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ORIGINAL ARTICLE

Maladaptive Food Attitudes and Behaviors in Individuals with Celiac Disease and Their Association with Quality of Life

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Abstract

Background The only treatment for celiac disease (CeD) is strict lifelong adherence to a gluten-free diet (GFD). In some individuals the demands of a GFD may contribute to maladaptive eating attitudes and behaviors that impair quality of life (QOL). The Celiac Disease Food Attitudes and Behaviors (CD-FAB) is an easily administered and scored 11-item tool querying potentially maladaptive food attitudes and behaviors resulting from beliefs around gluten exposures and food safety.

Objectives To assess the usefulness of the CD-FAB in establishing the presence of maladaptive food attitudes and behaviors among adults with CeD and to explore the relationship between these attitudes and behaviors and other factors including QOL, anxiety, depression, CeD symptoms and personality traits.

Methods The study is a cross-sectional pilot of 50 adults (mean age 29.6 years) with biopsy-proven CeD who followed a GFD for at least one year and had no self-reported eating disorder diagnosis. High scores on the CD-FAB tool suggest higher disordered eating attitudes and beliefs.

Results Compared to lower scores (mean 20.2), higher (worse) CD-FAB scores (mean 54.5) were positively associated with recency of diagnosis, number of CeD-related gastrointestinal symptoms, and the personality trait of neuroticism. Higher CD-FAB scores were statistically and clinically significantly associated with diminished QOL ($p < 0.001$). The relationship with anxiety and depression was less clear but trended in the expected direction.

Conclusion The CD-FAB may be a useful tool for dietitians who wish to monitor maladaptive food attitudes and behaviors among their CeD patients, especially in the first-year post-diagnosis.

Keywords Disordered eating · Maladaptive eating · Attitudes and behaviors · Celiac disease · Quality of life · Eating disorders · Food attitudes · CD-FAB

Introduction

Celiac disease (CeD) is an autoimmune disease in which exposure to gluten causes destruction to the villous architecture of the small intestine in genetically susceptible individuals. The consequent malabsorption of nutrients can impact almost any organ system and have multiple long-term negative effects [1]. Morbidity can be severe and CeD is associated with a small, but increased mortality [2]. The only treatment for CeD is lifelong adherence to a strict, gluten-free diet (GFD) [3]. While supporting adherence to the GFD is a priority for health professionals working with individuals with CeD, recent work suggests a number of psychosocial challenges associated with GFD adherence. In a recent systematic review, Zingone et al. reported that a diagnosis of CeD had significant impact on anxiety and depression, which may interact with GFD adherence [4].

Management of a GFD requires constant monitoring of ingredients, control around food, and avoidance of unsafe foods. However, accidental exposures to gluten when dining out, traveling, or at social events are common and often increase anxiety around dietary adherence. Emerging research indicates that while these approaches enable strict GFD adherence, they may impair psychological health and QOL [5–13]. In a recent study of adolescents with CeD

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(13–17 years old) following a GFD for at least one year recruited from an urban CeD referral center, it was found that approximately half the sample (53.3%) expressed maladaptive approaches to maintaining a GFD [5]. Although the mechanisms are unclear, studies have investigated the association between CeD and ED. One hypothesis is that some individuals experience distress in response to weight gain associated with their diagnosis and implementation of the prescribed GFD. Because they may feel the GFD is causing the unwanted weight gain, purposeful gluten ingestion may lead to restrictive or bulimic eating behaviors [7]. Another hypothesis is that patients who are highly compliant with the GFD and experience resolution of symptoms, anxiety around gluten cross-contamination may lead to limited food choices or eating only in situations with complete control over food preparation, which, in turn, may lead to disordered eating (DE) attitudes and behaviors [7]. Recent studies have investigated the association between CeD and ED. Several cases of EDs have been reported in patients with CeD, signifying that ED may be a comorbidity related to CeD [14, 15], and a few studies have investigated the association between the two disorders [4, 14, 16]. However, the presence of DE attitudes and behaviors was not investigated; neither was the association with the rigid nature of the GFD, the burden of dietary adherence and the constant vigilance needed to avoid chance gluten exposure [4, 12]. This study addressed some of these gaps in the literature by exploring prevalence of CeD in a sample of adults, examines attitudes and behaviors specific to individuals with CeD that may be associated with DE, and also examines whether there is a particular profile of individuals that may be at risk. This cross-sectional study was designed to explore associations between maladaptive eating and QOL using a newly developed validated tool.

