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1 **Development and Validation of the Child Three Factor Eating Questionnaire**  
2 **(CTFEQr17)**

3  
4 **ABSTRACT**

5 **OBJECTIVE:** Develop and validate a child and adolescent version of the Three Factor Eating  
6 Questionnaire (CTFEQr17), and to assess its psychometric properties and factor structure.  
7 We also examined associations between the CTFEQr17 and body mass index (BMI) and food  
8 preferences.

9 **DESIGN:** A two-phase approach was utilised, employing both qualitative and quantitative  
10 methodologies.

11 **SETTING:** Primary and secondary schools, UK.

12 **SUBJECTS:** In phase 1, 76 children (39 boys; mean age: 12.3±1.4 years) were interviewed to  
13 ascertain their understanding of the original TFEQr21 and to develop accessible and  
14 understandable items to create the CTFEQr17. In phase 2, 433 children (230 boys; mean age:  
15 12.0±1.7 years) completed the CTFEQr17 and a food preference questionnaire, a subsample  
16 (n = 253; 131 boys) had their height and weight measured and 45 children (23 boys) were  
17 interviewed to determine their understanding of the CTFEQr17.

18 **RESULTS:** The CTFEQr17 showed good internal consistency (Cronbach's  $\alpha=0.85$ ) and the  
19 three factor structure was retained: cognitive restraint (CR), uncontrolled eating (UE) and  
20 emotional eating (EE). Qualitative data demonstrated a high level of understanding of the  
21 questionnaire (95%). A high CR was found to be significantly associated with a higher body  
22 weight, BMI and BMI percentile. High UE and EE scores were related to a preference for  
23 high fat savoury and high fat sweet foods. The relationships between CTFEQr17,  
24 anthropometry and food preference were stronger in girls compared to boys.

25 **CONCLUSIONS:** The CTFEQr17 is a psychometrically sound questionnaire for use in  
26 children and adolescents, and is associated with anthropometric and food preference  
27 measures.

## 30 INTRODUCTION

31 The prevalence of obesity in children and adolescents has reached epidemic proportions  
32 worldwide and is associated with many comorbidities <sup>(1-3)</sup>. Pediatric obesity is closely linked  
33 to the so-called “obesogenic” environment where a myriad of factors are conducive to eating  
34 too much and not moving enough, thereby promoting weight gain and ultimately overweight  
35 and obesity <sup>(4, 5)</sup>. Among the many factors that explain the susceptibility to gain weight, a  
36 better understanding of the link between eating behaviours and weight gain is of crucial  
37 importance to overcome the rising rates of obesity.

38

39 Obesity interventions have to consider individuals’ eating behaviours, especially those that  
40 have been associated with obesity and weight gain <sup>(6, 7)</sup>. For example, dietary restriction can  
41 promote overeating in dietary restrained adolescents having disinhibited eating behaviour <sup>(8)</sup>.  
42 Additionally, adolescents with high restrained eating behaviour scores are more likely to gain  
43 weight over time <sup>(9)</sup>. Properly assessing eating behaviours of children and adolescents  
44 remains, however, challenging.

45

46 In 1985, Stunkard & Messick developed the Three-Factor Eating Questionnaire (TFEQ) as a  
47 self-reported scale based on the Restraint <sup>(10)</sup> and the Latent Obesity <sup>(11)</sup> theories, in order to  
48 assess Dietary Restraint (restriction of food intake to control weight), Disinhibition (tendency  
49 to overeat opportunistically), and Hunger (responsiveness to internal hunger sensations).  
50 While this initial version of the TFEQ developed in adults has been shown to clearly link  
51 eating behaviours with weight gain and weight loss success <sup>(12-15)</sup>, it has been recently revised  
52 into a shorter 21-item version (TFEQr21) focusing on Restraint, Uncontrolled Eating, and  
53 Emotional Eating <sup>(13)</sup>. In this last version, although the restraint dimension remains  
54 unchanged, uncontrolled eating refers to eating in response to food palatability and the  
55 likelihood to over-consume, and emotional eating represents the process to eat in response to  
56 negative moods <sup>(13)</sup>.

57

58 Despite a significant body of literature regarding the utility of the TFEQ in adults <sup>(13-18)</sup>, the  
59 validity of this TFEQr21 remains to be tested among children and adolescents. Although,  
60 Martin-Garcia et al. <sup>(19)</sup> recently reported a strong association between body composition and  
61 Cognitive Restraint in 7-17-year-old Spanish youth using a modified version of the Spanish  
62 adult TFEQ. These results highlight the usefulness of the TFEQr21 in children, but only in a

63 limited population. It thus remains important to develop and validate a specific version of the  
64 English TFEQr21 for children and adolescents in order to better characterize their eating  
65 behaviour traits and evaluate the impact of obesity interventions in this population.

66

67 The objective of this study was to develop an adapted-version of the adult TFEQr21 to be  
68 used among children and adolescents (CTFEQr17), and to assess its psychometric properties  
69 and factor structure. We also examined the associations between the CTFEQr17 and body  
70 mass index (BMI) and food preferences as a secondary objective.

71

72

## 73 **METHODS**

74 The process of developing and validating the CTFEQr17 was a two-phase process: the  
75 CTFEQr17 was developed in phase 1 and validated in phase 2. Each phase and subsequent  
76 results are detailed below.

