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ARTICLE

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Pathways to eating in children and adolescents with obesity

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Abstract

Background Paediatric obesity management remains generalised to dietary and exercise modifications with an under-appreciation for the contributions of eating behaviours and appetitive traits in the development of obesity.

Objectives To determine whether treatment-seeking children and adolescents with obesity cluster into phenotypes based on known eating behaviours and appetitive traits ("eating correlates") and how socio-demographic and clinical characteristics associate with different phenotypes.

Methods A cross-sectional, multi-centre questionnaire was administered between November 2015 and March 2017 examining correlates of eating in children and adolescents attending weight-management programmes in Canada. Latent profile analysis was used to cluster participants based on seven eating correlate scores obtained from questionnaires. Analysis of variance (ANOVA) was used to determine phenotype differences on socio-demographic and clinical characteristics. Multinomial logistic regression models assessed relative risk of specific characteristics associating with a disordered eating phenotype.

Results Participants were 247 children and adolescents (45.3% male, mean BMI z-score $= 3.4 \pm 1.0\,\mathrm{kg/m^2}$) from six paediatric weight management centres in Canada. Seven eating correlates clustered into three distinct phenotypes: (1) loss of control eating, emotional eating, external eating, hyperphagia, impulsivity ("Mixed-Severe"; $n = 42$, 17%), (2) loss of control eating, emotional eating, external eating, hyperphagia ("Mixed-Moderate"; $n = 138$, 55.9%), and (3) impulsivity ("Impulsive"; $n = 67$; 27.1%). Social functioning scores and body esteem were significantly different across groups, with the Mixed-Severe participants having the poorest social functioning and lowest body esteem. Low body esteem indicated a greater risk of being in a multi-correlate group compared to the Impulsive group, while poor social function had a greater risk of clustering in the Mixed-Severe than Impulsive phenotype.

Conclusions Distinct eating phenotypes were found in treatment-seeking children and adolescents with obesity. Empirical evidence is needed, but these data suggest that tailored treatment approaches could be informed by these classifications to improve weight-management outcomes.

Introduction

Recommendations for paediatric obesity management remain general and do not account for the heterogeneous factors that contribute to excess weight gain [1]. Guidelines to treatment include family-centred lifestyle modifications related to diet, physical activity, and behaviour [1]. There is increasing recognition that the limited effectiveness of obesity treatment and extensive variability in outcomes may be due to heterogeneous causes promoting excess weight gain [2]. Furthermore, evidence has accumulated over the past decade regarding the potential of precision medicine to inform therapeutic interventions in obesity [3].

Indeed, contrasting features of eating behaviours and appetitive traits ("eating correlates") have been documented between children with and without obesity [4–6], suggesting physiological and psychological variations corresponding to weight. Reported individual correlates of overeating include loss of control eating (LOC), emotional eating, external eating (e.g. food cues), restrained eating, hyperphagia, impulsivity, and inattention [7–11], some of

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which have been correlated with eating disorders [12]. These individual correlates are important to study for the following reasons: (1) The volume of literature available on LOC indicates that it is the most common eating correlate studied in overweight children; [8] (2) Emotional, external and restrained eating are often studied together using the same questionnaire which was validated in individuals with overweight and obesity; [13] (3) Hyperphagia has been studied primarily in several populations with syndromic obesity, the most common of which is Prader–Willi Syndrome; [14] and, (4) More recently, impulsivity and inattention have been increasingly studied in children who are overweight or obese [9]. Most studies in children and adolescents with obesity have focused on describing the prevalence of a single eating correlate, highlighting the need for a more comprehensive approach to this issue.

There is limited research examining multifactorial phenotypes based on eating correlates in paediatric populations. One study examined emotional eating, eating in the absence of hunger, and objective and subjective binge eating in children across the weight spectrum [15]. The study found five phenotypic groups, including a group characterised by emotional eating and eating in the absence of hunger, and two others with strictly LOC concerns. Two studies have specifically included children with overweight and obesity [16, 17]. One study examined emotional eating, eating in the absence of hunger, and objective and subjective binge eating and found that the largest of four groups had shape and weight concerns, while one third of participants had no eating disorder pathology [17]. The other found three significant phenotypic clusters which varied in response to internal satiety and external food cues based on questions related to sensitivity to food cues, satiety, and eating in the absence of hunger [16]. Considering the complexities of the underlying factors contributing to excess weight gain, and the limited number of eating correlates explored in combination, further research is needed to understand eating correlates in children and adolescents with obesity so that targeted interventions can be developed.