The Celiac Disease Food Attitudes and Behaviors (CD-FAB) is an eleven-item validated tool that queries eating attitudes and behaviors resulting from beliefs around cross-contact, and food safety (i.e., handling of food, trust, risk-taking, and food safety) [5, 8]. The survey tool is unique in that it is disease specific and is useful for evaluation of food concerns in individuals with CeD and further explores the development of DE in CeD. Answers give an overall score, as well as three clinically relevant subscales: food attitudes, fear response, and adaptive response. For some, these hypervigilant approaches and concerns around gluten exposure may lead to greater rigidity, limiting food choices, restrictive eating behaviors, preoccupation with food, or avoidance of social situations, which may predispose to the development of DE or even eating disorders, EDs [5, 8]. High CD-FAB scores have been associated with psychological distress (anxiety, depression, and stress) and with impaired CeD-specific QOL in a sample of CeD patients in the UK [17]. In a recent study conducted at the Celiac Disease Center at Columbia University, the tool was used as part of an online survey for adults (> 18 years) with biopsy-diagnosed CeD. Adults with major/moderate impact on dating had higher CD-FAB scores than adults with no major impact on dating [18]. The CD-FAB tool was also used in a study looking at factors associated with maladaptive eating behaviors, social anxiety, and quality of life (QOL) in adults with CeD, and adults who were on a GFD for a short duration had significantly higher CD-FAB scores (worse eating attitudes and behaviors) [19].

Many professionals and researchers in the gastroenterology field have recognized that a number of patients with CeD have EDs or DE that interact with their presenting GI-related symptoms. Dietitians and clinicians treating individuals with CeD urgently need guidance on how to assess and manage patients that may be at high risk for an ED and/or DE attitudes and behaviors while still advocating for strict adherence to a GFD and maintaining QOL. Despite increasing understanding of the impact of hypervigilant approaches to GFD management on psychosocial well-being and QOL, measures to detect hypervigilant approaches in clinical practice are limited. This study used the CD-FAB to determine the prevalence of maladaptive attitudes and behaviors around food and GFD management in adults with CeD and explore associations between the CD-FAB, body composition, GFD adherence, GI symptoms, personality characteristics, QOL, anxiety, and depression. This study also sought to aim to determine current frequency of ED diagnoses and symptoms through the administration of the Eating Disorder Diagnostic Scale (EDDS-DSM-5) and the Eating Pathology Symptoms Inventory (EPSI); however, those findings are beyond the scope of this paper and will be described elsewhere.

A central hypothesis in this research study is that DE attitudes and behaviors are likely common in adults with CeD on a strict GFD. Using a cross-sectional study, the primary objective of this research was to examine the prevalence of DE attitudes and behaviors in a sample of adults with CeD, as measured by a recently validated Celiac Disease Food Attitudes and Behaviors Scale (CD-FAB). A second objective was to examine the association between the CD-FAB scores and QOL, including anxiety and depression. A third objective was to explore the association between CD-FAB and personality characteristics; GI symptoms, GFD adherence, and body composition were also be examined.

Methods

This cross-sectional study was conducted at the Celiac Disease Center at CUIMC (Celiac Disease Center) in New York City. Individuals between 18 and 45 years of age, with biopsy-diagnosed CeD, following a GFD for at least a year, were eligible to participate. CeD diagnosis was confirmed from patients' medical records by the Celiac Disease Center

clinical staff. The age limit of 45 was a clinical decision made by the clinicians at the Celiac Center based on their experiences of when they felt maladaptive eating behaviors due to a strict GFD was likely to occur. Exclusion criteria included serum or self-diagnosed CeD (without biopsy), diagnosis < 1 year prior, and self-reported previous ED diagnosis.

