

REVIEW ARTICLE

Eating Disorders and Type 1 Diabetes: A Perspective

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Abstract: Patients with type 1 diabetes (T1D) are at risk of clinical eating disorders (EDs) and disordered eating behaviors (DEBs) than the general population. This burden is related mainly to diabetes-related physical and psychosocial issues especially beginning during childhood. DEBs must be investigated carefully and promptly managed in case of suspicion, as they can evolve into severe clinical EDs over time and are strictly related to poor outcomes.

The significant number of scientific articles dealing with the relationship between T1D and DEBs or EDs confirms the complexity of these problems and the difficulties in diagnosis and treatment.

This paper examined current scientific literature related to this topic, emphasizing the epidemiological and clinical complexity of the phenomenon and briefly summarizing DEBs management strategy in T1D patients.

Keywords: Type 1 diabetes mellitus, eating disorders, disordered eating behaviors, anorexia nervosa, bulimia, binge eating disorders.

1. INTRODUCTION

Type 1 Diabetes (T1D) is a chronic disease characterized by immune-mediated destruction of insulin-producing beta cells, leading to insulin depletion and chronic hyperglycemia [1]. T1D accounts for around 10% of all cases of diabetes mellitus worldwide [2]. The incidence rate of T1D is high in childhood, and the disease usually occurs abruptly due to acute and severe insulinopenic disorder [3]. After the diagnosis, insulin depletion is usually inevitable, and patients require a lifelong insulin requirement. A careful food selection is recommended to control exaggerated glycemic excursions and avoid insulin-related weight gain. In predisposed individuals, the burden of these demands may reduce adherence to therapeutic recommendations with negative consequences on long-term glucose control [4]. On the other hand, patients with T1D often self-report depressive symptoms, depressed mood, or anxiety due to fear of not achieving adequate glucose control or developing diabetes-related chronic complications. Symptoms severity may result in psychiatric diagnoses, such as major depressive disorder and dysthymia [5]. Psychiatric symptoms can occur in

adolescents as Disordered Eating Behaviors (DEBs) [6] and actual Eating Disorders (EDs) [7]. DEBs and EDs are characterized by restriction in daily caloric intake, distorted body image perceptions, binge eating, and purging behaviors to obtain weight loss obstinately (*e.g.*, exaggerated physical exercising, vomiting, and laxatives or diuretics). According to the DSM-V Statistical Manual of Mental Disorders [8], EDs include major diagnostic categories, such as Anorexia Nervosa (AN), Bulimia Nervosa (BN), Binge Eating Disorder (BED), and Other Specified Feeding or Eating Disorder (OSFED). New pathological phenotypes have also been included, such as pica, rumination disorder, atypical anorexia and bulimia, and avoidant/restrictive disorder [9]. DEBs are not classified as complete disorders but must be closely evaluated as they can evolve into true EDs over time. DEBs and EDs are associated with comorbid anxiety disorders [10] and elevated levels of depressive symptoms [11] in T1D patients. In T1D with DEBs or EDs, additional diagnostic criteria should be included, such as the intentional omission of insulin administration, a behavior strictly associated with poor outcomes [12, 13].

2. EATING DISORDERS

The prevalence of AN is 0.3-1% in women and less than 0.5% in men; the male-to-female ratio in adults is around 1:8

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[14]. Patients with AN exhibit frequent relapse of disturbance and poor quality of life, disability, and higher mortality than the general population [15]. AN is a severe disorder characterized mainly by pycnophobia, remarkable energy intake restriction, body image distortion, and lack of concerns related to risks related to low body weight and chronic undernourishment. The level of clinical severity in patients with AN is classified according to the restriction of body mass index (BMI) [16].

Patients with AN are also at higher risk of cardiovascular events, electrolyte imbalance, severe osteoporosis, and oral injuries (teeth and mucosae) [17]. Sexual development and cerebral maturation may also be impaired due to caloric intake restriction, especially in youth [18]. Neuroimaging data showed a possible reduction of the grey and white matter in some cerebral regions, such as the frontal and ventral striatal areas. Cerebral lesions are partially reversible as they may recover after weight regain [19].

Psychiatric comorbidities are commonly observed in AN since emotional symptoms could be exacerbated by starvation [20]. Body shape self-misperception in AN may impair self-confidence and induce maladaptive behaviors aiming to maintain body weight control rigorously [21]. Obscurity and perfectionism are related to this stringent control, and several behaviors in AN might be considered a coping strategy to balance mood [22] and avoid distress [23]. Restoring adequate energy intake to induce satisfactory weight gain is the cornerstone of medical treatment in AN. However, from the patient's perspective, bodyweight control is loosed due to food intake, and the patient may exhibit psychological imbalance, anxiety, and distress. Thus, symptoms are often denied, and patients usually refuse treatment or display adaptive behaviors.