Accordingly, the aims of this study were to: (i) determine how eating correlates (LOC, emotional eating, external eating, restrained eating, hyperphagia, impulsivity, and inattention) cluster into specific phenotypes and (ii) explore how identified eating phenotypes are associated with socio-demographic and clinical characteristics in children and adolescents with obesity. It was hypothesised that eating correlates would cluster into several eating phenotypes in children and adolescents with obesity, with LOC predominantly affecting the population. It was also expected that differences in socio-demographic and clinical characteristics between phenotypes would be found.

Participants and Methods

Participants

Study participants were recruited between November 2015 and March 2017 from the CANadian Pediatric Weight-management Registry (CANPWR) study, a prospective, multi-centre cohort study. CANPWR collects anthropometric, lifestyle, and behavioural measures from children, adolescents, and parents who have entered a paediatric, interdisciplinary weight management clinic. The overall aim of CANPWR is to evaluate anthropometrics and obesity-related co-morbidities over time in 2–17 year olds with a BMI ≥85th percentile [18].

The present cross-sectional study is a substudy of CANPWR. In this study, questionnaires examining eating correlates were added to the data being collected in CANPWR. Inclusion criteria included (i) enrolment in a participating CANPWR centre (6 sites from Alberta and Ontario, Canada), (ii) young people between 10–18 years of age with a BMI ≥85th percentile, and (iii) English-speaking. Exclusion criteria included significant developmental delay, learning disability, or acute mental health crisis (e.g. acute psychosis) precluding completion of the self-report questionnaires.

Study design and plan

(a) CANPWR recruitment and visits: eligible families were approached before commencing treatment at one of the participating programmes. After obtaining informed consent, data were collected at a baseline visit, and at 6, 12, 24 and 36-month follow-up time points. At each visit, a case report form was completed. This included data relevant to the current substudy, consisting of demographic information, eating environment and exercise habits, measured anthropometrics (e.g. height, weight), self-report questionnaires (see measures below), and medical and mental health diagnoses from the medical chart.

(b) Substudy recruitment and visits: Patients approached for enrolment in CANPWR at their baseline visit to the clinic who also met the substudy eligibility criteria were consented at the same time. Data collected from the larger CANPWR study were used in the substudy analysis. Substudy participants completed additional questionnaires related to eating behaviours and appetitive traits.

Research ethics board approval and consent/assent from patients and consent from parents were obtained at each site.

Measures

Measures to assess eating correlates

Age-appropriate and validated measures were used to assess eating correlates (see below), capturing a variety of appetitive traits and eating behaviours. These questionnaires were administered as part of a clinical assessment but were not used for diagnostic or screening purposes.

Loss of control eating (LOC) is the subjective feeling of being unable to stop eating irrespective of the amount of food in question and is the central component of binge eating, a well-recognised eating behaviour in adults and children [8]. The Eating Disorder Examination Questionnaire (EDE-Q) is a commonly used self-report questionnaire that measures an array of eating behaviours and attitudes and is validated in children and adolescents ages 9–19 years [19, 20]. Questions from the EDE-Q related to LOC (objective or subjective overeating with loss of control) over the past 14 days, which was a recall period that has previously been reported [21, 22]. LOC was used as a continuous variable as the sum of number of events (subjective and objective LOC).

Emotional eating is a coping method to deal with negative emotions, such as depression, loneliness, worrying, anxiety, and anger. External eating describes a heightened stimulation of senses to environmental food cues, such as sights and smells, leading to food intake. Restrained eating is a cognitive method of setting limits and boundaries to food intake for weight loss purposes. The Dutch Eating Behaviours Questionnaire for Children (DEBQ-C) is a validated 20-item, self-report questionnaire that measures emotional eating, external eating, and restrained eating [23, 24]. Items are scored on a 5-point Likert scale (0 = never to 4 = always) [25]. Higher numbers represent worse symptoms.

Hyperphagia describes a constant state of excessive hunger and associated preoccupation with food-seeking. The Hyperphagia Questionnaire (HQ) is a parent for-child report questionnaire that measures hyperphagic behaviour, drive, and severity [14]. It was originally validated in children with Prader Willi Syndrome (PWS), but has previously been used to assess hyperphagic symptoms in other paediatric populations [14, 26–28]. A total score can be calculated, with higher scores representing a greater degree of hyperphagia.

