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Article

Eating Behavior and Nutritional Status in Spanish Schoolchildren

Abstract: Background: Different investigations have shown an association between the eating behavior of children and adolescents, and their nutritional status. The objective is to identify eating behavior patterns associated with nutritional status diagnosed by anthropometry in a sample of Spanish schoolchildren. Methods: A cross-sectional study in 283 Spanish schoolchildren (6 to 16 years old). The sample was assessed anthropometrically by Body Mass Index (BMI), Waist-to height ratio (WHtR) and body fat percentage (%BF). Eating behavior was analyzed using the CEBQ "Children's Eating Behavior Questionnaire" answered by parents or guardians. Results: A positive association was found between excess weight, abdominal obesity, high adiposity, lower scores in anti-intake subscales and higher scores in pro-intake subscales. These were mainly associated with lower satiety response, higher food intake, higher food enjoyment, higher eating speed, and emotional overeating. Conclusion: Our results support the usefulness of the CEBQ as an easy-to-use tool to identify eating behaviors associated with the development of childhood and adolescent obesity. Its use in future research could help to understand behavioural phenotypes in schoolchildren and guide nutrition education and obesity prevention initiatives.

Keywords: appetite; satiety response; eating behavior; pediatric obesity

1. Introduction

Eating habits acquired during childhood and adolescence tend to become established during adulthood. For this reason, achieving a healthy diet at an early age is a definite factor in avoiding obesity and chronic diseases. Several experimental studies and reviews on the subject have shown that parents have a strong influence on their children's eating behavior [1, 2]. This is particularly important in childhood during when children learn what, when and how to eat according to the cultural transmission of family patterns and attitudes [3, 4]. During the first years of life, feeding practices regulated by the mother and developed in the family environment consolidate children's emotional responses to food [5]. Parental prohibition or restriction of food, or the use of food as a reward, are factors that impact on the emotional domain and predict children's enjoyment of food or their response to satiety [6]. Similarly, healthy nutrition education by families is associated with positive attitudes towards food and appropriate regulation of food intake which is reflected in children's improved nutritional status [7]. Obviously, parents also pass on their genes, which also play a proven role in the regulation of appetite and food preferences [8-10]. In any case, eating behavior, which undoubtedly has a genetic and environmental component, is reflected in the nutritional condition of the subject and modulates the risk of obesity.

Different studies conclude that the capacity to respond to satiety is lower in overweight and children and adolescents, especially obesity, as well as having a more noteworthy response to food cues, understood it as a higher desire to eat and greater likelihood of ingestion in the presence of food. For this reason, overweight children and adolescents seem to be more likely to eat food in the absence of hunger out of mere desire or pleasure [11]. In addition, food enjoyment and speed of intake appear to be higher in obese children, who have a delayed sense of satiety [12]. Therefore, this bidirectional association leads to children with a greater enjoyment or taste for food being at greater risk of obesity [13]. It is worth noting that a greater increase in intake under emotional stress has also been observed in overweight children and adolescents compared to medium and underweight subjects [14-15]. However, the results in this aspect are controversial as recent meta-analysis studies show that the relationship between emotional intake and body composition is not as direct in children and adolescents as in adults [16].

Previous findings show the usefulness of analyzing the eating behavior of children and adolescents in detail using questionnaires such as the Children's Eating Behavior Questionnaire (CEBQ) [17]. This test identifies different phenotypes related to habits such as food avoidance, early or late satiety, gluttony, or tendency to emotional overeating, habits that may eventually alter nutritional status [18-19]. Research using the CEBQ relates overweight and obesity in children and adolescents with higher scores on the pro-intake scales and lower scores on the anti-intake scales, pointing to higher consumption and enjoyment of food, lower satiety, and more emotional overeating behaviors. Conversely, low weight is associated with lower scores on the pro-intake scales and higher scores on the anti-intake scales, relating to avoidance eating behaviors, early satiety, and lower enjoyment of food [20].

Most of the studies published so far associate CEBQ scores with weight status assessed from weight and body mass index, with very few studies including other indicators of adiposity [21]. The main objective of the present study is to identify, in a sample of Spanish schoolchildren, eating behavior associated with nutritional status assessed by anthropometric parameters identifying size and body composition.

