with diabetes. Omitting or reducing insulin dose occurred in 15% of females with diabetes but not in males	Prior: (CI duration: 7.7 years)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Peveler et al. (2005)	Female adolescent subjects (n = 33; age=15.3) and young adults (n = 54; age=21.0) with type I diabetes who were followed-up 8–12 years later	EDE; clinical records	At baseline, 8% had a current DSM-IV ED and 2 more were diagnosed at follow-up, but 26% had a history of disordered eating over the course of follow-up, with scores worsening with age. Omitting or reducing insulin dose to control weight occurred in 36% of the sample; insulin misuse was significantly higher in subjects with a history of disordered eating (61%) than subjects without a history (26%). Subjects with a diagnosed ED had higher glycated hemoglobin at baseline than subjects without an ED, but there was no difference over time. Serious microvascular complications and hospital admissions were higher in subjects with a history of ED, disordered eating, and insulin misuse	Prior: (CI duration: 7.1 years)
Philippi, Cardoso, Koritar, and Alvarenga (2013)	Adolescent (n = 62; age <20) and adolescent/adult subjects (n = 137; age = 20–56) with type 1 diabetes	EAT-26; BITE; BES	Female adolescent subjects had elevated scores on the EAT and BITE (symptoms) scales, but not on the BITE (severity) and BES scales	After: (CI duration: 13.5 years)
Pinar (2005)	Subjects with type I diabetes (n = 45) and without diabetes (n = 55) with a total sample average age of 15.49	EAT-40; BIS	Most subjects with diabetes occasionally used strict diet restrictions to control body weight (75%) and 40% misused insulin. Negative eating attitudes were more prevalent in subjects with diabetes than controls and more prevalent in subjects with diabetes who restricted their diet and misused insulin. Disordered eating was more common in females than males in the diabetic group. Disordered eating was predictive of poor metabolic control, with 75% of subjects with diabetes and a glycated hemoglobin value at 7% or higher having an elevated EAT score. Menstrual problems were more common in subjects with diabetes and subjects with disordered eating. Females with diabetes had lower body image satisfaction than males	Prior: (CI duration: 4.73 years)
Pollock-BarZiv and Davis (2005)	Subjects with type 1 diabetes (n = 51; age = 21.5)	DSED; EDI	ED behaviors were reported by 27.5% of subjects. Neurotic perfectionism and socially prescribed perfectionism were associated with weight preoccupation. Borderline personality traits predicted being classified as having ED symptoms and having high glycated hemoglobin	After: (CI duration: 13.8 years)
Pollock et al. (1995)	Subjects with insulin-dependent diabetes (n = 79; age = 8.2–13.8) who are followed for an average of 9 years (age = 20.6)	ISC; DMIS	An ED was diagnosed in 3.8% of the sample. All subjects with disordered eating did not follow the medical regimen at least once, whereas only 36% of the subjects without eating problems. Subjects with disordered eating were 9 times as likely to have other psychiatric disorders	Prior: (CI duration: 9.7 years)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Powers et al. (1990)	Subjects with insulin-dependent diabetes (n = 97; female age = 15.7; male age = 15.5)	EHQ	None of the males and 4.3% of the females had an ED diagnosis (BN), with one female with a history of AN based on the DSM-III. Females were more likely to have a history of binge eating. Subjects used less severe forms of purging, including exercise and fasting, rather than laxatives and diuretic abuse. Females were more likely to abuse diuretics and diet excessively than males	Prior: (CI duration: 8.26 [males], 9.78 [females])
Quick et al. (2012)	Subjects with type 1 diabetes (n = 20) as part of a sample with CI (n = 164) and matched controls (n = 656). Average age was 19.92.	EDE-Q; TFEQ-18; NEQ; DTEDS; ASI; measures of disturbed eating behaviors and related psychographic characteristics	The data for children with diabetes were grouped with the other diet-treated CI. Subjects with a diet-treated CI were 2 times more likely to have an ED diagnosis. They were more likely to have inappropriate compensatory behaviors, body image pressures, use avoidant coping skills, and to recall that during childhood they witnessed greater emphasis placed on their mother's weight and experienced pressure to eat during mealtime	N/A
Rodin, Daneman, Johnson, Kenshole, and Garfinkel (1985)	Female subjects with insulin-dependent diabetes (n = 46; age = 17.2)	EDI; EAT-26; psychiatric interview (DSM-III)	Nine subjects scored above the cutoff for the EAT-26 and an additional 10 had elevated scores on the EDI subscales. 19.5% of the sample had a clinically significant ED pathology. Bulimia symptoms were associated with glycated hemoglobin	Prior: (CI duration: 8.4 years)
Rodin, Johnson, Garfinkel, Daneman, and Kenshole (1986)	Female subjects with insulin-dependent diabetes (n = 58; age = 17.6)	EDI; EAT-26; psychiatric interview (DSM-III)	Nearly half of subjects had an elevated score on one measure (46.6%), and of these subjects 20.7% had a clinically significant ED. Bulimia symptoms were associated with glycated hemoglobin in the total sample, with a stronger correlation in those with BN	Prior: (CI duration: 8.4 years)
Rodin et al. (1991)	Female subjects with insulin-dependent diabetes (n = 103; age = 15.1)	DSED	A diagnosis of ED was made for 13% of the sample and a history of insulin omission to reduce weight occurred in 12% of the sample. The average glycated hemoglobin was clinically and statistically higher in the group with EDs than the group without EDs. Subjects with EDs were more noncompliant with diabetes treatment in all areas, except acute treatment of insulin reactions	Prior: (CI duration: 8.7 years)
Rydall et al. (1997)	Subjects with insulin-dependent diabetes (n = 91; age=15) who were followed up 4.4 years later	DSED	Insulin omission/underuse and dieting for weight loss increased over time. At baseline, 9.9% had highly disordered eating and 18.7% had moderately disordered eating. Subjects with highly disordered eating had a longer duration of diabetes. Disordered eating, binge eating, self-induced vomiting, and dieting for weight loss persisted over time when existent at baseline. Disordered eating and metabolic control were associated over time, with highly disordered eating associated with the highest glycated hemoglobin. Retinopathy was associated with disordered eating at Time 1	Prior: (CI duration: 8 years)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Scheuing et al. (2014)	Subjects with type 1 diabetes (n = 52,215; age range: 15.6–17.7)	DSM-IV/ICD-10 diagnosis	Of the total sample, 467 patients had an ED diagnosis (A n = 141; B n = 62; EDNOS = 264). Hypertension and dyslipidemia were higher in patients with BN and EDNOS. Glycated hemoglobin was higher in patients with an ED than those without an ED, with BN having the highest levels. Insulin dosage per square meter body surface was lower in patients with AN or BN than patients with no ED. Rates of severe hypoglycemia was higher in patients with AN and EDNOS. Hospitalization and the length of stay was higher in patients with ED. Patients with BN had 2.5 increased risk for retinopathy	Prior/After: (female CI onset: 11.4 (AN), 9.8 (BN), 10.0 years (EDNOS); male CI onset: 7.3 years (EDNOS)
Schwartz, Weissberg-Benchell, and Perlmuter (2002)	Female subjects with type 1 diabetes (n = 45; age = 14.4)	EDE-Q	Total EDE-Q scores were not associated with glycated hemoglobin. Less overall personal control and a weak sense of control over one's body were associated with more severe ED symptoms, which were not moderated by pubertal status	Prior: (CI onset: 9.01 years)
Smith, Latchford, Hall, and Dickson (2008)	Female subjects with diabetes (n = 40; age = 15.2), scoliosis (n = 76; age=15.8) and controls (n = 76; age=15.8)	EDE-Q	Restrictive eating was highest in the scoliosis group (15.8%) compared to the control (13.2%) and diabetes group (10%). The diabetes group had higher percentages of binge eating and inappropriate compensatory behaviors than the scoliosis and control groups. EDs were more frequent in the diabetes group than the control group, including BN (15%) and BED (12.5%)	N/A
Steel, Young, Lloyd, and Clarke (1987)	Female subjects with diabetes (n = 208; age=20.5ª)	Clinical assessment	Fifteen subjects (7%) had a diagnosis of AN or BN. Of the patients with an ED, 73.3% had poorly controlled glycated hemoglobin and 73.3% developed retinopathy	Prior/concurrent: (86.7% prior/ 13.3% concurrent)
Striegel-Moore, Nicholson, and Tamborlane, (1992)	Female subjects with diabetes (n = 46; age = 13.0) and matched controls (n = 46; age = 13.0)	EDE; EDI	No subjects met criteria for an ED, but 52% of subjects with diabetes had body image problems and 33% had excessive weight control, which was not significantly different from the control subjects (41, 24%, respectively). Older subjects had worse weight concern, shape concern, and restraint of diet and weight than younger girls. In general, subjects were satisfied with their quality of life and believed diabetes had a minimal impact on their life. Low satisfaction with quality of life was associated with higher total EDE scores in older subjects	Prior: (CI duration: 7.04)
Svensson et al. (2003)	Male subjects with diabetes (n = 109; age = 16.6) and controls (n = 139; 16.4)	EDI-C; RAB-T	Subjects with diabetes had stronger desire to lose weight than controls, whereas controls had more bulimic symptoms. Subjects with diabetes who do not take their insulin at least twice a month had higher glycated hemoglobin than those who took their insulin regularly. None of the subjects had an ED	Prior: (CI duration: 7.2 years)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Takii et al. (1999)	Female subjects with type 1 diabetes and BN (n = 22) and with BED (n = 11), and controls with diabetes only (n = 32) assessed in adulthood but onset of diabetes and ED in childhood for BN (current age = 23.2; diabetes onset age = 14.5; binge eating onset = 18.2)	EDI; clinical interview	BN had an earlier onset and longer duration of binge eating and diabetes than BED	Prior: (CI onset prior for both ED groups)
Takii et al. (2002)	Female subjects with type 1 diabetes and BED (n = 24; current age = 25.2; diabetes onset = 17.5; ED onset = 21.7; BN with insulin omission (n = 22; current age = 22.3; diabetes onset = 15.9; ED onset = 17.9; BN with insulin omission and purging (n = 22; current age = 23.7; diabetes onset = 13.1; ED onset = 17.5; and BN without insulin omission (n = 11; current age = 22.3; diabetes onset = 14.0; ED onset 17.9)	EDI; clinical interview	The onset of diabetes preceded the diagnosis of an ED for 92.4% of subjects with an ED	Prior: (CI onset prior for all ED groups)
Takii et al. (2011)	Female subjects with type 1 diabetes (n = 53; age = 23.7) with an onset of diabetes (age = 13.9) and ED (age = 18.2) during childhood compared to controls (n = 49; age = 27.6) with childhood-onset diabetes only (age = 15.0)	EDI	The group with ED was younger and had a higher glycated hemoglobin than the control group. 69.8% of the ED group had an onset of diabetes during childhood (7 and 18 years old), which was a significantly higher rate than the control group	Prior: (CI onset prior than ED)
Tse, Nansel, Haynie, Mehta, and Laffel (2012)	Subjects with diabetes (n = 151; age = 15.6)	DEPS; HEAS	Subjects with high levels of disordered eating had a higher percentage of energy intake from total and saturated fat and poorer attitudes toward healthy eating than subjects with low disordered eating. Attitudes toward healthy eating included low self-efficacy, greater barriers, lower dietary satisfaction, and negative outcome expectations for healthy eating	Prior: (CI duration: 7.7 years
Vila et al. (1995)	Female subjects with diabetes and obesity (n = 15; age = 15.6) and without obesity (n = 37; age = 15.7) and controls without diabetes and with obesity (n = 22; age = 15.6) and without diabetes and obesity (n = 24; age = 16.2)	Clinical interview	Three subjects with diabetes and obesity had BN. 60% of subjects with diabetes and obesity, 41% of subjects with obesity, but without diabetes, 27% of subjects without obesity, but with diabetes, and 4% of subjects without obesity or diabetes had an EDNOS for bulimic behaviors. The glycated hemoglobin of subjects with obesity and with or without diabetes was not significantly different. The three subjects with BN had higher glycated hemoglobin and early signs of retinopathy	Prior: (CI onset: 7.7 years)

