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To cite this article: Nicholas L. Kerswell & Esben Strodl (2015) Emotion and its regulation predicts gluten-free diet adherence in adults with coeliac disease, Health Psychology and Behavioral Medicine, 3:1, 52-68, DOI: [10.1080/21642850.2015.1010534](https://doi.org/10.1080/21642850.2015.1010534)

To link to this article: <https://doi.org/10.1080/21642850.2015.1010534>



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Published online: 05 Feb 2015.



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## Emotion and its regulation predicts gluten-free diet adherence in adults with coeliac disease

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*(Received 31 July 2014; accepted 19 January 2015)*

**Objective:** The aim of this study was to explore the mediating and moderating relationships between emotional perceptions of coeliac disease, negative emotional states, emotion regulation, emotional eating and gluten-free diet adherence. **Method:** Adults with coeliac disease ( $N=253$ ) were recruited from state organisations of Coeliac Australia and completed an online questionnaire measuring illness perceptions, emotion regulation strategies, negative emotional states, emotional eating and gluten-free diet adherence. **Results:** Participants' levels of depression and anxiety, but not stress or emotional eating, were associated with gluten-free diet adherence. Emotional perception of coeliac disease was also associated with gluten-free diet adherence, and this relationship was partially mediated by depression and anxiety. Furthermore, the emotion regulation strategies of cognitive reappraisal and expressive suppression moderated the relationship between emotional perceptions and depression, but not emotional perceptions and anxiety. **Conclusions:** Interventions to improve dietary adherence for adults with coeliac disease displaying depressive symptoms should aim to increase the use of cognitive reappraisal and reduce the use of expressive suppression. Future studies should also explore mechanisms that may moderate the relationship between emotional perceptions and anxiety.

**Keywords:** coeliac disease; adherence; affect regulation

Coeliac disease is a commonly diagnosed autoimmune condition worldwide, with a prevalence of approximately 1 in 100 individuals (Jacobsson, Hallert, Milberg, & Friedrichsen, 2012). The condition is characterised by hypersensitivity to gluten which is found in wheat, rye, barley and oats (Autodore, Verma, & Gupta, 2012). When an individual with coeliac disease ingests food containing gluten, their immune system produces antibodies which progressively damage the small intestinal villi which absorb nutrients from food (Autodore et al., 2012). This condition, known as villous atrophy, manifests in gastrointestinal symptoms such as diarrhoea, vomiting, and abdominal pain and bloating, and non-gastrointestinal symptoms including anaemia, decreased bone density, fatigue and lethargy (Autodore et al., 2012; van Hees, Van der Does, & Giltay, 2012). Left untreated, coeliac disease is associated with increased risk of developing serious medical complications including cancer, neurological disorders, osteoporosis and infertility, although the absolute risks are still relatively low (Viljamaa et al., 2006; Zarkadas et al., 2006). Presently, there is no cure for coeliac disease, and the only effective course of treatment is a strict gluten-free diet with a lifelong course (Black & Orfila, 2011).

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Upon adopting a strict gluten-free diet, the majority of individuals with coeliac disease return to health over a course of months (Autodore et al., 2012). However, while the remission of physical symptoms of coeliac disease may provide short-term gains in health-related quality of life, a lifelong commitment to avoiding gluten to prevent illness may prove intimidating and disruptive to an individual's lifestyle and relationships, and therefore negatively impact on quality of life over time (Carrie & Chan, 2008; Zarkadas et al., 2013). Common activities such as shopping for food and dining with friends may change from being simple, to complicated, constrictive and costly (Zarkadas et al., 2013). While studies have demonstrated that individuals with coeliac disease generally possess good knowledge of their condition and its treatment, and strong beliefs in the importance of strict gluten-free diet adherence, adherence to the gluten-free diet is nonetheless highly variable (Black & Orfila, 2011; Hall, Rubin, & Charnock, 2009, 2013; Zarkadas et al., 2013).

Significant research attention has been directed towards determining the factors that are associated with gluten-free diet adherence, with a systematic review of such studies conducted by Hall et al. (2009) having identified a range of cognitive, sociocultural and emotional factors. While acknowledging the importance of a range of cognitive and sociocultural factors, this study focussed on better understanding the relationships between key emotional factors and dietary adherence. These key emotional factors include emotional perceptions of coeliac disease (represented by emotions directed towards the illness such as anger, fear or acceptance), emotion regulation strategies employed to cope with these emotions and associated levels of depression, anxiety and stress (Hall et al., 2009; Ludvigsson, Reutfors, Ösby, Ekblom, & Montgomery, 2007; Moss-Morris et al., 2002). Featuring prominently across a range of studies is the relationship between negative emotional states and gluten-free diet adherence, with anxiety and depression being associated with poorer adherence (Häuser, Stallmach, Caspary, & Stein, 2007; van Hees et al., 2012).

A previous study by Ford, Howard, and Oyeboode (2012) indicated that negative perceptions of coeliac disease were associated with more negative emotional states. However, this study did not employ a validated measure of gluten-free diet adherence and it did not examine a mediational relationship between these variables and adherence. The aim of the present study was to expand upon this research by exploring the relationship between emotional perceptions of coeliac disease, negative emotional states previously identified as predictive of gluten-free diet adherence and a validated measure of gluten-free diet adherence. In particular, it is hypothesised that negative emotional states will mediate the relationship between emotional perceptions about illness and adherence to a gluten-free diet.

