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Validation of the adult eating behavior questionnaire in a Norwegian sample of adolescents

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ABSTRACT

Eating behaviors are related to health and well-being. To examine stability and change in eating behaviors throughout life, developmentally appropriate measures capturing the same eating behavior dimensions are needed. The newly developed Adult Eating Behavior Questionnaire (AEBQ) builds on the well-established parent-reported Children's Eating Behavior Questionnaire (CEBQ), and together with the corresponding Baby Eating Behavior Questionnaire (BEBQ), these questionnaires cover all ages. However, validation studies on adolescents are relatively sparse and have yielded somewhat conflicting results. The present study adds to existing research by testing the psychometric properties of the AEBQ in a sample of 14-year-olds and examining its construct validity by means of the parent-reported CEBQ. The current study uses age 14 data (analysis sample: n = 636) from the ongoing Trondheim Early Secure Study, a longitudinal study of a representative birth cohort of Norwegian children (baseline: n = 1007). Confirmatory factor analysis (CFA) was conducted to test the factorial validity of AEBQ. Construct validity was examined by bivariate correlations between AEBQ subscales and CEBQ subscales. CFAs revealed that a 7-factor solution of the AEBQ, with the Hunger scale removed, was a better-fitting model than the original 8-factor structure. The 7-factor model was respecified based on theory and model fit indices, resulting in overall adequate model fit ($\chi^2 = 896.86$; CFI = 0.924; TLI = 0.912; RMSEA = 0.05 (90% CI: 0.043, 0.051); SRMR = 0.06). Furthermore, small-to-moderate correlations were found between corresponding AEBQ and CEBQ scales. This study supports a 7-factor solution of the AEBQ without the Hunger scale and provide evidence of its construct validity in adolescents. Several of the CEBQ subscales were significantly associated with weight status, whereas this was the case for only one of the AEBQ scales.

1. Introduction

Eating behaviors are assumed to be one of the driving forces in the etiology of childhood overweight and obesity (Carnell & Wardle, 2008). Some eating behaviors may pose a risk of excess weight gain, such as food responsiveness (i.e., eating in response to external cues such as the sight and smell of food) (van Jaarsveld, Boniface, Llewellyn, & Wardle, 2014), low satiety responsiveness (i.e., sensitivity to internal signals of fullness) (van Jaarsveld et al., 2014) and emotional overeating (i.e., eating more in response to negative emotions) (Derks et al., 2018), although not consistently so (Bjørklund, Wichstrøm, Llewellyn, & Steinsbekk, 2022). In addition, some studies (although not all) have found links between early eating behaviors and later eating disorder symptoms, including emotional overeating (Allen, Byrne, La Puma, McLean, & Davis, 2008; Pearson, Riley, Davis, & Smith, 2014), emotional undereating (i.e., eating less in response to negative emotions) (Kim, Heo, Kang, Song, & Treasure, 2010) and food fussiness (i.e., being highly selective about the types of food that are accepted) (Marchi & Cohen, 1990).

Given the potential impact of eating behaviors on health and well-being, identifying developmental trajectories of eating behaviors and their predictors is of importance to inform preventive efforts. Notably, different eating behaviors may have different trajectories across the life-course (Derks et al., 2019). For example, food fussiness, also termed

Abbreviations: CEBQ, Children's Eating Behaviour Questionnaire; AEBQ, Adult Eating behavior Questionnaire; FIML, Full Information Maximum Likelihood; SDQ, Strengths and Difficulties Questionnaire; TESS, Trondheim Early Secure Study; CFA, Confirmatory factor analysis.

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pickiness, is more prevalent in early compared to later childhood (Cardona Cano et al., 2015; Steinsbekk, Bonneville-Roussy, Fildes, Llewellyn, & Wichstrøm, 2017), whereas emotional eating increases with age (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008). Not only are the trajectories of different eating behavior dimensions likely to vary across different developmental periods, so are their predictors. In early childhood, for example, parents play a major role in development of eating behaviors as food-providers and role models (Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). However, with increasing age, biological maturation and corresponding autonomy, characteristics of the individual and the influence of peers may become more influential (Ragelienė & Grønhøj, 2020; Stok, De Ridder, Adriaanse, & De Wit, 2010). To exemplify the latter: In the absence of their parents, youth are more dependent on their own capacity for appetite self-regulation (Russell & Russell, 2021). To identify trajectories of different eating behaviors and their predictors, eating behaviors must be tracked throughout the entire developmental period from early childhood to adulthood. Although existing research has examined stability and change in parts of this developmental period (Ashcroft et al., 2008; Costa et al., 2023), studies positioned to capture developmental differences throughout childhood and adolescence are lacking. This is likely because until recently, no developmentally appropriate measure capturing the same eating behavior dimensions during this large age span has been available. Furthermore, a general focus on measurement is needed to better understand children's eating behaviors and their development (C. G. Russell, Burnett, Lee, Russell, & Jansen, 2023a).