(Continues)

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Welch et al. (2015)	Subjects with a diagnosed/suspected ED, including 58 male (age = 14.9) and 606 female (age = 15.2) patients	Psychiatric diagnosis (DSM-IV)	Diabetes occurred in 1% of female subjects with AN or other specified feeding or eating disorder (atypical AN). No comorbidity was found in male subjects	N/A
Wilson, Smith, Coker, Hobbis, and Acerini (2015)	Subjects with type 1 diabetes (n = 50; age = 14–16)	cEDE; EDE-Q	Subjects with ED attitudes had higher BMI, poorer glycemic control, and lower self-esteem, and subjects with ED behaviors had lower self-esteem and increased family conflict than those without ED problems. Females had more disordered eating attitudes than males	N/A
Wing et al. (1986)	Female subjects (n = 101; age = 14.5) and male subjects with diabetes (n = 101; age = 15.1)	EAT-26; BES; clinical interview	Subjects from this study were compared to subjects without diabetes from a previous study (Hsu, Milliones, Friedman, Holder, & Klepper, 1982). Female subjects with diabetes had worse dieting than controls and male subjects with diabetes had worse dieting and oral control but less BN symptoms. Female subjects with high disordered eating had significantly higher glycated hemoglobin than those with low disordered eating	N/A
Wisting, Bang, Skrivarhaug, Dahl-Jørgensen, and Rø (2015)	Subjects with type 1 diabetes (n = 105; age = 15.7)	cEDE	Females' ED scores were associated with their BMI, age, insulin restriction due to weight/shape concerns, perception of their illness, coping strategies, and beliefs about insulin use. Insulin restriction, age, and beliefs about their illness remained significant in predicting ED scores in a backward regression model. Males' ED scores were not associated with the other variables	Prior: (CI onset: 9.6 years old)
Wotton, James, and Goldacre (2016)	Subjects with AN (n = 1,642; age = 10–14) or BN (n = 4,196; age = 15–19)	Hospital admission records for EDs based on ICD-10 codes	There was an elevated risk of AN and BN in females and BN in males five or more years after admission for type 1 diabetes	N/A
Studies of children with cystic fibrosis and eating disorders				
Blair et al. (1994)	Subjects with AN (n = 27; age = 18.7), CF (n = 29; age 19.2), and healthy subjects (n = 31; age = 18.2)	MRS	Subjects with CF had worse food intake scores and lower weight than well patients, but better scores than subjects with AN. Subjects with AN and CF had parents with similar personal and social strain, and had high expressed emotion households. Parents of children with CF had higher mastery scores and were better problem solvers	Prior
Borawska-Kowalczyk and Sands (2015)	Subjects with CF (adolescent report: n = 70; age = 14.41; parent report: n = 70; age = 10.54)	CFQ-R	Adolescents scored eating problems as the most significant problem affecting their quality of life and BMI had the strongest influence on body image and eating problems for children	Prior
Bryon, Shearer, and Davies (2008)	Subjects with CF (n = 55; age = 14.2)	cEDE	Subjects did not meet diagnostic criteria for EDs but 5% of those with anorexic weight avoided weight gain, 53% had disturbed eating attitudes, and 16% had disturbed eating behaviors	Prior

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Pearson, Pumariega, and Seilheimer (1991)	Subjects with CF (n = 61; age = 10.96) and an older group not included in this review (n = 36; age = 24.81)	EAT	The illness severity of CF of the child group was in the "good" to "mild" range, with 16.4% of the child group having symptoms consistent with AN. The occurrence of ED symptoms was significantly higher in the child group than the adult group, including resisting food, being preoccupied by food, and using food as a control issue	Prior
Pumariega et al. (1993)	Subjects with CF (n = 44; age = 11)	EAT	Parents rated the impact of CF on their lives one standard deviation higher than parents with a child with CI and this was associated with severity and not duration of illness. Negative eating attitudes were elevated for 15.6% of subjects, but not associated with illness severity	Prior
Quick et al. (2012)	Subjects with CF (n = 9) as part of a sample with CI (n = 164) and matched controls (n = 656). Average age was 19.92	EDE-Q; TFEQ-18; NEQ; DTEDS; ASI; Measures of disturbed eating behaviors and related psychographic characteristics	The data for children with CF were grouped with the other diet-treated CI. Subjects with a diet-treated CI were 2 times more likely to have an ED diagnosis. They were more likely to have inappropriate compensatory behaviors, body image pressures, use avoidant coping skills, and to recall that during childhood they witnessed greater emphasis placed on their mother's weight and experienced pressure to eat during mealtime	Prior
Raymond et al. (2000)	Subjects with CF (n = 58; age = 16) and controls (n = 43; age = 16)	DIS; DISC; EDQ; BSQ	Subjects with CF did not meet criteria for an ED diagnosis, and had lower scores on drive for thinness, perfectionism, and body dissatisfaction than controls	Prior
Shearer and Bryon (2004)	Subjects with CF from two CF centers (Center 1: n = 33; age = 14.2; Center 2: n = 22; age = 14.14)	Cede	12% of those with a BMI in the AN range were avoiding gaining weight, and 16% rated body shape and 24% rated body weight as holding moderate/ supreme importance regarding their self-evaluation. Of the subjects with scores reflective of AN or sub-threshold AN, 16% were attempting to lose or maintain their weight. Of the subjects with scores reflective of BN or subthreshold BN, 5% were using compensatory behaviors, and 24% felt that their body shape and 29% felt that their weight influenced their self-evaluation. Global self-esteem predicted disordered eating	Prior
Steiner et al. (1990)	Subjects with CF (n = 10; age = 16.8) and with an ED (n = 10; age = 16.9)	EDI; SABS; psychodiagnostic interview	Subjects with AN had worse ED symptoms than subjects with CF, but subjects with CF had a mild elevation of AN symptoms, with resistance to eating being most prominent	Prior
Studies of children with celiac disease and eating disorders				
Basso et al. (2013)	Subjects with AN (n = 177; age = 14.5)	Psychiatric diagnosis (DSM-IV)	Fifty-seven subjects (32%) had abdominal complaints. Only one subject was positive to tTGA and to the intestinal biopsy, which indicated celiac disease	N/A

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Karwautz et al. (2008)	Subjects with celiac disease (n = 283; age = 14.8)	EDI-2; EDE-Q; EDE-12	4.8% of female subjects with celiac disease had a lifetime history of ED, 3.9% had a current ED, 10.2% had a history of a subclinical ED, and 10.7% had a current subclinical ED. None of the male subjects had a history of clinical or subclinical ED. Antiendomysial antibodies and IgG values were significantly higher in subjects with ED and a trend was shown for those with subclinical ED. Patients with comorbid ED behaviors were less compliant with having a gluten free diet. The onset of celiac disease was prior to disturbed eating behaviors for the majority of subjects (85.7%)	Prior: (CI onset was prior for 85.7%)
Quick et al. (2012)	Subjects with celiac disease (n = 36) as part of a sample with CI (n = 164) and matched controls (n = 656). Average age was 19.92	EDE-Q; TFEQ-18; NEQ; DTEDS; ASI; Measures of disturbed eating behaviors and related psychographic characteristics	The data for children with celiac were grouped with the other diet-treated CI. Subjects with a diet-treated CI were 2 times more likely to have an ED diagnosis. They were more likely to have inappropriate compensatory behaviors, body image pressures, use avoidant coping skills, and to recall that during childhood they witnessed greater emphasis placed on their mother's weight and experienced pressure to eat during mealtime	N/A
Wagner et al. (2015)	Female adolescents with celiac disease (n = 174; age = 14.53), celiac disease/ED (n = 32; age = 16.41) and healthy controls (n = 53; age = 14.70)	EDI-2; EDE-Q	Diagnoses included 1 AN, 4 BN, 6 EDNOS, and 21 subclinical ED	Prior: (CI duration: 9.69 years)
Welch et al. (2015)	Subjects with a diagnosed/suspected ED, including 58 male (age = 14.9) and 606 female (age = 15.2) patients	Psychiatric diagnosis (DSM-IV)	Celiac disease occurred in 2.4% of female subjects with AN or other specified feeding or eating disorder (atypical AN). No comorbidity was found in male subjects	N/A
Studies of children with gastrointestinal disorders or inflammatory bowel diseases and eating disorders				
Boyd et al. (2005)	Subjects admitted to an ED inpatient unit (n = 101; age 21)	EEE-C; EDI-2; EAT	Ninety-eight percent had at least one functional gastrointestinal disorder and 53% had 3 or more. Subjects had irritable bowel syndrome (52%), functional heartburn (51%), functional abdominal bloating (31%), functional constipation (24%), functional dysphagia (23%) and functional anorectal pain disorder (22%). State anxiety and somatization were predictors of irritable bowel syndrome in subjects with EDs	N/A
Boyd et al. (2010)	Subjects with an ED and functional gastrointestinal disorder symptoms admitted to an ED inpatient unit (n = 73; age = 20)	EEE-C; EAT	The rate of subjects with a functional gastrointestinal disorder decreased significantly from admission (97%) to 12-month follow-up (77%). Thirty-four percent of subjects developed a new functional gastrointestinal disorder regional category (esophageal, gastroduodenal, bowel, anorectal) at 12-month follow-up. Changes in BMI, ED behaviors (e.g., self-induced vomiting) or psychological variables (e.g., anxiety) were not associated with changes in functional gastrointestinal disorders over time	N/A

