The prevalence and predictors of disordered eating in women with coeliac disease

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1 **The Prevalence and Predictors of Disordered Eating in Women with Coeliac Disease**

2 **Purpose:** The need for dietary management in coeliac disease may lead to the development

3 of disordered eating. This study examined the prevalence of disordered eating and factors

4 predicting disordered eating in women with coeliac disease, compared with other dietary-

5 controlled conditions.

6 **Methods:** A cross-sectional, online survey assessing psychological well-being, disordered

7 eating behaviours (Eating Attitudes Test 26 (EAT-26); Binge Eating Scale (BES)) was

8 distributed using online forums, to those with coeliac disease (N=157), inflammatory bowel

9 disease (N=116), type two diabetes (N=88) and healthy controls (N=142). Hierarchical

10 regressions were conducted to explore and compare the predictors of EAT-26 and BES

11 scores across all groups. Within the coeliac disease group, a cluster analysis was conducted

12 to examine types of disordered eating.

13 **Results:** Higher EAT-26 scores were found in those with coeliac disease and inflammatory

14 bowel disease compared with healthy controls and type two diabetes; participants with a

15 chronic health condition had higher BES than healthy control participants. The factors

16 associated with EAT-26 scores differed across the dietary-controlled health conditions, with

17 dietary management being important for those with coeliac disease. Psychological distress

18 was associated with binge-eating behaviour across all groups. Cluster analyses found two

19 types of disordered eating in coeliac disease; a binge eating type and a restrictive type.

20 **Conclusions:** Disordered eating attitudes and behaviours are more prevalent in participants

21 with chronic health conditions relative to healthy controls. The presence of binge eating

22 behaviours in coeliac disease may be related to non-coeliac disease specific factors such as

23   the distress associated with dietary-controlled illness. EAT-26 scores in coeliac disease are

24   associated with disease specific factors, unique to following the gluten-free diet. These

25   factors are important for identifying and supporting those with coeliac disease and

26   disordered eating.

27   **Introduction**

28   Coeliac disease is an autoimmune condition characterised by damage to the small intestine

29   following the ingestion of the protein gluten (NICE, 2015). The condition is managed by a

30   life-long gluten-free diet, requiring the exclusion of wheat, rye, barley and sometimes oats

31   (GFD; Di Sabatino & Corazza, 2009; NICE, 2015). The GFD is the only treatment for coeliac

32   disease; it is effective in reversing intestinal damage and is necessary to avoid complications

33   such as osteoporosis and gastrointestinal cancers (Valdimarsson, Toss, Ross, Lofman &

34   Strom, 1994). However, management of a dietary-controlled health condition, such as

35   coeliac disease, creates pressures that may harm one's relationship with food and have

36   been associated with an increased prevalence of disordered eating attitudes and behaviours

37   (Quick, Byrd-Bredbenner & Neumark-Sztainer, 2013). Disordered eating describes a

38   spectrum of eating behaviours, which can range from clinical eating disorders to skipping

39   meals, binge eating, restricting certain food types or fasting (Grilo, 2006).

40   The risk of developing disordered eating behaviours increases with psychological distress,

41   which frequently occurs in a range of chronic health conditions (Quick, Byrd-Bredbenner &

42   Neumark-Sztainer, 2013). Furthermore there is an increased risk of developing disordered

43   eating in individuals diagnosed with a chronic health condition during puberty, when their

44   body shape is already changing (Smith, Latchford, Hall & Dickson, 2008). These factors are

45   common across all chronic health conditions. For individuals with coeliac disease, the need

46   to monitor the gluten content of food, combined with fears about the effectiveness of their

47   GFD and concerns about the prevention of gastrointestinal symptoms, may additionally

48   contribute to increased risk of disordered eating (Arigo, Anskis & Smyth, 2012; Karwautz et

49   al., 2008).

50   To date, there have been few studies of the prevalence of disordered eating in coeliac

51   disease. The results of two cross-sectional surveys suggest that between 22% and 29% of

52   individuals with coeliac disease score above the clinical cut-offs on measures assessing

53   Anorexia and Bulimia Nervosa (Arigo, Anskis & Smyth, 2012; Karwautz et al., 2008). Poor

54   dietary management, psychological distress and physical symptoms related to coeliac

55   disease were frequent in those with disordered eating attitudes and behaviours (Arigo,

56   Anskis & Smyth, 2012; Karwautz et al., 2008; Wagner et al., 2015), however, the absence of

57   a control group means that it is impossible to determine if the disordered eating is related

58   to the coeliac diagnosis or if it results from the nonspecific burden of a chronic health

59   condition. These factors are essential to understand the mechanisms behind disordered

60   eating in coeliac disease.

61   Case studies offer an understanding of the complex relationship between disordered eating

62   and coeliac disease (Leffler et al., 2007; Ricca et al., 2000; Yucel, Ozbey, Demir, Polat &

63   Yager, 2006). Yucel et al., (2006) suggested that the long-term dietary restraint, necessary in

64   coeliac disease, might contribute to disordered eating attitudes and behaviours whereas

65   Leffler et al., (2007) suggested that problems with maintaining the GFD may be associated

66   with disordered eating attitudes and behaviours. However, to fully understand the extent of

67   this problem and to understand the mechanisms behind disordered eating in coeliac

68   disease, larger sample sizes are required.