The Adult Eating Behavior Questionnaire (AEBQ) (Hunot et al., 2016) is a newly developed measure of eating behaviors in adulthood capturing the same eating behaviors as assessed by one of the most widely used assessments of children's eating behaviors, the parent-reported Children's Eating Behavior Questionnaire (CEBQ) (Wardle, Guthrie, Sanderson, & Rapoport, 2001), which is validated for use until 12 years of age. A corresponding Baby Eating Behavior Questionnaire (BEBQ) is used to assess eating behaviors during the period of exclusive milk-feeding, in the first months of life (Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2011). Such standardized questionnaires are needed in assessment of eating behavior for research purposes, but they can also be valuable in clinical settings, e.g., to identify difficulties with eating behaviors that could be addressed in treatment of obesity or eating disorders, for example avoidant/restrictive food intake disorder (ARFID) (Dovey, Kumari, & Blissett, 2019). The AEBQ has also been used to develop a tailored weight management intervention, based on adults' unique appetitive profiles derived using AEBQ scores (Hunot-Alexander, Croker, Fildes, Johnson, & Beeken, 2022), although clinically relevant cut-off scores have not yet been derived.

The AEBQ is shown to be valid in adult populations (Cohen, Kakinami, Plourde, Hunot-Alexander, & Beeken, 2021; He, Sun, Zickgraf, Ellis, & Fan, 2019; Hunot et al., 2016; Hunot-Alexander, Arellano-Gómez, et al., 2022; Jacob et al., 2021; Mallan et al., 2017; Zickgraf & Rigby, 2019), but only four studies have investigated adolescent samples. Three of these support the use of AEBQ with adolescents, if one of the scales is removed (the Hunger scale) (Guzek, Skolmowska, & Głąbska, 2020; Hunot-Alexander et al., 2019; Molitor, Fox, Bensignor, & Gross, 2021), whereas a study of 13 year-olds in Portugal failed to replicate the AEBQ factor structure (Warkentin, Costa, & Oliveira, 2022). Please note that among the three studies replicating the factor structure, one examined a clinical sample (Molitor et al., 2021); therefore, its findings cannot be generalized to normally developing adolescents. Another of the three studies (Guzek et al., 2020) reported lower than acceptable model fit for their CFA models and did not examine construct validity. Of further note, only one prior study (Warkentin et al., 2022) has examined whether the AEBQ and CEBQ truly capture the same eating behavior dimensions. As the authors did not replicate the original AEBQ factors, conclusions cannot be drawn regarding the overlap between the CEBQ and AEBQ eating behavior dimensions. Further research is therefore needed. We add to existing knowledge by testing the psychometric properties of the AEBQ in a Norwegian community sample of 14-year-olds and examine the construct validity of AEBQ by means of the parent-reported CEBQ (conducted at the same time-point). Additionally, given that the CEBQ and AEBQ aim to capture eating behaviors affecting weight, it is valuable to know how these self- and parent-reported questionnaires relate to adolescent weight status, which we therefore also explore in the current study.

2. Methods

2.1. Participants and procedure

The current study uses data from the Trondheim Early Secure Study (TESS), for which the overall aims are to capture psychosocial development, mental health, and health behavior from early childhood to adulthood. To recruit participants to TESS, an invitation letter was sent to parents of all children born in 2003 and 2004 in Trondheim, Norway, together with the Strengths and Difficulties Questionnaire (SDQ) version 4–16 (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000), a screening assessment for emotional and behavioral problems along with their appointment letter for the routine health check-up at age 4 at the community health care clinic (2006/2007). At the health check, the health nurse informed parents about the study, they submitted the completed SDQ and gave written consent to participate, all in accordance with the procedure approved by the Regional Committee for Medical and Health Research Ethics, Mid-Norway (approval numbers 2009/994; 2019/509). Parents with insufficient proficiency in Norwegian to fill out the SDQ screening were excluded (n = 176). Of those who were asked to participate (n = 3016), 82.2% consented. Because one of the main aims of TESS is to assess mental health, children with emotional or behavioral problems were oversampled to increase statistical power. To achieve this, participants were allocated to four strata according to their SDQ scores (cut-offs: 0–4, 5–8, 9–11, and 12–40), and a subsample (n = 1250) was drawn to participate and 1007 participated in the first assessment (T1) at the university clinic. Details of the recruitment procedure, participation rates and characteristics can be found elsewhere (Steinsbekk & Wichstrøm, 2018). Please note that as reported in a former publication (Steinsbekk, Barker, Llewellyn, Fildes, & Wichstrøm, 2017) the sample was comparable with the Norwegian parent population with regard to the parents' level of education (Statistics Norway, 2012; Wichstrøm et al., 2012) and children's BMI (Júlíusson et al., 2013). Of further importance here is that the cohorts have been assessed biennially since T1 (M_{age} = 4.4, SD = 0.21; T2 n = 797, M_{age} = 6.72 years, SD = 0.17; T3 n = 699, M_{age} = 8.80 years, SD = 0.24; T4 n = 702, M_{age} = 10.51 years, SD = 0.17; T5 n = 666, M_{age} = 12.49 years, SD = 0.15; and T6 n = 636, M_{age} = 14.33 years, SD = 0.59). The current study uses the age 14 years data only (52.4 % girls) as this is the only time point where we assessed both self- and parent-reported eating behaviors (AEBQ + CEBQ). From age 12 and onwards, the participants were specifically informed about the study. At age 14, the parent informant was most likely the mother (79.4%). Parents' occupation, as defined by the International Classification of Occupations (ISCO) (International Labour Office, 1990), spanned from unskilled worker (0.5%), farmer/fisherman (0.2%), formally skilled worker (12.3%), professional (lower level) (27.5%), professional (higher level) (37.1%) and leader (22.5%).