TABLE 1 (Continued)

Study	Sample	ED measure(s)	Findings	CI onset
Gendall et al. (2005)	Adult subjects with a primary diagnosis of BN (n = 135) who provided a retrospective report of gastrointestinal and ED problems before the age of 18	SCID	One third of the subjects had GI and constipation problems during childhood. Women with GI problems were significantly younger, and had earlier onset of BN and self-induced vomiting than women with no GI problems. Trends were found for younger age of first binge, greater frequency of binge eating during more severe binge-eating period, and likelihood of experiencing sexual abuse in women with childhood GI problems	Prior: (GI onset: 12.3 years; BN onset: 19.5 years)
Lee et al. (2012)	Subjects with "fat phobic" AN (n = 113) and "nonfat phobic" AN (n = 28) and an average age of 20.6	EDI-1; EAT-26	The majority of subjects with AN had one or more symptoms of gastrointestinal symptoms (79.4%), with subjects with "fat phobic" anorexia have more severe gastrointestinal symptoms than subjects who were "nonfat phobic." Longer duration of AN and being "fat phobic" predicted more severe gastrointestinal symptoms. "Fat phobic" anorexia with high gastrointestinal problems had the most severe ED symptom profile and worse eating attitudes	N/A
Perez et al. (2013)	Subjects with AN (n = 16; age: 15.5) who met criteria for medical admission and controls (n = 22; age: 16.8)	None	The AN group had significantly higher somatic symptoms than the control group. Seventy-five percent of the AN group met criteria for a functional gastrointestinal disorder compared to 18% of the controls, with irritable bowel syndrome being the most common disorder in the AN group. The AN group had an improvement of somatic and gastrointestinal symptoms after nutritional rehabilitation	N/A
Sullivan et al. (1997)	Subjects with irritable bowel syndrome (n = 48) compared to subjects at an ED clinic (n = 32), subjects with inflammatory bowel disease (n = 31), and normal controls (n = 28)	EAT	The ED group had the worse eating attitudes. The irritable bowel syndrome group had worse eating attitudes than the inflammatory bowel disease group and control group when the ED group was excluded from the analysis	N/A
Quick et al. (2012)	Subjects with inflammatory bowel disease (n = 30) and irritable bowel syndrome (n = 90) as part of a sample with CI (n = 164) and matched controls (n = 656). Average age was 19.92	EDE-Q; TFEQ-18; NEQ; DTEDS; ASI; Measures of disturbed eating behaviors and related psychographic characteristics	The data for children with inflammatory bowel disease were grouped with the other diet-treated CI. Subjects with a diet-treated CI were 2 times more likely to have an ED diagnosis. They were more likely to have inappropriate compensatory behaviors, body image pressures, use avoidant coping skills, and to recall that during childhood they witnessed greater emphasis placed on their mother's weight and experienced pressure to eat during mealtime	N/A

Note. Age = average age of the sample; AHEAD = assessing health and eating among adolescents with diabetes; AN = anorexia nervosa; ASI = appearance schema inventory; BAB-T = assessment of anorexia–bulimia-teenager version; BDS = Body Cathexis Scale; BITE = bulimic investigatory test, Edinburgh; BED = binge-eating disorder; BESAA = body esteem scale for adolescents and adults; BIS = body image scale; BMI = body mass index; BN = bulimia nervosa; BSQ = Body Shape Questionnaire; cEDE = Children's Eating Disorder Examination; CF = cystic fibrosis; CFQ-R = Cystic Fibrosis Questionnaire–Revised; CI Onset = chronic illness onset prior or after ED onset; DEBQ = Dutch Eating Behaviour Questionnaire; DEPS = Diabetes Eating Problem Survey; DEPS-R = Diabetes Eating Problems Survey–Revised; DiEPS-R = Dietary Eating Problems Survey–Revised; DIS = Diagnostic Interview Schedule; DISC = Diagnostic Interview Schedule for Children; DMIS = Diabetic = IV = Diagnostic and Statistical Manual of Mental Disorders-IV; DSED = Diagnostic Survey for Eating Disorders; DSED-M = Diagnostic Survey for Eating Disorders–Modified; DSM = Diagnostic and Statistical Manual of Mental Disorders (DSM) Fourth Edition; DTEDS = Dichotomous Thinking in Eating Disorders Scale (Eating subscale); EAT-26 = Eating Attitudes Test (26-item); EAT-40 = Eating Attitudes Test (40 item); EATS = Eating Among Teens Survey; ED = eating disorder; ED = Diagnostic Survey for Eating Disorders; EDE = Eating Disorder Examination; EDI = Eating Disorder Inventory; EDI = Eating Disorders Inventory; EDI-2 = Eating Disorders Inventory; EDI-2 = Eating Disorder Inventory-2nd version; EDI-3 = Eating Disorder Inventory 3rd edition; EDI-C = Eating Disorder Inventory–Children's version; EDE = Eating Disorder Examination Diabetes; EDE-12 = Eating Disorders Examination, Version 12.0; EDQ = Eating Disorder Questionnaire; EDE-Q = Eating Disorder Examination Questionnaire; EEE-C = Eating and Exercise Examination-computerized; EDNOS = eating disorder not otherwise specified; ESP = Eating Disorder Screen for Primary Care; HEAS = Healthful Eating Attitudes Scale; ISC = Interview Schedule for Children and Adolescents; MRS = Morgan and Russell Scales; N/A = not available data on chronological order of onset; NEQ = Night Eating Questionnaire; NS-CSHCN = National Survey of Children with Special Health Care Needs; P-EAT = Project EAT survey; PFS = Power of Food Scale; QEW-R = Questionnaire on Eating and Weight Patterns, Revised; RAB-T Rating of Anorexia and Bulimia-Teenager; SABS = Slade Anorexic Behavior Scale; SCID = Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-Third Edition-Revised; SCOFF = SCOFF Questionnaire; TFEQ = Three-Factor Eating Questionnaire; TFEQ-18 = Three Factor Eating Questionnaire-18; YEDE = youth version of the Eating Disorder Examination Questionnaire.

et al., 2005; Pollock, Kovacs, & Charron-Prochownik, 1995; Powers, Malone, Coovert, & Schulman, 1990; Rodin, Craven, Littlefield, Murray, & Daneman, 1991), but in general, the rate was higher than the general population (Hoek & van Hoeken, 2003). Individuals with diabetes tend to engage in poor dietary self-care, including a lower likelihood to monitor blood sugar levels, follow a meal plan, maintain appropriate blood sugar levels, and general compliance with diabetes treatment (Antisdel & Chrisler, 2000; Pollock et al., 1995; Rodin et al., 1991). Insulin restriction, manipulation, or omission are prevalent approaches to weight control that are associated with the severity of disordered eating (Cantwell & Steel, 1996; Grylli et al., 2004; Howe et al., 2008; Mellin et al., 2004; Jones et al., 2000; Peveler et al., 2005; Rodin et al., 1991; Rydall, Rodin, Olmsted, Devenyi, & Daneman, 1997). Intentional insulin restriction is an established risk factor for nephropathy, foot damage, increased healthcare utilization, and a threefold increased mortality rate (Goebel-Fabbri et al., 2008). Females with diabetes have unhealthy eating attitudes (Kaminsky & Dewey, 2014; Meltzer et al., 2001), disordered eating behaviors (Pinar, 2005; Powers et al., 1990), and more extreme weight loss/control behaviors (i.e., insulin restriction) (Ackard et al., 2008; Bryden et al., 1999; Caccavale et al., 2015) compared to males with diabetes. Most studies provide support that individuals with diabetes who engage in disordered eating or insulin restriction are at risk for elevated glycated hemoglobin (Lloyd et al., 1987; d'Emden et al., 2013; Jones et al., 2000; Rodin et al., 1991; Svensson, Engstrom, & Aman, 2003; Wing, Nowalk, Marcus, Koeske, & Finegold, 1986), but a couple of studies did not find a significant association (Colton et al., 2013; Engström et al., 1999).

Parents' personal eating attitudes (e.g., weight/shape concerns) and habits (e.g., attempts at weight loss) and negative comments about their child's weight were associated with child disordered eating (Colton, Olmsted, Daneman, Rydall, & Rodin, 2007; Maharaj, Rodin, Olmsted, Connolly, & Daneman, 2003; Mellin et al., 2004). In addition, characteristics of a maladaptive family environment were associated with child disordered eating, including: poor family mealtime structure, parent–child relationship quality, and communication, lack of trust, and low cohesion (Maharaj et al., 2003; Mellin et al., 2004; Neumark-Sztainer et al., 1996; Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002). Family conflict specifically about the child's diabetes was associated with increased disordered eating (Caccavale et al., 2015). In contrast, a positive parent–child relationship predicts better metabolic control (Helgeson, Siminerio, Escobar, & Becker, 2009).