1. Materials and Methods

2.1. Participants

This is a cross-sectional study in a sample of 283 Spanish schoolchildren aged 6 to 16 years (33.21% girls), recruited between 2019 and 2021 in public schools and municipal sports centers in the Community of Madrid, Spain. The data are anonymized and were disaggregated from information that can identify the subject. Participants' assent and informed consent from parents or guardians was required, in accordance with the bioethical principles of the Declaration of Helsinki in its most updated version [22]. The project were approved by the Ethics Committee of the Autonomous University of Madrid (CEI-91-1699).

1.2. Instruments

Each participant was assessed anthropometrically and s answered a CEBQ [17] questionnaire completed by their parents or guardians.

1.2.1. Anthropometric study

The anthropometric assessment was carried out according to the protocol of the International Biological Program. (IBP) [23]. Height (cm) was measured with a Tanita Leicester measuring rod with an accuracy of 1 mm; weight (kg) and body fat percentage (%BF) with a Tanita Inner Scan UM076 tetrapolar bioelectrical impedance analyser (BIA); umbilical waist circumference (cm) with a Cescorf tape and bicipital, tricipital, subscapular and suprailiac skinfolds (mm) with a Holtain adipometer with an accuracy of 0.2 mm and constant pressure (10g/mm2).

For prevalence analysis, the sample was stratified by sex. Nutritional categories were established based on the Body Mass Index [BMI = weight (kg)/height (m2)] using the cut-off points of Cole et al. [24-25] and the Waist to Height Ratio (WHtR = waist circumference/height), using the criteria established by Marrodán et al. [26] which define abdominal obesity as >0.51 in boys and 0.50 in girls, and abdominal overweight as >0.48 in boys and >0.47 in girls. Body fat percentage (%BF) was estimated by plicometry using the Siri equation [27], with a previous calculation of density [28, 29]. Adiposity levels were classified according to the references for the Spanish youth population [30].

1.2.1. CEBQ questionnaire

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As indicated above, the CEBQ [17], provides information on the response to satiety, taste for food, speed of intake, and emotional food consumption. It is a validated questionnaire with 35 items that assess eight sections of eating behavior and whose questions are answered on a Likert-type scale with an option to score from 1 to 5 according to the intensity of the behavior (where 1= never, 2= rarely, 3= sometimes, 4= often and 5= always).

The items are classified into eight subscales: food responsiveness (FR; 5 items), enjoyment of food (EF; 4 items), emotional overeating (EOE; 4 items), desire for drinks (DD; 3 items), slowness in eating (SE; 4 items), satiety responsiveness (SR; 5 items), food fussiness (FF; 6 items) and emotional under-eating (EUE; 4 items). The first four items have a positive focus or pro-intake dimension, while the last four relate to food avoidance or anti-intake. The questions corresponding to each subscale are defined according to the CEBQ's classification. (Table 1).

2.3. Data analysis

The internal consistency of the eight subscales of the CEBQ questionnaire and reliability estimates were determined using Cronbach's alpha. Depending on the normality of the variables, ANOVA, Mann Whitney U, or Kruskal-Wallis tests were performed to compare the mean scores of each subscale of the CEBQ according to nutritional categories. Logistic regression models were applied to establish as independent variables the CEBQ subscale score and, as dependent variables, nutritional categories categorized dichotomously according to excess weight, abdominal obesity, or high %BF. Statistical analysis was performed using R 4.1.2 software. Statistical significance was considered when $p<0.05$.

1. Results

3.1. Internal consistency of the subscales and factor structure of the CEBQ questionnaire

First, the internal consistency of the CEBQ questionnaire in the present sample was assessed using Cronbach's Alpha. Internal consistency was adequate (Cronbach's alpha above 0.7) for all factors except subscales 1 and 8. The unweighted mean factor scores (± SD) and internal reliability estimates (Cronbach's Alpha) for the CEBQ factors are presented in Table 2.

1.2. Sample characterization

According to BMI, 6.70% of the participants were underweight and 35% overweight (24% overweight and 11% obese). Regarding the WHtR, 14.80% were overweight, and 31.80% abdominal obese. According to %BF, 51.20% were classified as having high adiposity (19.40% between 90th - 97th percentiles and 31.80% >97th percentile). Significant differences were found between sexes in the categorization of the sample based on: BMI, WHtR, and %BF ($p<0.001$*), with the male sex having the highest percentage of overweight in all three classifications. (Table S1).

