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

ABSTRACT

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

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

SETTING: Primary and secondary schools, UK.

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

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

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

INTRODUCTION

The prevalence of obesity in children and adolescents has reached epidemic proportions worldwide and is associated with many comorbidities [1-3]. Pediatric obesity is closely linked to the so-called "obesogenic" environment where a myriad of factors are conducive to eating too much and not moving enough, thereby promoting weight gain and ultimately overweight and obesity [4, 5]. Among the many factors that explain the susceptibility to gain weight, a better understanding of the link between eating behaviours and weight gain is of crucial importance to overcome the rising rates of obesity.

Obesity interventions have to consider individuals' eating behaviours, especially those that have been associated with obesity and weight gain [6, 7]. For example, dietary restriction can promote overeating in dietary restrained adolescents having disinhibited eating behaviour [8]. Additionally, adolescents with high restrained eating behaviour scores are more likely to gain weight over time [9]. Properly assessing eating behaviours of children and adolescents remains, however, challenging.

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

Despite a significant body of literature regarding the utility of the TFEQ in adults [13 -18], the validity of this TFEQr21 remains to be tested among children and adolescents. Although, Martin-Garcia et al. [19] recently reported a strong association between body composition and Cognitive Restraint in 7-17-year-old Spanish youth using a modified version of the Spanish adult TFEQ. These results highlight the usefulness of the TFEQr21 in children, but only in a limited population. It thus remains important to develop and validate a specific version of the

English TFEQr21 for children and adolescents in order to better characterize their eating behaviour traits and evaluate the impact of obesity interventions in this population.

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

METHODS

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

Phase 1: Development of the CTFEQr17

Participants

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

Qualitative Design

The children took part in one-to-one structured interviews with the researchers. The child was presented with the adult version of the TFEQr21 [13] and was asked whether they understood each item, if they understood how to respond to each question, and asked to put each item into their own words. The interviews allowed the researchers to determine the children's

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

Anthropometric Measurements

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

Phase 2: Validation of the CTFEQr17

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

Validation Design

Children were asked to self-complete the CTFEQr17 and an adapted paper-based Leeds Food Preference Questionnaire (LFPQ), suitable for use with children [21]. The LFPQ consists of a list of common UK foods (e.g., crisps, strawberries, yoghurt, biscuits) and the child was asked to indicate if they would like to consume these foods. Responses were then coded and summed into preference for high protein (8 items), high fat (8 items), high carbohydrate (8 items), and low energy foods (8 items). Mean taste preference scores were also calculated for low fat savoury foods (LFSA: 12 items), low fat sweet foods (LFSW: 5 items), high fat savoury foods (HFSA: 8 items), and high fat sweet foods (HFSW: 7 items).

Anthropometric Measurements

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

Qualitative Design

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

Statistical Analysis

We calculated that a total sample of 338 would be sufficient (1-â = ~0.90, effect size = 0.25, á = 0.05) to run the planned analysis. An exploratory, varimax rotation, principal components factor analysis (PCA) was carried out to determine the factor structure of the CTFEQr17. An item analysis was also conducted to confirm the internal consistency, item-convergent and item-divergent validity of the CTFEQr17 items. Bivariate correlations explored relationships between age and CTFEQr17 factors by sex, and an ANOVA was used to determine differences between sex and age groups (7-10 years and 11-15 years) on each CTFEQr17 factor. Partial correlations, controlling for age, were used to examine relationships between CTFEQr17 factors and anthropometric measurements. Partial correlations, controlling for age and BMI, were also used to explore relationships between CTFEQr17 factors and food and taste preference. Only correlations above 0.20 are reported. Groups were formed using a median split on cognitive restraint (CR), uncontrolled eating (UE) and emotional eating (EE) scale scores to create a low and high CR groups (LCR & HCR), low and high UE groups (LUE & HUE) and low and high EE groups (LEE & HEE). ANCOVAs were used to analyse differences in anthropometric measures (controlling for age) and in food and taste preference (controlling for age and BMI) by sex and eating behaviour groupings. Effect size was measured through Eta^2 (η^2). For the qualitative data, the children's comments were used to determine their level of understanding of each item of the CTFEQr17, and percentages of the correctly understood items were calculated. Understanding of items between phase 1 and 2 was examined using t-

tests. SPSS version 22 was used to conduct the analysis, and the level of statistical significance was set at $p<0.05$ for all analyses.