4.2 | Cystic fibrosis

Cystic fibrosis is a life-limiting, autosomal recessive genetic disease, with a current median life expectancy in the United States of 42 years (Cystic Fibrosis Foundation, 2017) that has improved compared to decades earlier (1979: 15 years; 1991: 23 years) (Halliburton, Mannino, & Olney, 1996). The most concerning symptoms of cystic fibrosis for children are failure to thrive and malnutrition, which makes feeding a priority early and throughout child development. Children with cystic fibrosis are born with the disease, which places the CI onset prior to
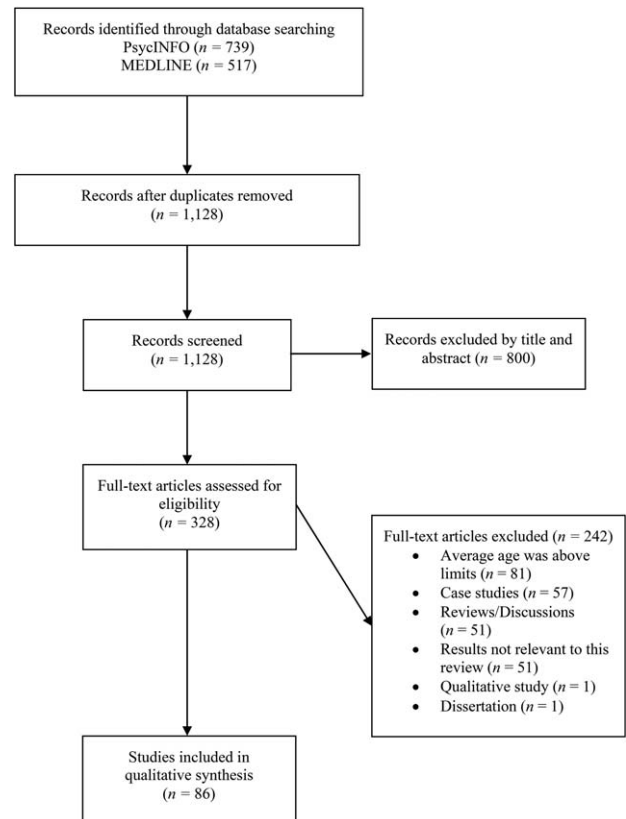

FIGURE 1 PRISMA flow diagram for study inclusion

the development of ED symptoms for all nine studies (see Table 1). Children with cystic fibrosis who engage in disordered eating are inclined to have AN symptoms rather than BED or BN symptoms. This pattern of disordered eating counters the pediatric pulmonary treatment goals and parents' feeding objective to increase children's nutritional intake and maintain sufficient body weight. Children with cystic fibrosis did not meet full criteria for AN or any other ED in studies that used a diagnostic assessment, but disordered eating prevalence was elevated in most studies, with some ED scores indicating a possible ED. Children with cystic fibrosis had less severe disordered eating than children with an ED only, but more severe than controls (Blair, Cull, & Freeman, 1994; Quick, McWilliams, & Byrd-Bredbenner, 2012; Steiner, Rahimzadeh, & Lewiston, 1990). In contrast, Raymond et al. (2000) found that children with cystic fibrosis did not have a negative body image or desire for perfection when compared to healthy children (Raymond et al., 2000). Parents of children with cystic fibrosis were significantly impacted by their child's illness, including financial and social stress, and tended to be overinvolved in their child's life (Blair et al., 1994; Pumariega, Pearson, & Seilheimer, 1993). However, parents of a child with cystic fibrosis also tended to use healthy coping skills, including seeking social support, feel more competent in coping with the illness, and excel at problem solving compared to parents of a child with an ED (Blair et al., 1994; Steiner et al., 1990). More recent research on parents coping skills in the context of disordered eating is lacking in the cystic fibrosis literature.

TABLE 2 Critical analysis of studies: risk of bias and statistically significant differences of disordered eating in children with chronic illness versus controls

Study	Study type	Sampling	Control group	Measure of ED	Attrition	ED in CI versus control group
Diabetes						
Ackard et al. (2008)	C	−	−	+		+body dissatisfaction; +unhealthy weight control behavior
Antisdel and Chrisler (2000)	C	+		−		
Bächle et al. (2016)	C	−		−		
Baechle et al. (2014)	C	−	−	−		−body dissatisfaction; +food-intrusive thoughts
Battaglia et al. (2006)	C	+		−		
Bernstein et al. (2013)	C	+		−		
Bryden et al. (1999)	L	+		−	+	
Caccavale et al. (2015)	C	+		+		
Cantwell and Steel (1996)	C	+		−		
Colton et al. (2004)	C	−	−	−		+disordered eating; +excessive exercise; +binge eating; +EDNOS
Colton et al. (2007)	L	+		−	−	
Colton et al. (2013)	L	+		−	+	
d'Emden et al. (2013)	C	+		−		
Engstrom et al. (1999)	C	+	−	−		+drive for thinness; +body dissatisfaction
Grylli et al. (2004)	C	−		−		
Grylli et al. (2005)	C	+		−		
Grylli et al. (2005)	C	+		−		
Helgeson, Escobar, (2007)	L	+	+	−	+	+drive for thinness
Helgeson, Snyder, (2007)	L	+	+	−	+	+disordered eating
Helgeson et al. (2009)	L	+		−	−	
Howe et al. (2008)	C	+		+		
Hsu et al. (2009)	C	+	−	−		+bulimic symptoms
Hudson et al. (1985)	C	+		+		
Johnson et al. (2014)	C	−		−		
Jones et al. (2000)	C	−	−	−		+binge eating; +ED diagnosis
Kaminsky and Dewey (2014)	C	−	−	−		No differences
Khan and Montgomery (1996)	C	+	−	−		+drive for thinness; +body dissatisfaction
Kichler et al. (2008)	C	+	−	−		
Lloyd et al. (1987)	C	+	+	−		+body dissatisfaction (female); +drive for thinness; +disordered eating (male)
Maharaj et al. (2003)	C	+		−		
Markowitz et al. (2009)	C	+		−		
Markowitz et al. (2010)	C	+		+		
Markowitz et al. (2013)	L	+		−	+	
Mellin et al. (2004)	C	+		+		
Meltzer et al. (2001)	C	+	+	−		−body dissatisfaction (girls); −bulimic symptoms (boys)
Neumark-Sztainer et al. (1995)	C	−	−	+		+body dissatisfaction; +risky weight loss practices
Neumark-Sztainer et al. (1996)	C	−	−	+		+binge eating; +purging
Neumark-Sztainer et al. (2002)	C	−		+		
O'Dell and DuPaul (2012)	C	+		+		
Olmsted et al. (2008)	L	−		−	−	
Palladino et al. (2013)	L	+	−	−	+	No differences
Peveler et al. (1992)	C	+	−	−		+dietary restraint; +disordered eating
Peveler et al. (2005)	L	+		−	−	
Philippi et al. (2013)	C	+		−		
Pinar (2005)	C	+	−	−		+disordered eating
Pollock-BarZiv and Davis (2005)	C	+		−		
Pollock et al. (1995)	L	−		−	+	
Powers et al. (1990)	C	+		−		
Quick et al. (2012)	C	−	−	−		+excessive exercise; +use medication to control weight
Rodin et al. (1985)	C	+		−		
Rodin et al. (1986)	C	+		−		
Rodin et al. (1991)	C	+		−		
Rydall et al. (1997)	L	+		+	+	
Scheuing et al. (2014)	L	−		+	−	
Schwartz et al. (2002)	C	+		−		

(Continues)

TABLE 2 (Continued)

Study	Study type	Sampling	Control group	Measure of ED	Attrition	ED in CI versus control group
Smith et al. (2008)	C	–	+	–		+ED diagnosis;
Steel et al. (1987)	C	+		+		
Striegel et al. (1992)	C	–	–	–		–overeating
Svensson et al. (2003)	C	–	–	–		+drive for thinness
Takii et al. (1999)	C	+	–	–		Subjects selected based on having an ED.
Takii et al. (2002)	C	+	–	–		
Takii et al. (2011)	C	+	+	–		Subjects selected based on having an ED.
Tse et al. (2012)	C	–		–		
Vila et al. (1995)	C	+	–	–		N/A
Welch et al. (2015)	C	+		–		
Wilson et al. (2015)	C	+		–		
Wing et al. (1986)	C	–	–	–		+disordered eating
Wisting et al. (2015)	C	+		–		N/A
Wotton et al. (2016)	C	–	–	+		Subjects selected based on having an ED
Cystic fibrosis						
Blair et al. (1994)	C	–	+	–		N/A
Borawska-Kowalczyk and Sands (2015)	C	+		+		
Bryon et al. (2008)	C	–		–		
Pearson et al. (1991)	C	+		–		
Pumariega et al. (1993)	C	+		+		
Quick et al. (2012)	C	–	–	–		+excessive exercise; +use medication to control weight
Raymond et al. (2000)	C	+	–	–		–drive for thinness; –body dissatisfaction
Shearer and Bryon (2004)	C	–		–		
Steiner et al. (1990)	C	+	–	–		–disordered eating
Celiac disease						
Basso et al. (2013)	C	+		–		
Karwautz et al. (2008)	C	+	–	–		N/A
Quick et al. (2012)	C	–	–	–		+excessive exercise; +use medication to control weight
Wagner et al. (2015)	C	+	–	–		N/A
Welch et al. (2015)	C	–		–		
Gastrointestinal disorders and inflammatory bowel diseases						
Boyd et al. (2005)	C	–		–		
Boyd et al. (2010)	L	–		–	+	
Gendall et al. (2005)	C	+		–		
Lee et al. (2012)	C	–		–		
Perez et al. (2013)	L	–	–	–	–	Subjects selected based on having an ED
Quick et al. (2012)	C	–	–	–		+excessive exercise; +use medication to control weight
Sullivan et al. (1997)	C	+	+	–		No differences

Note. C = cross-sectional; CI = chronic illness; ED = eating disorders; L = longitudinal; – low bias (columns 3–6) or less disordered eating in the group with chronic illness than the control group (column 7); + high bias (columns 3–6) or more disordered eating in the group with chronic illness than control group (column 7).
The critical analysis of the risk of bias is based on the Fowkes and Fulton (1991) method. A column for quality of blind assessments of the outcome variable was not included because none of the studies included blind assessments.