At this stage, AN needs combined therapy, including nutritional and psychological supports [24, 25]. A multidisciplinary team could adequately manage the patients in several clinical settings, including general practitioners, psychiatrists, endocrinologists, psychologists, nutritionists, physiotherapists, and specialized nurses [26]. Prevention programs aimed to increase the knowledge of eating disorders and school-based interventions for children and adolescents, teachers, and families are considered fruitful to reduce potential burdens in the general population [27].

3. EATING DISORDERS AND T1D

EDs or DEBs are more prevalent in patients with diabetes mellitus than in the general population [28, 29]. It has been estimated that the prevalence rate of DEBs in patients with T1D ranges from 8% to 55%. In one meta-analysis, Young and colleagues [30] found DEBs in 39.3% of T1D patients and 32.5% of healthy controls. Similarly, EDs were more frequently observed among T1D individuals (7%) than healthy controls (2.8%).

However, the use of a specific diabetes-adapted questionnaire reduces the prevalence of DEBs (24.4%) and EDs (6.4%) in T1D; therefore, it could be a more appropriate tool to avoid possible risk overestimation [31-33]. The questionnaires specifically designed to evaluate unhealthy eating behaviors in diabetes contain questions regarding

eating, weight management, and self-confidence. Notably, the revised Diabetes Eating Problem Survey (DEPS-R) includes 16 items. It is an easy-to-use tool, and it can be completed in less than 10 minutes, displaying excellent internal consistency and specificity [32]. DEPS-R is also validated in an Italian version by Pinna and colleagues [28].

Among pubertal T1D patients, the level of DEBs was usually low (59%) or less frequently moderate (26%) or severe (15%) [34]. Girls are at a greater risk of moderate (62%) and high (65%) levels of DEBs [35]. These data are relevant according to two points of view. On the one hand, the greater the levels of DEBs in adolescents, the greater the risk of developing severe eating disorders. On the other side, the level of DEBs was inversely related to the frequency of glucose monitoring and glycemic control [35].

Many studies examining the prevalence of DEBs in T1D have been conducted among young patients, primarily girls, while a few studies have examined the prevalence of EDs and DEBs in adulthood [36]. Angel *et al.* found DEBs in around 21% of T1D and 50% of T2D patients [37]. These frequencies are more significant than the general adult population as the frequency of DEBs is estimated to be 3.6% among healthy people and 15-20% among obese patients [38]. The frequency of DEBs in women with T1D is around 30% and increased to 35-40% in those aged 10-19 years old. Many studies suggest that the risk of DEBs decreases over time in T1D patients, and the current median age of onset is 14 [39]. However, in a longitudinal study, the incidence rate of DEBs and eating disorders was similar in childhood and adulthood [32].

The etiology of DEBs is complex and is related to individual, familial, and sociocultural factors. In T1D, the burden of insulin therapy and carbohydrate management may be additional trigger factors. Although low body weight is often associated with clinical EDs, such as AN, clinicians should be aware that a higher BMI is also associated with DEBs in people with T1D [5]. However, recent studies highlight the role of genetic factors in the pathogenesis of AN, celiac disease, and diabetes [40]. Also, gut microbiota may have a role in the pathogenesis of AN and T1D. Gut microbes and their fermentative products can influence the metabolism, and dysbiosis is crucially involved in the pathogenesis of some metabolic disorders, such as obesity, diabetes mellitus, cardiovascular diseases, and metabolic syndrome [41]. As reviewed by Genchulescu *et al.*, chronic starvation and energy intake restriction can significantly modify the gut microbiome composition. Notably, the levels of *Methanobrevibacter smithii* are increased in gut microbiome samples by patients with chronic undernourishment, including those with AN. This hydrogenotrophic methanogenic bacterium was found to slow intestinal transit and reduce appetite, thus contributing to further caloric restriction and weight loss [42]. Microbiome composition may also affect mental health, leading possibly to anxiety and depressive symptoms [43]. Integrative therapies restoring gut microbiota may improve gastrointestinal symptoms in individuals experiencing difficulties with weight stabilization [44].

Detailed meal planning with continuous monitoring of food portions and carbohydrate intake is essential for managing glycemic excursions. However, predisposed patients

may experience some psychiatric disorders associated with EDs and DEBs [45]. Thus, patients may restrict carbohydrate intake or perform more physical exercise than prescribed to avoid or contain the risk of hyperglycemia [46]. Dietary restraints can also increase sweetened foods and beverage consumption to satisfy intense hunger caused by frequent episodes of hypoglycemia and chronic carbohydrate deprivation. This behavior can create a vicious cycle similar to that observed in the over-eating and guilt cycles in BN [47].