69   Prior to diagnosis, some individuals with coeliac disease experience severe gastrointestinal

70   symptoms, which may contribute to the development of disordered eating attitudes and

71   behaviours (Arigo, Anskis & Smyth, 2012; Satherley, Howard & Higgs, 2014). Although most

72   individuals will experience clinical remission on the GFD, some will continue to experience

73   gastrointestinal symptoms, which may result from refractory coeliac disease where the

74   individual is not responsive to the GFD (Daum, Cellier & Mulder, 2005). Alternatively,

75   Midhagen and Hallert (2003) suggested that the nutritional composition of the GFD might

76   be responsible for persistent gastrointestinal symptoms, whereas Nachman et al, (2010)

77   suggested this results from poor dietary management. Untreated gastrointestinal symptoms

78   may trigger an aversion to food, which can influence disordered eating attitudes and

79   behaviours (Berstein & Borson, 1986). Gastrointestinal symptoms have been associated with

80   food aversion in a variety of chronic health conditions including cancer (Coa et al., 2015),

81   autism (Nadon, Feldman, Dunn & Gisel, 2011) and gastroparesis (a condition characterised

82   by delayed gastric emptying; NIDDK Gastroparesis Clinical Research Consortium). However,

83   the role of gastrointestinal symptoms in coeliac disease and the development of disordered

84   eating has received little attention.

85   Gastrointestinal symptoms and dietary management are closely associated via a

86   bidirectional relationship, where good dietary management is associated with fewer and/or

87   less severe gastrointestinal symptoms, and poor dietary management is associated with

88   increased/more severe gastrointestinal symptoms (Murray, Eason, Clearman & Mitros,

89   2003). The associations between gastrointestinal symptoms and disordered eating attitudes

90   and behaviours may be explained by the deliberate consumption of gluten in those

91   diagnosed with coeliac disease; Leffler et al., (2007) described cases in which individuals

92   would consume gluten in order to encourage gastrointestinal symptoms to promote weight

93   loss. However, this phenomenon has only been described in case studies and it is not clear

94   how these findings will generalise to larger samples. Misuse of dietary regimens has been

95   reported in diabetes (Young-Hyman & Davis, 2010) and there is potential for this to occur in

96   coeliac disease.

97   Satherley, Howard and Higgs' (2014) developed a two-path, theoretical model of disordered

98   eating in gastrointestinal disease, suggesting disordered eating differs depending on beliefs

99   about the disease and dietary management. The first pathway describes individuals who

100 experience extreme anxiety around unfamiliar foods and/or overestimate the negative

101 consequences associated with their condition. These individuals may fear food prepared

102 outside of their control, and cope with this by eating a limited variety of foods. The second

103 pathway describes individuals who experience weight gain after commencing their

104 prescribed dietary regimen and may use techniques to reverse this weight gain. Not all

105 individuals with coeliac disease will experience weight gain after commencing the GFD;

106 however, good dietary management has been associated with a post-diagnosis increase in

107 weight (Kabbani et al., 2012). Prior to coeliac diagnosis, individuals may present as

108 underweight, meaning that increased weight is an indicator of recovery of the intestine,

109 however, for some individuals this weight change may be negatively interpreted and trigger

110 disordered eating. These individuals may recognise the association between weight gain and

111 the GFD and aim to reduce their weight gain through poor dietary management (Leffler et

112 al., 2007). The model proposed by Satherley, Howard and Higgs (2014) has the potential to

113 help us to interpret and understand the relationships between disordered eating and coeliac

114 disease by testing specific hypotheses.

115   This study is the first to apply Satherley, Howard and Higgs' (2014) model of disordered

116   eating in gastrointestinal disease to coeliac disease. Given the limitations of prior studies,

117   this study assessed the prevalence, predictors and types of disordered eating in coeliac

118   disease compared to other dietary-controlled conditions. Individuals with coeliac disease,

119   who follow a strict GFD, were compared to those with inflammatory bowel disease and type

120   two diabetes (both of which have dietary components to their management) and healthy

121   controls. Dietary management in inflammatory bowel disease and type two diabetes is

122   unlike that for coeliac disease as it is less strict and regimented when compared to the GFD

123   and other medical interventions may be required, which is generally not the case in coeliac

124   disease. Individuals with inflammatory bowel disease experience gastrointestinal symptoms

125   associated with the ingestion of certain restricted foods, which can differ between patients,

126   but will avoid these trigger foods during a flare-up and may use medical or surgical

127   approaches to manage flare-ups (NICE, 2015); those with type two diabetes do not have

128   gastrointestinal symptoms as a feature of their diagnosis and do not avoid particular food

129   types, but will follow a balanced diet with an emphasis on consuming high fibre and low-