Impulsivity, a key component of attention deficit hyperactivity disorder (ADHD), characterises the propensity towards rash decision-making and decreased planned actions, with lack of consideration to negative consequences. Inattention is another important element of ADHD. The Strengths and Weaknesses of ADHD Symptoms and Normal Behaviour Scale (SWAN) is a parent report for-child questionnaire evaluating symptoms related to ADHD [29–31]. Items on the SWAN are rated on a 7-point scale (−3 to +3), with average behaviour rated zero. Positive scores indicate the child is worse than average in ADHD symptoms and negative scores signify above average strengths. For the purpose of this analysis, both the inattention and hyperactive-impulsive subscales were used.

Socio-demographic and clinical measures

Demographic variables were collected by each CANPWR site, including child's age, self-reported ethnicity and sex. Household demographic characteristics were recorded, including socioeconomic status (based on parent report of total household income) and living arrangement (child living in one or multiple residences and with one or more than one parental figure). Height and weight were measured using hospital scales and stadiometers, calibrated for clinical use, at the sites according to individual clinic protocols and BMI and BMI z-scores were calculated based on WHO criteria [32]. Indices related to location and timing of meals were collected, including self-reported frequency of eating out or ordering in meals, meals with family, meals in front of the television, and eating breakfast. These questions were taken from the Canadian Health Measures Survey, so comparison with national representative data is possible [33]. Data on medication use was also collected from the parents by the research staff at each site. Specific notation was made of medications known to be associated with changes in appetite (anti-depressants/anxiolytics, anti-psychotics and medications for ADHD).

Research assistants ascertained medical and mental health diagnoses (depression, anxiety, ADHD and other mental health disorders) from the physician and psychologist notes in the medical record at the time of the study visit. Social functioning was measured from the Pediatric Quality of Life child self-report questionnaire [34]. Questions capture self-reported problems over the previous month with peers and teasing, with higher scores indicating poorer social function. The Body Esteem Scale for Adolescents and Adults (BESAA) – shortened version (10-item self-report) was administered to obtain information related to weight and shape concerns [35]. Higher scores on the BESAA indicate higher body esteem.

Statistical analysis

Descriptive statistics (mean ± SD and frequency) were used to measure socio-demographic and clinical characteristics of the participants and their families.

Latent profile analysis (LPA) was used to determine the number of 'phenotypes' that can be derived from the eating correlates of interest (indicator variables). LPA assigns

membership to a 'latent' class from patterns of inter-relationships among indicator variables. Multiple modelling methods were compared to determine the best fitting model, which included latent classes (phenotypes) that were distinct from each other, but with the highest amount of similarity within each phenotype [36]. A priori determination of sample size is not possible for LPA; [37] however, other studies using LPA have used sample sizes ranging from 117 to 411 [15, 16, 38]. The modelling indices used in this analysis were Bayesian Information Criterion (BIC), sample size adjusted BIC (aBIC), and bootstrap likelihood ratio test (BLRT) [36].

Once the best-fitting model was identified, participants were assigned to the phenotype that most closely resembled their eating correlate scores (posterior probability) using Expectation-Maximisation method assuming Gaussian mixture models. F-test analysis of variance (ANOVA) or Kruskal–Wallis non-parametric test was then used to compare mean or median eating correlate scores among phenotypes. Post-hoc pairwise comparisons of mean or median scores of eating correlates between phenotypes were performed using *t*-tests or Mann–Whitney tests. In each significant comparison between phenotypes, the phenotype with the higher mean or median eating correlate score indicating more severe symptoms was determined to include that eating correlate in its eating profile.

Subsequently, socio-demographic and clinical characteristics were compared between phenotypes. Continuous variables were assessed using ANOVA, categorical variables were tested using X^2 or Fisher's exact test, and non-normally distributed variables were analyzed based on medians using Kruskal–Wallis test.

Multinomial logistic regression models then assessed the relative risk of membership to a complex disordered eating phenotype based on socio-demographic and clinical characteristics. Variables with p values <0.2 in univariate analysis and deemed clinically relevant were included in the full model [39]. The cluster with the least disordered phenotype was used as a reference group.