2.2. The adult eating behavior questionnaire

The Adult Eating Behavior Questionnaire (AEBQ) (Hunot et al., 2016) contains 35 items capturing the following eight subscales: Hunger (involving the physical experience of hunger; 5 items, e.g. "I often feel so hungry that I have to eat something right away"); Food responsiveness (eating in response to external food cues; 4 items, e.g., "When I see or smell food that I like, it makes me want to eat"); Emotional overeating

(eating more in response to negative emotions; 5 items, e.g., "I eat more when I'm anxious"); Enjoyment of food (being interested in and enjoying meals; 3 items, e.g., "I love food"); Satiety responsiveness (being sensitive to internal signals of hunger and fullness; 4 items, e.g., "I often leave food on my plate at the end of a meal"); Emotional undereating (eating less in response to negative emotions; 5 items, e.g., "I eat less when I'm worried"); Food fussiness (being highly selective about which foods are accepted; 5 items, e.g., "I refuse new foods at first") and Slowness in eating (eating speed; 4 items, e.g., "I am often last at finishing a meal"). All AEBQ items are rated along a 5-point Likert scale (1 = "strongly disagree"; 5 = "strongly agree").

2.3. The Children's eating behavior questionnaire

The Children's Eating Behavior Questionnaire (CEBQ) (Wardle et al., 2001) is a 35-item questionnaire completed by parents, including eight subscales. In the present sample, the internal consistency was as follows: Food responsiveness (5 items, e.g., "If allowed to, my child would eat too much"; $\alpha = 0.65$), Emotional overeating (4 items, e.g., "My child eats more when worried"; $\alpha = 0.80$), Enjoyment of food (4 items, e.g., "My child looks forward to mealtimes"; $\alpha = 0.84$), Satiety responsiveness (5 items, e.g., "My child gets full easily"; $\alpha = 0.70$), Emotional undereating (4 items, e.g. "My child eats less when upset"; $\alpha = 0.83$), Food Fussiness (6 items, e.g., "My child is difficult to please with meals"; $\alpha = 0.89$), and Slowness in eating (4 items, e.g., "My child takes more than 30 min to finish a meal"; $\alpha = 0.60$). Response options are measured along a 5-point Likert scale (1 = Never, 2 = Rarely. 3 = Sometimes, 4 = Often, 5 = Always). The CEBQ has shown good validity (Carnell & Wardle, 2007) and test-retest reliability (Wardle et al., 2001).

2.4. Weight status

Digital scales were used to assess children's and parent's height (Heightronic digital stadiometer: QuickMedical, Model 235 A) and weight (Tanita BC420MA; adjusting 0.5 kg for indoor clothing). Body mass index (BMI) was calculated (Cole, Freeman, & Preece, 1998) and the International Obesity Task Force (IOTF) cut-offs (Cole & Lobstein, 2012) were used to estimate the proportion of participants and parents with a healthy weight or overweight/obesity combined.

2.5. Statistical analyses

All analyses were performed in Mplus version 8.5 (Muthèn & Muthèn, 1998-2015) using a robust maximum likelihood estimator, providing standard errors that are robust to non-normality. Missing data were handled using a Full Information Maximum Likelihood (FIML) procedure. To account for the oversampling, we used probability weights, which were proportional to the number of children in the population in a specific stratum divided by the number of participating children in that stratum.

2.5.1. Factorial validity

Confirmatory factor analysis (CFA) was conducted to test the internal structure of the AEBQ. We also estimated Cronbach's alpha values based on polychoric correlations to assess internal consistency of the AEBQ. Building on previous research (Hunot et al., 2016; Hunot-Alexander et al., 2019; Mallan et al., 2017; Molitor et al., 2021; Warkentin et al., 2022), we tested two alternative CFA models: 1) The orginal 8-factor structure, and 2) A 7-factor solution without the Hunger scale. Based on Hu and Bentler (1999), the following were considered to be adequate model fit: Values of > 0.90 for Comparative fit index (CFI) and Tucker-Lewis index (TLI), <0.06 for Root mean square error of approximation (RMSEA) and <0.08 for Standardized root mean square residuals (SRMR). These criteria were also applied in former validation studies of AEBQ in adolescents (Guzek et al., 2020; Molitor et al., 2021; Warkentin et al., 2022). In addition, we considered the Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC), lower values being preferred (Kline, 2016).