130   glycaemic index foods. This may be combined with blood glucose monitoring and insulin

131   injections (NICE, 2009). These control groups allowed us to explore the role of nonspecific

132   factors common to *all* dietary-controlled conditions (years with condition, psychological

133   distress), factors common to gastrointestinal disease (gastrointestinal symptoms) and

134   factors *unique* to the coeliac disease diagnosis (GFD management). The most common types

135   of disordered eating patterns related to Binge Eating, Anorexia Nervosa and Bulimia

136   Nervosa, were assessed (NHS, 2015).

137   We anticipated the following: 1) individuals with dietary-controlled conditions (coeliac

138   disease, inflammatory bowel disease and type two diabetes) would score greater on

139   disordered eating measures than healthy controls; 2) psychological distress, a nonspecific

140   factor, would be associated with disordered eating across all groups; 3) in those with

141   gastrointestinal disorders (inflammatory bowel disease and coeliac disease), factors unique

142   to these conditions (gastrointestinal symptoms) would explain additional variance in

143   disordered eating scores; 4) additional variance in disordered eating would be explained by

144   dietary-management in coeliac disease and 5) based on the theoretical model of disordered

145   eating (Satherley, Howard & Higgs, 2014), we expected two types of disordered eating to be

146   present in coeliac disease. One group of disordered eaters was expected to show good

147   dietary self-management and few gastrointestinal symptoms, associated with increased

148   anxiety around new foods. The second group was expected to have poor dietary

149   management and experience increased gastrointestinal symptoms, associated with gluten

150   ingestion.

151   **Methods**

152   The cross-sectional survey was conducted between June and December 2014. Individuals

153   living in the United Kingdom, aged between 18-69 years and who self-reported a biopsy-

154   confirmed diagnosis of coeliac disease, type two diabetes or inflammatory bowel disease,

155   were eligible to participate. Healthy controls with no reported health conditions or food

156   allergies were also recruited. Participants were excluded if 1) they reported having a dietary-

157   controlled condition other than coeliac disease, type two diabetes or inflammatory bowel

158   disease (e.g. cystic fibrosis, type I diabetes) and 2) if they had any other food allergies.

159   Individuals with type two diabetes were required to be following a prescribed dietary

160   regimen as a part of their treatment programme and individuals with coeliac disease were

161   required to self-report a biopsy confirmed diagnosis.

162   Participants were recruited through adverts on online support forums (e.g. Facebook) and

163   through Coeliac UK, the main charity supporting people with coeliac disease in the UK.

164   Interested individuals were directed to an online survey to complete the following

165   questionnaires. Men were recruited but only 14 took part, so this data was not analysed.

166   *Measures*

167   *Demographic and General Health Information*

168   For participants with type two diabetes, inflammatory bowel disease and coeliac disease,

169   information was gathered on demographics, information relating to diagnosis (method of

170   diagnosis, date of diagnosis, dietary management) and health status (allergies, medication).

171   For individuals with coeliac disease, diagnostic method was assessed on a 3 item scale

172   including 1) biopsy provided diagnosis; 2) blood test; 3) I diagnosed myself based on dietary

173   changes, and dietary self-management was rated on a 5-point Likert scale, in response to

174   the question "*In general, how strictly do you maintain a gluten free diet?*" *ranging from '1)*

175   *All of the time'; 2) 'Most of the time'; 3) 'Some of the time'; 4) 'Now and then'; 5) 'Not at all'*

176   (Ford, Howard & Oyebode, 2012). For those with inflammatory bowel disease and type two

177   diabetes dietary self-management was also rated on a 5-point Likert scale but the item was

178   phrased "*In general, how strictly do you maintain your prescribe dietary-regimen*?"

179   The presence of gastrointestinal symptoms was assessed using the Illness Perception

180   Questionnaire Revised (IPQ-R; Moss-Morris et al., 2002). Participants are asked to rate

181   whether they have experienced a symptom since their diagnosis (yes/no). A total

182   gastrointestinal symptom was calculated by adding up the total of gastrointestinal

183   symptoms (nausea, weight loss, upset stomach, abdominal pain, bloating, excessive wind,

184   constipation, indigestion) experienced in the last four weeks, providing a score between 0

185   and 8, with 8 indicating a greater number of gastrointestinal symptoms.

186   The IPQ-R also measures an individual's perceptions of illness, the cause of their illness and

187   their personal views of the illness. Only those with coeliac disease only completed this

188   questionnaire but the results are not reported here, as they are not directly relevant to the

189   aims of this study.

190   *Psychological Distress*

191   The Depression, Anxiety, Stress Scale 21 (DASS-21; Lovibond & Lovibond, 1995) assesses

192   levels of depression, anxiety and stress. The items consist of statements referring to the

193   past week, rated on a 4-point scale. Scores on each subscale range from 0 to 42 with higher

194   scores indicating greater distress. The DASS-21 has strong psychometric properties (Brown

195   et al., 1997).