4.3 | Celiac disease

Celiac disease is an autoimmune disorder that causes an inflammatory reaction to the ingestion of gluten due to immune system, genetic, and environmental factors (Green & Cellier, 2007). Approximately one third of children with EDs report having abdominal complaints, including constipation, bloating, abdominal pain, and dyspepsia (Basso et al., 2013) (see Table 1). Basso et al. (2013) reported the rate of celiac disease in a sample of children (81% female) with AN (0.6%) (Basso et al., 2013) to be similar to the general population (Green & Cellier, 2007), but Welch, Ghaderi, and Swenne (2015) examined a larger sample of children with different types of EDs and found a rate of AN or atypical

AN that was four times greater in girls (2.4%) and absent in boys (Welch et al., 2015). Similarly, Karwautz et al. (2008) examined a sample of children with celiac disease and found that the rates of EDs for females (4.8% with a history of ED; 3.9% with a current ED; [Karwautz et al., 2008]) were substantially higher than the general population (AN 0.3%; BN 1%; BED 1%) (Hoek & van Hoeken, 2003). However, males did not meet criteria for any EDs or subclinical EDs, and had low scores on the Eating Disorder Inventory-2 (Karwautz et al., 2008). Celiac disease typically preceded the onset of disordered eating and a diagnosable ED in the majority of cases (85.7%), with an average of 9.87 years between the onset of celiac disease and the onset of eating pathology

(Karwautz et al., 2008). Karwautz et al. (2008) and Wagner et al. (2015) found evidence that celiac disease started prior to the onset of disordered eating, but Basso et al. (2013), Quick et al. (2012), and Welch et al. (2015) did not provide data on the order of onset. Overall, children with celiac disease have a greater risk for developing EDs and disordered eating than the general population and the risk is predominant in females.

4.4 | Gastrointestinal disorders and inflammatory bowel diseases

Gastrointestinal disorders (e.g., irritable bowel syndrome) and inflammatory bowel diseases (e.g., Crohn's disease) are a heterogeneous group of CIs that affect the gastrointestinal tract and digestive system. Children with gastrointestinal disorders and inflammatory bowel diseases tend to have feeding and eating problems (e.g., low variety and volume of intake, food refusal, gagging/vomiting) that can extend after treatment of the disorder (Field, Garland, & Williams, 2003; Mackner & Crandall, 2007; Meyer et al., 2014; Mukkada et al., 2010). The literature provides consistent evidence that children with EDs have a high rate of gastrointestinal disorders and inflammatory bowel diseases (see Table 1). Boyd, Abraham, and Kellow (2005) and Boyd, Abraham, and Kellow (2010) studies have found that 97–98% of inpatients with an ED had a gastrointestinal disorder, 53% had three or more gastrointestinal disorders, and 77% continued to have a gastrointestinal disorder at 12-month follow-up (Boyd et al., 2005, 2010). Children with AN specifically have a high rate of gastrointestinal disorders or symptoms (75–79%) compared to healthy children and the severity of AN is positively associated with gastrointestinal symptoms (Lee, Ng, Kwok, Thomas, & Becker, 2012; Perez, Coley, Crandall, Di Lorenzo, & Bravender, 2013). Irritable bowel syndrome presents as the most common gastrointestinal disorder in children with AN (Perez et al., 2013). Women with BN who retrospectively reported having pediatric GI problems (33%) were more likely to be younger when they started binge eating, have more severe binge-eating behavior, and have experienced sexual abuse than women without GI problems (Gendall, Joyce, Carter, McIntosh, & Bulik, 2005). Sullivan, Blewett, Jenkins, and Allison (1997) found that children with irritable bowel syndrome had more unhealthy eating attitudes than children with inflammatory bowel disease and controls (Sullivan et al., 1997). Only one of the seven studies reviewed provided evidence of the age of onset between the CI and ED, with the gastrointestinal disorder starting before the ED. In summary, ED and gastrointestinal/inflammatory bowel symptoms are highly comorbid and the collection of symptoms can impact pediatric quality of life.

5 | DISCUSSION

This is the first comprehensive, systematic review of the relationship between diet-treated CI and EDs in children to our knowledge. The review followed the PRISMA guidelines, covered literature up to June 2016, and utilized a broad definition of eating pathology (i.e., disordered eating) and pediatric age (i.e., late adolescence). Limitations of the review include: (a) chronological order had to be inferred or

relevant data was unavailable for several studies and (b) over 50 assessments of disordered eating were used, which may explain differential findings, and (c) a few number of studies for each CI except for diabetes (see Table 1). We found that diet-treated CI inherently requires a focus on a child's food intake and nutrition to optimize health outcomes, but are also associated with disordered eating and EDs. This literature review indicates that children with diabetes, cystic fibrosis, celiac, gastrointestinal disorders, and inflammatory bowel disease have a higher likelihood of experiencing disordered eating habits or developing an ED during the course of childhood. We also found that onset of type 1 diabetes, cystic fibrosis, and celiac disease is more likely to occur prior to the development of disordered eating behaviors.

The diabetes literature we reviewed had the largest number of studies and strongest evidence for the association between a diet-treated CI and disordered eating. Disordered eating behaviors and attitudes, body dissatisfaction, and an unhealthy drive for thinness were commonly experienced by children with diabetes. A pattern of impaired self-care is evident in the noncompliance with medical recommendations and improper use of insulin to regulate weight. Maladaptive eating and lack of self-care result in negative medical outcomes, including elevated glycosylated hemoglobin, a marker of poor disease control that is related to long-term complications. Cystic fibrosis, celiac disease, gastrointestinal disorders, and inflammatory bowel disease are associated with similar disordered eating attitudes and behaviors, but a limited number of studies have been conducted on these medical conditions. Studies that differentiated male and female patients revealed a higher likelihood of females having an ED than males, which mirrors the findings of the general ED literature (Bulik et al., 2006; Hoek & van Hoeken, 2003; Kjelsås, Bjørnstrøm, & Götestam, 2004).

Overall, children with diet-treated CI are at risk for developing ED symptomatology and the onset of diet-treated CI preceded the onset of disordered eating or a diagnosable ED. This pattern was most noticeable for children with diabetes and cystic fibrosis. The directionality of the relationship between diet-treated CI and disordered eating can be inferred based on their strong association and the order of onset. Future research is needed on: (a) the relation between disordered eating and cystic fibrosis, celiac disease, gastrointestinal disorders, and inflammatory bowel diseases due to the limited number of studies and (b) brief disordered eating screening tools based on the norms of children with diet-treated CI.

ORCID

Sheehan D. Fisher PhD https://orcid.org/0000-0003-4078-8448

REFERENCES

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

Antisdel, J. E., & Chrisler, J. C. (2000). Comparison of eating attitudes and behaviors among adolescent and young women with type 1

diabetes mellitus and phenylketonuria. *Journal of Developmental & Behavioral Pediatrics*, 21(2), 81–86. https://doi.org/10.1097/00004703-200004000-00001

Bächle, C., Stahl-Pehe, A., & Rosenbauer, J. (2016). Disordered eating and insulin restriction in youths receiving intensified insulin treatment: Results from a nationwide population-based study. *International Journal of Eating Disorders*, 49(2), 191–196. https://doi.org/10.1002/eat.22463

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

Basso, M. S., Zanna, V., Panetta, F., Caramadre, A. M., Ferretti, F., Ottino, S., & Diamanti, A. (2013). Is the screening for celiac disease useful in anorexia nervosa? *European Journal of Pediatrics*, 172(2), 261–263. https://doi.org/10.1007/s00431-012-1864-8

Battaglia, M. R., Alemzadeh, R., Katte, H., Hall, P. L., & Perlmuter, L. C. (2006). Brief report: Disordered eating and psychosocial factors in adolescent females with type 1 diabetes mellitus. *Journal of Pediatric Psychology*, 31(6), 552–556. https://doi.org/10.1093/jpepsy/jsj047

Bernstein, C. M., Stockwell, M. S., Gallagher, M. P., Rosenthal, S. L., & Soren, K. (2013). Mental health issues in adolescents and young adults with type 1 diabetes prevalence and impact on glycemic control. *Clinical Pediatrics*, 52(1), 10–15. https://doi.org/10.1177/0009922812459950

Birch, L. L., & Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics*, 101(Supplement 2), 539–549.

Birch, L. L., Fisher, J. O., & Davison, K. K. (2003). Learning to overeat: Maternal use of restrictive feeding practices promotes girls' eating in the absence of hunger. *American Journal of Clinical Nutrition*, 78(2), 215–220.

Blair, C., Cull, A., & Freeman, C. P. (1994). Psychosocial functioning of young adults with cystic fibrosis and their families. *Thorax*, 49(8), 798–802. https://doi.org/10.1136/thx.49.8.798

Borawska-Kowalczyk, U., & Sands, D. (2015). Determinants of health-related quality of life in polish patients with CF-adolescents' and parents' perspectives. *Developmental Period Medicine*, (1), 127–136.

Boyd, C., Abraham, S., & Kellow, J. (2005). Psychological features are important predictors of functional gastrointestinal disorders in patients with eating disorders. *Scandinavian Journal of Gastroenterology*, 40(8), 929–935. https://doi.org/10.1080/00365520510015836

Boyd, C., Abraham, S., & Kellow, J. (2010). Appearance and disappearance of functional gastrointestinal disorders in patients with eating disorders. *Neurogastroenterology & Motility*, 22(12), 1279–1283. https://doi.org/10.1111/j.1365-2982.2010.01576.x

Brown, R., & Ogden, J. (2004). Children's eating attitudes and behaviour: A study of the modelling and control theories of parental influence. *Health Education Research*, 19(3), 261–271. https://doi.org/10.1093/her/cyg040

Bryden, K. S., Neil, A., Mayou, R. A., Peveler, R. C., Fairburn, C. G., & Dunger, D. B. (1999). Eating habits, body weight, and insulin misuse. A longitudinal study of teenagers and young adults with type 1 diabetes. *Diabetes Care*, 22(12), 1956–1960. https://doi.org/10.2337/diacare.22.12.1956

Bryon, M., Shearer, J., & Davies, H. (2008). Eating disorders and disturbance in children and adolescents with cystic fibrosis. *Children's Health Care*, 37(1), 67–77. https://doi.org/10.1080/02739610701766909

Bulik, C. M., Sullivan, P. F., Tozzi, F., Furberg, H., Lichtenstein, P., & Pedersen, N. L. (2006). PRevalence, heritability, and prospective risk factors for anorexia nervosa. *Archives of General Psychiatry*, 63(3), 305–312. https://doi.org/10.1001/archpsyc.63.3.305

Caccavale, L. J., Nansel, T. R., Quick, V., Lipsky, L. M., Laffel, L., & Mehta, S. N. (2015). Associations of disordered eating behavior with the family diabetes environment in adolescents with type 1 diabetes. *Journal of Developmental & Behavioral Pediatrics*, 36(1), 8–13. https://doi.org/10.1097/DBP.0000000000000116

Cantwell, R., & Steel, J. M. (1996). Screening for eating disorders in diabetes mellitus. *Journal of Psychosomatic Research*, 40(1), 15–20. https://doi.org/10.1016/0022-3999(95)00534-X

Carper, J. L., Orlet Fisher, J., & Birch, L. L. (2000). Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding. *Appetite*, 35(2), 121–129. https://doi.org/10.1006/appe.2000.0343

Chapman, D. P., Perry, G. S., & Strine, T. W. (2005). The vital link between chronic disease and depressive disorders. *Preventing Chronic Disease*, 2(1), 1–10.