In addition, it was of interest to explore the association between emotional eating and poor gluten-free diet adherence. Emotional eating refers to a pattern of behaviour whereby individuals respond to negative emotional states by sharply increasing their intake of food (Adriaanse, de Ridder, & Evers, 2011). Emotional eating is commonly found in individuals who demonstrate disordered eating such as obesity or bulimia; yet to date it has not been applied to the study of coeliac disease and the gluten-free diet. Given that individuals with coeliac disease display higher rates of disordered eating than the general population, and that emotional eating is a behaviour associated with increased use of expressive suppression (Arigo, Anskis, & Smyth, 2012; Evers, Stok, & de Ridder, 2010), it seemed reasonable to expect that individuals who may not be coping well with coeliac disease may engage in emotional eating. In addition, previous research indicates negative emotional states are a proximal predictor of variance in gluten-free diet adherence (Leffler et al., 2008; Sainsbury, Mullan, & Sharpe, 2012). As emotional eating represents a maladaptive response to negative emotional states, it may therefore represent a further proximal predictor of gluten-free diet adherence (Koball, Meers, Storfer-Isser, Domoff, & Musher-Eizenman, 2012) in addition to negative emotional states.

Living with coeliac disease presents individuals with practical and emotional challenges that may affect adherence to a gluten-free diet (Hall et al., 2009). While practical strategies such as learning to read labels effectively may help with managing practical challenges, how individuals regulate their emotions may also play an important role in managing the emotional challenges. An example could be how an individual manages or copes with feelings of depression after being excluded from a social event due to the unavailability of gluten-free food. Understanding why one individual with coeliac disease experiences strong negative emotional states while another does not in such circumstances will help guide the development of suitable interventions for this population. One target may be the negative illness perceptions of coeliac disease, while another possible target may be the coping strategies that an individual with coeliac disease employs. Based upon the work by Ford et al. (2012), it could be suspected that negative emotional representations of coeliac disease may be an important target for intervention. Additionally, another target of intervention may be how individuals cope with their negative illness perceptions of coeliac disease.

While there are numerous forms of emotional regulation strategies (Aldao, Nolen-Hoeksema, & Schweizer, 2010), one commonly utilised strategy is cognitive reappraisal, which involves an individual deliberately changing the way he/she thinks about a situation in order to alter the trajectory of emotion generation (Gross, 2007). Among all forms of emotion regulation, cognitive reappraisal demonstrates the strongest empirical support for reducing the experience of negative emotions and also increasing the experience of positive emotions (Ayduk & Kross, 2009; DeSteno, Gross, & Kubzansky, 2013; Gross, 2007; Samson & Gross, 2012). Importantly, cognitive reappraisal has been associated with better mental health in contrast to expressive suppression which has been associated with experiencing psychopathology (Aldao et al., 2010). Another key emotional regulation strategy is expressive suppression which involves attempting to inhibit the experience and expression of emotions after they have been generated (Gross & John, 2003). Individual differences in emotion regulation may therefore account for differences in the emotional adjustment to life with coeliac disease and the formation of emotional perceptions of the illness. This study therefore aimed to examine the moderating effects of these two key emotional regulation strategies upon the relationship between emotional perceptions of coeliac disease and the experience of negative emotional states.

This study aimed to build on previous research showing associations between emotional factors and gluten-free diet adherence by testing a model to explain the association between some of these key variables. It is hoped that such a model could guide future interventions by identifying important targets for such interventions. The first hypothesis was that negative emotional states and emotional eating would be associated with poorer gluten-free diet adherence. The second hypothesis was that negative emotional perceptions of coeliac disease would be associated with poorer gluten-free diet adherence and that this association would be mediated by the experience of negative emotions and the behaviour of emotional eating. The third hypothesis was that emotion regulation strategies would moderate the relationship between emotional perceptions of coeliac disease and negative emotional states.

## **Method**

### ***Participants***

Participants were 253 members of state and territory organisations of Coeliac Australia, which is a not-for-profit organisation that supports individuals with coeliac disease, dermatitis herpetiformis and those who have been medically diagnosed as gluten-intolerant. Obtaining membership to a state coeliac organisation requires a letter of referral from a medical professional confirming a

diagnosis of one of the aforementioned conditions. Though the gluten-free diet is central to the treatment of all of these conditions, participation was restricted to individuals self-reporting diagnosis of coeliac disease by a medical professional using small bowel biopsy (endoscopy).

Participant demographics are detailed in Table 1. The majority of participants were middle aged ( $M=42.34$ ;  $SD=13.75$ ), with a mean age of diagnosis being in the mid-30s ( $M=35.72$ ;  $SD=12.32$ ). The overwhelming majority of participants were female, which is consistent with the gender distribution of similar studies (Sainsbury, Mullan, & Sharpe, 2013). While the Coeliac Society in all states of Australia was invited to promote the study, the promotion was strongest in Queensland and so this state had the largest representation in the sample. However, there is no evidence to suggest any systematic differences between states in demographic profile. In summary, the most common participant profile is that of a woman in middle age, married, university educated and working in a formal capacity.

## Measures

### *Illness Perception Questionnaire – Revised*

The Illness Perception Questionnaire – Revised (IPQ-R) consists of three components measuring participants' perceptions of illness symptoms, the cause of their illness and their personal view of their illness. It has demonstrated validity with a range of chronic conditions such as diabetes, and has been employed in previous studies of coeliac disease (Ford et al., 2012; Moss-Morris et al., 2002). Furthermore, the IPQ-R demonstrates strong discriminant and predictive validity and test–retest reliability (Moss-Morris et al., 2002). The present study focussed

Table 1. Participant demographics.