196   *Food Anxiety*

197   The Food Neophobia Scale (FNS; Pliner & Hobden, 1992) is a ten-item scale that measures

198   willingness to try new foods. Scores above 35 are considered high, with lower scores

199   indicating greater willingness to try unfamiliar foods (Pliner & Hobden, 1992). The scale has

200   been validated numerous times and is the standard measure of food neophobia, with good

201   reliability and validaty (Miselman, King & Gilette, 2010). At present no appropriate

202   measures of food anxiety have been developed. The FNS was chosen as the best available

203   tool to measure anxiety around new foods.

204   *Disordered Eating*

205   Two questionnaires were used to target the differing attitudes and behaviours surrounding

206   disordered eating, to account for any overlap in disordered eating categories (Eddy et al.,

207   2008; Swanson et al., 2011).

208   The Eating Attitudes Test (EAT-26; Garner & Garfinkel, 1979) is used to assess eating

209   disorder risk by measuring the attitudes and behaviours suggestive of Anorexia and Bulimia

210   Nervosa. It has been used to identify eating disturbances in non-clinical samples. It is used

211   as a screening tool for eating disorders, but is not a diagnostic tool. The items are scored on

212   a 3-point scale, with a score of 20 or above requiring further evaluation. The tool has strong

213   psychometric properties (Garner et al., 1982) and has been used in populations with dietary-

214   controlled conditions (Guthrie, Creed & Whorwell, 1990) Confirmatory factor analysis found

215   poor support for Garner et al.'s (1982) three-factor model (RCFI=.889, RMSEA=.075),

216   strongest support was found for a one factor model (RCFI=.922, RMSEA=.066). Therefore,

217   total EAT-26 scores were used throughout the analysis and subscales were not explored.

218   The Binge Eating Scale (BES; Gormally et al., 1982) assesses the behavioural aspects of binge

219   eating and the thoughts and feelings associated with these behaviours. The BES is a

220   screening tool to help identify individuals who may be at risk for binge eating behaviours.

221   Scores on the BES range from 0-46, with scores above 17 indicating moderate bingeing and

222   scores greater than 27 indicating severe binging. The BES has been validated in both obese

223   and non-obese population and used in those with gastrointestinal disorders (Duarte, Pinto-

224   Gouveia & Ferreira, 2015; Passananti et al., 2013; Timmerman, 1999).

225

226   *Ethical Approval*

227   Ethical approval was granted by the Psychology Research Ethics Committee, University of

228   Birmingham.

229   *Statistical Analysis*

230   Data was analysed using the Statistics for the Social Sciences (SPSS) version 22.0. 69 coeliac

231   disease participants were excluded across the groups due to the absence of a biopsy-proven

232   diagnosis. Overall, 77 individuals were removed from the coeliac disease group, 27 from

233   type two diabetes and 9 from inflammatory bowel disease and 4 from health controls,

234   providing 503 participants for analysis.

235   To assess the predictors of disordered eating, regression analyses were conducted to

236   examine the relationships between disease specific factors, disease non-specific factors and

237   disordered eating scores and to compare these amongst the different diagnostic categories.

238   Correlations were run between BES and EAT-26 scores and all other variables to select

239   covariates for the regression models. The covariates and nonspecific predictors were added

240   into stage one of the hierarchical regression, followed by disease specific predictors (dietary

241   management, gastrointestinal symptoms). All variables were centered before being entered

242   into the regression models. Bonferroni corrections were used to control for multiple

243   comparisons and reduce the chance of type one errors (Armstrong, 2014).

244   The fit of the model across the groups was assessed using three stages: 1) does the

245   predictor set work better for coeliac disease than other groups; 2) are the models

246   substitutable and 3) are the regression weights across the groups different. 1) Fishers Z test

247   was used to compare the R^2 values from each of the groups regression models. A significant

248   p-value (<.05) would indicate a difference in model fit across the groups. 2) Differences in

249   model structure across the diagnostic groups were explored using a cross validation

250   technique (Palmer & O'Connell, 2009). The regression model from each group was applied

251   to every other group (e.g. the coeliac disease regression model was applied to all other

252   diagnostic groups) to create both a "direct" and a "crossed" model. The resulting crossed R^2

253   and direct R^2 were compared using Hotelling's t-test, a significant p-value (<.05) indicates a

254   difference in model structure across the groups, which requires further investigation. 3) To

255   examine the individual predictors within the models, regression weights across the groups

256   were compared.

257   To investigate the types of eating behaviours, a two-step cluster analysis was performed on

258   the coeliac disease sample. Three theoretical groups were hypothesised to come out of the

259   analysis (two disordered and a healthy type) so specified three groups to emerge from the

260   analysis. Years with diagnosis, psychological distress, disordered eating scores, Food

261   Neophobia scores, dietary-management and gastrointestinal symptoms were entered into

262   the analysis. Variables with a predictor importance less than 0.2 were subsequently

263   removed from the analysis. The average silhouette measure of cohesion and separation

264   (ranging from -1 to +1) was used to determine the goodness of model fit. A silhouette

265   measure <0.2 is considered poor, between 0.2 and 0.5 is considered a fair solution and >0.5

266   is considered a good solution (Mooi & Sarstedt, 2011).