Colton, P. A., Olmsted, M. P., Daneman, D., & Rodin, G. M. (2013). Depression, disturbed eating behavior, and metabolic control in teenage girls with type 1 diabetes. *Pediatric Diabetes*, 14(5), 372–376. https://doi.org/10.1111/pedi.12016

Colton, P., Olmsted, M., Daneman, D., Rydall, A., & Rodin, G. (2004). Disturbed eating behavior and eating disorders in preteen and early teenage girls with type 1 diabetes: A case-controlled study. *Diabetes Care*, 27(7), 1654–1659. https://doi.org/10.2337/diacare.27.7.1654

Colton, P., Olmsted, M., Daneman, D., Rydall, A., & Rodin, G. (2007). Natural history and predictors of disturbed eating behaviour in girls with type 1 diabetes. *Diabetic Medicine*, 24(4), 424–429. https://doi.org/10.1111/j.1464-5491.2007.02099.x

Cromley, T., Neumark-Sztainer, D., Story, M., & Boutelle, K. N. (2010). Parent and family associations with weight-related behaviors and cognitions among overweight adolescents. *Journal of Adolescent Health*, 47(3), 263–269. https://doi.org/10.1016/j.jadohealth.2010.02.009

Cystic Fibrosis Foundation (2017). *Cystic fibrosis foundation patient registry annual data report 2016.* https://www.cff.org/Research/Researcher-Resources/Patient-Registry/2016-Patient-Registry-Annual-Data-Report.pdf

d'Emden, H., Holden, L., McDermott, B., Harris, M., Gibbons, K., Gledhill, A., & Cotterill, A. (2013). Disturbed eating behaviours and thoughts in Australian adolescents with type 1 diabetes. *Journal of Paediatrics & Child Health*, 49(4), E317–EE23. https://doi.org/10.1111/jpc.12014

Engstrom, I. (1999). Inflammatory bowel disease in children and adolescents: Mental health and family functioning. *Journal of Pediatric Gastroenterology & Nutrition*, 28(4), S28–S33. doi:https://doi.org/10.1097/00005176-199904001-00004

Engström, I., Kroon, M., Arvidsson, C. G., Segnestam, K., Snellman, K., & Åman, J. (1999). Eating disorders in adolescent girls with insulin-dependent diabetes mellitus: A population-based case–control study. *Acta Paediatrica (Oslo, Norway: 1992)*, 88(2), 175–180. https://doi.org/10.1111/j.1651-2227.1999.tb01078.x

Favaro, A., Caregaro, L., Tenconi, E., Bosello, R., & Santonastaso, P. (2009). Time trends in age at onset of anorexia nervosa and bulimia nervosa. *Journal of Clinical Psychiatry*, 70(12), 478–1721. https://doi.org/10.4088/JCP.09m05176blu

Field, D., Garland, M., & Williams, K. (2003). Correlates of specific childhood feeding problems. *Journal of Paediatrics & Child Health*, 39(4), 299–304. https://doi.org/10.1046/j.1440-1754.2003.00151.x

Fowkes, F., & Fulton, P. (1991). Critical appraisal of published research: Introductory guidelines. *British Medical Journal (Clinical Research Edition)*, 302(6785), 1136.

Gendall, K. A., Joyce, P. R., Carter, F. A., McIntosh, V. V., & Bulik, C. M. (2005). Childhood gastrointestinal complaints in women with bulimia

nervosa. *International Journal of Eating Disorders, 37*(3), 256–260. https://doi.org/10.1002/eat.20088

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

Green, P. H., & Cellier, C. (2007). Celiac disease. *New England Journal of Medicine, 357*(17), 1731–1743. https://doi.org/10.1056/NEJMra071600

Greenley, R. N., Hommel, K. A., Nebel, J., Raboin, T., Li, S.-H., Simpson, P., & Mackner, L. (2010). A meta-analytic review of the psychosocial adjustment of youth with inflammatory bowel disease. *Journal of Pediatric Psychology, 35*(8), 857–869. https://doi.org/10.1093/jpepsy/jsp120

Grylli, V., Hafferl-Gattermayer, A., Schober, E., & Karwautz, A. (2004). Prevalence and clinical manifestations of eating disorders in Austrian adolescents with type-1 diabetes. *Wiener Klinische Wochenschrift, 116*(7–8), 230–234. https://doi.org/10.1007/BF03041052

Grylli, V., Hafferl-Gattermayer, A., Wagner, G., Schober, E., & Karwautz, A. (2005). Eating disorders and eating problems among adolescents with type 1 diabetes: Exploring relationships with temperament and character. *Journal of Pediatric Psychology, 30*(2), 197–206. https://doi.org/10.1093/jpepsy/jsi007

Grylli, V., Wagner, G., Hafferl-Gattermayer, A., Schober, E., & Karwautz, A. (2005). Disturbed eating attitudes, coping styles, and subjective quality of life in adolescents with type 1 diabetes. *Journal of Psychosomatic Research, 59*(2), 65–72. https://doi.org/10.1016/j.jpsychores.2005.02.010

Halliburton, C. S., Mannino, D. M., & Olney, R. S. (1996). Cystic fibrosis deaths in the United States from 1979 through 1991: An analysis using multiple-cause mortality data. *Archives of Pediatrics & Adolescent Medicine, 150*(11), 1181–1185. https://doi.org/10.1001/archpedi.1996.02170360071012

Haycraft, E., & Blissett, J. (2012). Predictors of paternal and maternal controlling feeding practices with 2-to 5-year-old children. *Journal of Nutrition Education & Behavior, 44*(5), 390–397. https://doi.org/10.1016/j.jneb.2010.03.001

Haynos, A. F., Watts, A. W., Loth, K. A., Pearson, C. M., & Neumark-Stzainer, D. (2016). Factors predicting an escalation of restrictive eating during adolescence. *Journal of Adolescent Health.* https://doi.org/10.1016/j.jadohealth.2016.03.011

Helgeson, V. S., Escobar, O., Siminerio, L., & Becker, D. (2007). Unmitigated communion and health among adolescents with and without diabetes the mediating role of eating disturbances. *Personality & Social Psychology Bulletin, 33*(4), 519–536. https://doi.org/10.1177/0146167206296953

Helgeson, V. S., Snyder, P. R., Escobar, O., Siminerio, L., & Becker, D. (2007). Comparison of adolescents with and without diabetes on indices of psychosocial functioning for three years. *Journal of Pediatric Psychology, 32*(7), 794–806. https://doi.org/10.1093/jpepsy/jsm020

Helgeson, V. S., Siminerio, L., Escobar, O., & Becker, D. (2009). Predictors of metabolic control among adolescents with diabetes: A 4-year longitudinal study. *Journal of Pediatric Psychology, 34*(3), 254–270. https://doi.org/10.1093/jpepsy/jsn079

Hoek, H. W., & van Hoeken, D. (2003). Review of the prevalence and incidence of eating disorders. *International Journal of Eating Disorders, 34*(4), 383–396. https://doi.org/10.1002/eat.10222

Howe, C. J., Jawad, A. F., Kelly, S. D., & Lipman, T. H. (2008). Weight-related concerns and behaviors in children and adolescents with type 1 diabetes. *Journal of the American Psychiatric Nurses Association, 13*(6), 376–385. https://doi.org/10.1177/1078390307310154

Hsu, L. K. G., Milliones, J., Friedman, L., Holder, D., & Klepper, T. (1982). *A survey of eating attitudes and behaviors in adolescents in a Northeast urban school system.* Washington, DC: American Academy of Child Psychiatry.

Hsu, Y. Y., Chen, B. H., Huang, M. C., Lin, S. J., & Lin, M. F. (2009). Disturbed eating behaviors in Taiwanese adolescents with type 1 diabetes mellitus: A comparative study. *Pediatric Diabetes, 10*(1), 74–81. https://doi.org/10.1111/j.1399-5448.2008.00422.x

Hu, F. B., Neuhouser, M. L., Perez-Escamilla, R., Martinez-Gonzalez, M. A., & Willett, W. C. (2016). U.S. dietary guidelines. *Annals of Internal Medicine, 165*(8), 604–605. https://doi.org/10.7326/L16-0170.

Hudson, J. I., Wentworth, S. M., Hudson, M. S., & Pope, H. G. (1985). Prevalence of anorexia nervosa and bulimia among young diabetic women. *Journal of Clinical Psychiatry, 46*(3), 88–89.