Demographic variables	Frequency	%
<i>Participant gender</i>		
Female	213	91.4
Male	20	8.6
<i>Coeliac Australia State Organisation Membership</i>		
Coeliac Queensland	128	54.9
Coeliac Victoria and Tasmania	70	30
Coeliac Western Australia	33	14.2
Coeliac NSW and ACT	1	0.3
Coeliac South Australia and Northern Territory	1	0.3
<i>Relationship status</i>		
Single	25	10.7
In a relationship	25	10.7
Married	142	60.9
De facto	24	10.3
Divorced/separated	17	7.3
<i>Highest educational attainment</i>		
High school	47	20.2
TAFE	52	22.3
University undergraduate	74	31.8
University postgraduate	60	25.8
<i>Employment status</i>		
Full-time	99	42.5
Part-time	61	26.2
Casual	19	8.2
Other	52	22.3

only on the emotional representation subscale of the domain measuring participants' personal views of their illness. This subscale reflects participants' subjective emotional experience of their illness through questions such as "I get depressed when I think about my illness" (Moss-Morris et al., 2002). In the present study, the emotional representations subscale was employed as a measure of participants' emotional perceptions of coeliac disease. The items were measured on a five-point Likert scale, ranging over 1 *strongly disagree*, 2 *disagree*, 3 *neither agree nor disagree*, 4 *agree* and 5 *strongly agree*. The Cronbach's alpha for this subscale in the present study was good at .89.

#### *Emotion Regulation Questionnaire*

The Emotion Regulation Questionnaire (ERQ) consists of two subscales measuring participants' tendency to employ cognitive reappraisal or expressive suppression to regulate their emotions when attempting to increase or decrease the experience or intensity of positive or negative emotions (Gross & John, 2003). Participants responded to 10 items comprising statements such as "I control my emotions by changing the way I think about the situation I'm in" and "I keep my emotions to myself" on a seven-point Likert scale, with 1 representing *strongly disagree*, 4 *neutral* and 7 *strongly agree* (Gross & John, 2003). The ERQ has been demonstrated to possess strong construct, convergent and discriminant validity (Gross & John, 2003). The internal consistency of both cognitive reappraisal and expressive suppression were found to be good in the present study, demonstrated by a Cronbach's alpha of .89 and .82, respectively.

#### *Depression Anxiety Stress Scales 21*

The Depression Anxiety Stress Scales 21 (DASS21) consists of 21 questions divided evenly between measuring participants' subjective experience of three negative emotions: depression, anxiety and stress symptoms (Lovibond & Lovibond, 1995). Participants indicate how often over the previous week statements such as "I felt down-hearted and blue", "I felt I was close to panic" and "I found it difficult to relax" applied to them on a four-point scale, ranging over 0 *never*, 1 *sometimes*, 2 *often* and 3 *almost always*. The DASS21 demonstrates strong construct, convergent and discriminant validity and test-retest reliability (Brown, Chorpita, Korotitsch, & Barlow, 1997; Crawford, Cayley, Lovibond, Wilson, & Hartley, 2011; Henry & Crawford, 2005). In the present sample, the Cronbach's alpha for depression and stress were excellent at .93 and .90, respectively, and good for anxiety at .77.

#### *Emotional Eating Scale*

The Emotional Eating Scale (EES) consists of 25 questions measuring participants' tendency to eat food as a means of regulating negative emotional states associated with depression, boredom and anger/anxiety (Koball et al., 2012). Participants record the extent to which feelings such as "upset", "unexcited" or "jittery" give them an urge to eat on a five-point Likert scale ranging over 1 *no desire to eat*, 2 *a small desire to eat*, 3 *a moderate desire to eat*, 4 *a strong urge to eat*, and 5 *an overwhelming urge to eat*. The EES has demonstrated strong construct, criterion, discriminant and convergent validity (Koball et al., 2012). In the present study, the Cronbach's alpha for the depression and boredom subscales was excellent at .92 and .91, respectively, whereas for anger/anxiety it was good at .88.

### *Coeliac Dietary Adherence Test*

This scale consists of seven questions measured on a five-point Likert scale relating to an individual's experience of following the gluten-free diet (Leffler et al., 2009). The labels of responses vary owing to syntactical differences between questions. For example, "Have you been bothered by low energy over the past 4 weeks?" is measured between 1 *none of the time* and 5 *all of the time*, whereas "How important to your health are accidental gluten exposures?" is measured between 1 *very important* and 5 *not at all important*. Higher scores reflect poorer gluten-free diet adherence, with a total in the range of 7–12 representing excellent or very good, 13–17 moderate and 18–35 fair-to-poor diet adherence (Leffler et al., 2009). In the present study, it has been employed as a continuous measure. The Coeliac Dietary Adherence Test (CDAT) has been demonstrated to possess stronger predictive power of gluten-free diet adherence for individuals with coeliac disease than tissue transglutaminase serology, and demonstrates strong face and external validity (Leffler et al., 2009).

### **Data analysis**

A correlational table was produced to inspect the bivariate associations between all the variables used in the hypothesis testing. The first hypothesis was tested using multiple regression. For the first hypothesis, the dependent variable was gluten-free diet adherence (CDAT), and the independent variables were negative emotional states (DASS21 (depression, anxiety, stress)) and emotional eating (EES (depression, boredom, anger/anxiety)). Variables found to be significant and unique predictors of gluten-free diet adherence at this stage would be retained for subsequent analyses. The second hypothesis was tested using multiple hierarchical regression and mediation analysis via PROCESS, and the third using hierarchical multiple regression and moderation analysis via PROCESS (Hayes, 2013). PROCESS is an add-on for SPSS and SAS that uses an ordinary least squares or logistic regression-based analytic framework for estimating direct and indirect mediator and moderator relationships. For the second hypothesis, the dependent variable was gluten-free diet adherence (CDAT), the independent variable was emotional perceptions of coeliac disease (IPQ-R (emotional representations)) and the mediating variables were predictors of gluten-free diet adherence retained after testing the first hypothesis. For the third hypothesis, the independent variable was emotional perceptions of coeliac disease (IPQ-R (emotional representations)), the moderating variables were emotion regulation (ERQ (cognitive reappraisal, expressive suppression)) and the dependent variables were the predictors of gluten-free diet adherence retained after testing the first and second hypotheses.