Enrollment began on January 28th, 2020, was halted due to COVID-19 after recruitment of the 22nd participant, resumed on October 16, 2020, and was completed on December 15, 2020. Informed consent was obtained in person at the Celiac Disease Center. Pre-screened age-eligible patients with biopsy-diagnosed CeD were approached consecutively upon arrival for their clinic appointment. Of 62 approached, 50 (80.6%) agreed and were eligible to participate (12 lacked interest or time). Eligible participants were provided a private space in the Center, if such was requested, where they completed the self-administered paper and pen surveys. Anthropomorphic measurements were taken by study personnel in an examination room at the Celiac Disease Center.

Measurement Tools

Food Attitudes and Behaviors Specific to CeD

The Celiac Disease-specific Food Attitudes and Behaviors (CD-FAB) is an 11-item tool that queries food attitudes and behaviors resulting from beliefs around avoiding minor gluten contamination and food safety (i.e., handling of food, trust, risk-taking, and food safety). The survey tool is CeD specific. Likert-type responses (from 1 = Strongly disagree to 7 = Strongly agree), with high scores suggesting more maladaptive eating attitudes and behaviors. Clinical relevance cut-offs have not yet been established.

CeD-Specific QOL

The Celiac Disease-Specific Quality of Life (CD-QOL) is a 20-item instrument assessing the QOL in adults with CeD. Likert-type responses range between 1 = Not at all and 5 = A great deal [20]. Responses yield an overall score, as well as four clinically relevant subscales: Dysphoria (how much individuals feel depressed, frightened, or overwhelmed by their diagnosis; 4 items), Limitations (how much individuals feel limited by CeD when eating out with others, socializing, and traveling; 9 items), Health Concerns (how much individuals feel worried about long-term health outcomes of their diagnosis for other family members and themselves; 5 items), and Inadequate Treatment (how much individuals feel there are enough treatment options for their CeD; 2 items). The possible range for all subscales and the overall score is 0–100. Higher scores indicate a better QOL; scores ≥ 60 are considered "Good."

Anxiety and Depression

The State Trait Anxiety Inventory (STAI) is a two-part tool with 20 items assessing anxiety as an existing state (i.e., transitory, State Anxiety) and 20 items assessing a predisposition to anxious response to situations (i.e., latent, Trait Anxiety) [21]. Higher scores indicate more anxiety and scores ≥ 40 are considered to indicate clinically significant anxiety. The Center for Epidemiologic Studies Depressive Scale (CES-D) is a 20-item screening test for depression and depressive disorder measuring symptoms defined by the DSM-V for a major depressive episode [22, 23]. CES-D scores > 15 suggest clinical depression.

Personality Traits

The Big Five Inventory is a 44-item inventory assessing five main dimensions of personality: Extroversion (8 items), Agreeableness (9 items), Conscientiousness (9 items), Neuroticism (8 items), and Openness to Experience (10 items) [24]. It consists of short phrases presented with accessible vocabulary. Response options range between 1 = Strongly disagree and 5 = Strongly agree [25]. Items are reverse coded, as appropriate, and summed to form subscales in which higher scores indicate more of the named quality.

CeD Symptoms

The Celiac Disease Symptoms Diary (CDSD) is a 6-item Patient-Reported Outcome (PRO) daily symptom diary developed in line with the US Food and Drug Administration PRO Guidance. The diary assesses the presence/absence and severity of five of the six CeD-related symptoms (diarrhea, abdominal pain, bloating, nausea, fatigue). A 1-day diary was collected which was scored in accordance with recommendations of CDSD authors [26] and number of five symptoms present was counted.

GFD Adherence

The Celiac Disease Adherence Test (CDAT) is a 7-item instrument assessing four dimensions of GFD adherence: CeD Symptoms, Self-efficacy, Reasons to follow a GFD, and level of adherence [27]. Response options for each item range from 1 to 5. Total scores range between 7 and 35, with scores ≥ 13 indicating poor compliance.