267   **Results**

268   Overall, 72.8% of participants identified as White British, 18.6% as White Other, 2% as Asian,

269   1% as Black and 2.8% as Mixed Background. Table 1 displays the mean age, Body Mass Index

270   (BMI) and years since diagnosis across the groups. The type two diabetes group were older

271 and had a higher BMI when compared to other diagnostic groups. There were no other

272 differences between the groups. The BMI, ethnicity and years with diagnosis for each

273 condition were similar to previous samples; however, across all groups our samples were

274 younger than previous reports (Hauser et al., 2010; Koro, Bowlin, Bourgeois & Fedder, 2004;

275 Wada et al., 2015).

276 68.5% of participants with coeliac disease reported that they followed their GFD "all the

277 time". Of the remaining 31.5%, 9.4% were completely non-adherent and 22.1% were

278 partially adherent to the GFD

279 Table 1

280 *Demographic Information (Age, Body Mass Index, Years with Condition) Displayed as Means*

281 *and Standard Deviations. Ethnicity Displayed as Number and Percentage.*

	Coeliac Disease (n=157)	Inflammatory Bowel Disease (n=116)	Type Two Diabetes (n=88)	Healthy Controls (n=142)	Group Differences
Age (years)	38 (13.4)	36 (11.98)	47 (12.83)	33 (13.72)	T2D > CD, IBD, HC
Body Mass Index	22.91 (3.83)	23.05 (4.91)	29.13 (3.63)	22.39 (4.75)	T2D > CD, IBD, HC
Years since Diagnosis	9 (10.25)	8 (7.62)	9 (7.29)	-	CD= IBD= T2D
Ethnicity (White)	150 (95.5)	108 (93.1)	84 (95.5)	133 (93.0)	CD= IBD= T2D= HC
Ethnicity (Non-White)	7 (4.5)	8 (6.9)	4 (4.5)	10 (7.0)	CD= IBD= T2D= HC

282   CD: Coeliac disease; T2D: Type Two Diabetes; IBD: Inflammatory Bowel Disease; HC: Healthy

283   Controls. Standard deviations are displayed in brackets (for ethnicity, percentage is

284   displayed in brackets).

285   *Prevalence of Disordered Eating in Coeliac Disease compared to Controls*

286   Table two displays the proportion of participants scoring above the clinical cut-off for the

287   EAT-26 and the BES and the mean total scores for each group. The Kruskal Wallis tests found

288   significant differences in mean EAT-26 scores across the diagnostic groups ($H(3)=31.84$,

289    $p<.001$). EAT-26 scores were higher in those with coeliac disease than healthy controls

290   ($U=5312.5$, $p=.001$) and those with coeliac disease scored higher than those with type two

291   diabetes ($U=2532$, $p=.001$). There was a significant difference in BES scores across the

292   diagnostic groups ($H(3)=82.41$, $p<.001$). Those with coeliac disease had higher BES scores

293   than healthy controls ($U=3947$, $p<.001$) but scored lower than those with type two diabetes

294   ($U=2268$, $p=.001$).

295   Table 2

296   *Mean Scores and Percentage scoring above the clinical cut-offs for measures of disordered eating*

Measure	Coeliac Disease (n=157)	Type Two Diabetes (n=88)	Inflammatory Bowel Disease (n=116)	Healthy Controls (n=142)	Group Differences
Eating Attitudes Test (>20)	11.1 (15.7%)	7.4 (8.8%)	12.8 (20%)	7.7 (3.8%)	CD > T2D, HC; IBD > T2D, HC
Binge Eating Scale (>17)	11.2 (19.4%)	13.6 (25%)	9.9 (22.2%)	3.9 (2.3%)	CD, T2D, IBD > HC

297   CD: Coeliac disease; T2D: Type Two Diabetes; IBD: Inflammatory Bowel Disease; HC: Healthy Controls.

298   The number in brackets represents the percentage of participants scoring above the pre-determined clinical cut-offs for the Binge Eating Scale

299   and Eating Attitudes Test-26. EAT-26 and BES scores were compared across all groups (p<.05; see group differences column).

300   *Predictors of Disordered Eating*

301   Strong associations (p<.008) were found for scores on the EAT-26 and BES, and measures of

302   psychological distress, as well as age, BMI, symptoms and GFD management. These factors

303   were added as covariates. Based on the significant relationships with disordered eating and

304   between the subscales, total DASS-21 scores were entered into step one of the regression

305   model. Years with condition, BMI and age were also added. This model accounted for 23.1%

306   of the variance in EAT-26 scores (F=(4, 90)=8.36, p<.001; see Table 3) with distress having a

307   significant positive regression weight.

308   The disease specific variables were entered in step two (dietary-management and

309   gastrointestinal symptoms). For the coeliac disease group, when predicting EAT-26 score,

310   this model accounted for 54.3% of the variance in EAT-26 scores (F=(6, 90)=20.42, p<.001;

311   see Table 3) with dietary-management and gastrointestinal symptoms having significant

312   positive regression weights. Based on the examination of ß weights, dietary-management

313   has the major contribution.