Johnson, B., Elliott, J., Scott, A., Heller, S., & Eiser, C. (2014). Medical and psychological outcomes for young adults with type 1 diabetes: No improvement despite recent advances in diabetes care. *Diabetic Medicine, 31*(2), 227–231. https://doi.org/10.1111/dme.12305

Jones, J. M., Lawson, M. L., Daneman, D., Olmsted, M. P., & Rodin, G. (2000). Eating disorders in adolescent females with and without type 1 diabetes: Cross sectional study. *British Medical Journal (Clinical Research Edition), 320*(7249), 1563–1566. https://doi.org/10.1136/bmj.320.7249.1563

Kaminsky, L. A., & Dewey, D. (2014). The association between body mass index and physical activity, and body image, self-esteem and social support in adolescents with type 1 diabetes. *Canadian Journal of Diabetes, 38*(4), 244–249. https://doi.org/10.1016/j.jcjd.2014.04.005

Karwautz, A., Wagner, G., Berger, G., Sinnreich, U., Grylli, V., & Huber, W.-D. (2008). Eating pathology in adolescents with celiac disease. *Psychosomatics, 49*(5), 399–406. https://doi.org/10.1176/appi.psy.49.5.399

Katon, W., Lin, E. H. B., & Kroenke, K. (2007). The association of depression and anxiety with medical symptom burden in patients with chronic medical illness. *General Hospital Psychiatry, 29*(2), 147–155. https://doi.org/10.1016/j.genhosppsych.2006.11.005

Khan, Y., & Montgomery, A. (1996). Eating attitudes in young females with diabetes: Insulin omission identifies a vulnerable subgroup. *British Journal of Medical Psychology, 69*(4), 343–353. https://doi.org/10.1111/j.2044-8341.1996.tb01877.x

Kichler, J. C., Foster, C., & Opipari-Arrigan, L. (2008). The relationship between negative communication and body image dissatisfaction in adolescent females with type 1 diabetes mellitus. *Journal of Health Psychology, 13*(3), 336–347. https://doi.org/10.1177/1359105307088138

Kjelsås, E., Bjørnstrøm, C., & Götestam, K. G. (2004). Prevalence of eating disorders in female and male adolescents (14–15 years). *Eating Behaviors, 5*(1), 13–25. https://doi.org/10.1016/S1471-0153(03)00057-6

Lawrence, J. M., Standiford, D. A., Loots, B., Klingensmith, G. J., Williams, D. E., Ruggiero, A., ... McKeown, R. (2006). Prevalence and correlates of depressed mood among youth with diabetes: The SEARCH for diabetes in youth study. *Pediatrics, 117*(4), 1348–1358. https://doi.org/10.1542/peds.2005-1398

Lee, S., Ng, K. L., Kwok, K. P., Thomas, J. J., & Becker, A. E. (2012). Gastrointestinal dysfunction in Chinese patients with fat-phobic and nonfat-phobic anorexia nervosa. *Transcultural Psychiatry, 1363461512459487.* https://doi.org/10.1177/1363461512459487

Lee, S., Wu, J., Ma, Y. L., Tsang, A., Guo, W. J., & Sung, J. (2009). Irritable bowel syndrome is strongly associated with generalized anxiety disorder: A community study. *Alimentary Pharmacology & Therapeutics, 30*(6), 643–651. https://doi.org/10.1111/j.1365-2036.2009.04074.x

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... Moher, D. (2009). The PRISMA statement for reporting

systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *PLoS Medicine*, 6(7), e1000100. https://doi.org/10.1371/journal.pmed.1000100

Lloyd, G., Steel, J., & Young, R. (1987). Eating disorders and psychiatric morbidity in patients with diabetes mellitus. *Psychotherapy & Psychosomatics*, 48(1–4), 189–195. https://doi.org/10.1159/000288052

Mackner, L. M., & Crandall, W. V. (2007). Psychological factors affecting pediatric inflammatory bowel disease. *Current Opinion in Pediatrics*, 19(5), 548–552. https://doi.org/10.1097/MOP.0b013e3282ef4426

Maharaj, S., Rodin, G., Olmsted, M., Connolly, J., & Daneman, D. (2003). Eating disturbances in girls with diabetes: The contribution of adolescent self-concept, maternal weight and shape concerns and mother–daughter relationships. *Psychological Medicine*, 33(03), 525–539. https://doi.org/10.1017/S0033291702007213

Markowitz, J. T., Alleyn, C. A., Phillips, R., Muir, A., Young-Hyman, D., & Laffel, L. M. (2013). Disordered eating behaviors in youth with type 1 diabetes: Prospective pilot assessment following initiation of insulin pump therapy. *Diabetes Technology & Therapeutics*, 15(5), 428–433. https://doi.org/10.1089/dia.2013.0008

Markowitz, J. T., Butler, D. A., Volkening, L. K., Antisdel, J. E., Anderson, B. J., & Laffel, L. M. (2010). Brief screening tool for disordered eating in diabetes internal consistency and external validity in a contemporary sample of pediatric patients with type 1 diabetes. *Diabetes Care*, 33(3), 495–500. https://doi.org/10.2337/dc09-1890

Markowitz, J., Lowe, M., Volkening, L., & Laffel, L. (2009). Self-reported history of overweight and its relationship to disordered eating in adolescent girls with type 1 diabetes. *Diabetic Medicine*, 26(11), 1165–1171. https://doi.org/10.1111/j.1464-5491.2009.02844.x

Matheson, B. E., Camacho, C., Peterson, C. B., Rhee, K. E., Rydell, S. A., Zucker, N. L., & Boutelle, K. N. (2015). The relationship between parent feeding styles and general parenting with loss of control eating in treatment-seeking overweight and obese children. *International Journal of Eating Disorders*, 48(7), 1047–1055. https://doi.org/10.1002/eat.22440

Mazzone, L., Reale, L., Spina, M., Guarnera, M., Lionetti, E., Martorana, S., & Mazzone, D. (2011). Compliant gluten-free children with celiac disease: An evaluation of psychological distress. *BMC Pediatrics*, 11(1), 6. https://doi.org/10.1186/1471-2431-11-46

Mellin, A. E., Neumark-Sztainer, D., Patterson, J., & Sockalosky, J. (2004). Unhealthy weight management behavior among adolescent girls with type 1 diabetes mellitus: The role of familial eating patterns and weight-related concerns. *Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 35(4), 278–289. https://doi.org/10.1016/j.jadohealth.2003.10.006

Meltzer, L. J., Johnson, S. B., Prine, J. M., Banks, R. A., Desrosiers, P. M., & Silverstein, J. H. (2001). Disordered eating, body mass, and glycemic control in adolescents with type 1 diabetes. *Diabetes Care*, 24(4), 678–682. https://doi.org/10.2337/diacare.24.4.678

Meyer, R., Rommel, N., Van Oudenhove, L., Fleming, C., Dziubak, R., & Shah, N. (2014). Feeding difficulties in children with food protein-induced gastrointestinal allergies. *Journal of Gastroenterology & Hepatology*, 29(10), 1764–1769. https://doi.org/10.1111/jgh.12593

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264–269. https://doi.org/10.1371/journal.pmed.1000097

Mukkada, V. A., Haas, A., Maune, N. C., Capocelli, K. E., Henry, M., Gilman, N., ... Atkins, D. (2010). Feeding dysfunction in children with eosinophilic gastrointestinal diseases. *Pediatrics*, 126(3), e672–e677. https://doi.org/10.1542/peds.2009-2227

Neumark-Sztainer, D., Patterson, J., Mellin, A., Ackard, D. M., Utter, J., Story, M., & Sockalosky, J. (2002). Weight control practices and disordered eating behaviors among adolescent females and males with type 1 diabetes associations with sociodemographics, weight concerns, familial factors, and metabolic outcomes. *Diabetes Care*, 25(8), 1289–1296. https://doi.org/10.2337/diacare.25.8.1289

Neumark-Sztainer, D., Story, M., Hannan, P. J., Perry, C. L., & Irving, L. M. (2002). Weight-related concerns and behaviors among overweight and nonoverweight adolescents: Implications for preventing weight-related disorders. *Archives of Pediatrics & Adolescent Medicine*, 156(2), 171–178. https://doi.org/10.1001/archpedi.156.2.171

Neumark-Sztainer, D., Story, M., Resnick, M. D., Garwick, A., & Blum, R. W. (1995). Body dissatisfaction and unhealthy weight-control practices among adolescents with and without chronic illness: A population-based study. *Archives of Pediatrics & Adolescent Medicine*, 149(12), 1330–1335. https://doi.org/10.1001/archpedi.1995.02170250036005

Neumark-Sztainer, D., Story, M., Toporoff, E., Cassuto, N., Resnick, M. D., & Blum, R. W. (1996). Psychosocial predictors of binge eating and purging behaviors among adolescents with and without diabetes mellitus. *Journal of Adolescent Health*, 19(4), 289–296. https://doi.org/10.1016/S1054-139X(96)00082-1

O'Dell, S. M., & DuPaul, G. J. (2012). Predictors of emotional problems in children with diabetes mellitus. *Children's Health Care*, 41(1), 32–42. https://doi.org/10.1080/02739615.2012.643289

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

Palladino, D. K., Helgeson, V. S., Reynolds, K. A., Becker, D. J., Siminerio, L. M., & Escobar, O. (2013). Emerging adults with type 1 diabetes: A comparison to peers without diabetes. *Journal of Pediatric Psychology*, 38(5), 506–517. https://doi.org/10.1093/jpepsy/jst002

Pearson, D. A., Pumariega, A. J., & Seilheimer, D. K. (1991). The development of psychiatric symptomatology in patients with cystic fibrosis. *Journal of the American Academy of Child & Adolescent Psychiatry*, 30(2), 290–297. https://doi.org/10.1097/00004583-199103000-00019

Perez, M. E., Coley, B., Crandall, W., Di Lorenzo, C., & Bravender, T. (2013). Effect of nutritional rehabilitation on gastric motility and somatization in adolescents with anorexia. *Journal of Pediatrics*, 163(3), 867–872, e1. https://doi.org/10.1016/j.jpeds.2013.03.011

Peveler, R. C., Bryden, K. S., Neil, H. A., Fairburn, C. G., Mayou, R. A., Dunger, D. B., & Turner, H. M. (2005). The relationship of disordered eating habits and attitudes to clinical outcomes in young adult females with type 1 diabetes. *Diabetes Care*, 28(1), 84–88. https://doi.org/10.2337/diacare.28.1.84

Peveler, R. C., Fairburn, C. G., Boller, I., & Dunger, D. (1992). Eating disorders in adolescents with IDDM: A controlled study. *Diabetes Care*, 15(10), 1356–1360. https://doi.org/10.2337/diacare.15.10.1356

Philippi, S. T., Cardoso, M. G., Koritar, P., & Alvarenga, M. (2013). Risk behaviors for eating disorder in adolescents and adults with type 1 diabetes. *Revista Brasileira De Psiquiatria (Psiquiatria) (Sao Paulo, Brazil: 1999)*, 35(2), 150–156. https://doi.org/10.1590/1516-4446-2012-0780

Pinar, R. (2005). Disordered eating behaviors among Turkish adolescents with and without type 1 diabetes. *Journal of Pediatric Nursing*, 20(5), 383–388. https://doi.org/10.1016/j.pedn.2005.07.001