1.2. Comparison between mean scores of CEBQ scales and nutritional status

Figures 1, 2, and 3 show a clear trend towards higher scores on the pro-intake subscales and lower scores on the anti-intake subscales as BMI, abdominal obesity, and relative adiposity categories increase. Table 3 compares the mean scores of the different subscales of the CEBQ as a function of nutritional status as assessed by BMI, WHtR, and %BF. In the pro-intake dimension, scores for the subscales EF, FR, and EOE were higher ($p<0.05$) in overweight schoolchildren according to BMI or above the cut-off point for WHR and %BF. The score for the DD subscale was higher only for the abdominal obese. On the other hand, they obtained lower scores ($p<0.05$) for the SR and SE subscales for the anti-intake dimension than their no obese peers.

As the regression model (Table 4) shows, in general terms, higher mean scores on the pro-intake scales translate into a higher risk of excess weight, abdominal fat, or high %BF.

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For example, each point scored on the FR and EOE subscales increases the risk of overweight by 2.385 and 2.253 times, respectively. Likewise, each point obtained in the EF subscale increases the likelihood of having high adiposity by 1.8 times. In contrast, the higher the score on the anti-intake subscales (SR and SE), the lower ($p<0.05$) the risk of being overweight or obese, and the lower the risk of having a high %BF.

1. Discussion

Previous research yields results similar to those obtained in our study, showing a significantly lower satiety response capacity in children and adolescents with obesity, as well as greater enjoyment of food, high responsiveness to external stimuli associated with increased food intake, and a tendency to eat at a faster rate [31-33]. Two recently published major studies provide a comprehensive review of eating behaviors linked to childhood obesity, with an emphasis on appetite control and satiety regulation. They have shown that aspects such as satiety responsiveness, responsiveness to food and the tendency to overeat, which are collected in CEBQ, are positively associated with BMI in children [34-35]. Several theories have been put forward to explain delayed satiety in overweight schoolchildren. These include the ability to ingest food without hunger, larger gastric size, metabolic-hormonal dysregulation associated with appetite-satiety control, and greater sensitivity to external factors that predispose to caloric, fatty or sweet products [36]. Similarly, emotional overeating, primarily associated with situations such as anxiety or boredom, or emotional eating due to food restrictions, is associated with an increased risk of developing obesity. On the other hand, several studies suggest that non-hunger eating may be an exciting predictor of weight and obesity at an early age, although the evidence is limited. This is because children who eat more in the absence of hunger are more likely to be able to eat again in a shorter time after a meal, especially more palatable, high-fat, and high-calorie foods [37].

In a sample of 240 Portuguese schoolchildren aged 3-13 years also found a significant association between scores on all pro-intake subscales of the CEBQ and increased risk of elevated BMI. In particular, the risk of obesity was associated with a weaker satiety response and greater food enjoyment [32]. Another study in Portugal involving 2951 schoolchildren concluded that high scores on the pro-intake and low scores on the anti-intake subscales at seven years of age were associated with increased cardiometabolic risk at ten years of age and vice versa [33]. Similar research involving 406 London schoolchildren aged 7-12 years found significant associations between subscales of emotional overeating, increased enjoyment of food, and increased desire to drink with higher adiposity and weight [31]. However, as in the present study, no relationship was observed between EUE score and nutritional status. It is worth noting that some review papers report a close relationship between EOE and emotional disturbances, especially if they are of a negative nature [35]. At the same time, other authors underline an evolutionary tendency to overeat, which generally promotes a higher intake of snacks and low-quality foods [38].