314   The overall model predicted total EAT-26 score equally well for all of the diagnostic groups.

315   Comparison of the fit of the model across those with type two diabetes (z=2.87,p=.004) and

316   inflammatory bowel disease (z=6.12,p<.001) revealed that there was no significant

317   difference between the respective R^2 values for the EAT-26 score.

318   When examining the model structure across the groups, structural differences were found.

319   When looking at coeliac disease and inflammatory bowel disease, the combined direct R^2 =

320   .60 and crossed R^2 = .40 were significantly different (z=2.87,p=.004). There are structural

321   differences between the best regression model for predicting EAT-26 score in those with

322   coeliac disease and inflammatory bowel disease. When looking at coeliac disease and type

323   two diabetes together, the combined direct R^2 = .60 and crossed R^2 = -.43 were significantly

324   different (z=6.12,p<.001), indicating that there are structural differences between the best

325   regression model for predicting EAT-26 score in those with coeliac disease and type two

326   diabetes.

327   Further analysis revealed that dietary self-management (z=3.62, p<.001) and DASS-21 scores

328   (z=-2.80, p=.006) had significantly different regression weights in the coeliac disease and

329   inflammatory bowel disease groups, with dietary-management having more influence on

330   EAT-26 scores in those with coeliac disease and DASS-21 scores in those with inflammatory

331   bowel disease. Dietary self-management (z=4.60 p<.001) had a significantly different

332   regression weight in the coeliac disease and type two diabetes groups, with poor dietary

333   self-management being associated with EAT-26 scores in those with coeliac disease. The

334   regression weights for gastrointestinal symptoms were close to significance across coeliac

335   disease and type two diabetes (z=1.90, p=.057). The regression models for the comparison

336   groups are provided in the supplementary materials for comparison but are not central to

337   the aims of the research.

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345   Table 3

346   *Disease specific and Non-Specific Factors in Predicting EAT-26 Scores in Coeliac Disease*

Predictors	B	*B*	R^2	F	R^2 Change
Model 1) Non-specific Factors					
Age	*-.02*	*-.03*			
Body Mass Index	*-.24*	*-.12*			
Years with Condition	*.01*	*.08*			
DASS-21	*.21*	*.04**	*.26*	*8.36**	*.26**
Model 2) Disease Specific Factors					
Age	*.02*	*.03*			
Body Mass Index	*-.11*	*-.06*			
Years with Condition	*.05*	*.06*			
DASS-21	*.09*	*.22*			
Gastrointestinal Symptoms	*.65*	*.50**			
Dietary-management	*2.52*	*.24**	*.57*	*20.42**	*.31**

347   * = significance at p<.008. The significance of the F value refers to the F associated with each

348   step.

349   For the coeliac disease group, when predicting BES score, collectively this model (disease

350   non-specific factors) accounted for 41.8% of the variance in BES scores (F=(4,86)=17.53,

351   p<.001; see table 4) with distress having a significant positive regression weight. The

352   addition of disease-specific factors only explained no additional variance.

353   The overall model fit all of the diagnostic groups equally well. Comparison of the fit of the

354   disease-nonspecific model across those with type two diabetes (z=-1.33,p=.180) and

355   inflammatory bowel disease (z=0.64,p=.521) revealed no significant difference between the

356   respective R^2 values for BES scores between inflammatory bowel disease, type two diabetes

357   and coeliac disease. These predictors do equally well across the groups. Examination of ß

358   weights found a positive association between depression and BES scores across all of the

359   groups.

360   Table 4

361   *Disease specific and Non-Specific Factors in Predicting BES Scores in Coeliac Disease*

Predictors	B	*B*	R^2	F	R^2 Change
Model 1) Non-specific Factors					
Age	*-.13*	*-.14*			
Body Mass Index	*.71*	*.23*			
Years with Condition	*-.07*	*-.06*			
DASS-21	*.33*	*.51**	*.44*	*17.53**	*.44**
Model 2) Disease Specific Factors					
Age	*-.13*	*-.15*			
Body Mass Index	*.69*	*.22*			
Years with Condition	*-.09*	*-.07*			
DASS-21	*.35*	*.55**			
Gastrointestinal Symptoms	*-.14*	*-.07*			
Dietary-management	*-.34*	*-.02*	*.67*	*11.61**	*.00*

362   * = significance at p<.008. The significance of the F value refers to the F associated with each

363   step.

364   *Typologies of Eating Attitudes and Behaviour in Coeliac Disease*

365   Three groups emerged from the cluster analysis producing a "fair" model with a silhouette

366   measure of cohesion and separation of 0.5 (Mooi & Sarstedt, 2011). The first group was the

367   largest (N=60) containing those with low psychological distress, few gastrointestinal

368   symptoms, good dietary-management and low scores on all disordered eating measures.