77

### 78 **Phase 1: Development of the CTFEQr17**

#### 79 *Participants*

80 A sample of 76 children (39 boys and 37 girls) recruited between 2013 – 2014, from primary  
81 and secondary schools in North and West Yorkshire, UK were interviewed to determine their  
82 understanding of the original TFEQr21 <sup>(13)</sup> items and to develop the wording of the  
83 CTFEQr17 (mean age: 12.3±1.4 years; mean BMI: 19.1±2.5 kg/m<sup>2</sup>; mean BMI percentile:  
84 59.4±25.8). All children, their guardians and the school gave informed consent for  
85 participation. Children who had any known eating disorders or eating issues, or who had  
86 difficulties with reading were excluded from participation (n=5 excluded). These children  
87 were identified by parents and/or teachers. The project gained full ethical approval from the  
88 University of Bradford Ethics Committee.

89

#### 90 *Qualitative Design*

91 The children took part in one-to-one structured interviews with the researchers. The child was  
92 presented with the adult version of the TFEQr21 <sup>(13)</sup> and was asked whether they understood  
93 each item, if they understood how to respond to each question, and asked to put each item

94 into their own words. The interviews allowed the researchers to determine the children's  
95 understanding of each item. Sample percentages were calculated for correct understanding of  
96 each item. In addition, the wording the children used to describe each item was then used to  
97 develop the CTFEQr17. This was achieved by recording the most frequently used words and  
98 phrases for each item and adopting these words, and phrases, in the new items. The  
99 interviews were tape-recorded and transcribed for analysis. Two researchers independently  
100 analysed the children's responses to try to reach a subjective consensus on the child's  
101 responses.

102

### 103 *Anthropometric Measurements*

104 Body weight was assessed using a Seca 877 weighing scale and was measured to the nearest  
105 0.1 kg. Children wore loose and lightweight shorts and a T-shirt to be weighed. Height was  
106 measured while the child was barefoot, using a Leicester stadiometer and was measured to  
107 the nearest 0.1 cm. BMI was calculated as weight (kg) / height (m)<sup>2</sup>. BMI percentiles were  
108 calculated using the WHO <sup>(20)</sup> criteria based on age and sex.

109

### 110 **Phase 2: Validation of the CTFEQr17**

111 A sample of 433 children (230 boys; mean age: 12.0±1.7 years; mean BMI: 19.7±4.5 kg/m<sup>2</sup>;  
112 mean BMI percentile: 57.6±30.9) from primary and secondary schools in West Yorkshire and  
113 Lancashire, UK were recruited between 2016-2017. A subsample of 45 children (23 boys and  
114 22 girls) took part in interviews to confirm their understanding of the CTFEQr17. All  
115 children, their guardians and the school gave informed consent for participation. Children  
116 who had any known eating disorders or eating issues, or who had difficulties with reading  
117 were excluded from participation (n = 23). The project gained full ethical approval from the  
118 University of Bradford Ethics Committee.

119

### 120 *Validation Design*

121 Children were asked to self-complete the CTFEQr17 and an adapted paper-based Leeds Food  
122 Preference Questionnaire (LFPQ), suitable for use with children <sup>(21)</sup>. The LFPQ consists of a  
123 list of common UK foods (e.g., crisps, strawberries, yoghurt, biscuits) and the child was  
124 asked to indicate if they would like to consume these foods. Responses were then coded and  
125 summed into preference for high protein (8 items), high fat (8 items), high carbohydrate (8  
126 items), and low energy foods (8 items). Mean taste preference scores were also calculated for

127 low fat savoury foods (LFSA: 12 items), low fat sweet foods (LFSW: 5 items), high fat  
128 savoury foods (HFSA: 8 items), and high fat sweet foods (HFSW: 7 items).

129

### 130 *Anthropometric Measurements*

131 A subsample of children had their height and weight measured (131 boys and 122 girls).  
132 Anthropometric measures were taken using the same procedure used in phase 1.

133

### 134 *Qualitative Design*

135 The children took part in structured one-to-one interviews with a researcher. They were  
136 presented with the CTFEQr17 and asked if they understood each item, understood how to  
137 respond to each question and asked to elaborate on what they thought each item meant, to  
138 confirm their understanding. Each interview lasted approximately 20 minutes. Interviews  
139 were recorded and transcribed for analysis.

140

141

142

### 143 *Statistical Analysis*

144 We calculated that a total sample of 338 would be sufficient ( $1-\hat{\alpha} = \sim 0.90$ , effect size = 0.25,  $\alpha$   
145 = 0.05) to run the planned analysis. An exploratory, varimax rotation, principal components  
146 factor analysis (PCA) was carried out to determine the factor structure of the CTFEQr17. An  
147 item analysis was also conducted to confirm the internal consistency, item-convergent and  
148 item-divergent validity of the CTFEQr17 items. Bivariate correlations explored relationships  
149 between age and CTFEQr17 factors by sex, and an ANOVA was used to determine  
150 differences between sex and age groups (7-10 years and 11-15 years) on each CTFEQr17  
151 factor. Partial correlations, controlling for age, were used to examine relationships between  
152 CTFEQr17 factors and anthropometric measurements. Partial correlations, controlling for age  
153 and BMI, were also used to explore relationships between CTFEQr17 factors and food and  
154 taste preference. Only correlations above 0.20 are reported. Groups were formed using a  
155 median split on cognitive restraint (CR), uncontrolled eating (UE) and emotional eating (EE)  
156 scale scores to create a low and high CR groups (LCR & HCR), low and high UE groups  
157 (LUE & HUE) and low and high EE groups (LEE & HEE). ANCOVAs were used to analyse  
158 differences in anthropometric measures (controlling for age) and in food and taste preference  
159 (controlling for age and BMI) by sex and eating behaviour groupings. Effect size was  
160 measured through  $\eta^2$  ( $\eta^2$ ). For the qualitative data, the children's comments were used to

161 determine their level of understanding of each item of the CTFEQr17, and percentages of the  
162 correctly understood items were calculated. Understanding of items between phase 1 and 2  
163 was examined using t-tests. SPSS version 22 was used to conduct the analysis, and the level  
164 of statistical significance was set at  $p < 0.05$  for all analyses.