Pinquart, M., & Shen, Y. (2011). Depressive symptoms in children and adolescents with chronic physical illness: An updated meta-analysis. *Journal of Pediatric Psychology*, 36(4), 375–384. https://doi.org/10.1093/jpepsy/jsq104

Polivy, J., & Herman, C. P. (2002). Causes of eating disorders. *Annual Review of Psychology*, *53*(1):187–213. https://doi.org/10.1146/annurev.psych.53.100901.135103

Pollock, M., Kovacs, M., & Charron-Prochownik, D. (1995). Eating disorders and maladaptive dietary/insulin management among youths with childhood-onset insulin-dependent diabetes mellitus. *Journal of the American Academy of Child & Adolescent Psychiatry*, *34*(3), 291–296. https://doi.org/10.1097/0000458303000-00012

Pollock-BarZiv, S. M., & Davis, C. (2005). Personality factors and disordered eating in young women with type 1 diabetes mellitus. *Psychosomatics*, *46*(1), 11–18. https://doi.org/10.1176/appi.psy.46.1.11

Powers, P. S., Malone, J. I., Coovert, D. L., & Schulman, R. G. (1990). Insulin-dependent diabetes mellitus and eating disorders: A prevalence study. *Comprehensive Psychiatry*, *31*(3), 205–210. https://doi.org/10.1016/0010-440X(90)90003-B

Pumariega, A. J., Pearson, D. A., & Seilheimer, D. K. (1993). Family and childhood adjustment in cystic fibrosis. *Journal of Child & Family Studies*, *2*(2), 109–118. https://doi.org/10.1007/BF01350647

Quick, V. M., Byrd-Bredbenner, C., & Neumark-Sztainer, D. (2013). Chronic illness and disordered eating: A discussion of the literature. *Advances in Nutrition: An International Review Journal*, *4*(3), 277–286. https://doi.org/10.3945/an.112.003608

Quick, V. M., McWilliams, R., & Byrd-Bredbenner, C. (2012). Case–control study of disturbed eating behaviors and related psychographic characteristics in young adults with and without diet-related chronic health conditions. *Eating Behaviors*, *13*(3), 207–213. https://doi.org/10.1016/j.eatbeh.2012.02.003

Quittner, A. L., Barker, D. H., Snell, C., Grimley, M. E., Marciel, K., & Cruz, I. (2008). Prevalence and impact of depression in cystic fibrosis. *Current Opinion in Pulmonary Medicine*, *14*(6), 582–588. https://doi.org/10.1097/MCP.0b013e3283121cf1

Raymond, N. C., Chang, P.-N., Crow, S. J., Mitchell, J. E., Dieperink, B. S., Beck, M. M., ... Warwick, W. J. (2000). Eating disorders in patients with cystic fibrosis. *Journal of Adolescence*, *23*(3), 359–363. https://doi.org/10.1006/jado.2000.0321

Rodin, G. M., Daneman, D., Johnson, L. E., Kenshole, A., & Garfinkel, P. (1985). Anorexia nervosa and bulimia in female adolescents with insulin dependent diabetes mellitus: A systematic study. *Journal of Psychiatric Research*, *19*(2–3), 381–384. https://doi.org/10.1016/0022-3956(85)90044-5

Rodin, G. M., Johnson, L. E., Garfinkel, P. E., Daneman, D., & Kenshole, A. B. (1986). Eating disorders in female adolescents with insulin dependent diabetes mellitus. *International Journal of Psychiatry in Medicine*, *16*(1), 49–57. https://doi.org/10.2190/HULH-CTPR-4V17-383C

Rodin, G., Craven, J., Littlefield, C., Murray, M., & Daneman, D. (1991). Eating disorders and intentional insulin undertreatment in adolescent females with diabetes. *Psychosomatics*, *32*(2), 171–176. https://doi.org/10.1016/S0033-3182(91)72088-4

Rydall, A. C., Rodin, G. M., Olmsted, M. P., Devenyi, R. G., & Daneman, D. (1997). Disordered eating behavior and microvascular complications in young women with insulin-dependent diabetes mellitus. *New England Journal of Medicine*, *336*(26), 1849–1854. https://doi.org/10.1056/NEJM199706263362601

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

Schwartz, S. A., Weissberg-Benchell, J., & Perlmuter, L. C. (2002). Personal control and disordered eating in female adolescents with type 1 diabetes. *Diabetes Care*, *25*(11), 1987–1991. https://doi.org/10.2337/diacare.25.11.1987

Shearer, J., & Bryon, M. (2004). The nature and prevalence of eating disorders and eating disturbance in adolescents with cystic fibrosis. *Journal of the Royal Society of Medicine*, *97*(Suppl 44), 36.

Smith, F. M., Latchford, G. J., Hall, R. M., & Dickson, R. A. (2008). Do chronic medical conditions increase the risk of eating disorder? A cross-sectional investigation of eating pathology in adolescent females with scoliosis and diabetes. *Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, *42*(1), 58–63. https://doi.org/10.1016/j.jadohealth.2007.08.008

Steel, J. M., Young, R. J., Lloyd, G. G., & Clarke, B. F. (1987). Clinically apparent eating disorders in young diabetic women: Associations with painful neuropathy and other complications. *British Medical Journal (Clinical Research Edition)*, *294*(6576), 859–862. https://doi.org/10.1136/bmj.294.6576.859

Steiner, H., Rahimzadeh, P., & Lewiston, N. B. (1990). Psychopathology in cystic fibrosis and anorexia nervosa: A controlled comparison. *International Journal of Eating Disorders*, *9*(6), 675–683. https://doi.org/10.1002/1098-108X(199011)9:6<675::AID-EAT2260090610>3.0.CO;2-Q

Stice, E., Marti, C. N., & Durant, S. (2011). Risk factors for onset of eating disorders: Evidence of multiple risk pathways from an 8-year prospective study. *Behaviour Research & Therapy*, *49*(10), 622–627. https://doi.org/10.1016/j.brat.2011.06.009

Striegel-Moore, R. H., Nicholson, T. J., & Tamborlane, W. V. (1992). Prevalence of eating disorder symptoms in preadolescent and adolescent girls with IDDM. *Diabetes Care*, *15*(10), 1361–1368. https://doi.org/10.2337/diacare.15.10.1361

Sullivan, G., Blewett, A. E., Jenkins, P. L., & Allison, M. C. (1997). Eating attitudes and the irritable bowel syndrome. *General Hospital Psychiatry*, *19*(1), 62–64. https://doi.org/10.1016/S0163-8343(96)00106-5

Svensson, M., Engstrom, I., & Aman, J. (2003). Higher drive for thinness in adolescent males with insulin-dependent diabetes mellitus compared with healthy controls. *Acta Paediatrica (Paediatrica)*, *92*(1), 114–117. https://doi.org/10.1111/j.1651-2227.2003.tb00480.x

Takii, M., Komaki, G., Uchigata, Y., Maeda, M., Omori, Y., ... Kubo, C. (1999). Differences between bulimia nervosa and binge-eating disorder in females with type 1 diabetes: The important role of insulin omission. *Journal of Psychosomatic Research*, *47*(3), 221–231. https://doi.org/10.1016/S0022-3999(99)00031-8

Takii, M., Uchigata, Y., Kishimoto, J., Morita, C., Hata, T., Nozaki, T., ... Kubo, C. (2011). The relationship between the age of onset of type 1 diabetes and the subsequent development of a severe eating disorder by female patients. *Pediatric Diabetes*, *12*(4 Pt 2), 396–401. https://doi.org/10.1111/j.1399-5448.2010.00708.x

Takii, M., Uchigata, Y., Nozaki, T., Nishikata, H., Kawai, K., Komaki, G., ... Kubok, C. (2002). Classification of type 1 diabetic females with bulimia nervosa into subgroups according to purging behavior. *Diabetes Care*, *25*(9), 1571–1575. https://doi.org/10.2337/diacare.25.9.1571

Tanofsky-Kraff, M., Faden, D., Yanovski, S. Z., Wilfley, D. E., & Yanovski, J. A. (2005). The perceived onset of dieting and loss of control eating behaviors in overweight children. *International Journal of Eating Disorders*, *38*(2), 112–122. https://doi.org/10.1002/eat.20158

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

Vila, G., Robert, J. J., Nollet-Clemencon, C., Vera, L., Crosnier, H., Rault, G., ... Mouren-Simeoni, M. (1995). Eating and emotional disorders in

adolescent obese girls with insulin-dependent diabetes mellitus. *European Child Adolescent Psychiatry*, *4*(4), 270–279. https://doi.org/10.1007/BF01980491

Wagner, G., Zeiler, M., Berger, G., Huber, W. D., Favaro, A., Santonastaso, P., & Karwautz, A. (2015). Eating disorders in adolescents with celiac disease: Influence of personality characteristics and coping. *European Eating Disorders Review*, *23*(5), 361–370. https://doi.org/10.1002/erv.2376

Welch, E., Ghaderi, A., & Swenne, I. (2015). A comparison of clinical characteristics between adolescent males and females with eating disorders. *BMC Psychiatry*, *15*(1), 1. https://doi.org/10.1186/s12888-015-0419-8

Wilson, C. E., Smith, E. L., Coker, S. E., Hobbis, I. C., & Acerini, C. L. (2015). Testing an integrated model of eating disorders in paediatric type 1 diabetes mellitus. *Pediatric Diabetes*, *16*(7), 521–528. https://doi.org/10.1111/pedi.12202

Wing, R. R., Nowalk, M. P., Marcus, M. D., Koeske, R., & Finegold, D. (1986). Subclinical eating disorders and glycemic control in adolescents with type I diabetes. *Diabetes Care*, *9*(2), 162–167. https://doi.org/10.2337/diacare.9.2.162

Wisting, L., Bang, L., Skrivarhaug, T., Dahl-Jørgensen, K., & Rø, Ø. (2015). Adolescents with type 1 diabetes–the impact of gender, age, and

health-related functioning on eating disorder psychopathology. *PloS One*, *10*(11), e0141386. https://doi.org/10.1155/2016/3486094

Wotton, C. J., James, A., & Goldacre, M. J. (2016). Coexistence of eating disorders and autoimmune diseases: Record linkage cohort study, UK. *International Journal of Eating Disorders*, *49*(7), 663–672. https://doi.org/10.1002/eat.22544

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.