369   These were determined to be the "low risk" group. The second group contained 25

370   participants. This group was named the "critical" group. These individuals' scored high on

371   EAT-26, and reported poor dietary self-management, many gastrointestinal symptoms and

372   moderate stress scores. The "high distress" group included 11 individuals with high BES

373   scores; this group scored highest on all measures of psychological distress but show good

374   dietary-management. The Kruskal Wallis tests found significant differences in all variables

375   across the three groups (see Table 5). Further post-hoc Mann-Whitney tests revealed that

376   when the critical group and the high distress group were compared to the low risk group,

377   significant differences were found across all of the variables ($p < .05$).

378   Table 5

379   *Cluster Analysis in Individuals with Coeliac Disease*

Variable	**Low Risk (60)**	**Critical (25)**	**High Distress (11)**
Depression (0-14)	1.72	5.4	12
BES Total (0-46)	6.58	11.44	39
Stress (0-17)	3.57	8.72	14.45
GFD Management (Always-Never)	Always	Most of the time	Always
EAT-26 Total (10-40)	8.3	18.96	10.36
Gastrointestinal Symptoms (0-15)	7.13	11.72	13.82

380   *GFD, gluten-free diet; BES, Binge Eating Scale; EAT-26, Eating Attitudes Test-26*

381   Surprisingly, years with diagnosis had a predictor importance less than 0.2 and was

382   subsequently removed from this cluster analysis. We calculated the age of diagnosis and

383   divided this into adult diagnosis, childhood diagnosis and less than 4 years. However, the

384   sample sizes were too small to conduct further analysis.

385   **Discussion**

386   The primary goal of this study was to explore the prevalence, predictors and types of

387   disordered eating in coeliac disease, inflammatory bowel disease, type two diabetes and

388   healthy controls, and examine whether factors unique to the diagnosis of coeliac disease

389   contributed to reports of disordered eating above the impact of having a dietary-controlled

390   health condition.

391   This study used two screening tools for disordered eating, measuring a combination of

392   disordered eating attitudes and self-reported behaviours. Our findings were consistent with

393   previous research; the prevalence of disordered eating as assessed by the EAT-26 was

394   greater in coeliac disease compared to healthy controls, with 15.7% scoring above the

395   clinical cut-off. This is lower than previous reports of 22-29% but significantly higher than

396   healthy controls (Arigo, Anskis & Smyth, 2012; Karwautz et al., 2008).

397   Uniquely, our research compared the prevalence of disordered eating across dietary-

398   controlled health conditions. Of those with inflammatory bowel disease, 20% scored above

399   the cut-off on the EAT-26, with no significant differences in prevalence scores between

400   inflammatory bowel disease and coeliac disease. Individuals with dietary-controlled

401   gastrointestinal conditions may be placed at a unique risk for the development of Anorexic-

402   type attitudes and behaviours. We do not know the nature of these associations, however,

403   the presence of gastrointestinal symptoms may be important in the development of

404   disordered eating in those with gastrointestinal disease (Tang et al., 1997). It is not clear

405   how gastrointestinal symptoms are associated with disordered eating but potential

406   mechanisms may include accidental or intentional gluten ingestion, which is consistent with

407   the model of disordered eating in gastrointestinal disease (Satherley, Howard & Higgs,

408   2014). Case reports indicate that for some individuals with gastrointestinal disease, their

409   prescribed dietary-regimen may interact with disordered eating; the consumption of foods

410   that trigger gastrointestinal symptoms may be used to promote weight loss (Leffler et al.,

411   2007; Yucel et al., 2006). Furthermore, larger studies in coeliac disease have found

412   associations between disordered eating scores and dietary transgressions (Wagner et al.,

413   2015). A similar phenomenon has been described in type one diabetes, where individuals

414   may withhold insulin to promote weight loss (Jones, Lawson, Daneman, Olmsted & Rodin,

415   2000). Future research should focus on the role of gastrointestinal symptoms, dietary-

416   management and disordered eating in coeliac disease.

417   Our research has identified specific factors that are associated with disordered eating in

418   coeliac disease. In coeliac disease, disease specific factors explained additional variance in

419   EAT-26 scores (29.7%) when compared to disease-nonspecific factors, and dietary

420   management was only important for the coeliac disease group. In line with previous

421   research, poor dietary self-management explained addition variance in EAT-26 scores for

422   those with coeliac disease (Arigo, Anskis & Smyth 2012; Karwautz et al., 2008; Wagner et

423   al., 2015). In addition, distress was associated with EAT-26 scores in coeliac disease,

424   however, distress scores were no longer significant when accounting for gastrointestinal

425   symptoms and dietary management in coeliac disease. Furthermore, the cluster analysis

426   produced a "critical" group who scored high on the EAT-26 but reported poorer dietary self-

427   management. This suggests that a small group of individuals with coeliac disease may have a

428   difficult relationship with food. Some individuals may engage in poor dietary self-

429   management in order to promote villous atrophy and subsequent weight loss (Leffler et al.,

430   2007). This offers one interpretation of our results; however, the self-reported measures of

431   dietary self-management and the motivations behind poor management are unclear.