### **Procedure**

Ethical clearance was obtained prior to commencing the study. A brief overview of the study and a hyperlink to the online questionnaire were advertised via the Facebook pages of Coeliac Queensland, Coeliac Victoria and Tasmania and Coeliac Western Australia, and in the monthly e-newsletters of the aforementioned organisations. Participants self-selected to take part in the study by following the hyperlink, whereupon they were provided with a participant information form detailing the study's purpose and ethical clearance to ensure informed consent. While participants could skip any question, they were withdrawn from the study if they indicated they were not diagnosed with coeliac disease via small bowel biopsy (endoscopy) without completing further questions.

### **Results**

Table 2 details the bivariate correlations between survey variables. A Bonferroni correction was employed to control for inflated type 1 error rate owing to the large number of variables and

Table 2. Bivariate correlations for survey subscales.

Variable	1	2	3	4	5	6	7	8	9	10
1. Diet Adherence	–	.45*	-.26*	.20*	.51*	.44*	.38*	.17	.17	.05
2. Emotional Representations	.45*	–	-.31*	.26*	.57*	.45*	.40*	.21*	.20	.11
3. Reappraisal	-.26*	-.31*	–	-.08	-.34*	-.10	-.19	-.17	-.02	-.08
4. Suppression	.20*	.26*	-.08	–	.33*	.24*	.14	.06	.07	.01
5. Depression	.51*	.57*	-.34*	.33*	–	.60*	.67*	.27*	.13	.11
6. Anxiety	.44*	.45*	-.10	.24*	.60*	–	.72*	.18	.21*	.20*
7. Stress	.38*	.40*	-.19	.14	.67*	.72*	–	.24*	.25*	.21*
8. EES Depression	.17	.21*	-.17	.06	.27*	.18	.24*	–	.77*	.69*
9. EES Boredom	.17	.20	-.02	.07	.13	.21*	.25*	.77*	–	.67*
10. EES Anger/Anxiety	.05	.11	-.08	.01	.11	.20*	.21*	.69*	.67*	–

Note:  $N = 233$ ;  $\alpha$  adjusted by Bonferroni correction.

1 = CDAT = Celiac Dietary Adherence Test; 2 = IPQ-R = Illness Perception Questionnaire – Revised; 3 = ERQ = Reappraisal from Emotion Regulation Questionnaire; 4 = Suppression from Emotion Regulation Questionnaire; 5 = Depression from DASS; 6 = Anxiety from DASS; 7 = Stress from DASS; EES = Emotional Eating Scale.

\* $p < .003$ .

therefore associations were only considered statistically significant if  $p < .003$ . Negative emotional representations of coeliac disease were associated with poorer dietary adherence, as were negative emotional states, demonstrated by a strong positive relationship with depression, and moderate positive relationships with anxiety and stress. The two styles of emotion regulation demonstrated small yet divergent relationships with diet adherence; cognitive reappraisal was associated with greater dietary adherence, whereas expressive suppression was associated with poorer dietary adherence.

**Hypothesis 1**

The first hypothesis that negative emotional states and emotional eating were associated with poorer gluten-free diet adherence was tested using multiple regression. While the emotional eating subscales were originally intended to be included in this analysis they were excluded as the correlation matrix indicated there were no significant bivariate correlations with gluten-free diet adherence. The overall model as detailed in Table 3 was significant, and accounted for 28.6% of variance in gluten-free diet adherence, with depression and anxiety functioning as significant and unique predictors. The first hypothesis was thus conditionally supported; while the

Table 3. Summary of multiple regression analysis for predicting gluten-free diet adherence.

Variable	<i>B</i>	SE <i>B</i>	$\beta$	<i>t</i>	95% CI
Depression	0.3	.06	.40	5.16**	[.19, .42]
Anxiety	0.24	.09	.24	2.85**	[.08, .41]
Stress	-0.04	.06	-.06	-.68	[-.17, .08]
$R^2$	.29				
<i>F</i>	18.27**				

Note:  $N = 233$ .

\* $p < .05$ .

\*\* $p < .01$ .



negative emotional states of depression and anxiety were significant predictors of gluten-free diet adherence, neither stress nor any measure of emotional eating was a significant predictor.

**Hypothesis 2**

A mediation analysis was undertaken to test the second hypothesis that negative emotional states and emotional eating would mediate the relationship between emotional perceptions of coeliac disease and gluten-free diet adherence. An analysis was conducted using hierarchical regression to obtain beta weights and bootstrapped 95% confidence intervals, and PROCESS to explore indirect effects (Hayes, 2013). The model is depicted in Figure 1 and the results are detailed in Table 4. All paths in the model were significant, with emotional representations, depression and anxiety accounting for 31% of variance in gluten-free diet adherence.

Emotional representations were found to have a significant indirect effect on diet adherence through depression and anxiety, thereby demonstrating the occurrence of mediation. As emotional representations remained a significant predictor of diet adherence with the inclusion of the mediators, this was indicative of partial mediation. To summarise the model, as emotional representations of coeliac disease become more negative, diet adherence becomes poorer both as an indirect function of increased depressive symptoms, and to a lesser degree increased anxiety symptoms, and a direct function of negative emotional representations. Thus, the second hypothesis was conditionally supported, as the relationship between emotional representations of coeliac disease and diet adherence was partially mediated by depression, yet not by stress or emotional eating.