For any test, statistical significance was determined at $p < 0.05$. LPA analysis was conducted using R version 3.2.5 and the remaining statistics were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Socio-demographic and clinical characteristics

Demographic characteristics of participants and their families are presented in Table 1. In total, 247 participants (45.3% male) between 10.1 and 17.8 years of age (mean age = 13.85 ± 2.13) were included in the analysis. The self-identified ethnic/cultural background of the population was 70.0% White. Participants' mean BMI was 35.2 ± 7.7 kg/m^2, with a BMI *z*-score of 3.35 ± 0.98. Six out of ten CANPWR sites participated in the study and included the following sample sizes from each site: McMaster Children's Hospital, Hamilton, ON ($n = 81$), Hospital for Sick Children, Toronto, ON ($n = 43$), Children's Hospital of Eastern Ontario, Ottawa, ON ($n = 30$), Alberta Children's Hospital, Calgary, AB ($n = 46$), Credit Valley Hospital, Mississauga, ON ($n = 35$), Stollery Children's Hospital, Edmonton, AB ($n = 12$).

Identification of eating phenotypes

Scores for each of the seven eating correlates of interest are provided in Table 2. LPA was conducted and best-fitting model was assigned using three recommended indices [36] (Table 3). The overall model was chosen based on a combination of model fit indices and number of individuals in each phenotype. Examination of the results from the LPA determined that a model including three phenotypes was most appropriate. The three-phenotype model had robust group sizes. The eating correlate profile for the three phenotypes is displayed in Table 2.

To further define the phenotypes by their eating correlates, a comparison between eating phenotypes was assessed (Table 2), which showed that LOC, emotional eating, external eating, hyperphagia and impulsivity were significantly different between phenotypes (all $p < 0.05$). Results from post-hoc analysis are presented in Table 2. The first phenotype ($n = 42$; 17%) was characterised by significant LOC symptoms, emotional eating, external eating, hyperphagia and impulsivity (termed "Mixed-Severe").

Table 1 Socio-demographic and clinical characteristics of participants and their families

Characteristic	Summary statistics: $n = 247$
Age (y): mean (SD)	13.85 (2.13)
Range (min, max)	10.05, 17.82
Sex (male): *n* (%)	112 (45.3)
BMI (kg/m^2)[a]: mean (SD)	35.2 (7.7)
Range (min, max)	22.6, 71.1
BMI *z*-score[a]: mean (SD)	3.4 (1.0)
Range (min, max)	1.3, 7.9
Ethnicity: n *(%)*	
White	173 (70.0)
Black	18 (7.3)
Latin American	9 (3.6)
Other	59 (23.9)

SD standard deviation, *BMI* body mass index

[a]$n = 246$

Table 2 Eating correlate scores for the total sample and for each phenotype in the 3-class model

Eating correlate	Possible scoring range	Total sample mean (SD)	Total sample median	Total sample range (min, max)	Mixed-severe ($n = 42$)	Mixed-moderate ($n = 138$)	Impulsive ($n = 67$)	p-value
Loss of control eating[1]	$0 \rightarrow \infty$	1.88 (4.45)	0	(0, 43)	6 [3, 10]	0 (0, 2)	0 (0, 0)	<0.001[a,b,c]
Emotional eating[1]	$7 \rightarrow 35$	13.62 (6.05)	12	(7, 35)	20 (14, 24)	14 (9, 17)	9 (7, 11)	<0.001[a,b,c]
External eating[2]	$6 \rightarrow 30$	16.24 (4.96)	16	(6, 30)	19.1 ± 5.0	16.9 ± 4.7	13.2 ± 3.9	<0.001[b,c,d]
Restrained eating[2]	$7 \rightarrow 35$	17.96 (5.09)	18	(7, 34)	17.2 ± 4.0	17.6 ± 4.7	19.2 ± 6.2	0.067
Hyperphagia[1]	$11 \rightarrow 55$	22.32 (8.05)	22	(6, 49)	29 (22, 34)	22 (16, 28)	16 (13, 23)	<0.001[a,b,c]
Impulsivity[1]	$-27 \rightarrow +27$	−1.72 (9.68)	0	(−27, 25)	1.5 (−3, 6)	−1 (−11, 3)	1 (0, 4)	<0.001[c,d]
Inattention[1]	$-27 \rightarrow +27$	1.06 (9.91)	1	(−27, 27)	2 (−10, 7)	0.5 (−6, 10)	1 (0, 5)	0.722

Results presented as mean (±standard deviation (SD)) or median (interquartile range)

Results from pairwise comparisons of means or medians of eating correlates between phenotypes: a = Mixed-Severe vs Mixed-Moderate $p < 0.001$; b = Mixed-Severe vs Impulsive $p < 0.001$; c = Mixed-Moderate vs Impulsive $p < 0.001$; d = Mixed-Severe vs Mixed-Moderate $p = 0.009$