165

## 166 **RESULTS**

### 167 **Phase 1: Development of the CTFEQr17**

168 The qualitative data from the interviews with children revealed that there were a number of  
169 items in the TFEQr21<sup>(13)</sup> that the children had difficulty in understanding, particularly items  
170 9, 17 and 21. To develop a more understandable questionnaire, these items were reworded,  
171 using the children's own language, and ascertained from the interviews (see Appendix for the  
172 CTFEQr17). In addition, the children also deemed the response format of the TFEQr21  
173 unclear and too complex; thus, the response format of the CTFEQr17 was altered to read  
174 'totally true', 'mostly true' 'mostly false', and 'totally false', again utilising the phraseology  
175 of the children from the interviews.

176

### 177 **Phase 2: Validation of the CTFEQr17**

#### 178 *Structure and Internal Consistency of the CTFEQr17*

179 The data met the assumptions for factor analysis with the Kaiser-Meyer-Olkin measure of  
180 sampling adequacy index  $KMO = 0.87$ , and Bartlett's test of sphericity ( $\chi^2 = 2706.45$ ,  
181  $p < 0.001$ ), indicating that the correlations between items were sufficiently large for a PCA. A  
182 varimax rotation PCA initially revealed four factors with Eigenvalues  $> 1$ , which in  
183 combination explained 51.6% of the variance. The factors of UE (items 3, 6, 8, 9, 12, 13, 15,  
184 19 and 20) and EE (items 2, 4, 7, 10, 14 and 16) were retained as in the original TFEQr21.  
185 However, CR loaded into two factors: CR1 items 1, 5 and 11 and CR2 items 17, 18 and 21.  
186 The items in CR1 are related to current food restriction behaviour, whereas CR2 is related to  
187 more prospective food restriction behaviours. However, following the removal of weak items  
188 due to low inter-item and item-total correlations and Cronbach's  $\alpha$  increasing after item  
189 removal (17, 18, 19 & 21), a three factor structure was revealed, which explained 53.5%  
190 variance. The factors of UE (items 3, 6, 8, 9, 12, 13, 15 and 20), EE (items 2, 4, 7, 10, 14 and  
191 16) and CR (items 1, 5 and 11) were retained to create a CTFEQr17.

192

193 Following an analysis of internal consistency, the CTFEQr17 had a Cronbach's  $\alpha$  of 0.85,  
194 with the factors of UE ( $\alpha = 0.85$ ) and EE ( $\alpha = 0.83$ ) showing similarly high scores. The factor

195 of CR was ( $\alpha = 0.67$ ) which although lower than UE and EE, was deemed adequate. The item  
196 analysis also revealed that the factors had adequate to good inter-item correlations for CR ( $r =$   
197  $0.38 - 0.47$ ), UE ( $r = 0.32 - 0.58$ ) and EE ( $r = 0.36 - 0.59$ ), showing that the items within  
198 each scale correlated with one another. The corrected item-total correlations were good; CR  
199 ( $r = 0.46 - 0.52$ ), UE ( $0.53 - 0.63$ ) and EE ( $r = 0.55 - 0.70$ ), with the items correlating most  
200 strongly with their respective factors, supporting item-discriminant and convergent validity.  
201 The factor of UE correlated significantly with EE ( $r = 0.47, p < 0.001$ ) only.

202

203 Insert Table 1 here

204

### 205 *Children's Understanding of the Items*

206 The qualitative aspect of the analysis, concerning the children's understanding of the  
207 questionnaire items, revealed a very good level of understanding of the CTFEQr17. More  
208 specifically, in comparison to the original TFEQr21, all items of the CTFEQr17 were more  
209 understandable (mean understanding of 95% compared with 81% for the original TFEQr21;  
210 see Figure 1), where items 2, 9, 10, 11 and 12 were significantly more understood ( $p < 0.05$ )  
211 compared to the original TFEQr21.

212

213 Insert Figure 1 here

214 Insert Table 2 here

215

### 216 *Participant Characteristics and CTFEQr17*

217 For both boys and girls, UE correlated negatively with age ( $r = -0.32, p < 0.001$  and  $r = -0.25,$   
218  $p = 0.001$ , respectively). CR correlated negatively with age for girls only ( $r = -0.21, p < 0.01$ ).  
219 No significant correlations for EE were found. Younger children scored higher on CR and  
220 UE respectively ( $F(1, 439) = 4.56, p < 0.05, \eta^2 = 0.01$ ;  $F(1, 437) = 34.61, p < 0.001, \eta^2 = 0.07$ ).  
221 While boys reported higher UE scores ( $F(1, 437) = 7.07, p < 0.01, \eta^2 = 0.02$ ). No differences  
222 for age and sex were found for EE (see Table 2).

223

224 Insert Table 3 here

225

### 226 *CTFEQr17, Body Weight, and BMI*



227 After controlling for age, CR was found to correlate positively with weight ( $r = 0.21$ ,  
228  $p < 0.05$ ), BMI ( $r = 0.25$ ,  $p < 0.01$ ) and BMI percentile ( $r = 0.21$ ,  $p < 0.05$ ) for girls only. No  
229 other associations were found.