2.5.2. Construct validity

To examine the construct validity of AEBQ, we estimated bivariate correlations between corresponding AEBQ and CEBQ scales.

2.5.3. Weight status, CEBQ and AEBQ

Bivariate logistic regression analyses were conducted to test the associations between each of the CEBQ and AEBQ subscales (continuous independent variables, and participant's weight status as binary outcome variable). Separate models for each of the subscales of the two questionnaires were estimated (i.e., 14 models in total).

3. Results

Descriptive statistics and correlations between adolescents' AEBQ scores and CEBQ scores are displayed in Table 1 and factor loadings are shown in Table 2. Inspection of Table 2 reveals that with one exception, all Cronbach's alpha values, were above 0.70, which is considered adequate (Field, 2013). The internal consistency of Hunger was marginally below this cutoff ($\alpha = 0.69$). Nearly nine of ten (89%) of the participants were categorized as having normal weight, whereas 11% had overweight or obesity, which is somewhat lower, but comparable, to the general adolescent population in Norway (Øvrebø et al., 2021). The corresponding numbers for parents were 42,4% and 57,6%, respectively.

3.1. Confirmatory factor analysis (CFA)

CFA of the original factor structure (i.e., 8 subscales) of AEBQ evidenced lower than acceptable model fit ($\chi^2 = 1372.39$; CFI = 0.892; TLI = 0.880; RMSEA = 0.05 (90% CI: 0.047, 0.054); SRMR = 0.07). The 7-factor solution with the Hunger scale removed yielded somewhat better, yet still inadequate, model fit ($\chi^2 = 1041.12$; CFI = 0.903; TLI = 0.890; RMSEA = 0.05 (90% CI: 0.049, 0.056); SRMR = 0.07).

The latter model was preferred to the original 8-factor solution because its AIC and BIC values were lower (7-factor model: AIC = 43163.78; BIC = 43655.12; 8-factor model: AIC = 51349.77; BIC = 51938.49), which indicates a better-fitting and more parsimonious model (Kline, 2016).

3.2. Model re-spesification

Because several AEBQ items appear to be similarly worded, there is a possibility of misspecified uncorrelated errors (i.e., residual covariances) stemming from method effects (Brown, 2015; Brown & Moore, 2012; Byrne, 2012). Such overlap can especially be seen for the following pairs of items: "I often feel hungry when I am with someone who is eating" (food responsiveness) and "When I see or smell food that I like, it makes me want to eat" (food responsiveness) (both: direct exposure to food); "I eat more when I'm upset" (emotional overeating) and "I eat more when I'm worried" (emotional overeating) (both: eating more due to distress); "I am interested in tasting new food I haven't tasted before" (food fussiness) and "I enjoy tasting new foods" (food fussiness) (both: being positive about tasting new foods); "I eat less when I'm annoyed" (emotional undereating) and "I eat less when I'm angry" (emotional undereating) (both: eating less in response to angry/irritable feelings). Keeping in mind that the model fit indicators of the CFA model omitting the Hunger scale were below adequate thresholds, we inspected the modification indices, which indeed indicated residual covariances between the above-noted pairs of items. Therefore, respecified versions of the 7-factor model were compared by means of the Satorra-Bentler scaled chi square difference test (Satorra & Bentler, 2001), adding one residual covariance at a time (Models 1–5, see Table 3). The Satorra-Bentler scaled chi square test showed significant

Table 1
Descriptives and bivariate correlations between AEBQ and CEBQ scales.

	Mean (SD)	C EF	A EF	C FR	A FR	C EOE	A EOE	C SR	A SR	C EUE	A EUE	C FF	A FF	C SE	A SE
AEBQ EF	4.16 (.71)	**.17****	-												
AEBQ FR	2.72 (.77)	–	.43***	**.12****	-										
AEBQ EOE	1.89 (.79)	–	.03	–	.38***	**.09***	-								
AEBQ SR	2.51 (.79)	–	−.36***	–	−.04	–	.25***	**.30*****	-						
AEBQ EUE	1.98 (.86)	–	−.15**	–	.22***	–	.68***	–	.33***	**.03**	-				
AEBQ FF	2.33 (.81)	–	−.34***	–	−.12**	–	.20***	–	.34***	–	.14**	**.55*****	-		
AEBQ SE	2.58 (.84)	–	−.13**	–	.01	–	.13**	–	.29***	–	.16**	–	.08*	**.34*****	-
AEBQ H	2.42 (.70)	–	.22***	–	.61***	–	.52***	–	.10*	–	.39***	–	.06	–	.08

Note. A = AEBQ; C=CEBQ; FR=Food responsiveness; EOE = Emotional overeating; EF = Enjoyment of food; SR=Satiety responsiveness; SE=Slowness in eating; EUE = Emotional undereating; FF=Food fussiness; H=Hunger. Correlations between corresponding AEBQ and CEBQ scales in bold. *p < .05; **p < .01; ***p < .001.

differences in chi square values when testing these models consecutively (Table 3), thus indicating significant improvements in model fit.