432   When compared with healthy controls, all dietary-controlled diagnostic groups had

433   increased scores on the BES. Binge eating is commonly reported in those with type two

434   diabetes, so it is unsurprising that those with type two diabetes scored highest on these

435   measures (Crow, Kendall, Praus & Thuras, 2001). Binge eating has not previously been

436   reported in those with coeliac disease. In the United Kingdom, it has been reported that up

437   to 81% of individuals gain weight after commencing the GFD (Dickey & Kearney, 2006). This

438   weight gain has been attributed to factors including the poor nutritional quality of some

439   gluten-free foods, resulting in an increased energy intake, and intestinal recovery (Garcia-

440   Manzanares & Lucendo, 2011; Kabbani et al., 2012); however for a subset of individuals, our

441   results suggest that binge eating may also play a role in weight gain. Future research should

442   focus on the relationship between binge eating and weight changes in coeliac disease.

443   Factors common to all conditions (years with condition, psychological distress) were more

444   strongly associated with BES scores across all diagnostic groups. Binge eating in coeliac

445   disease may be influenced by distress associated with the presence of a long-term

446   condition. Greater psychological distress has frequently been associated with binge eating

447   behaviours (Dide & Fitzgibbon, 2005). Furthermore, the cluster analysis highlighted a "High

448   Distress" group who were characterised by increased BES scores and psychological distress.

449   Alternatively, following a restricted dietary regimen, like the GFD, may increase the risk of

450   binge eating behaviours through disinhibition (Herman & Polivy, 1985).

451   *Limitations and Future Research*

452   The cross-sectional nature of this study limits any conclusions about the sequence of events

453   between disordered eating and coeliac disease diagnosis. Longitudinal studies are essential

454   in determining the timeframe between disordered eating onset and coeliac disease

455   diagnosis. Furthermore, we recognise that online recruitment may create a bias in sampling

456   which may over/under-inflate problems with eating behaviors and dietary self-

457   management. In addition, our samples were younger than those previously reported across

458   all conditions. This may be due to the nature of online sampling, which is likely to attract a

459   younger population (Remillard et al., 2014). Despite these limitations, this study provides an

460   important extension in exploring disordered eating in those with coeliac disease and online

461   methods allowed recruitment of a large sample.

462   Due to the nature of online data collection, coeliac disease diagnosis, dietary management,

463   disordered eating scores and psychological distress were all based on self-report. These

464   findings need replication in a biopsy-confirmed sample of individuals with coeliac disease

465   and should focus on more objective measures of dietary-management such as anti-tissue

466   transglutaminase assays, questionnaires designed to assess gluten-free dietary management

467   (Leffler et al., 2009) and multi-modal approaches, including self-report and dietician

468   assessment. However, the comparison across different chronic health conditions, recruited

469   in the same manner, is a strength of this study and provides an extension of existing

470   research in coeliac disease and disordered eating.

471   No evidence was found for the role of anxiety in the development of disordered eating

472   behaviours. Surprisingly the FNS was not a good predictor of disordered eating. We had

473   anticipated that FNS scores might tap into fears about cross-contamination and trying new

474   foods. However, the FNS may lack sensitivity to assess this mechanism in those with coeliac

475   disease. The development of a scale measuring food anxiety in coeliac disease may allow

476   further investigation of the role of anxiety around food in disordered eating in coeliac

477   disease.

478   *Clinical Implications*

479   The observation that individuals with dietary-controlled chronic health conditions have

480   increased scores in disordered eating tools when compared to healthy controls suggesting

481   that the use of screening tools for disordered eating may be valuable in these individuals.

482   More specifically, the observation that gastrointestinal symptoms and dietary management

483   were associated with EAT-26 scores in coeliac disease, indicates that individuals

484   experiencing difficulties in managing their gluten-free diet and reporting gastrointestinal

485   symptoms may benefit from have their eating attitudes and behaviors explored. In addition,

486   for those who do score above clinical cut-offs, it is important to consider how their chronic

487   health condition may interact with disordered eating attitudes and behaviours.

488   *Conclusions*

489   Our research indicates factors both common to all dietary-controlled health conditions

490   (psychological distress), gastrointestinal symptoms and factors unique to the coeliac disease

491   diagnosis (GFD management) require further assessment in relation to coeliac disease and

492   disordered eating.

493   A small group of people with coeliac disease display poor dietary management and this is

494   associated with disordered eating attitudes and beliefs, lending some support to models of

495   disordered eating in gastrointestinal disorders (Satherley, Howard & Higgs, 2014). The

496   majority of individuals with coeliac disease display a typical eating pattern, but for some,

497   disordered eating behaviours are a feature of their coeliac disease. We have isolated some

498   factors that are specific to coeliac disease that may place individuals at increased risk for

499   disordered eating attitudes and behaviours. Future research should focus on understanding

500   this sub-group of individuals with coeliac disease and look at ways to identify them and

501   provide support.

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