Anthropometrics

Patients were weighed barefoot on a Tanita Dual-frequency body composition analyzer (Model # DC43OU), in a private room, with two pounds subtracted to account for clothing. Height was measured via a stadiometer (model #HR200). BMI was calculated as Weight (kg)/Height $(m)^2$.

Ethical Approval

IRB approval was obtained from Columbia University Irving Medical Center (CUIMC) on August 1st, 2019 (Rascal IRB-AAAS550), with approval for modifications on December 5th, 2019. IRB approval at Teachers College was obtained on September 5th, 2019 (IRB ID 19-479), with approval for modifications on January 7th, 2020.

Statistical Procedures

Means, standard deviations (SDs), and frequencies were used to describe demographic and other characteristics of the study sample. Total and subscale scores for each instrument were calculated according to the individual instrument specifications. Internal consistency reliability of the CD-FAB was evaluated with Cronbach's α.

Differences in CD-FAB scores across demographics, BMI, GI symptoms, GFD adherence, and personality characteristics were assessed with independent samples *t* tests, ANOVAs, or χ^2, as appropriate. An independent samples *t* test compared study sample CD-FAB scores with those of 41 adults with biopsy-diagnosed CeD recruited in the UK by Dr. Satherley's research study [25].

The relationship of CD-FAB to QOL, anxiety, and depression was examined with simple correlations, with ANOVAs comparing means across tertiles of total CD-FAB and by cross-tabulating presence/absence of concerning characteristics (e.g., less than "Good" QOL, non-compliance with GFD, etc.) across tertiles of total CD-FAB. Stepwise regressions were run to explore the relative predictive value of variables associated with QOL, anxiety, and/or depression.

Some subjects were recruited before the COVID-19 pandemic and others during the COVID-19 pandemic, but after the NYC lockdown, we took several steps to address the impact of the pandemic on our results: checking for differences, demographic and otherwise, between participants recruited pre- ($n=22$) and mid-pandemic ($n=28$), and rerunning and examining correlations and ANOVAs on each sub-sample.

Privacy and Data Security

Study data were de-identified, coded, and kept in an encrypted endpoint device to which only study personnel had access.

Results

Fifty adults with CeD were recruited (62 patients were approached, 12 patients did not want to participate due to lack of interest or lack of time), the mean age of adults in this study was 29.6 years (SD = 7.4), and the mean age at diagnosis was 22.8 years (SD = 9.3). Participants had CeD for an average of 7.2 years (SD = 5.3); 40% diagnosed in the last 1 to 4 years, 40% between 5 and 10 years ago, and 20% > 10 years ago (Table 1).

The negative CD-FAB items most strongly agreed with were: "I am afraid to eat outside my home" [mean (SD) = 3.9 (2.1)] and "I get worried when eating with strangers" [mean (SD) = 3.9 (2.0)]. The item least strongly agreed with was: "I will only eat food that I have prepared myself" [2.4 (1.5)]. Cronbach's α for the Total CD-FAB scale was 0.91 (Table 2).

Total CD-FAB scores did not differ significantly from those of the original 41 adults with biopsy-diagnosed CeD recruited in the UK as part of Dr. Satherley's research [28]. The current study Mean (SD) is 37.0 (15.3) vs. UK Study 39.7 (7.3); $t=1.06$, DF = 89, $p=0.29$). UK participants were aged between 18 and 69 years [mean (SD) = 40.6 (18.2)]; 70.7% were female compared to our sample of adults between the ages of 19 and 45 and 70% were female.

Twenty-one participants (42%) had lower CD-QOL scores (< 60) suggesting lower QOL, 44% ($N=22$) were above the cut-off point (score > 39, STAI) for trait anxiety, and 40% ($N=20$) were above the cut-off point (> 39, STAI) for state anxiety. 13 Participants (26%) were above the cut-off point (score > 15, CES-D) for depressive symptoms (Table 3).