As a last step, based on the modification indices in Model 5 showing that the reversed Slowness in eating item "I often finish my meals quickly" should also load on the Food responsiveness factor, we specified a crossloading in Model 6. This was deemed appropriate, based on a CEBQ validation study showing that higher score on food responsiveness is associated with faster eating rate observed in a laboratory setting (Carnell & Wardle, 2007). More recently, scholars have also argued that measures of eating behaviors are affected by boundary problems in conceptualization, including a lack of agreement about how separate domains of eating behaviors should be defined (for a review, see A. Russell, Jansen, Burnett, Lee, & Russell, 2023b). Such reasoning further raises the possibility of some overlap in the AEBQ dimensions as well. Again, the Satorra-Bentler scaled chi square test indicated significant improvement in model fit when Model 6 was compared with model 5 (including vs. not including the crossloading, Table 3).

The model fit of this final respecified CFA model (Model 6) was acceptable ($\chi^2 = 896.86$; CFI = 0.924; TLI = 0.912; RMSEA = 0.05 (90% CI: 0.043, 0.051); SRMR = 0.06).

3.3. Construct validity: correlations between AEBQ and CEBQ

Bivariate correlations between corresponding AEBQ and CEBQ subscales are shown in Table 1. Correlations were small to moderate, but significant for all corresponding eating behavior dimensions (e.g., CEBQ satiety responsiveness correlated with AEBQ satiety responsiveness), apart from emotional undereating ($r = 0.03$; $p = .56$). Upon inspection, these correlations seemed to differ in strength, which we therefore tested by conducting Wald tests. We found that the AEBQ-CEBQ correlation for satiety responsiveness was significantly stronger than AEBQ-CEBQ correlations for food responsiveness, emotional overeating and enjoyment of food (W ranging from 4.68 to 12.15, $df = 1$, $p = .0005$-.03), and so was the AEBQ-CEBQ correlations for slowness in eating (W ranging from 8.1 to 15.36, $df = 1$, $p = .0001$-.004) and food fussiness (W ranging from 79.65 to 82.86, $df = 1$, $p = <.001$).

3.4. CEBQ, AEBQ and weight status

Due to the low number of participants with overweight and obesity (see above), we did not have enough power to differentiate between these, thus healthy weight vs. overweight/obesity were applied when examining the associations between eating behavior subscales and weight status. As shown in Table 4, among the AEBQ subscales, only food responsiveness was significantly associated with weight status. However, the OR was below 1, indicating that those scoring higher on food responsiveness were less likely to have overweight/obesity. However, significant associations were found between CEBQ-measured food responsiveness, enjoyment of food, emotional overeating, and emotional undereating, all in the expected directions. More specifically, food responsiveness, enjoyment of food and emotional overeating all increased the odds for having overweight/obesity, whereas high scores on emotional undereating were associated with lower risk of belonging to this weight category.

4. Discussion

The current study evaluated the psychometric properties and validity of the AEBQ in a sample of Norwegian adolescents aged 14 years. We found that a 7-factor structure, excluding the subscale Hunger, is a valid measure of eating behaviors in adolescents. Furthermore, the results confirmed that apart from emotional undereating, self-reported AEBQ dimensions correlate with corresponding dimensions of the parent-reported CEBQ.

The superiority of a 7-factor solution, omitting the subscale Hunger, is in line with previous validation studies in adolescents (Guzek et al., 2020; Hunot-Alexander et al., 2019; Molitor et al., 2021), except for Warkentin et al. (2022), who did not confirm the factor structure of AEBQ overall. Unlike the other subscales, Hunger captures physiological aspects of hunger rather than biological dispositions towards food, which might explain why omitting Hunger improves the validity (Hunot et al., 2016). More specifically, reporting of physiological aspect of hunger and satiety may be more affected by individual differences in perception and interpretation (Wardle, 1987) compared to reporting of dispositions (i.e., 'what I usually do').

With regards to construct validity, the results showed that corresponding AEBQ and CEBQ dimensions were indeed correlated, except for emotional undereating. Although the correlations were significant, it should be noted that they were small to moderate. However, low agreement between self-report and parent-report of the same psychological phenomon is very common (Achenbach et al., 1987, 2005). Correlations are typically in the low to moderate range, whether they concern psychiatric symptoms, e.g. ADHD (Barkley, Fischer, Smallish, & Fletcher, 2002) and anxiety (Weems, Taylor, Marks, & Varela, 2010), or health behaviors such as sleep (Short, Gradisar, Lack, Wright, & Chatburn, 2013) and physical activity (Dowda, Dishman, Saunders, & Pate, 2021), likely reflecting the different perspectives youth and parents hold. The low to moderate correlations between self-report and parent-report in the present study are therefore not surprising, and it is still reasonable to conclude that the AEBQ is related to the CEBQ in an expected manner, thus providing evidence of construct validity.