**Hypothesis 3**

Following the results of the previous tests of hypotheses, the third hypothesis tested if emotion regulation would moderate the relationship between emotional perceptions of coeliac disease

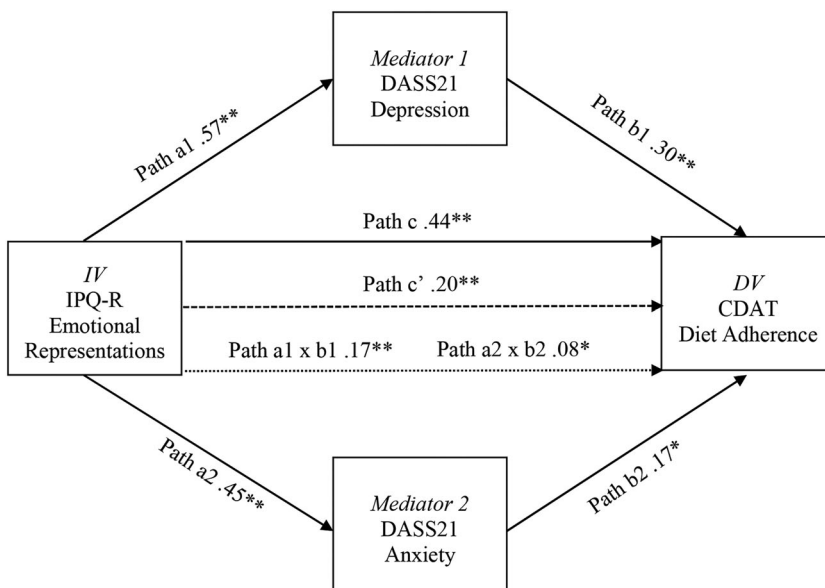


Figure 1. Standardised beta weights for the mediation pathways between emotional perceptions of coeliac disease and gluten-free diet adherence through depression and anxiety. \* $p < .05$ , \*\* $p < .01$ .

Table 4. Unstandardised (*B*) coefficients and standard errors (SE) for multiple parallel mediation analysis with emotional representations as predictor of gluten-free diet adherence.

Mediator	Gluten-free diet adherence		
	<i>B</i>	SE	BCa 95% CI
<i>Depression</i>			
<i>a</i> <sub>1</sub>	2.64**	.30	[2.06, 3.23]
<i>b</i> <sub>1</sub>	0.22**	.06	[.08, .37]
<i>a</i> <sub>1</sub> × <i>b</i> <sub>1</sub>	0.59**	.20	[.21, 1.00]
<i>Anxiety</i>			
<i>a</i> <sub>2</sub>	1.57**	.20	[1.14, 1.92]
<i>b</i> <sub>2</sub>	0.17*	.07	[.01, .34]
<i>a</i> <sub>2</sub> × <i>b</i> <sub>2</sub>	0.27**	.14	[.01, .53]
Total effect <i>c</i>	1.54**	.24	[1.05, 2.00]
Direct effect <i>c</i> '	0.68**	.27	[.16, 1.21]
Indirect effect <i>c</i> – <i>c</i> '	0.86**	.17	[.55, 1.22]

Note: BCa 95% CI = bias-corrected and accelerated 95% confidence interval.

\**p* < .05.

\*\**p* < .01.

and the negative emotional states of depression and also anxiety. A series of hierarchical multiple regressions were conducted, with the results detailed in Table 5. The first analysis set depression as the dependent variable, emotional representations as the independent variable and cognitive reappraisal as the moderating variable. In the first step, emotional representations and cognitive reappraisal both demonstrated a significant effect on depression  $F(2, 225) = 60.34, p < .01$ , collectively accounting for 35% of variance. The addition of the interaction term in step two indicated a

Table 5. Summary of hierarchical regression analysis for predicting depression.

	<i>B</i>	SE <i>B</i>	$\beta$	BCa 95% CI	<i>R</i> <sup>2</sup>	<i>F</i> change
Analysis 1 variables						
Step 1						
IPQ-R Emotional Representations	2.4	.28	.51**	[1.86, 2.93]	.35	60.34**
ERQ Cognitive Reappraisal	-0.76	.3	-.18*	[-1.33, -.19]		
Step 2						
IPQ-R Emotional Representations	2.36	.28	.5**	[1.83, 2.87]	.4	17.56**
ERQ Cognitive Reappraisal	-0.57	.27	-.14*	[-1.1, -.08]		
IPQ-R Emotional Representations × ERQ Cognitive Reappraisal	-0.76	.16	-.22**	[-1.08, -.44]		
Analysis 2 variables						
Step 1						
IPQ-R Emotional Representations	2.39	.28	.52**	[1.84, 2.92]	.36	63.08**
ERQ Expressive Suppression	0.68	.21	.19**	[.3, 1.03]		
Step 2						
IPQ-R Emotional Representations	2.32	.28	.51**	[1.81, 2.87]	.39	11.88**
ERQ Expressive Suppression	0.56	.19	.16**	[.2, .86]		
IPQ-R Emotional Representations × ERQ Expressive Suppression	0.59	.2	.18**	[.19, .95]		

Note: *N* = 233.

\**p* < .05.

\*\**p* < .01.

significant interaction effect between emotional representations and cognitive reappraisal  $F(3, 224) = 49.04, p < .01$ , accounting for a further 5% of variance in depression.

The second analysis set depression as the dependent variable, emotional representations as the independent variable and expressive suppression as the moderating variable. In the first step, emotional representations and expressive suppression both demonstrated a significant effect on depression  $F(2, 225) = 63.08, p < .01$ , collectively accounting for 36% of variance. The addition of the interaction term in step two indicated a significant interaction effect between emotional representations and expressive suppression  $F(3, 224) = 49.04, p < .01$ , accounting for a further 3% of variance in depression.

As both analyses were indicative of moderation, follow-up tests were conducted for both cognitive reappraisal and expressive suppression using PROCESS (Hayes, 2013). Simple slopes analysis via the Johnson–Neyman technique revealed that cognitive reappraisal had a significant effect on the relationship between emotional representations and depression commencing at the value of 1,  $t(232) = 7.62, p < .01, 95\% \text{ CI } [3.88, 6.59]$  increasing negatively until the value of 6.85,  $t(232) = 1.97, p < .05, 95\% \text{ CI } [.0, 1.54]$ . Thus, as the use of cognitive reappraisal increases, the relationship between emotional representations and depression decreases. Expressive suppression also demonstrated a significant effect on the relationship between emotional representations and depression commencing at the value of 1.06,  $t(232) = 1.86, p < .05, 95\% \text{ CI } [0, 1.99]$  increasing positively until the maximum value of 7  $t(232) = 5.38, p < .01, 95\% \text{ CI } [2.86, 6.18]$ . Conversely to cognitive reappraisal, as expressive suppression increases, the relationship between emotional representations and depression increases.