RESULTS

Phase 1: Development of the CTFEQr17

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

Phase 2: Validation of the CTFEQr17

Structure and Internal Consistency of the CTFEQr17

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

Following an analysis of internal consistency, the CTFEQr17 had a Cronbach's α of 0.85, with the factors of UE ($\alpha = 0.85$) and EE ($\alpha = 0.83$) showing similarly high scores. The factor of CR was ($\alpha = 0.67$) which although lower than UE and EE, was deemed adequate. The item analysis also revealed that the factors had adequate to good inter-item correlations for CR ($r = 0.38$ –

0.47), UE (r = 0.32 – 0.58) and EE (r = 0.36 – 0.59), showing that the items within each scale correlated with one another. The corrected item-total correlations were good; CR (r = 0.46 – 0.52), UE (0.53 – 0.63) and EE (r = 0.55 – 0.70), with the items correlating most strongly with their respective factors, supporting item-discriminant and convergent validity. The factor of UE correlated significantly with EE (r = 0.47, $p<0.001$) only.

Insert Table 1 here

Child*ren's* Understanding of the Items

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

Insert Figure 1 here

Insert Table 2 here

Participant Characteristics and CTFEQr17

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

Insert Table 3 here

CTFEQr17, Body Weight, and BMI

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

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

Insert Table 4 here

CTFEQr17, Food and Taste Preference

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

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

Food preferences were found to differ significantly between the CTFEQr17 groups (see Table 4). ANCOVA revealed that for high protein preference, the HUE group had a higher preference compared to the LUE ($F(1, 241) = 17.74$, $p<0.001$, $\eta^2 = 0.07$). Boys consistently showed a higher protein preference, regardless of CR, UE and EE groups ($F(1, 242) = 20.09$, $p<0.001$, $\eta^2 = 0.08$; $F(1, 241) = 14.98$, $p<0.001$, $\eta^2 = 0.06$; $F(1, 242) = 18.28$, $p<0.001$, $\eta^2 = 0.07$,

respectively). Both the HUE and HEE groups reported a greater preference for high fat ($F(1, 241) = 16.79$, $p<0.001$, $\eta^2 = 0.07$ and $F(1, 242) = 5.45$, $p<0.05$, $\eta^2 = 0.02$ respectively) and high carbohydrate foods ($F(1, 241) = 16.85$, $p<0.001$, $\eta^2 = 0.07$ and $F(1, 242) = 4.63$, $p<0.05$, $\eta^2 = 0.02$, respectively). No differences were found for preference for low energy foods. Age was a significant covariate throughout the analyses ($p<0.001$).

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

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

The CTFEQr17 groups also discriminated between taste preferences (see Table 4). The ANCOVA revealed that irrespective of CR, UE or EE group, boys consistently had higher preferences for LFSA foods ($F(1, 241) = 6.50$, $p<0.05$, $\eta^2 = 0.03$; $F(1, 240) = 4.23$, $p<0.05$, $\eta^2 = 0.02$; $F(1, 241) = 6.02$, $p<0.05$, $\eta^2 = 0.02$) and HFSA foods ($F(1, 242) = 9.44$, $p<0.01$, $\eta^2 = 0.04$; $F(1, 241) = 6.70$, $p = 0.01$, $\eta^2 = 0.02$; $F(1, 242) = 8.71$, $p<0.01$, $\eta^2 = 0.04$, respectively). The HUE group had a higher preference for LFSA foods ($F(1, 240) = 9.24$, $p<0.01$, $\eta^2 = 0.04$). In addition, those with a HUE and HEE had a higher preference for HFSA foods ($F(1, 240) = 18.66$, $p<0.001$, $\eta^2 = 0.09$; $F(1, 242) = 3.62$, $p = 0.058$, $\eta^2 = 0.02$) and HFSW foods ($F(1, 241) = 18.60$, $p<0.001$, $\eta^2 = 0.07$; $F(1, 242) = 8.45$, $p<0.01$, $\eta^2 = 0.03$). Age was a significant covariate throughout the analyses ($p<0.001$).