The strongest correlations were found for food fussiness, slowness in eating and satiety responsiveness, compared to food responsiveness, enjoyment of food and emotional overeating. This is perhaps not surprising, as food fussiness, slowness in eating and satiety responsiveness are behaviors that are clearly expressed during meals and often the behaviors that parents find troublesome, at least in childhood (e.g., a child refusing to eat certain foods, or eating only a limited number of foods, rarely finishing meals and eating very slowly). These would therefore be clearly evident both to the parents and the adolescents themselves. Food fussiness, for example, may be an eating behavior the whole family is aware of, as it potentially impacts joint meals and promotes mealtime conflicts (Harris, Ria-Searle, Jansen, & Thorpe, 2018). Similarly, eating slowly or rapidly (slowness in eating) and leaving food

Table 2
AEBQ: Reliability and factor loadings.

Items	Original 8-factor structure: λ (95% CI)	7-factor structure λ (95% CI)	α
FR: Food responsiveness			.71
Q22: "I am always thinking about food"	.66 (.57, .74)	.74 (.66, .81)	
Q17: "Given the choice, I would eat most of the time"	.67 (.59, .74)	.71 (.64, .79)	
Q13: "I often feel hungry when I am with someone who is eating"	.60 (.52, .68)	.49 (.39.59)	
Q33: "When I see or smell food that I like, it makes me want to eat"	.54 (.45, .62)	.44 (.34, .54)	
Q14: "I often finish my meals quickly"	–	.28 (.18, .38)	
EOE: Emotional overeating			.91
Q10: "I eat more when I'm upset"	.83 (.78, .88)	.80 (.75, .85)	
Q8: "I eat more when I'm worried"	.80 (.72, .87)	.76 (.68, .83)	
Q16: "I eat more when I'm anxious"	.86 (.82, .91)	.88 (.84, .91)	
Q5: "I eat more when I'm annoyed"	.73 (.67, .78)	.71 (.65, .77)	
Q21: "I eat more when I'm angry"	.85 (.80, .89)	.87 (.83, .91)	
EF: Enjoyment of food			.86
Q3: "I enjoy eating"	.88 (.84, .92)	.88 (.84, .92)	
Q1 "I love food"	.79 (.74, .84)	.80 (.75, .85)	
Q4: "I look forward to mealtimes"	.78 (.72, .83)	.78 (.72, .83)	
H: Hunger			.69
Q6: "I often notice my stomach rumbling"	.34 (.24, .44)	–	
Q28: "I often feel so hungry that I have to eat something right away"	.72 (.66, .77)	–	
Q32 "I often feel hungry"	.68 (.61, .74)	–	
Q34: "If my meals are delayed I get light-headed"	.49 (.41, .58)	–	
Q9: "If I miss a meal I get irritable"	.55 (.46, .64)	–	
SR: Satiety responsivesness			.73
Q31: "I get full up easily"	.70 (.63, .77)	.70 (.63, .77)	
Q30: "I cannot eat a meal if I have had a snack just before"	.58 (.49, .67)	.58 (.48, .67)	
Q11: "I often leave food on my plate at the end of a meal"	.66 (.59, .74)	.67 (.60, .74)	
Q23: "I often get full before my meal is finished"	.68 (.60, .77)	.68 (.60, .77)	
SE: Slowness in eating			.77
Q29: "I eat slowly"	.83 (.75, .91)	.80 (.72.88)	
Q25: "I am often last at finishing a meal"	.77 (.70, .85)	.80 (.74, .87)	
Q14: "I often finish my meals quickly"[a]	−.55 (−.64, −.46)	−.58 (−.67, −.50)	
Q26: "I eat more and more slowly during the course of a meal"	.57 (.48, .65)	.57 (.49, .65)	
EUE: Emotional undereating			.93
Q27: "I eat less when I'm annoyed"	.87 (.83, .92)	.85 (.80, .90)	
Q15: "I eat less when I'm worried"	.78 (.73, .84)	.79 (.73, .84)	
Q35: "I eat less when I'm anxious"	.88 (.85, .92)	.89 (.86, .93)	
Q20: "I eat less when I'm upset"	.88 (.84, .91)	.89 (.85, .92)	
Q18: "I eat less when I'm angry"	.84 (.80, .89)	.82 (.76, .87)	
FF: Food fussiness			.83
Q7: "I refuse new foods at first"	.48 (.38, .57)	.52 (.42, .61)	
Q19: "I am interested in tasting new food I haven't tasted before"[a]	−.86 (−.91, −.81)	−.78 (−.85, −.72)	
Q2: "I often decide that I don't like a food, before tasting it"	.58 (.51, .66)	.62 (.54, .70)	
Q12: "I enjoy tasting new foods"[a]	−.88 (−.93, −.83)	−.81 (−.87, −.74)	
Q24: "I enjoy a wide variety of foods"[a]	−.72 (−.77, −.66)	−.76 (−.81, −.70)	