Total CD-FAB did not vary by gender, ethnicity, race, education level, household income, visits with a registered dietitian, age at enrollment, or BMI. Correlations of CD-FAB scores and years since diagnosis and with number of GI symptoms were in the medium range (i.e., 0.3–0.5), more recently diagnosed participants, and those with more symptoms having higher (i.e., worse) scores (Table 2). Big Five Neuroticism was positively correlated with most CD-FAB scores. Weak-positive correlations (i.e., 0.1–0.3) were observed between CD-FAB and Anxiety State and Depression. The highest correlations observed were between CD-FAB and CD-QOL overall, Dysphoria, and Limitations, with higher CD-FAB scores being associated with lower QOL (i.e., 0.5–1.0, Table 3).

As expected from the correlations, number of years since CeD diagnosis decreased, and number of GI symptoms, Big Five Neuroticism, Anxiety State, and Anxiety Trait increased across tertiles of total CD-FAB. The most significant differences across tertiles of total CD-FAB

Table 1 Descriptive statistics for the study sample ($N = 50$)

	N (%)
Female	35 (70.0)
Non-Hispanic	45 (90.0)
White	47 (94.0)
Education	
Some college	8 (16.0)
College graduate	32 (64.0)
Postgraduate	10 (20.0)
Household income	
< $50K/year	4 (8.0)
$50–$100K/year	11 (22.0)
> $100K/year	31 (62.0)
Did not disclose	4 (8.0)
RDN visit	
RDN currently	24 (48.0)
RDN past only	16 (32.0)
RDN never	14 (28.0)
	Mean (SD)
Age at enrollment (years)	29.6 (7.4)
Years since diagnosis	7.2 (5.3)
BMI (kg/cm^2)	23.2 (4.0)
GFD compliance (CDAT)	11.9 (3.3)
# of 5 GI symptoms (CDSD)	1.9 (1.5)
CD-FAB items	
1 I get concerned being near others when they are eating gluten	3.8 (2.0)
2 I am afraid to eat outside my home	3.9 (2.1)
3 I am afraid to touch gluten-containing foods	3.5 (2.3)
4 I get worried when eating with strangers	3.9 (2.0)
5 I find it hard to eat gluten-free foods that look like the gluten-containing foods that have made me ill in the past	2.8 (1.8)
6 I will only eat food that I have prepared myself	2.4 (1.5)
7 My concerns about cross-contamination prevent me from going to social events involving food	3.0 (1.9)
Despite having Celiac Disease…	
8 I enjoy going out for meals as much as I did before my diagnosis	3.2 (2.2)
9 I am comfortable eating gluten-free food from other people's kitchens	4.1 (1.9)
10 Being contaminated by gluten in the past has not stopped me from enjoying restaurants	4.4 (2.0)
11 If I ask questions, I can normally find gluten-free food to eat	5.4 (1.4)
TOTAL CD-FAB score (Range 11 to 77)	37.0 (15.3)

CD-FAB: Likert-type responses (from 1 = Strongly disagree to 7 = Strongly agree) are summed to yield an overall score, as well as three clinically relevant subscales. Note items 8–11 are not reverse scored in the table but get reverse scored when CD-FAB score is calculated

CDAT: Excellent or very good adherence to a GFD was marked with total scores below or equal to 13; moderate to poor adherence was marked with total scores above 13

were in overall, Dysphoria, and Limitations QOL. These differences were clinically as well as statistically significant, ranging between 27.5 and 33.5 points across tertiles. The percentages of patients with less than "Good" overall and Limitations QOL (i.e., < 60) in the highest tertile of total CD-FAB were 7+ times higher than those in the lowest tertile.