230

231 Table 3 presents the participant characteristics by CTFEQr17 group. The ANCOVA revealed  
232 that those who have a HCR had a significantly higher weight ( $F(1, 247) = 8.29$ ,  $p < 0.01$ ,  $\eta^2 =$   
233  $0.04$ ), higher BMI ( $F(1, 247) = 12.35$ ,  $p = 0.001$ ,  $\eta^2 = 0.05$ ), and higher BMI percentile ( $F(1,$   
234  $246) = 8.41$ ,  $p < 0.01$ ,  $\eta^2 = 0.04$ ), regardless of sex. No significant differences between UE and  
235 EE groups and anthropometric measures were evident. Age was a significant covariate  
236 throughout these analyses ( $p < 0.01$ ).

237

238 Insert Table 4 here

239

#### 240 *CTFEQr17, Food and Taste Preference*

241 Younger children were found to have a higher food preference for all categories; high  
242 carbohydrate ( $r = -0.33$ ,  $p < 0.001$ ), high fat ( $r = -0.24$ ,  $p < 0.001$ ), and low energy ( $r = -0.23$ ,  
243  $p < 0.001$ ). This was particularly so for younger girls compared to boys. BMI correlated  
244 negatively with high carbohydrate ( $r = -0.24$ ,  $p < 0.001$ ). This association was found to be  
245 stronger in boys. No association between BMI percentile and food preference was found.

246

247 Partial correlations showed that UE was positively related to preferences for high fat foods ( $r$   
248  $= 0.26$ ,  $p < 0.001$ ), high protein foods ( $r = 0.27$ ,  $p < 0.001$ ) and high carbohydrate foods ( $r =$   
249  $0.23$ ,  $p < 0.001$ ). The relationships between UE and food preferences were found to be  
250 stronger in girls. Also, for EE significant relationships existed only for girls, for high  
251 carbohydrate foods ( $r = 0.25$ ,  $p < 0.01$ ), high protein foods ( $r = 0.22$ ,  $p < 0.05$ ) and high fat  
252 foods ( $r = 0.21$ ,  $p < 0.05$ ). No significant correlations between CR and food preference were  
253 found.

254

255 Food preferences were found to differ significantly between the CTFEQr17 groups (see Table  
256 4). ANCOVA revealed that for high protein preference, the HUE group had a higher  
257 preference compared to the LUE ( $F(1, 241) = 17.74, p < 0.001, \eta^2 = 0.07$ ). Boys consistently  
258 showed a higher protein preference, regardless of CR, UE and EE groups ( $F(1, 242) = 20.09,$   
259  $p < 0.001, \eta^2 = 0.08$ ;  $F(1, 241) = 14.98, p < 0.001, \eta^2 = 0.06$ ;  $F(1, 242) = 18.28, p < 0.001, \eta^2 =$   
260  $0.07$ , respectively). Both the HUE and HEE groups reported a greater preference for high fat  
261 ( $F(1, 241) = 16.79, p < 0.001, \eta^2 = 0.07$  and  $F(1, 242) = 5.45, p < 0.05, \eta^2 = 0.02$  respectively)  
262 and high carbohydrate foods ( $F(1, 241) = 16.85, p < 0.001, \eta^2 = 0.07$  and  $F(1, 242) = 4.63,$   
263  $p < 0.05, \eta^2 = 0.02$ , respectively). No differences were found for preference for low energy  
264 foods. Age was a significant covariate throughout the analyses ( $p < 0.001$ ).

265

266 In terms of taste preference, younger children had a higher preference across most categories;  
267 LFSA ( $r = -0.25, p < 0.001$ ), LFSW ( $r = -0.23, p < 0.001$ ) and HFSW ( $r = -0.26, p < 0.001$ ).  
268 Taste preference was found to correlate more strongly for girls compared to boys for age.  
269 However, BMI was only found to correlate with taste preference in boys for HFSW foods ( $r$   
270  $= -0.24, p < 0.01$ ).

271

272 Partial correlations revealed that UE was positively correlated with preference for HFSA ( $r =$   
273  $0.31, p < 0.001$ ) and HFSW foods ( $r = 0.27, p < 0.001$ ). When examined by sex, taste  
274 preference associations were stronger in girls: UE and EE with HFSW ( $r = 0.38, p < 0.001$ ;  $r =$   
275  $0.25, p < 0.01$ , respectively), and HFSA foods ( $r = 0.34, p < 0.001$ ;  $r = 0.20, p < 0.05,$   
276 respectively) and UE with LFSA foods ( $r = 0.25, p < 0.01$ ). No taste preference associations  
277 were found with CR.

278

279 The CTFEQr17 groups also discriminated between taste preferences (see Table 4). The  
280 ANCOVA revealed that irrespective of CR, UE or EE group, boys consistently had higher  
281 preferences for LFSA foods ( $F(1, 241) = 6.50, p < 0.05, \eta^2 = 0.03$ ;  $F(1, 240) = 4.23, p < 0.05, \eta^2 =$   
282  $0.02$ ;  $F(1, 241) = 6.02, p < 0.05, \eta^2 = 0.02$ ) and HFSA foods ( $F(1, 242) = 9.44, p < 0.01, \eta^2 =$   
283  $0.04$ ;  $F(1, 241) = 6.70, p = 0.01, \eta^2 = 0.02$ ;  $F(1, 242) = 8.71, p < 0.01, \eta^2 = 0.04$ , respectively).  
284 The HUE group had a higher preference for LFSA foods ( $F(1, 240) = 9.24, p < 0.01, \eta^2 =$   
285  $0.04$ ). In addition, those with a HUE and HEE had a higher preference for HFSA foods ( $F(1,$

286 240) = 18.66,  $p < 0.001$ ,  $\eta^2 = 0.09$ ;  $F(1, 242) = 3.62$ ,  $p = 0.058$ ,  $\eta^2 = 0.02$ ) and HFSW foods  
287 ( $F(1, 241) = 18.60$ ,  $p < 0.001$ ,  $\eta^2 = 0.07$ ;  $F(1, 242) = 8.45$ ,  $p < 0.01$ ,  $\eta^2 = 0.03$ ). Age was a  
288 significant covariate throughout the analyses ( $p < 0.001$ ).