Note. α = Cronbach's alpha; λ = Standardized factor loadings.
[a] Items that are to be reversed for scoring.

on the plate (satiety responsiveness), are easily observable behaviors. On the other hand, emotional overeating may be done entirely in secret as children mature into adolescence. In addition, adolescents are less likely to reveal their thoughts and feelings to their parents, thus parents may be less positioned to know their child's inner states and consequently less positioned to report on adolescents' emotional over- and undereating. With regard to food responsiveness and enjoyment of food, it may be the case that adolescents who are self-conscious about their body size deliberately change the way they respond to food when they are in the presence of other people, and downplay self-reports of these behaviors, to avoid judgements being made about their appetite, possibly as a result of internalized weight stigma. Based on this, it is reasonable to assume that the self-reported AEBQ, as compared to the parent-reported CEBQ, is a more reliable measure of adolescent eating behaviors when it comes to internal states, such as emotional over- and undereating, simply because parents cannot always know how their adolescent is feeling. On the other hand, parents who know their child very well, are well-positioned to observe and report on eating behaviors that are clearly expressed externally such as food fussiness, eating speed and satitety sensitivity.

Another possible explanation for our finding that the strongest correlations between the AEBQ and the CEBQ were found for food fussiness, slowness in eating and satiety responsivenss, could be that these eating behaviors are more heritable than the other eating behaviors. Some support for such a claim comes from twin studies showing high heritability estimates for slowness in eating (84%) and satiety responsiveness (72%) in infants (Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2010) as well as high heritability of food fussiness (78%) in young children (Fildes, van Jaarsveld, Cooke, Wardle, & Llewellyn, 2016), whereas heritability for emotional overeating and emotional undereating has been shown to be low (7%) (Herle, Fildes, Steinsbekk, Rijsdijk, & Llewellyn, 2017). However, no study has examined the heritability of all these eating behaviors in the same sample at the same age during childhood, which complicates comparison of heritability estimates. Only future research can resolve this issue.

Importantly, the question is not so much about whether the adolescent or the parent is correct about the adolescents' eating behaviors, rather, our results indicate that the AEBQ and the CEBQ offer somewhat different perspectives about adolescents' eating behaviors. More research is needed to conclude whether one measure better captures some aspects of eating behaviors than others. Validation studies comparing behavioral measures of eating behaviors to both AEBQ and CEBQ, similar to the above-mentioned study by Carnell and Wardle (Carnell & Wardle, 2007), could be one such avenue of research. In addition, including a third informant to report on eating behavior (e.g., a close friend) could be helpful, although such an option might be difficult to obtain.

Finally, we examined how the CEBQ and AEBQ were associated with weight status. For the CEBQ, adolescents scoring high on food responsiveness, enjoyment of food and emotional overeating had increased risk of having overweight/obesity, whereas the opposite direction of association was found for emotional undereating. These findings confirm former cross-sectional research (Kininmonth et al., 2021), although prospective studies are less consistent (e.g., Bjørklund et al., 2022). As for the AEBQ, the present findings showed that only food responsiveness was associated with weight status, but in an unexpected direction – adolescents reporting higher scores on food responsiveness items were *less* likely to have overweight/obesity. Although some former studies have reported a positive association between AEBQ measured food responsiveness and weight (Hunot et al., 2016; Jacob et al., 2021), others have revealed null findings in adults (He et al., 2019; Zickgraf & Rigby, 2019) as well as adolescents (Warkentin et al., 2022), and also a negative association, (Mallan et al., 2017), the latter in accordance with the present study. As noted by Mallan et al. (2017), food responsiveness may be tapping into more restricted eating behavior or dieting, at least in adults, which may help explain the negative association. Such an

Table 3
Results of model re-specification.

	χ^2	df	p-value	Δ χ^2	Δ df	p-value	RMSEA[a] (90% CI)	SRMR[b]	CFI[c]	TLI[d]
Model 1: Original CFA 7-factors	1041.12	384	<.001				.053 (.049, .056)	.068	.903	.890
Model 2: Residual covariance [e]	1007.79	383	<.001	30.09	1	<.001	.051 (.048, .055)	.068	.908	.895
Model 3: Residual covariance [f]	970.95	382	<.001	16.94	1	<.001	.050 (.046, .054)	.067	.913	.901
Model 4: Residual covariance [g]	952.42	381	<.001	18.53	1	<.001	.049 (.045, .053)	.066	.916	.904
Model 5: Residual covariance [h]	932.14	380	<.001	7.82	1	.005	.048 (.045, .052)	.066	.919	.907
Model 6: Crossloading [i]	**896.86**	**379**	**<.001**	**38.47**	**1**	**<.001**	**047 (.043, .051)**	**.063**	**.924**	**.912**

Note. All models are nested and compared with the next model; $\Delta\chi^2$ is corrected according to Satorra-Bentler's scaled chi square test; preferred model in bold.
[a] Root mean square error of approximation.
[b] Standardized root mean square residual.
[c] Comparative fit index.
[d] Tucker Lewis index.
[e] Food responsiveness items "I often feel hungry when I am with someone who is eating" and "When I see or smell food that I like, it makes me want to eat".
[f] Emotional overeating items "I eat more when I'm upset" and "I eat more when I'm worried".
[g] Food fussiness items "I am interested in tasting new food I haven't tasted before" and "I enjoy tasting new foods".
[h] Emotional undereating items "I eat less when I'm annoyed" and "I eat less when I'm angry".
[i] Slowness in eating item (reversed), "I often finish my meals quickly", crossloading on food responsivenss.