Stepwise regressions with possible predictors that included years since CeD diagnosis, GFD adherence (CDAT), number of GI symptoms, and total CD-FAB were run to predict QOL, anxiety, and depression. For CD-QOL overall, Dysphoria, and Limitations, R^2 ranged between 0.40 and 0.57 with only total CD-FAB and CDAT entering the equation. For CD-QOL Health concerns, only total CD-FAB

Table 2 CeD patient characteristics by tertile of TOTAL CD-FAB score

Continuous variables	Tertile of TOTAL CD-FAB Score				
	Lowest tertile $N=17$ Mean (SD) = 20.2 (5.3)	Middle tertile $N=16$ Mean (SD) = 36.1 (3.9)	Highest tertile $N=17$ Mean (SD) = 54.5 (6.8)	TOTAL $N=50$ Mean (SD) = 37.0 (15.3)	Linear trend F p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Years since CeD diagnosis	10.9 (5.8)	5.6 (4.6)	5.0 (3.3)	7.2 (5.3)	13.2 0.001
GFD compliance (CDAT)	11.6 (4.1)	10.8 (2.3)	13.2 (2.8)	11.9 (3.2)	2.3 0.137
# GI symptoms (CDSD)	1.4 (1.2)	1.8 (1.8)	2.6 (1.2)	1.9 (1.5)	6.6 0.013
Big Five: Extroversion	29.1 (4.4)	28.7 (7.2)	27.1 (7.0)	28.3 (6.3)	0.8 0.376
Agreeableness	35.5 (6.2)	36.4 (4.4)	35.6 (6.2)	35.8 (5.6)	0.0 0.929
Conscientiousness	38.0 (4.0)	35.8 (4.1)	35.1 (1.2)	36.3 (4.5)	3.6 0.065
Neuroticism	19.5 (6.0)	22.6 (6.1)	26.3 (6.9)	22.8 (6.8)	9.9 0.003
Openness to Experience	35.9 (5.8)	36.2 (5.8)	39.7 (5.5)	37.3 (5.8)	3.7 0.059
CD-QOL: OVERALL	74.5 (18.8)	67.0 (20.3)	47.0 (14.5)	62.7 (21.2)	19.7 0.000
Dysphoria	85.3 (23.30	80.1 (24.1)	57.7 (23.8)	74.2 (26.2)	11.5 0.001
Limitations	74.0 (17.3)	64.3 (17.5)	40.5 (18.8)	59.8 (22.7)	29.9 0.000
Health Concerns	65.9 (24.9)	60.0 (29.7)	45.4 (18.4)	57.0 (25.7)	5.8 0.019
Inadequate treatment	76.5 (26.8)	65.6 (40.4)	58.8 (29.9)	67.0 (32.9)	2.5 0.123
STAI: Anxiety State	32.1 (10.9)	37.5 (12.5)	42.5 (14.2)	37.4 (1.9)	5.7 0.021
Anxiety Trait	36.3 (10.6)	39.2 (9.6)	43.7 (11.0)	39.8 (10.7)	4.3 0.044
Depression (CES-D)	14.6 (4.1)	13.4 (2.5)	16.8 (6.2)	15.0 (4.6)	1.9 0.179
Dichotomous variables	N (%)	N (%)	N (%)	N (%)	χ^2 p^1
		N (%)	N (%)	N (%)	
CDAT: GFD Non-compliant (≥ 13)	4 (23.5)	3 (18.8)	9 (52.9)	16 (32.0)	3.3 0.069
# GI symptoms ≥ 1	13 (76.5)	12 (75.0)	17 (100.0)	42 (84.0)	3.4 0.064
CD-QOL: Less than Good OVERALL (< 60)	2 (11.8)	5 (31.2)	14 (82.4)	21 (42.0)	17.0 0.000
Less than Good Dysphoria (< 60)	2 (11.8)	2 (12.5)	7 (41.2)	11 (22.0)	4.2 0.040
Less than Good Limitations (< 60)	2 (11.8)	4 (25.0)	15 (88.2)	21 (42.0)	20.0 0.000
Less than Good Health Concerns (< 60)	5 (24.9)	7 (43.8)	12 (70.6)	24 (48.0)	5.7 0.017
Less than Good Inadequate Treatment (< 60)	5 (29.4)	7 (43.8)	7 (29.9)	19 (38.0)	0.5 0.484
STAI: Anxiety State indicated (> 39)	5 (29.4)	6 (37.5)	9 (52.9)	20 (40.0)	1.9 0.166
Anxiety Trait indicated (> 39)	5. (29.4)	7 (43.8)	10 (58.8)	22 (44.0)	2.9 0.246
CES-D: Depression indicated (> 15)	4 (23.5)	2 (12.5)	7 (41.2)	13 (26.0)	1.3 0.246

[1]Linear trend χ^2, Df = 1

entered the equation ($R^2 = 0.15$). No variables entered the regression predicting CD-QOL Inadequate Treatment. Only CDAT entered the equations for STAI scores and CES-D (R^2 between 0.16 and 0.36).