289

290

## 291 **DISCUSSION**

292 The main aim of the present work was to propose a validated adaptation of the TFEQr21  
293 among children and adolescents. According to our results, the proposed CTFEQr17  
294 successfully assesses psychological eating behaviour traits in children and adolescents, and  
295 also shows associations with body weight, BMI and food preference. These findings are  
296 supported by qualitative data showing that the children had a good understanding of the  
297 CTFEQr17 items, confirming the strength and usefulness of this tool.

298

### 299 **CTFEQr17 and Anthropometric Measures**

300 A high CR score was shown to be associated with a higher body weight, BMI and BMI  
301 percentile, in girls. This finding supports previous work with adolescents by van Strein et al  
302 <sup>(8)</sup>, Snoek et al <sup>(9)</sup> and Martin-Garcia et al <sup>(19)</sup>. Evidence also supports a stronger association  
303 between adverse weight regulation and dietary restraint in girls compared to boys <sup>(22)</sup>. These  
304 seemingly counterintuitive findings are explained well with the goal conflict theory <sup>(23)</sup>. This  
305 theory posits that weight regulation issues are a result of the conflict between the goal of  
306 weight control and the goal of eating enjoyment; the hedonic expectation of food often  
307 undermines the goal of weight control <sup>(24)</sup>. In the current obesogenic environment, replete  
308 with palatable foods, the goal of eating enjoyment is more often primed, requiring a higher  
309 cognitive effort to maintain the goal of weight control <sup>(23)</sup>. Such cognitive effort can easily  
310 become more difficult to maintain when other issues (e.g. emotions, work) reduce cognitive  
311 capacity available, resulting in the goal of eating enjoyment becoming much easier to access  
312 <sup>(23)</sup>. As a consequence, a less healthy eating pattern can occur, leading to a susceptibility to  
313 weight gain <sup>(25)</sup>.

314

315 Although the goal conflict theory supports our results, conflicting evidence exists, as  
316 restrained eating has also been associated with lower food intake and better weight regulation  
317 (e.g. 26-28). This suggests that some individuals are better able to maintain their weight control  
318 goal in comparison to their eating enjoyment goal. Thus, the relationship between CR and  
319 weight is complex, and CR likely interacts with other eating behaviour traits (e.g.  
320 Disinhibition) to produce differing influences upon body weight (6;29). That CR was  
321 associated with a higher weight and BMI in this child and adolescent sample supports a large  
322 body of adolescent and adult data, suggesting the CTFEQr17 has successfully measured this  
323 psychological construct.

324

325 Both UE and EE were found not to be related to anthropometric measures. This lack of  
326 association has also been found in adults (13). However, there is evidence that suggests EE (30),  
327 UE (19;31) or both UE and EE (32;33) are associated with higher weight and BMI in adolescents  
328 and adults. Where relationships have been found in adolescents (19), the study sample  
329 consisted of overweight/obese and lean groups of children/adolescents. In the current study,  
330 children and adolescents were sampled from schools and not selected based on their weight  
331 status, thus having a lower proportion of overweight and obese participants. This could  
332 explain why associations with UE and EE were not found. In addition, where relationships  
333 have been found in adult samples, this has, at least partially, been attributed to food choice,  
334 whereby those with a higher UE and EE have a less healthful diet, higher energy intake and  
335 higher snack intake (31; 33) and partake in less physical activity (33). This suggests that the food  
336 preferences of UE and EE can impact adversely upon weight status.

337

### 338 **CTFEQr17, Food and Taste Preference**

339 Higher preferences for HFSA, HFSW, high carbohydrate and high fat foods were evident in  
340 those children who were characterised with higher UE and EE scores; this relationship was  
341 particularly strong in girls. This taste preference pattern reflects evidence from adult  
342 populations, which have shown a higher preference for high fat foods in UE and EE adults  
343 (34). A preference for HFSW foods in individuals with a high EE has also been found to be  
344 particularly strong in women compared to men (34). This indicates that the taste preferences,  
345 and associated sex differences, found in adults are also found in children and adolescents,

346 suggesting these preferences begin in childhood and persist into adulthood. Furthermore, UE  
347 and EE are characterised by eating in response to the palatability of food, eating  
348 opportunistically and eating in response to negative affect. Individuals with a HUE and HEE  
349 report a higher preference for high fat (savoury and sweet) and high carbohydrate foods <sup>(34;35)</sup>.  
350 These foods typically reflect highly palatable, energy dense foods (e.g. crisps, sausage roll,  
351 biscuits, cakes). Due to their macronutrient content, these foods have a relatively low  
352 satiating ability <sup>(36)</sup>, and eating them can result in passive overconsumption <sup>(37)</sup>, increasing  
353 vulnerability to future weight gain <sup>(38)</sup>. Indeed, this is reflected in adult data where UE and EE  
354 are related to higher body weight <sup>(32;33)</sup>.

355

356 Independently of CTFEQr17 scores, males were found to have a higher preference for high  
357 protein food, HFSA and LFSA foods. This pattern has previously been reported in children  
358 and adolescents <sup>(39)</sup>, and in adults <sup>(40)</sup>. In addition, younger children also reported higher food  
359 preferences than older children, regardless of gender; this has also been previously reported  
360 <sup>(39)</sup>. Interestingly, food and taste preference were more strongly related to psychological  
361 factors of the CTFEQr17 in girls than boys, whereas food preference was more strongly  
362 associated with anthropometric measures in boys. This is despite no difference in sex being  
363 reported for CR and EE, and boys scoring higher on the UE scale. Existing evidence purports  
364 that females tend to score more highly on CR, UE and EE in adolescents <sup>(41)</sup>, on EE in adults  
365 <sup>(14;42)</sup> and CR in adults <sup>(43;44)</sup>. Thus, females are reporting a higher influence of psychological  
366 eating behaviour traits over their eating behaviour. The reason for this sex difference is  
367 unclear and needs to be further elucidated.