DISCUSSION

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

CTFEQr17 and Anthropometric Measures

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

Although the goal conflict theory supports our results, conflicting evidence exists, as restrained eating has also been associated with lower food intake and better weight regulation [e.g. 26-28]. This suggests that some individuals are better able to maintain their weight control goal in comparison to their eating enjoyment goal. Thus, the relationship between CR and weight is complex, and CR likely interacts with other eating behaviour traits (e.g. Disinhibition) to produce differing influences upon body weight [6;29]. That CR was associated with a higher

316 weight and BMI in this child and adolescent sample supports a large body of adolescent and
317 adult data, suggesting the CTFEQr17 has successfully measured this psychological construct.

318

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

331

332 **CTFEQr17, Food and Taste Preference**

333 Higher preferences for HFSA, HFSW, high carbohydrate and high fat foods were evident in
334 those children who were characterised with higher UE and EE scores; this relationship was
335 particularly strong in girls. This taste preference pattern reflects evidence from adult
336 populations, which have shown a higher preference for high fat foods in UE and EE adults [34].
337 A preference for HFSW foods in individuals with a high EE has also been found to be
338 particularly strong in women compared to men [34]. This indicates that the taste preferences,
339 and associated sex differences, found in adults are also found in children and adolescents,
340 suggesting these preferences begin in childhood and persist into adulthood. Furthermore, UE
341 and EE are characterised by eating in response to the palatability of food, eating
342 opportunistically and eating in response to negative affect. Individuals with a HUE and HEE
343 report a higher preference for high fat (savoury and sweet) and high carbohydrate foods [34;35].
344 These foods typically reflect highly palatable, energy dense foods (e.g. crisps, sausage roll,
345 biscuits, cakes). Due to their macronutrient content, these foods have a relatively low satiating
346 ability [36], and eating them can result in passive overconsumption [37], increasing vulnerability

to future weight gain [38]. Indeed, this is reflected in adult data where UE and EE are related to higher body weight [32;33].

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

Strengths and Limitations

A strength of this study is that the CTFEQr17 was both statistically and qualitatively verified as valid. The development of the CTFEQr17 involved creating accessible items by using the children/adolescent's own phraseology ascertained from interviews. This produced a questionnaire that was highly understandable for children and adolescents. However, although associations between the CTFEQr17 and food and taste preference were found, measurement of actual food intake was not carried out. Food preferences and the relationship between 'liking' and 'wanting' of foods have been found to be related to food intake [45] and also associated with TFEQ factors in adults [e.g. 46], thus an examination of this relationship in children and adolescents would be beneficial. A further limitation of the study is that body composition was not assessed; with research suggesting measurement of actual body composition is more accurate in determining relevant relationships than BMI [47, 48]. Research by Martin-Garcia et al., [19] also found an association between fat mass and CR in children and adolescents, therefore further exploration of this is of interest. Furthermore, although our sample size was adequate for the intended analysis, there were a larger proportion of secondary

school children; further consideration of the CTFEQr17 in primary school children would be interesting. However, our sample did reflect that which was used to validate the Spanish TFEQr21C [19].

CONCLUSION

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

APPENDIX 1

The items have been coded as in the original TFEQr21 [13].

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

2. I start to eat when I feel worried: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

3. Sometimes when I start eating, it seems I can't stop: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

4. When I am sad, I usually eat too much: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

5. I don't eat some kinds of food because they can make me fat: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

6. When I am next to someone who is eating, I also feel like eating: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

7. When I feel angry, I need to eat: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

8. I often get so hungry that I feel like I could eat loads of food without getting full: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

9. When I am hungry, I feel like to have to eat all of the food on my plate in one go, without stopping: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

10. When I feel lonely, I make myself feel better by eating: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

11. I eat less than I want at meal times to stop myself putting on weight: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

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: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

13. I'm always hungry enough to eat at any time: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

14. If I feel nervous, I try to calm myself down by eating: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

15. When I see something that looks delicious, I get so hungry that I have to eat it right away: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

16. When I feel really upset, I want to eat: Totally true (4); Mostly true (3); Mostly false (2); Totally false (1).

17. How often do you feel hungry? Only at mealtimes (1); Sometimes between meals (2); Often between meals (3); Almost always (4).