Demographic characteristics of the sample pre- and mid-pandemic were similar, but CD-QOL overall (mean difference = 19.0, $t = 3.4$, DF = 48, $p = 0.001$), Dysphoria, Limitations and Health, and Big Five Neuroticism scores were significantly better mid-COVID versus pre-COVID. Sub-sample correlations and ANOVAs were consistent with overall results with the following qualification: associations with total CD-FAB appeared to be stronger in the mid-COVID sub-sample.

Discussion

In this cross-sectional study, we found that maladaptive food attitudes and behavior was correlated with specific personality traits, symptoms, and recency of diagnosis among

Table 3 Correlations of CD-FAB scores with patient characteristics

	CD-FAB score			
	Food Attitudes	Fear Response	Adaptive Response	TOTAL score
	r (*p*)	*r* (*p*)	*r* (*p*)	*r* (*p*)
Age at enrollment (years)	−0.049 (0.735)	−0.021 (0.884)	0.155 (0.282)	0.031 (0.831)
Years since CeD diagnosis	−0.519 (0.000)	−0.422 (0.002)	−0.334 (0.018)	−0.493 (0.000)
Tanita BMI (kg/cm^2)	−0.157 (0.275)	−0.150 (0.299)	−0.144 (0.319)	−0.172 (0.232)
GFD compliance (CDAT)	0.252 (0.078)	0.217 (0.129)	0.208 (0.147)	0.261 (0.067)
# GI symptoms (CDSD)	0.306 (0.030)	0.457 (0.001)	0.384 (0.006)	0.419 (0.002)
Big Five: Extroversion	−0.185 (0.200)	−0.118 (0.414)	−0.103 (0.476)	−0.161 (0.265)
Agreeableness	0.092 (0.525)	−0.007 (0.959)	−0.118 (0.415)	−0.003 (0.981)
Conscientious	−0.169 (0.242)	−0.125 (0.386)	−0.255 (0.074)	−0.214 (0.136)
Neuroticism	0.350 (0.013)	0.194 (0.177)	0.428 (0.002)	0.387 (0.005)
Openness	0.233 (0.104)	0.141 (0.328)	0.179 (0.215)	0.219 (0.126)
CD-QOL: OVERALL	−0.652 (0.000)	−0.465 (0.001)	−0.407 (0.003)	−0.597 (0.000)
Dysphoria	−0.549 (0.000)	−0.411 (0.003)	−0.307 (0.030)	−0.494 (0.000)
Limitations	−0.711 (0.000)	−0.539 (0.000)	−0.499 (0.000)	−0.681 (0.000)
Health concerns	−0.478 (0.000)	−0.219 (0.126)	−0.234 (0.102)	−0.381 (0.006)
Inadequate treatment	−0.192 (0.181)	−0.243 (0.090)	−0.131 (0.363)	−0.209 (0.145)
STAI: Anxiety state	0.292 (0.039)	0.182 (0.205)	0.352 (0.012)	0.327 (0.021)
Anxiety trait	0.285 (0.045)	0.088 (0.545)	0.262 (0.066)	0.263 (0.065)
Depression (CES-D)	0.304 (0.032)	0.168 (0.242)	0.199 (0.166)	0.269 (0.059)

people with CeD. The CD-FAB is a short (11-item) easily administered and scored instrument assessing food attitudes and behaviors relevant to CeD patients as they maintain the GFD. The maladaptive eating attitudes and behaviors assessed by the CD-FAB may be precursors to or even markers for serious EDs, such as anorexia nervosa, bulimia nervosa and binge ED. The CD-FAB may be a useful tool for detecting CeD patients at risk for these outcomes.