[1]Kruskal–Wallis test

[2]F-test (ANOVA)

Table 3 Model fit indices

No of latent class	BIC	aBIC	AIC	BLRT
1	11233.33	11315.21	5590.25	
2	10950.52	11102.59	5426.21	549.51 (0.001)
3	10988.35	11210.59	5422.48	187.26 (0.001)
4	11033.38	11325.82	5422.36	19.27 (0.988)
5	11124.18	11486.78	5445.11	218.17 (0.001)
6	11184.14	11616.93	5452.45	-18.38 (0.508)
7	11274.07	11777.05	5474.78	95.05 (0.001)
8	11306.54	11879.69	5468.37	27.90 (0.559)

The second phenotype, ($n = 138$; 55.9%) was characterised as having some LOC, emotional eating, external eating, and hyperphagia (termed "Mixed-Moderate"). The third phenotype ($n = 67$; 27.1%) included participants with moderate impulsivity. This phenotype was termed "Impulsive".

Participant socio-demographic and clinical characteristics according to eating phenotypes

The three phenotypes were compared across various demographic, anthropometric, and eating environment measures. The phenotypes did not differ by age, sex, ethnicity, socioeconomic status, living arrangement, treatment site, BMI or BMI z-score, eating location, or time of meal.

The phenotypes were also compared across mental health indices, including social functioning, medication use, mental health diagnoses and body esteem. Phenotypes were significantly different for social functioning ($p = 0.002$) and body esteem ($p = 0.001$). Mixed-Severe had the greatest social functioning difficulties and the lowest body esteem.

Relative risk of membership to eating phenotype based on socio-demographic and clinical characteristics

Characteristics used in the multinomial logistic regression included frequency of eating out or ordering in meals, social functioning, and body esteem. The relative risk of clustering into the Mixed-Severe versus the Impulsive (reference) group was 7% lower for those with good body esteem, and 65% greater for those with poor social function (see Table 4). The relative risk of clustering into the Mixed-Moderate versus Impulsive group was 4% lower for those with good body esteem (see Table 4).

Discussion

Treatment-seeking children and adolescents with obesity can be classified into 3 latent groups based on 7 eating

Table 4 Risk profile for Mixed-Severe and Mixed-Moderate phenotypes compared to Impulsive phenotype

Socio-demographic or clinical characteristic	Relative risk ratio (95% CI)	*p*-value
MODEL 1 –Mixed-Severe versus Impulsive		
Frequency of eating out	1.00 (0.76, 1.31)	1.000
Social functioning	1.65 (1.03, 2.63)	0.036
Body esteem	0.93 (0.88, 0.98)	0.003
MODEL 2 –Mixed-Moderate versus Impulsive		
Frequency of eating out	1.14 (0.93, 1.38)	0.201
Social functioning	1.05 (0.72, 1.53)	0.789
Body esteem	0.96 (0.93, 1.00)	0.031

CI confidence interval

correlates: (1) Mixed-Severe (LOC, emotional eating, external eating, hyperphagia, impulsivity), (2) Mixed-Moderate (LOC, emotional eating, external eating, hyperphagia), and (3) Impulsive (impulsivity). Furthermore, phenotypes differed by social functioning and body esteem, with the Mixed-Severe group having the lowest social functioning and poorest body esteem. Overall, this study adds further insight into eating groupings in this population and the characteristics which may increase the likelihood of having an eating phenotype with multiple eating correlates.

Members of the Mixed-Severe and Mixed-Moderate groups, which comprised 17 and 56% of the sample, respectively, had similar complex eating profiles which differed in severity. These profiles reflected findings from a previous study that identified the co-occurrence of LOC, emotional eating and external eating in adolescents with obesity [21]. Furthermore, although these groups did not significantly differ from the Impulsive group in restrained eating scores which may indicate significant restrained eating behaviour across the whole population, their scores on this eating correlate were elevated in similar proportions to the other eating correlates. Previous research has also found a correlation between LOC and restrained eating in adolescents with obesity [40]. Based on the literature, we hypothesise that this phenotype may trigger a repeated cycle of dieting and overeating [41]. Restraint Theory posits that chronic dieting behaviours, known to be common in overweight adolescents [42], lead to disinhibited eating caused by internal or external triggers [43]. In this case, internal triggering factors may include emotions and hyperphagic drive whereas external factors may include environmental food cues. These groups seem to represent subgroups of children and adolescents with obesity who are triggered to overeat to different extents by internal and external stimuli.