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### 369 **Strengths and Limitations**

370 A strength of this study is that the CTFEQr17 was both statistically and qualitatively verified  
371 as valid. The development of the CTFEQr17 involved creating accessible items by using the  
372 children/adolescent's own phraseology ascertained from interviews. This produced a  
373 questionnaire that was highly understandable for children and adolescents. However,  
374 although associations between the CTFEQr17 and food and taste preference were found,  
375 measurement of actual food intake was not carried out. Food preferences and the relationship  
376 between 'liking' and 'wanting' of foods have been found to be related to food intake <sup>(45)</sup> and

377 also associated with TFEQ factors in adults (e.g. 46), thus an examination of this relationship in  
378 children and adolescents would be beneficial. A further limitation of the study is that body  
379 composition was not assessed; with research suggesting measurement of actual body  
380 composition is more accurate in determining relevant relationships than BMI (47, 48). Research  
381 by Martin-Garcia et al., (19) also found an association between fat mass and CR in children  
382 and adolescents, therefore further exploration of this is of interest. Furthermore, although our  
383 sample size was adequate for the intended analysis, there were a larger proportion of  
384 secondary school children; further consideration of the CTFEQr17 in primary school children  
385 would be interesting. However, our sample did reflect that which was used to validate the  
386 Spanish TFEQr21C (19).

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## 389 **CONCLUSION**

390 The CTFEQr17 shows good internal consistency and is suitable for use in children and  
391 adolescents. The factor of CR was found to be associated with higher body weight, BMI and  
392 BMI percentile, thus those children who were larger showed more restrictive eating  
393 behaviours. Both UE and EE were associated with a higher preference for HFSA and HFSW  
394 foods, which is consistent with adult data and demonstrates that children with these eating  
395 behaviour traits have less healthy food preferences. Furthermore, a sex difference in the  
396 relationships between CTFEQr17 factors, anthropometric measurements and food  
397 preferences was apparent, whereby a stronger relationship was observed in girls. Collectively,  
398 the CTFEQr17 appears to be a valid and suitable tool to measure eating behaviour traits in  
399 children and adolescents.

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## 402 **APPENDIX 1**

403 The items have been coded as in the original TFEQr21 (13).

404 1. I eat small portions of food to help control my weight: Totally true (4); Mostly true  
405 (3); Mostly false (2); Totally false (1).

- 406 2. I start to eat when I feel worried: Totally true (4); Mostly true (3); Mostly false (2);  
407 Totally false (1).
- 408 3. Sometimes when I start eating, it seems I can't stop: Totally true (4); Mostly true (3);  
409 Mostly false (2); Totally false (1).
- 410 4. When I am sad, I usually eat too much: Totally true (4); Mostly true (3); Mostly false  
411 (2); Totally false (1).
- 412 5. I don't eat some kinds of food because they can make me fat: Totally true (4); Mostly  
413 true (3); Mostly false (2); Totally false (1).
- 414 6. When I am next to someone who is eating, I also feel like eating: Totally true (4);  
415 Mostly true (3); Mostly false (2); Totally false (1).
- 416 7. When I feel angry, I need to eat: Totally true (4); Mostly true (3); Mostly false (2);  
417 Totally false (1).
- 418 8. I often get so hungry that I feel like I could eat loads of food without getting full:  
419 Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).
- 420 9. When I am hungry, I feel like to have to eat all of the food on my plate in one go,  
421 without stopping: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).
- 422 10. When I feel lonely, I make myself feel better by eating: Totally true (4); Mostly true  
423 (3); Mostly false (2); Totally false (1).
- 424 11. I eat less than I want at meal times to stop myself putting on weight: Totally true (4);  
425 Mostly true (3); Mostly false (2); Totally false (1).
- 426 12. When I smell or see my favourite food, I find it hard to stop myself from eating it,  
427 even if I've just finished a meal: Totally true (4); Mostly true (3); Mostly false (2); Totally  
428 false (1).
- 429 13. I'm always hungry enough to eat at any time: Totally true (4); Mostly true (3); Mostly  
430 false (2); Totally false (1).
- 431 14. If I feel nervous, I try to calm myself down by eating: Totally true (4); Mostly true  
432 (3); Mostly false (2); Totally false (1).

- 433 15. When I see something that looks delicious, I get so hungry that I have to eat it right  
434 away: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).
- 435 16. When I feel really upset, I want to eat: Totally true (4); Mostly true (3); Mostly false  
436 (2); Totally false (1).
- 437 17. How often do you feel hungry? Only at mealtimes (1); Sometimes between meals (2);  
438 Often between meals (3); Almost always (4).

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589 **Table 1.** Rotated factor structure loading of the CTFEQr17.