Table 4
Associations between weight status and self-reported (AEBQ) and parent-reported (CEBQ) eating behaviors: Results of bivariate logistic regression analyses.

Eating behaviors	Weight status							
	AEBQ subscales				CEBQ subscales			
	OR	95% CI	S.E.	*p*	*OR*	95% CI	S.E.	*p*
Enjoyment of food	.77	.56, 1.08	.13	.13	1.53	1.01, 2.33	.33	.04
Food responsiveness	.70	.51, .98	.12	.03	3.15	1.72, 5.79	.98	<.001
Emotional overeating	1.18	.85, 1.65	.20	.32	2.11	1.20, 3.71	.61	.01
Satiety responsiveness	1.14	.85, 1.53	.17	.38	.72	.49, 1.07	.15	.11
Emotional undereating	1.23	.91, 1.64	.18	.17	.68	.47, .98	.13	.04
Food fussiness	1.38	.98, 1.94	.24	.06	.77	.54, 1.10	.14	.16
Slowness in eating	.88	.66, 1.19	.13	.41	.96	.64, 1.42	.19	.82

Note. AEBQ = Adult eating behavior questionnaire; CEBQ= Children's eating behavior questionnaire; OR=Odds ratio. Weight status: Categorical variable, either normal weight or overweight/obesity at age 14.

assumption is supported by research showing a positive correlation between food responsiveness and restrained eating (Groppe & Elsner, 2014), but should indeed be tested in future studies before conclusions are drawn.

Except for food responsiveness, the present study did not identify any significant associations between AEBQ subscales and weight status. Given that the CEBQ scales were more consistently associated with weight compared to AEBQ in the current study, one interpretation of our findings is that parents are more appropriate informants than adolescents when it comes to eating behaviors at age 14. However, it should also be noted that earlier reports on AEBQ and the relation to weight are fairly inconsistent, especially when it comes to food approach behaviors (i.e., food responsiveness, enjoyment of food, emotional overeating), whereas findings are more consistent for the avoidance-related traits (e.g., slowness in eating, satiety responsiveness) (He et al., 2019; Mallan et al., 2017). Even among adults seeking treatment for obesity, only two AEBQ subscales (Emotional overeating and slowness in eating) were associated with BMI (Zickgraf & Rigby, 2019). Nevertheless, the present findings need to be replicated before conclusions can be drawn about the relationship between weight status and self-reported eating behaviors using the AEBQ in adolescents.

4.1. Strengths and limitations

The present study has several strengths, including a large and representative community sample and objective measures of weight and height. Yet, some limitations should be noted. First, because we used data at one time point, we were unable to examine test-retest reliability. Second, as for any self-report measure, social desirability may have affected the results, although this potential effect may have been reduced in the present study because the data collection did not happen in a school-setting in the presence of peers (Braet, Claus, Verbeken, & Van Vlierberghe, 2007). Third, the lack of other measures of construct validity in addition to CEBQ, such as behavioral or laboratory-based measures of eating behaviors, is another limitation that should be acknowledged. As noted above, future research should carry out such studies. Finally, although we used CEBQ at age 14 to examine the construct validity of AEBQ, it should be noted that the CEBQ is validated up to 12 years of age only.

4.2. Conclusions

The present study supports the use of a 7-factor version of AEBQ (i.e., with the Hunger scale removed) as a valid measure of eating behaviors in adolescents. Model fit was acceptable, but not optimal. In combination with the corresponding BEBQ and CEBQ, the AEBQ enables researchers to capture development, stability and change of eating behavior throughout the life course, although the relationship between the AEBQ and weight requires further examination in future studies. The questionnaires can also be applied to assess and track eating behaviors in clinical settings.

Authors' contributions

OB, LW and SS contributed to conceptualize and design the study. OB carried out the main analyses. OB, LW, CL and SS interpreted the results. OB drafted the manuscript, whereas LW, CL and SS revised and finalized the manuscript together with OB. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to restrictions related to participant consent and because the study is still ongoing, but potential collaborators are welcome to contact the PI of the study.

Ethical statement

Parents gave written consent to participate, all in accordance with the procedure approved by the Regional Committee for Medical and Health Research Ethics, Mid-Norway (approval numbers 2009/994; 2019/509). When the participants were 12 years old, they were specifically informed about the study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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