REFERENCES

1. The GBD 2015 Obesity Collaborators (2017) Health Effects of Overweight and Obesity in 195 Countries over 25 Years. The New Eng. J. Med. Published online 12th June 2017: DOI: 10.1056/NEJMoa1614362
2. Ogden CL, Lamb MM, Carroll MD et al. (2010) Obesity and socioeconomic status in children and adolescents: United States, 2005-2008. NCHS Data Brief. **51**, 1-8.
3. Cattaneo A, Monasta L, Stamatakis E et al. (2010) Overweight and obesity in infants and pre-school children in the European Union: a review of existing data. Obes Rev. **11**, 389-98.
4. Swinburn, B., Egger, G., & Raza, F. (1999) Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. Prev. Med. **29**, 563–570.
5. Swinburn BA, Sacks G, Hall KD et al. (2011) The global obesity pandemic: shaped by global drivers and local environments. Lancet. **378**, 804-14.
6. Gallant AR, Tremblay A, Perusse et al. (2010) The Three-Factor Eating Questionnaire and BMI in adolescents: results from the Que´bec Family Study. Brit. J. Nutr. **104**, 1074-9.
7. Chaput JP, Leblanc C, Pérusse L et al. (2009) Risk factors for adult overweight and obesity in the Quebec Family Study: have we been barking up the wrong tree? Obesity. **17,** 1964-70.
8. van Strien T, Herman CP, Verheijden MW (2012) Eating style, overeating and weight gain. A prospective 2-year follow-up study in a representative Dutch sample. Appetite. **59**, 782-9.
9. Snoek HM, Engels RC, van Strien T et al (2013) Emotional, external and restrained eating behaviour and BMI trajectories in adolescence. Appetite. **67**, 81-7.
10. Polivy J, & Herman, CP (1976) Effects of alcohol on eating behavior: influence of mood and perceived intoxication. J. Abnorm. Psych. **85**, 601.
11. Meyer JE, & Pudel VE (1977). Experimental feeding in man: a behavioral approach to obesity. Psych. Med. **39**, 153-157.
12. Bryant EJ, King NA & Blundell JE (2008) Disinhibition: its effect on appetite and weight regulation. Ob. Rev. **9**, 409-419.
13. Cappelleri JC, Bushmakin AG, Gerber RA et al. (2009) Psychometric analysis of the Three-Factor Eating Questionnaire-R21: results from a large diverse sample of obese and non-obese participants. Int. J. Obes. **33**, 611–620.

14. Karlsson J, Persson LO, Sjostrom L et al. (2000) Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. Int. J. Obes. **24,** 1715–1725.
15. Stunkard AJ, & Messick S (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. J. Psychosom. Res. **29**, 71-83.
16. Karakuş SŞ, Yıldırım, H, & Büyüköztürk Ş (2016) Adaptation of three factor eating questionnaire (TFEQ-R21) into Turkish culture: A validity and reliability study. TAF Prevent. Med. Bull. **15**, 229-237.
17. Drapeau V, Depres JP, Bouchard C et al (2004) Modifications in food-group consumption are related to long-term body-weight changes. Am. J. Clin. Nutr. **80**, 29-37.
18. de Medeiros ACQ, Yamamoto ME, Pedrosa LFC et al. (2016). The Brazilian version of the three-factor eating questionnaire-R21: psychometric evaluation and scoring pattern. Eat. Weight Dis. **22**, 169-175.
19. Martín-García M, Vila-Maldonado S, Rodríguez-Gómez I, et al. (2016) The Spanish version of the Three Factor Eating Questionnaire-R21 for children and adolescents (TFEQ-R21C): Psychometric analysis and relationships with body composition and fitness variables. Physiol Behav. **165**, 350-7.
20. de Onis M, Onyango AW, Borghi E et al. (2007) Development of a WHO growth reference for school-aged children and adolescents. Bull. WHO. **85**, 660-67.
21. Halford JCG, Boyland E J, Cooper GD et al. (2008) Children's food preferences: Effects of weight status, food type, branding and television food advertisements (commercials). Int. J.Ped. Obes. **3**, 31-38.
22. Halberstadt J, van Strien T, de Vet E et al. (2016) The association of eating styles with weight change after an intensive combination lifestyle intervention for children and adolescents with severe obesity. Appetite. **99**, 82-90.
23. Stroebe W, van Koningsbruggen GM, Papies EK et al. (2013) Why most dieters fail but some succees: A goal conflict model of eating behavior. Psych. Rev. **120**, 110-138.
24. Veling H, Aarts H, & Papies EK (2011) Using stop signals to inhibit chronic dieters' responses toward palatable foods. Beh. Res. & Therapy. **49**, 771-780.
25. van Strien T, Herman CP, Verheijden MW (2014) Dietary restraint and body mass change. A 3-year follow-up study in a representative Dutch sample. Appetite. **76**, 44-49.