	Uncontrolled Eating	Emotional Eating	Cognitive Restraint (1)	Communalities
12. When I smell or see my favourite food, I find it hard to stop myself from eating it, even if I've just finished a meal.	0.73			0.56
8. I often get so hungry that I feel like I could eat loads of food without getting full.	0.72			0.53
15. When I see something that looks delicious, I get so hungry that I have to eat it right away.	0.70			0.53
3. Sometimes when I start eating, it seems I can't stop.	0.69			0.52
6. When I am next to someone who is eating, I also feel like eating.	0.67			0.51
13. I'm always hungry enough to eat at any time.	0.66			0.49
20. How often do you feel hungry?	0.63			0.47
9. When I am hungry, I feel like to have to eat all of the food on my plate in one go, without stopping.	0.61			0.45
16. When I feel really upset, I want to eat.		0.81		0.67
14. If I feel nervous, I try to calm myself down by eating.		0.73		0.60
2. I start to eat when I feel worried.		0.72		0.55
7. When I feel angry, I need to eat.		0.68		0.49

4. When I am sad, I usually eat too much.	0.66		0.49
10. When I feel lonely, I make myself feel better by eating.	0.65		0.51
1. I eat small portions of food to help control my weight.		0.80	0.64
11. I eat less than I want at meal times to stop myself putting on weight.		0.78	0.61
5. I don't eat some kinds of food because they can make me fat.		0.72	0.55
Explained variance	31.20	12.75	9.54
Cumulative variance	31.20	43.95	53.45

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607 **Table 2.** CTFEQr17 factor scores between age groups and sex.

	Primary School (7-10 years)		Secondary School (11-15years)	
	Boys (n = 46)	Girls (n = 39)	Boys (n = 184)	Girls (n = 174)
CR	2.38 (0.78)#	2.52 (0.81)#	2.37 (0.72)	2.16 (0.66)
UE	2.88 (0.87)*#	2.50 (0.88)#	2.25 (0.59)*	2.11 (0.64)
EE	1.52 (0.61)	1.65 (0.65)	1.48 (0.54)	1.58 (0.63)

608 Data are presented as mean (SD).

609 CR, cognitive restraint; UE, uncontrolled eating; EE, emotional eating.

610 \*Boys have a significantly higher UE score compared to girls (p<0.001).

611 #Younger children have a significantly higher CR and UE compared to older children  
 612 (p<0.01).

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614 **Table 3.** Body measurements and food preference by CTFEQr17 groups.

	<b>Low CR</b>		<b>High CR</b>		<b>Low UE</b>		<b>High UE</b>		<b>Low EE</b>		<b>High EE</b>	
	<b>Boys</b> (n = 48)	<b>Girls</b> (n = 55)	<b>Boys</b> (n = 82)	<b>Girls</b> (n = 66)	<b>Boys</b> (n = 48)	<b>Girls</b> (n = 55)	<b>Boys</b> (n = 82)	<b>Girls</b> (n = 66)	<b>Boys</b> (n = 48)	<b>Girls</b> (n = 55)	<b>Boys</b> (n = 82)	<b>Girls</b> (n = 66)
<b>Weight</b> (kg)	44.41 (16.71)	45.60 (12.78)	48.37¶ (17.91)	45.77¶ (16.88)	50.29 (18.54)	47.85 (14.69)	44.85 (16.63)	43.63 (15.51)	45.92 (17.21)	48.01 (15.52)	47.73 (17.84)	43.52 (14.57)
<b>BMI</b> (kg/m <sup>2</sup> )	18.60 (3.72)	19.47 (3.78)	20.02¶ (4.72)	20.36¶ (4.94)	20.35 (5.04)	20.25 (4.47)	18.99 (3.93)	19.69 (4.52)	19.59 (4.70)	20.31 (4.43)	19.49 (4.28)	19.64 (4.51)
<b>BMI percentile</b>	50.34 (31.90)	51.24 (31.36)	60.69¶ (30.27)	63.32¶ (29.53)	60.86 (32.79)	56.69 (31.62)	54.81 (29.93)	59.17 (30.46)	60.69 (30.87)	58.81 (29.42)	54.92 (31.23)	57.19 (32.30)
<b>% overweight / obese<sup>1</sup></b>	18.2	11.1	22.4	25.0	24.2	15.9	17.9	23.1	26.0	15.3	17.7	22.2

615 Data are shown as mean (SD).

616 CR, cognitive restraint; UE, uncontrolled eating; EE, emotional eating; BMI, body mass index.

617 <sup>1</sup>Based on the World Health Organization criteria.

618 ¶ = high CR, UE or EE group was significantly different to low CR, UE or EE group

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624 Table 4 – Food preference by sex and CTFEQR17 groups