In this study, the Impulsive group did not show a clustering of other eating correlates with impulsivity. Preliminary evidence in the literature shows high impulsivity scores in children and adolescents with obesity [9]. Restrained eating scores in this group were also elevated, although they were not statistically significant compared to the other two groups. Perhaps there is some interplay of impulsivity and restrained eating in this group leading to overeating behaviour. Longitudinal assessment of associations between eating correlates may assist in understanding the eating profile of this group of patients and the impact of this behaviour on clinical outcomes.

A few notable differences were found between phenotypes in clinical characteristics. Groups significantly differed in social functioning scores and body esteem. The Mixed-Severe group with the most complex eating profile also had the poorest social function scores and the lowest body esteem. Our finding of lower social functioning in this group is consistent with the interpersonal model of LOC, such that poor social functioning leads to LOC behaviour [44]. As well, lower body esteem in the two phenotypes with several eating correlates compared to the single-correlate Impulsive phenotype is reflected in the more significant disordered eating behaviours clustered in these two groups. Low body esteem has been associated with disordered eating and eating disorders [45]. It is possible that in our sample, low body esteem leads to some of the eating correlates such as emotional eating; however, the eating correlates may also cause lower body esteem. These results indicate that not only do most children and adolescents with obesity have significant disordered eating behaviour, but they also have significant psychological manifestations that should not be overlooked in treatment plans.

The present study provides evidence that phenotypes differ between individuals presenting to weight management programmes and consideration for more tailored management strategies for children and adolescents with obesity may improve outcomes. Standard diet and physical activity counselling offered in weight management programmes leads to modest reductions in BMI [46]. Specific eating triggers or behaviours which lead to overeating should be accounted for in treatment plans. For all groups, counselling techniques such as cognitive-behavioural therapy may be used to help reframe distorted thoughts leading to restrictive eating behaviour and subsequent overeating. Furthermore, for the Impulsive phenotype, a combined treatment approach of cognitive-behavioural therapy with dietary and physical activity counselling may help to reduce excess body weight, similar to the effects shown in overweight adolescents [47]. Additionally, mindfulness-based therapy is another treatment option studied in the context of external eating, emotional eating, and hyperphagic characteristics [48]. Mindfulness encourages judgement-free awareness of emotional, mental, and physical states, and therefore, could aid in channelling appropriate awareness to appetite cues [48]. This approach may be beneficial for the Mixed-Severe and Mixed-Moderate phenotypes whose

overeating may be related to multiple internal and external triggers. Thus, further emphasis on underlying eating correlates, and how they cluster together, may help to tailor individual treatment.

This study has several strengths. Most importantly, our findings contribute to the limited available research on the clustering of appetitive traits and eating behaviours in children and adolescents, and is the only study to examine several correlates in a clinical population with obesity. We investigated several common eating correlates, including components of attention deficit hyperactivity disorder which is highly co-morbid in our population of interest. Eating behaviours are complex, and new treatment paradigms are necessary to address co-occurring correlates that promote overeating. A second strength of this study is that data were collected using an approach that could easily be incorporated into a fast-paced clinical setting, as is the case at the CANPWR clinics. We used a concise package of patient self-report and parent for-child questions that could be easily completed between clinician appointments. The questionnaire format allows for several eating correlates to be captured in a short amount of time with low patient burden.

There were also several limitations to this study. First, our sample included exclusively treatment-seeking participants, which may represent a more severely affected subgroup of children and adolescents with obesity. Therefore, results may not be fully generalisable to children and adolescents with obesity treated in community or primary care settings. Second, since the eating correlates of interest did not have questionnaires available exclusively for children or for parents, it was necessary to use a combination of patient self-report and parent for-child report questionnaires. Therefore, we had to rely on reported behaviour from two different sources, which may have confounded results. Third, it is possible that there are higher frequencies of loss of control eating reported using a questionnaire versus a semi-structured interview [19]. Finally, this study was also limited by the cross-sectional design. Longitudinal investigation into treatment effects on eating correlates would assist in determining whether certain phenotypes change over time and how they respond to existing lifestyle treatment approaches.

Conclusion

In summary, we found that seven common eating correlates clustered into three distinct phenotypes in a sample of children and adolescents seeking obesity treatment. Most participants (73%) had a complex eating profile defined by multiple eating correlates. Further evaluation of targetable phenotypes may aid in the development of more tailored intervention strategies to improve health outcomes for children and adolescents with obesity.

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Compliance with ethical standards

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

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