In young people with T1D and AN, each disorder may adversely influence the other. For instance, malnutrition may hamper glycemic control, and insulin therapy may lead to disappointment with weight gain and body shape. For these reasons, young patients with AN and T1D have low compliance and adherence to prescribed treatments with detrimental clinical consequences [48]. From a psychological perspective, youths may experience diabetes-specific stressors related to insulin therapy and the transfer of responsibility from parents to themselves regarding disease management [49]. Physiological and psychological changes occurring through puberty may lead to body image dissatisfaction and foster eating disorders. Insulin purging, the attitude of omitting insulin boluses or administering less insulin than required, is an unsafe method to avoid weight gain [50]. Insulin purging has been associated with poor metabolic control, ketoacidosis, prolonged hospital stay, and a high risk of morbidity and mortality [51]. More recently, Gibbings *et al.* found that adolescents and young adults with T1D and eating disorders have more than triple the risk of diabetic ketoacidosis and nearly six-fold increased risk of death compared with those without eating disorders [52].

Screening for disordered eating should begin in pre-adolescence and be continued throughout early adulthood in patients with T1D. Current evidence suggests that some unhealthy eating behavior remains undiagnosed and untreated in 17% of girls and 1.8% of boys [53]. Prompt identification of borderline disorders may ensure adequate treatment to prevent dysfunctional behavior in adulthood [54].

4. MEDICAL AND PSYCHOLOGICAL COMPLICATIONS, AND INSULIN OMISSION (DIABULIMIA)

Costa and colleagues identified several biomedical and psychosocial issues in T1D [34]. Insulin boluses omission or restriction were found in 11-30% of girls and women with T1D. This attitude was associated with poor diabetes self-management and worse metabolic control, thus raising the risk of both acute and chronic complications [55]. Insulin restriction in young patients is less frequently reported than in adults (30-35%), possibly because of parental supervision of insulin administration in the former group [56]. Patients who restrict insulin boluses administration often exhibit higher baseline BMI than those who do not [57]. It could be described as a concomitant maladaptive behavior aimed to attenuate weight gain. In one study among adolescents, overweight (30%) recurred more frequently in girls than in boys (38.8% vs. 20.4%), and girls omitting insulin injections for avoiding weight gain showed a mean HbA1c value ($8.0 \pm 0.4\%$) mildly higher than girls who did not ($7.5 \pm 0.8\%$; $p 0.046$) [59].

Patients with BEDs display a higher risk of diabetic retinopathy due to poor glycemic control [6]. Diabetic retinopathy was demonstrated in 86% and 43% of patients with severe or moderate EDs and only 24% of those without DEBs [58].

Berger and Caswell speculated that patients with T1D and EDs might also overdose on insulin therapy factitiously to justify a large carbohydrate and sweets ingestion. Binge eating and psychiatric comorbidities have been observed in nearly half of so-named "insulin manipulators" (46.3%). This frequency was remarkably higher compared to that observed in patients exhibiting optimal adherence to the prescribed regimen (17.5%). Depressive mood (18.3% vs 4.9%), specific phobia (21.1% vs 2.9%), and social phobia (7.0% vs. 0%), were significantly more prevalent among insulin manipulators [59]. Insulin omission was more frequently reported in women (37.7%) diagnosed with psychiatric disorders than men (18.4%) [60]. According to Coleman *et al.*, most of the patients (87%) were aware of serious consequences of incautious insulin manipulation but persevered in that behavior consciously [60]. In one series, insulin delivery was restricted in the late afternoon and omissions were carried out in concomitance with snack consumption and dinner [61].

Overweight/obesity syndrome affects roughly 39% of adolescents. The prevalence of obesity among T1D patients has more than triplicated over the last few decades, especially among girls. Overweight and obesity may be considered additional risk factors affecting psychosocial health [59].

In a Turkish study, children and adolescents with higher BMI and HbA1c levels displayed more significant levels of DEBs (assessed by DEPS-R questionnaire) [49]. A recent Norwegian study found similar results regarding BMI [62]. Using a non-diabetes-specific questionnaire for Eating Disorders (EDE-Q), Keane *et al.* found associations between the global EDE-Q score and BMI but not HbA1c levels [63].