To test if emotion regulation would similarly moderate the relationship between emotional representations and anxiety, multiple hierarchical regression was employed, with the results detailed in Table 6. The first analysis set anxiety as the dependent variable, emotional representations as the independent variable and cognitive reappraisal as the moderating variable. For the

Table 6. Summary of hierarchical regression analysis for predicting anxiety.

	<i>B</i>	SE <i>B</i>	$\beta$	BS 95% CI	$R^2$	<i>F</i> change
Analysis 1 variables						
Step 1						
IPQ-R Emotional Representations	1.58	.21	.46**	[1.15, 2.03]		
ERQ Cognitive Reappraisal	0.15	.19	.05	[-.23, .54]	.2	28.24**
Step 2						
IPQ-R Emotional Representations	1.58	.21	.46**	[1.15, 2.01]		
ERQ Cognitive Reappraisal	0.15	.18	.05	[-.21, .53]		
IPQ-R Emotional Representations × ERQ Cognitive Reappraisal	-.02	.14	-.01	[-.29, .28]	.2	.01
Analysis 2 variables						
Step 1						
IPQ-R Emotional Representations	1.39	.2	.41**	[.99, 1.81]		
ERQ Expressive Suppression	0.36	.17	.14*	[.03, .69]	.22	31.55**
Step 2						
IPQ-R Emotional Representations	1.37	.2	.41**	[.96, 1.8]		
ERQ Expressive Suppression	0.33	.17	.13*	[-.02, .66]		
IPQ-R Emotional Representations × ERQ Expressive Suppression	0.17	.17	.07	[-.16, .47]	.22	1.35

Note:  $N = 233$ .  
 \* $p < .05$ .  
 \*\* $p < .01$ .

first step, emotional representations yet not cognitive reappraisal demonstrated a significant effect on anxiety  $F(3, 223) = 45.56, p < .01$ , accounting for 20% of variance. The addition of the interaction term in step two did not explain additional variance. The second analysis replaced expressive suppression with cognitive reappraisal as the moderating variable. In the first step, emotional representations and expressive suppression both demonstrated a significant effect on anxiety  $F(2, 225) = 60.34, p < .01$ , collectively accounting for 22% of variance. However, the addition of the interaction term in step two did not explain any additional variance. As neither analysis demonstrated evidence of moderation, follow-up tests were not conducted. Thus, the third hypothesis was conditionally supported as emotion regulation moderated the relationship between emotional perceptions of coeliac disease and depression, yet not anxiety.

## Discussion

The purpose of this study was to explore how gluten-free diet adherence varies for individuals with coeliac disease as a function of their emotional perceptions of their condition, their experience of negative emotional states and the emotion regulation strategies they employ. The first hypothesis predicted variance in gluten-free diet adherence through variables assumed to be proximal to gluten-free diet adherence: negative emotional states and emotional eating. Greater depression, anxiety and stress were associated with poorer diet adherence; however, stress was not an independent predictor and emotional eating was not associated with diet adherence. The second hypothesis aimed to build upon this finding by including the emotional perceptions individuals with coeliac disease form of their illness as a predictor of negative emotional states, and thus a distal predictor of gluten-free diet adherence. Results demonstrated that negative emotional perceptions were associated with more negative emotional states, and poorer gluten-free diet adherence both as a direct and indirect effect. The third hypothesis aimed to explain individual variance in the relationship between emotional perceptions and negative emotional states through differences in emotion regulation strategies. This demonstrated that emotion regulation moderates the relationship between emotional perceptions and depressive emotional states, but not between emotional perceptions and anxiety. In summary, negative emotional perceptions of coeliac disease are related to both negative emotional states and gluten-free diet adherence, and individual differences in two common emotion regulation strategies may partly explain variance in depressive but not anxious emotional states.

### *Proximal predictors of gluten-free diet adherence*

Previous research into psychological factors associated with coeliac disease has principally focused on distal predictors of variance in gluten-free diet adherence including individuals' beliefs regarding coeliac disease and the gluten-free diet and impact on health-related quality of life (Leffler et al., 2008; Zarkadas et al., 2013). However, the variables most consistently and strongly identified as impacting on diet adherence relate to negative emotions and emotion disorders, with depression and anxiety featuring prominently (Smith & Gerdes, 2012). In the present study, the findings were consistent with previous research showing a strong relationship between depressive and anxious emotional states and diet adherence (Ludvigsson et al., 2007). This suggests that coeliac disease is comparable to other chronic conditions such as diabetes and cancer where research has demonstrated poorer treatment adherence as a function of emotion disorders (DiMatteo, Haskard-Zolnierok, & Martin, 2012).

This study was the first to explore if emotional eating is associated with poorer gluten-free diet adherence. However, no subscale of the EES reported a significant correlation with gluten-free diet adherence. Though this is partly attributable to the Bonferroni adjustment employed, the

strength of correlations were also weak, suggesting emotional eating is of limited statistical or practical significance to gluten-free diet adherence. There is some evidence that individuals with coeliac disease report social situations as the most likely to produce negative emotions (Sverker, Hensing, & Hallert, 2005). Intentional non-adherence to the gluten-free diet is most common in social settings, as individuals with coeliac disease may feel compelled to eat food that contains gluten in order to fit in, and avoid negative emotions associated with feeling isolated (Lee, Ng, Diamond, Ciaccio, & Green, 2012). If an individual with coeliac disease holds strong beliefs regarding the seriousness of their condition and the harmful consequences of non-adherence, yet ingests food containing gluten to avoid negative emotional states, this appears comparable to emotional eating. However, the EES may lack sensitivity to this mechanism in the context of coeliac disease as it measures the strength of urge to eat in response to negative emotional states, rather than the amount or types of foods that are eaten. Development of a scale measuring intentional non-adherence to the gluten-free diet in response to negative emotional states associated with coeliac disease may facilitate further investigation.