As dietitians and clinicians stress the importance of maintaining a strict GFD for their CeD patients, they must also strive to offset the diminished QOL associated with this challenging dietary regimen. In this study, high (worse) CD-FAB scores were strongly associated with diminished QOL and suggestive of increased anxiety. These results are consistent with other research associating high CD-FAB scores with fear of trying new foods and with impaired QOL, particularly in social domain [17]. The CD-FAB may be a useful first step for dietitians and other health professionals managing patients with CeD wishing to identify those at highest risk of diminished QOL.

In this study, worse CD-FAB scores were associated with recency of CeD diagnosis and with number of GI symptoms. The implication for practitioners is that newly diagnosed CeD patients and those with GI symptoms merit special attention to avoid maladaptive attitudes and beliefs surrounding the GFD that could lead to DE behaviors. Interestingly, neither years since CeD diagnosis nor number of GI symptoms met inclusion criteria in stepwise regressions predicting QOL. In this sample, total CD-FAB and CDAT, together, were the best predictors of QOL.

An unexpected finding was that participants recruited during the pandemic (despite being similar demographically to those recruited pre-COVID) had significantly better CD-QOL and Big Five Neuroticism scores and trended toward having less anxiety and depression and better GFD adherence. This is perhaps attributable to their being more or less homebound, where control around food is more easily managed and maintaining the GFD less problematic. The fact that they visited the Celiac Center during the pandemic may also suggest personality and health characteristics reflective of individuals who sought in-person care.

While no clinical relevance cut-offs have been established, we recommend that unusually high CD-FAB scores be followed up with screening for DSM-V Eating Disorders using the Eating Disorder Diagnosis Scale (EDDS-DSM-5) to rule out the presence of a shape/weight-motivated ED. Given revised DSM-5 TR 2022, we may see more patients with CeD diagnosed with Avoidance/Restrictive Food Intake Disorder (ARFID) [29, 30]. Eating/feeding disturbance (e.g., food avoidance) as the new definition does not have to include weight or body image concerns. While it remains premature to recommend that the CD-FAB be used to screen for ARFID, it may be used in conjunction with AFRID screeners provided they are validated for the new criteria. The utility of screening patients with CeD that have high CD-FAB scores for

ARFID and other EDs [31] is warranted and needs further study.

This study had several limitations, foremost of which was the homogeneity of the study sample. Participants were predominantly white, highly educated, and well off financially. Nevertheless, there was enough variability in CD-FAB scores to allow us to see statistically and clinically significant differences in QOL across tertiles of those scores. Our study was limited to those that self-reported not having had a prior ED, which may have been less likely to be disclosed in patients seeking care for CeD and/or gastrointestinal symptoms. We did explore the frequency of current ED diagnoses and symptoms through the administration of the Eating Disorder Diagnostic Scale (EDDS-DSM-5) and the Eating Pathology Symptoms Inventory (EPSI). Although DE behaviors and weight/shape concerns were apparent, only one patient met full criteria for an ED diagnosis (unpublished data). These findings were beyond the scope of this paper will be published separately. Finally, the interruption mid-study in recruitment caused by the COVID-19 pandemic was an unavoidable complication.

Conclusion

The CD-FAB may help clinicians and dietitians monitor concerning eating attitudes and behaviors in their patients with CeD. CD-FAB scores had statistically and clinically significant associations with QOL. Higher (worse) CD-FAB scores were also associated with number of GI symptoms, recency of CeD diagnosis, and Big Five Neuroticism. The CD-FAB is easily administered and scored and may be particularly useful to dietary practitioners as a screening tool during the first years after CeD diagnosis.

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Author's contribution YG, AL, JS, RS, PG, BL, and RW all conceptualized and designed the study. PZ managed and analyzed the data. JS and RS contributed substantive content related to disordered eating and relevant literature. All authors reviewed and commented on multiple drafts of the manuscript and all played a key role in the interpretation and clinical relevance of study results.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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