The mortality rate among T1D individuals without EDs is around 2.5%, rising to approximately 6.5% among patients with AN. When combined with both conditions, the mortality rate rises to 34.8% [64]; therefore, it is essential to consider this burden. Sub-threshold EDs in T1D are more frequently observed than AN and usually remain underdiagnosed. Early detection and treatment of EDs and DEBs in T1D patients should be considered essential to avoid detrimental consequences over time.

5. PREVENTION AND THERAPY

The management of T1D and EDs is complex and requires specific diagnostic tools designed for these patients. Early intervention has been reported to improve long-term outcomes, even if the treatment appears to be less effective when T1D coexists [65].

The current recommendation suggests a glycemic goal of HbA1c around 7% in T1D, achieving more time spent in the euglycemic range and avoiding prolonged or recurrent hypoglycemic episodes. Recurrent failure in obtaining adequate glucose control may compromise mental health over time. Perfectionism and frustration may be the results of anxiety to obtain a complete control of the disease. This psychological

burden may exacerbate maladaptive behaviors, such as poor adherence to therapy and other recommendations, especially in adolescents and young adults [66].

Glucose excursions and frequent hypoglycemic episodes influence food intake [67] and may foster depressive symptoms or bulimic behaviors [37]. A compensatory insulin restriction may be a solution to reduce hunger and caloric intake [68].

Some data suggest that pump insulin therapy may partially restore hunger-satiety cycles, possibly improving eating disorders [69, 70]. However, it should be noted that children with DEBs are more likely to discontinue insulin pump use than those without DEBs since the shift from a multi-daily insulin regimen may be a source of additional psychological discomfort. On the other hand, hypoglycemia could be associated with depressive mood, fear, and poor emotion regulation [71]. These conditions may exacerbate clinical dysfunction in DEBs, and insulin pump therapy may mitigate DEBs by reducing the amplitude of glucose excursions and normalizing eating patterns [72].

Since individuals transitioning to pump therapy had experienced unsuccessful blood glucose control with a multi-daily insulin injection regimen, the assessment of DEBs prevalence in this at-risk population may prompt DEBs requiring therapeutic support and therapeutic strategies to manage glucose levels better. Comprehensive management, including psychological support and insulin adjustments, appears appropriate for these patients. Therefore, a multidisciplinary approach involving families, diabetologists/endocrinologists, dietitians, psychologists, and psychiatrists would be recommended.

A more flexible dietary regimen and non-restrictive attitudes should avoid psychological discomfort [73]. A gradual increase in insulin delivery should be prescribed with adequate education on problem-solving skills [69]. Interpersonal psychotherapy, family-based therapy, and EDs-validated cognitive and behavioral therapy are valuable tools to manage DEBs better when coexisting with T1D [74]. Cognitive-behavioral, interpersonal, integrative cognitive therapy, and pharmacotherapy can be adapted to address diabetes self-management behaviors when comorbid psychiatric symptoms are also diagnosed [31]. Cognitive-behavioral therapy should also target cognition regarding body image dissatisfaction, fears of hypoglycemia, and other associated depressive symptoms commonly associated with psychiatric problems in young T1D patients [75].

Despite the high prevalence of mental health disorders among adolescents with T1D, treatment options are limited.

Randomized controlled trials showed that psychological therapy, including counseling, cognitive behavior therapy, family systems therapy, and psychodynamic therapy, may improve glycemic control in children and adolescents with T1D [76]. A family-based behavioral nutrition intervention has been shown to enhance the quality of diet without increasing the risk of DEBs [76]. Additionally, the family-based approach provides a more robust support system and more family connectedness, increasing motivation and self-efficacy [77]. Self-compassion is an emerging approach that appears as an effective method to improve psychological

health and self-management among adolescents with T1D. A sense of emotional stability characterizes self-compassion, and non-judgment (mindfulness), which allows the patient to recognize that imperfection and mistakes are part of the human being. Patients should be educated to take an active role in caring about themselves (self-kindness) [78].

CONCLUSION

Eating disorders are commonly observed among patients with T1D, and when both conditions coexist, patients' outcomes deteriorate significantly [79-82]. EDBs are very common among younger patients, and when underdiagnosed, the potential risk of progression to clinical EDs in adulthood is high. Healthcare professionals should be aware of this matter, and specialized skills are required for dealing with these patients, especially adolescents.

The leading issue overlaps with the transitioning age. During this phase, the transition from pediatrics to adult healthcare may exacerbate a vulnerable step with possible drop-out, risk of decreased frequency of follow-up, insulin discontinuation, and serious adverse outcomes [53]. An integrated multidisciplinary approach that includes metabolic control, insulin confidence, and psychological aspects correlate to coping strategies and illness perception is recommended [45].

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CONFLICT OF INTEREST

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