### ***Distal predictors of gluten-free diet adherence***

An important part of adjustment to life with chronic illness is coming to a position of acceptance regarding the nature of the condition (de Ridder, Geenen, Kuijer, & van Middendorp, 2008). This process is complex for individuals with coeliac disease, as they face novel challenges in common situations that may produce negative emotional states, and thus undermine the process of adjustment (Zarkadas et al., 2013). Remarkably, the first study exploring the relationship between illness perceptions, psychological well-being and diet adherence for individuals with coeliac disease was conducted only recently by Ford et al. (2012). Like the present study, illness perceptions were measured using the IPQ-R; however, it employed different measures of psychological well-being and diet adherence. A key strength of the present study is that it employed a validated measure of gluten-free diet adherence, while otherwise replicating the findings of Ford et al. (2012) regarding the relationship between negative illness perceptions and negative emotional states. In particular, the use of a continuous measure of gluten-free diet adherence provides support for variable gluten-free diet adherence as a function of illness perceptions. This indicates that individuals with coeliac disease who hold negative attitudes and beliefs towards their condition may be at greater risk of poor dietary adherence.

The findings of the present study suggest that negative emotional states experienced by individuals with coeliac disease may be partly attributable to the emotional perceptions they form of their condition. However, given the cross-sectional nature of this study, the experience of negative emotional states may also lead individuals with coeliac disease to form negative emotional perceptions of their condition. While the present study cannot definitively establish the direction of causality, it is reasonable to suggest that both processes may occur, reflecting a bi-directional relationship. DiMatteo et al. (2012) noted if individuals with chronic illness hold negative attitudes towards their condition it can reduce their motivation to adhere to treatment. Consistent with this, the partial mediation effect demonstrated in the present study suggests emotional perceptions of coeliac disease are important as a predictor of negative emotional states, as an indirect predictor of diet adherence through them and also as a direct predictor of diet adherence.

### ***Emotion regulation as a moderating mechanism***

Studies of emotion regulation have consistently demonstrated that increased use of expressive suppression and reduced use of cognitive reappraisal are associated with the experience of more negative emotional states (Aldao et al., 2010). The moderating effect demonstrated by

these two emotion regulation strategies on the relationship between emotional perceptions of coeliac disease and depressive emotional states is consistent with these findings. The results of the analyses associated with previous hypotheses have demonstrated that negative emotional perceptions and depressive emotional states are both associated with poorer diet adherence. Thus, an intervention for individuals with coeliac disease to increase their use of cognitive reappraisal and reduce their use of expressive suppression presents as a logical means of reducing negative emotions that may undermine motivation to maintain treatment adherence. Furthermore, as these two emotion regulation strategies are not correlated to one another, they represent two separate targets for intervention (Moore, Zoellner, & Mollenholt, 2008).

By contrast to depression, neither expressive suppression nor cognitive reappraisal moderated the relationship between emotional perceptions and anxiety, suggesting a different mechanism accounts for this relationship. Anxiety associated with coeliac disease largely pertains to the demands of vigilance to avoid gluten ingestion, and fears of becoming contaminated by gluten (Sverker et al., 2005). However, most individuals with coeliac disease demonstrate reduced anxiety over time as they become more comfortable with managing the gluten-free diet (Addolorato et al., 2004). Enduring and excessive fear and anxiety regarding the gluten-free diet may indicate that an individual needs more information to understand their condition or lacks confidence in their strategies to manage the associated practical challenges (Black & Orfila, 2011; DiMatteo et al., 2012). As emotion regulation appears less relevant for addressing these practical challenges, it stands to reason that task-oriented coping strategies may moderate the relationship between emotional perceptions and anxiety; however, this requires further investigation.

### ***Implications for interventions***

Presently there is extremely limited research into interventions to improve dietary adherence for individuals with coeliac disease. This may be partly attributable to a lack of understanding of the underlying mechanisms that are responsible for variance in outcomes. Furthermore, most intervention studies are limited by the use of non-validated measures of gluten-free diet adherence (e.g. Addolorato et al., 2004) or including no measure of gluten-free diet adherence (Jacobsson, Friedrichsen, Göransson, & Hallert, 2012; Meyer, Fasshauer, Nebel, & Paschke, 2004). The most comprehensive intervention conducted thus far is a recent study conducted by Sainsbury et al. (2013) which employed a series of six online modules addressing behaviour change techniques to modify attitudes, self-efficacy and motivation, as well as cognitive behavioural strategies. A key strength of this study was that over the course of the intervention, the modules targeted aspects of coeliac disease that pertain to all three factors of the information–motivation–strategy model of treatment adherence (DiMatteo et al., 2012). This model posits that patients require information regarding their condition and treatment, motivation to adhere to treatment and strategies to manage challenges (DiMatteo et al., 2012). For example, the first module covered information (detailing coeliac disease and the gluten-free diet) motivation (detailing the health benefits of diet adherence) and strategies (detailing how to read labels and avoid cross-contamination) (Sainsbury et al., 2013). Notable challenges such as social settings were addressed in later modules, with the third module explicitly addressing how to manage the ambivalence presented by not wanting to stand out against the need to ensure one's dietary needs are met. The results of the study were promising, with participants completing the intervention reporting significantly greater diet adherence compared to wait-listed controls, with these gains maintained at three-month follow-up. Notably, improved diet adherence was not attributable to increased knowledge of the gluten-free diet, indicating the active component of treatment related to factors such as motivation, attitudes towards coeliac disease and self-efficacy beliefs.