502 26. Kemps E, Herman CP, Hollitt S et al. (2016) The role of expectations in the effect of
503 food exposure on food intake. Appetite. **103**, 259-264.
504 27. Graham A, Gluck ME, Votruba SB et al (2014) Perseveration augments the effect of
505 cognitive restraint on ad libitum food intake in adults seeking weight loss. Appetite.
506 **82**, 78-84.
507 28. Roberts CJ, Campbell IC & Troop N (2013) Increases in weight during chronic stress
508 are partially associated with a switch in food choice towards increased carbohydrate
509 and saturated fat intake. Euro. Eating Dis. Rev. **22**, 77-82.
510 29. Bryant EJ, Kiezebrink K, King NA et al (2010) Interaction between disinhibition and
511 restraint: implications for body weight and eating disturbance. Eat. Weight Disord.
512 **15**, e43 – e51.
513 30. Angle S, Engblom J, Eriksson T et al (2009) Three Factor Eating Questionnaire R18
514 as a measure of cognitive restraint, uncontrolled eating and emotional eating in a
515 sample of young Finnish females. Int. J. Beh. Nutr & Phys. Activity. **6**, 41-48.
516 31. de Lauzon B, Roman M, Deschamps V et al (2004) The Three Factor Eating
517 Questionnaire R18 is able to distinguish among different eating patterns in the general
518 population. Am. Soc. Nutr. Sci. **134**, 2372-2380.
519 32. Konttinen H, Haukala A, Sarlio-Lahteenkarva S et al (2009) Eating styles, self-
520 control and obesity indicators. The moderating role of obesity status and dieting
521 history on restrained eating. Appetite. **53**, 131-134.
522 33. Green GW, Schembre SM, White AA et al. (2011) Identifying clusters of college
523 students at elevated health risk based on eating and exercise behaviors and
524 psychosocial determinants of body weight. J. Am. Dietetic Assoc. **111**, 394-400.
525 34. Keskitalo K, Tuorila H, Spector TD et al (2008) The Three Factor Eating
526 Questionnaire, body mass index, and responses to sweet and salty fatty foods: a twin
527 study of genetic and environmental associations. Am. J. Clin. Nutr. **88**, 263-71.
528 35. Camilleri GM, Mejean C, Kesse-Guyot E et al. (2014) The associations between
529 emotional eating and consumption of energy-dense snack foods are modified by sex
530 and depressive symptomology. J. Nutr. doi: 10.3945/jn.114.193177.
531 36. Gerstein DE, Woodward-Lopez G, Evans AE et al. (2004) Clarifying concepts about
532 macronutrients' effects on satiation and satiety. J. Am. Diet. Assoc. **104**, 1151-1153.
533 37. Westerterp KR (2006) Perception, passive overfeeding and energy metabolism. Phys.
534 Behav. **89**, 62-65.

38. Blundell JE & MacDiarmid JI (1997) Fat as a risk factor for overconsumption: satiation, satiety and patterns of eating. J. Am. Diet. Assoc. **97**, S63-S69.
39. Caine-Bish NL & Scheule B (2009) Gender differences in food preferences of school-aged children and adolescents. J. Sch. Health. **79**, 532-540.
40. Arganini C, Saba A, Comitato F, Turrini A (2012) Gender differences in food choice and dietary intake in modern western societies. Public Health – Social and Behavioral Health. Chapter 4. Intech: open science.
41. Vagstrand K, Linne Y, Karlsson J et al (2009) Correlates of soft drink and fruit juice consumption among Swedish adolescents. Brit. J. Nutr. **101**, 1541-1548.
42. Peneau S, Menard E, Mejean C et al. (2013) Sex and dieting modify the association between emotional eating and weight status. Am. Soc. Nutr. **97**, 1307-1313.
43. Hainer V, Kanesova M, Bellisle F et al. (2006) The Eating Inventory, body adiposity and prevention of diseases in a quota of Czech adults. Int. J. Obes. **30**, 830-36.
44. Provencher V, Drapeau V, Tremblay A et al (2003) Eating behaviors and indices of body composition in men and women from the Quebec family study. Obes. Res. **11**, 783-792.
45. Finlayson G, Dalton M (2012) Current progress in the assessment of 'liking' vs. 'wanting' food in human appetite. Comment on "'You say it's liking, i say it's wanting...". On the difficulty of disentangling food reward in man'. Appetite. **58**, 373-378.
46. Finlayson G, Bordes I, Griffioen-Roose S et al. (2012) Susceptibility to Overeating Affects the Impact of Savory or Sweet Drinks on Satiation, Reward, and Food Intake in Nonobese Women. Am. Soc. Nutr. **142**, 125-130.
47. Prentice AM, and Jebb SA (2001) Beyond body mass index. *Ob. Rev*. **2**, 141-147.
48. Wells JCK, Coward WA, Cole TJ *et al.* (2002) The contribution of fat and fat-free tissue to body mass index in contemporary children and the reference child. *Int. J. Obes. Rel. Metab. Dis.* **26**, 1323-1329.