		CR			UE			EE		
		Low	High	Mean Sex Score	Low	High	Mean Sex Score	Low	High	Mean Sex Score
<b>High Protein Preference</b>	<b>Boys</b>	2.91 (2.96)	2.42 (2.25)	2.59 (2.52)	1.82 (1.98)	3.09 (2.71)	2.59 (2.52)	2.59 (2.92)	2.59 (2.23)	2.59 (2.52)
	<b>Girls</b>	1.19 (1.66)	1.56 (1.82)	1.40 (1.76)*	0.79 (1.03)	2.03 (2.11)	1.40 (1.77)*	0.93 (1.40)	1.83 (1.95)	1.40 (1.76)*
	<b>Mean</b>	1.97	2.03	1.25	2.63	1.71	2.24			
	<b>CTFEQR17 Score</b>	(2.48)	(2.11)	(1.61)	(2.52) ¶	(2.38)	(2.13)			
<b>High Carbohydrate Preference</b>	<b>Boys</b>	3.27 (2.23)	3.24 (2.17)	3.25 (2.19)	2.50 (2.09)	3.74 (2.12)	3.25 (2.19)	3.29 (2.19)	3.22 (2.20)	3.25 (2.19)
	<b>Girls</b>	2.36 (1.96)	3.35 (2.02)	2.92 (2.05)	2.21 (1.93)	3.68 (1.92)	2.93 (2.05)	2.28 (2.13)	3.51 (1.80)	2.92 (2.05)
	<b>Mean</b>	2.77	3.29	2.34	3.71	2.75	3.35			
	<b>CTFEQR17 Score</b>	(2.13)	(2.11)	(2.00)	(2.02) ¶	(2.21)	(2.03) ¶			
<b>High Fat Preference</b>	<b>Boys</b>	3.45 (2.19)	3.51 (2.43)	3.50 (2.34)	2.86 (2.63)	3.90 (2.05)	3.50 (2.34)	3.29 (2.26)	3.63 (2.40)	3.50 (2.34)
	<b>Girls</b>	3.64 (2.47)	3.51 (1.74)	3.57 (2.08)	2.77 (1.38)	4.42 (2.35)	3.58 (2.09)	3.05 (1.61)	4.05 (2.36)	3.57 (2.08)
	<b>Mean</b>	3.56	3.51	2.81	4.13	3.17	3.82			
	<b>CTFEQR17 Score</b>	(2.34)	(2.14)	(2.03)	(2.20) ¶	(1.93)	(2.38) ¶			
<b>Low Energy Preference</b>	<b>Boys</b>	3.25 (2.31)	3.01 (1.82)	3.10 (2.15)	3.28 (2.05)	2.97 (1.97)	3.10 (2.00)	3.45 (2.35)	2.85 (1.70)	3.10 (2.00)
	<b>Girls</b>	2.49 (2.15)	3.59 (2.01)	3.11 (2.14)	2.69 (1.92)	3.56 (2.28)	3.12 (2.14)	2.67 (1.88)	3.51 (2.29)	3.11 (2.14)
	<b>Mean</b>	2.84	3.27	2.96	3.23	3.04	3.15			
	<b>CTFEQR17 Score</b>	(2.25)	(1.92)	(1.99)	(2.13)	(2.13)	(2.01)			

	<i>Score</i>									
<b>LFSA Preference</b>	<b>Boys</b>	0.35 (0.30)	0.32 (0.20)	0.33 (0.24)	0.28 (0.22)	0.36 (0.25)	0.33 (0.24)	0.35 (0.27)	0.32 (0.22)	0.33 (0.24)
	<b>Girls</b>	0.22 (0.21)	0.30 (0.20)	0.26 (0.21)*	0.19 (0.17)	0.34 (0.22)	0.26 (0.21)*	0.20 (0.18)	0.32 (0.21)	0.26 (0.21)*
	<i>Mean</i>	0.28	0.31		0.23	0.35		0.27	0.32	
	<i>CTFEQr17</i>	(0.26)	(0.20)		(0.20)	(0.24) ¶		(0.24)	(0.22)	
	<i>Score</i>									
<b>LFSW Preference</b>	<b>Boys</b>	0.48 (0.33)	0.48 (0.30)	0.48 (0.31)	0.48 (0.31)	0.48 (0.32)	0.48 (0.31)	0.54 (0.35)	0.44 (0.28)	0.48 (0.31)
	<b>Girls</b>	0.41 (0.28)	0.59 (0.28)	0.51 (0.29)	0.48 (0.30)	0.55 (0.29)	0.51 (0.29)	0.47 (0.29)	0.55 (0.29)	0.51 (0.29)
	<i>Mean</i>	0.44	0.53		0.48	0.51		0.50	0.49	
	<i>CTFEQr17</i>	(0.31)	(0.30)		(0.30)	(0.31)		(0.32)	(0.29)	
	<i>Score</i>									
<b>HFSA Preference</b>	<b>Boys</b>	0.36 (0.25)	0.34 (0.27)	0.35 (0.26)	0.25 (0.24)	0.41 (0.26)	0.35 (0.26)	0.34 (0.27)	0.35 (0.26)	0.35 (0.26)
	<b>Girls</b>	0.21 (0.22)	0.28 (0.21)	0.25 (0.22)*	0.17 (0.16)	0.34 (0.23)	0.25 (0.22)*	0.20 (0.19)	0.30 (0.23)	0.25 (0.22)*
	<i>Mean</i>	0.28	0.31		0.21	0.38		0.26	0.33	
	<i>CTFEQr17</i>	(0.24)	(0.25)		(0.21)	(0.25) ¶		(0.24)	(0.25)	
	<i>Score</i>									
<b>HFSW Preference</b>	<b>Boys</b>	0.49 (0.30)	0.46 (0.34)	0.47 (0.33)	0.38 (0.37)	0.53 (0.28)	0.47 (0.33)	0.44 (0.32)	0.49 (0.34)	0.47 (0.33)
	<b>Girls</b>	0.47 (0.39)	0.47 (0.32)	0.47 (0.32)	0.35 (0.21)	0.60 (0.37)	0.47 (0.32)	0.37 (0.25)	0.56 (0.36)	0.47 (0.32)
	<i>Mean</i>	0.48	0.46		0.36	0.56		0.40	0.52	
	<i>CTFEQr17</i>	(0.35)	(0.31)		(0.29)	(0.32) ¶		(0.28)	(0.35) ¶	
	<i>Score</i>									

625 Data are shown as mean (SD).

626

627 CR, cognitive restraint; UE, uncontrolled eating; EE, emotional eating.

628 LFSA, low fat savoury; HFSA, high fat savoury; LFSW, low fat sweet; HFSW, high fat sweet.

629 \* = boys are significantly different to girls.

630 ¶ = high CR, UE or EE group was significantly different to low CR, UE or EE group.

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638 **FIGURE LEGEND**

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640 **Figure 1.** Comparison of percentage correct understanding of items between the original  
641 TFEQr21 and the new CTFEQr17.

642

643 \*Understanding of the CTFEQr17 item is significantly higher than original TFEQr21 ( $p < 0.05$ ).

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