One specific element of this intervention which is comparable to the focus of the present study was the fourth module, which focused on coping with negative thoughts and emotions regarding the gluten-free diet by increasing participants' use of cognitive reframing (Sainsbury et al., 2013): a coping technique which is comparable to cognitive reappraisal (Aldao et al., 2010). While the results of the present study suggest this would be efficacious for reducing participants' negative perceptions of coeliac disease and experience of depressive emotional states, it is unclear if the study also aimed to reduce the use of maladaptive strategies, such as expressive suppression. Both previous research and the findings of the present study suggest that adaptive and maladaptive strategies are not necessarily mutually exclusive, and thus both should be targeted, for increased and decreased use respectively (Moore et al., 2008).

While coping strategies are an important part of adjustment to coeliac disease, emotion regulation represents a further, specific target for intervention that could help individuals with coeliac disease adjust to life with their condition, and improve their gluten-free diet adherence. The lived experience of coeliac disease is one associated with a range of challenges, and the difficulties individuals experience can give rise to a range of negative emotions (Zarkadas et al., 2013). However, for many individuals with coeliac disease, negative perceptions and emotions associated with their condition decrease over time, and adherence to the gluten-free diet becomes a routine element of life (Zarkadas et al., 2013). Alongside a strong understanding of the condition and its treatment, adaptive coping strategies to manage practical challenges and a strong belief in the importance of maintaining adherence, adaptive emotion regulation may contribute to greater adherence, by reducing negative emotions that can undermine an individual's motivation to maintain adherence.

To this end, it may also be necessary to re-evaluate the services individuals with coeliac disease are referred to after being diagnosed. Studies consistently conclude that individuals newly diagnosed with coeliac disease may benefit from receiving counselling to assist the process of adjustment. However, the most common form of referral is to the services of a nutritionist to provide education on the gluten-free diet (Zarkadas et al., 2006). While the gluten-free diet is complex and challenging, this form of intervention only addresses the information component of treatment adherence (DiMatteo et al., 2012). The results of the present study indicate that individuals experiencing difficulty adjusting to life with coeliac disease may benefit from psychological intervention targeting emotion regulation strategies, to address the emotional challenges that may undermine motivation to maintain dietary adherence. This should be complemented by the development of adaptive coping strategies to deal with the practical challenges of the gluten-free diet.

### **Limitations**

The limitations of this study pertain to the characteristics of the sample and the correlational research design. Participation was not only through self-selection but also restricted to members of coeliac associations. As this is a population associated with greater gluten-free diet adherence, this may have limited the response of individuals with poor diet adherence (Leffler et al., 2008). However, while the low mean on the CDAT suggests the sample was strongly adherent in general, 40% of participants reported a score that did not fall in the excellent to very good range. Recruiting a more broadly representative sample remains an enduring challenge for studies of this population. One method that could improve this is to identify individuals newly diagnosed with coeliac disease through recruitment by their treating physician. This would require significantly more resources and the involvement of hospital staff compared to the convenience of sampling from support organisations; however, it would improve the representativeness of the sample. A further limitation of the present sample is that it demonstrated a strong

female bias in gender distribution. Though previous research has demonstrated that women with coeliac disease consistently report lower quality of life relative to men, there is limited support for gender differences in dietary adherence (Hall et al., 2009). Nonetheless, the generalisability of this study to men with coeliac disease must remain tentative.

An enduring conundrum regarding research into factors associated with gluten-free diet adherence in coeliac disease lies in establishing causality. While the present study presents a cogent model for predicting variance in the emotional experience of coeliac disease and gluten-free diet adherence, the correlational design limits the capacity to establish causality. The dynamic interplay of psychological and gastrointestinal symptoms associated with treatment non-adherence suggests these relationships may be most meaningfully interpreted as bi-directional. For example, it could also be the case that the experience of depression/anxiety influences an individual's perceptions of their illness rather than that an individual's perceptions of illness influences experiences of depression or anxiety. The directions of these associations need to be further tested using prospective or interventional research designs. In addition, in the context of the present study, structural equation modelling may have provided a greater capacity to explore the relationships between variables in both directions. Unfortunately, the present study lacked sufficient sample size to make this method of analysis viable. Future research should thus focus on recruiting more broadly, to both achieve a higher number of participants to facilitate more complex analyses and a more representative sample. However, it will remain important to ensure that participants are all genuinely diagnosed with coeliac disease to ensure the validity of findings.

## Conclusions

Strict adherence to a gluten-free diet is essential to the treatment of coeliac disease. However, despite the critical importance of gluten-free diet adherence for individuals with coeliac disease, focussing solely on the aspect of treatment risks overlooking the lived experience of the condition and the difficulties this can often entail. Individuals with coeliac disease face challenges in a range of common situations that prior to diagnosis would be taken for granted, and difficulties negotiating these challenges can lead to negative perceptions of their condition. This study demonstrates that negative emotional perceptions of coeliac disease are associated with negative emotional states of depression and anxiety, which are in turn associated with poorer gluten-free diet adherence. In addition, how individuals regulate their emotions appears to moderate the relationship between emotional perceptions and depression, but not the relationship between emotional perceptions and anxiety. Future interventions to improve gluten-free diet adherence for individuals with coeliac disease and depressive symptoms may benefit by including a focus on emotion regulation, aiming to increase participants' use of adaptive strategies such as cognitive reappraisal, and reduce their use of maladaptive strategies such as expressive suppression. Additionally, future studies should explore further psychological mechanisms that may moderate the relationship between emotional perceptions of coeliac disease and anxiety to inform further targets for intervention.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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