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	0.70			0.53

hungry that I have to eat it right away.				
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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600 **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)

601 Data are presented as mean (SD).

602 CR, cognitive restraint; UE, uncontrolled eating; EE, emotional eating.
603 *Boys have a significantly higher UE score compared to girls ($p<0.001$).
604 #Younger children have a significantly higher CR and UE compared to older children
605 ($p<0.01$).

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

	Low CR		High CR		Low UE		High UE		Low EE		High EE	
	Boys (n = 48)	**Girls** (n = 55)	**Boys** (n = 82)	**Girls** (n = 66)	**Boys** (n = 48)	**Girls** (n = 55)	**Boys** (n = 82)	**Girls** (n = 66)	**Boys** (n = 48)	**Girls** (n = 55)	**Boys** (n = 82)	**Girls** (n = 66)
Weight (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)
BMI (kg/m^2)	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)
BMI percentile	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)
% overweight / obese[1]	18.2	11.1	22.4	25.0	24.2	15.9	17.9	23.1	26.0	15.3	17.7	22.2

Data are shown as mean (SD).

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

[1]Based on the World Health Organization criteria.

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

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617 **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**
High Protein Preference	**Boys**	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)
	Girls	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)*
	Mean CTFEQr17 Score	1.97 (2.48)	2.03 (2.11)		1.25 (1.61)	2.63 (2.52) ¶		1.71 (2.38)	2.24 (2.13)	
High Carbohydrate Preference	**Boys**	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)
	Girls	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)
	Mean CTFEQr17 Score	2.77 (2.13)	3.29 (2.11)		2.34 (2.00)	3.71 (2.02) ¶		2.75 (2.21)	3.35 (2.03) ¶	
High Fat Preference	**Boys**	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)
	Girls	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)
	Mean CTFEQr17 Score	3.56 (2.34)	3.51 (2.14)		2.81 (2.03)	4.13 (2.20) ¶		3.17 (1.93)	3.82 (2.38) ¶	
Low Energy Preference	**Boys**	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)
	Girls	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)

	Mean CTFEQr17 Score	2.84 (2.25)	3.27 (1.92)		2.96 (1.99)	3.23 (2.13)		3.04 (2.13)	3.15 (2.01)	
LFSA Preference	**Boys**	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)
	Girls	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)*
	Mean CTFEQr17 Score	0.28 (0.26)	0.31 (0.20)		0.23 (0.20)	0.35 (0.24) ¶		0.27 (0.24)	0.32 (0.22)	
LFSW Preference	**Boys**	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)
	Girls	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)
	Mean CTFEQr17 Score	0.44 (0.31)	0.53 (0.30)		0.48 (0.30)	0.51 (0.31)		0.50 (0.32)	0.49 (0.29)	
HFSA Preference	**Boys**	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)
	Girls	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)*
	Mean CTFEQr17 Score	0.28 (0.24)	0.31 (0.25)		0.21 (0.21)	0.38 (0.25) ¶		0.26 (0.24)	0.33 (0.25)	
HFSW Preference	**Boys**	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)
	Girls	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)
	Mean CTFEQr17 Score	0.48 (0.35)	0.46 (0.31)		0.36 (0.29)	0.56 (0.32) ¶		0.40 (0.28)	0.52 (0.35) ¶	

Data are shown as mean (SD).

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

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

* = boys are significantly different to girls.

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

FIGURE LEGEND

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

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