Our results are also consistent with previous findings on the association between lower scores on the anti-intake subscales of the CEBQ in overweight schoolchildren and higher scores in underweight schoolchildren. In particular, a study with a sample of 7,295 schoolchildren from the Generation R Study cohort found that children rated by the CEBQ as "more irritable towards food," less enjoyable, more avoidant, or more likely to be satiated sooner, had significantly lower BMI, and %BF [39]. Similarly, a study involving 2,500 schoolchildren aged 3-10 years in Bosnia and Herzegovina also found a linear increase in BMI as a function of scores on the pro-intake subscales, except for the desire to drink, and a decrease in BMI as a function of scores on the anti-intake subscales [40]. In general, underweight and normal-weight schoolchildren appear to exhibit certain behavioral traits that protect against the obesogenic environment, while overweight schoolchildren exhibit the opposite traits considered risk factors, supporting the theory of "behavioural susceptibility to obesity" [41].

Several lines of research reflect the possibility that overweight children may have been more vulnerable to the obesogenic environment. This means they have been more receptive to advertising and other external stimuli that encourage a higher intake of caloric and unhealthy products. In addition, behavioral patterns predisposing to obesity that begin in childhood may become more pronounced in adolescence and even more so in adulthood [42]. Since interventions to modify eating behavior be more effective at earlier ages, it is of interest to prevent overweight and obesity to understand the eating behavior of children and adolescents by using validated questionnaires for an individualized approach [43]. This study shows the apparent association between nutritional status and scores on the subscales of the psychometric test CEBQ. In all pro-intake subscales, schoolchildren with overweight, abdominal obesity or high %BF scored higher, while in the anti-intake subscales, the average scores were lower than those of their normal-weight peers. This confirms that overweight or obese schoolchildren have a lower satiety response, faster food intake and a pattern of emotional overeating.

Our results support the usefulness of the CEBQ as an easy-to-use tool to identify eating behaviors associated with the development of obesity in children and adolescents. Its use in future research could help to understand behavioral phenotypes in schoolchildren and guide nutrition education and obesity prevention initiatives.

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Institutional Review Board. This project has been approved by the ethics committee of Autonomus University of Madrid (UAM). Informed consent was required from parents or guardians, in accordance the bioethical principles of the Declaration of Helsinki in its most updated version.

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Conflicts of Interest. The authors declare no conflict of interest.

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TABLES AND FIGURES

Table 1. Subscales of the CEBQ questionnaire [17].

Pro-intake criterion	Anti-intake criterion
Subscale 1: enjoyment of food (EF) • Question 1: My child loves food. • Question 5: My child is interested in food. • Question 20: My child waits to eat at the established mealtimes (breakfast, lunch...). • Question 22: My child enjoys eating.	**Subscale 5: satiety responsiveness (SR)** • Question 3: My child has a good appetite. • Question 17: My child leaves food on his plate after finishing his meal. • Question 21: My child gets full before finishing his/her meal. • Question 26: My child gets full easily. • Question 30: If my child has had something to eat before, he/she does not get any food in. •
Subscale 2: food responsiveness (FR) • Question: 12: My child is always asking for food. • Question 14: If I let him/her, my child would eat too much.	**Subscale 6: slowness in eating (SE)** • Question 4: My child finishes his or her food quickly. • Question 8: My child eats slowly.

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• Question 19: Given the chance, my child would eat most of the time • Question 28: Even if my child is full, he always has room for his favourite food. • Question 34: If I give him the chance, my child always has food in his mouth.	• Question 18: My child takes more than 30 minutes to finish a meal. • Question 35: My child eats more and more slowly during the course of the meal.
Subscale 3: emotional overeating (EOE) • Question 2: My child eats more when he/she is worried. • Question 13: My child eats more when he/she is bored. • Question 15: My child eats more when he/she is anxious. • Question 27: My child eats more when he/she has nothing to do.	**Subscale 7: emotional under-eating (SUA)** • Question 9: My child eats less when he/she is angry. • Question 11: My child eats less when he/she is tired. • Question 23: My child eats more when he/she is happy. • Question 25: My child eats less when he/she is angry.
Subscale 4: desire for drinks (DD) • Question 6: My child asks for liquids all the time. • Question 29: If given the chance, my child would drink constantly throughout the day. • Question 31: If given the chance, my child would always have something to drink.	**Subscale 8: food fussiness (FF)** • Question 7: My child initially refuses new foods. • Question 10: My child enjoys tasting new foods. • Question 16: My child enjoys a wide variety of foods. • Question 24: My child is difficult to please with foods. • Question 32: My child is interested in trying foods he/she has not tried before. • Question 33: My child decides that he/she does not like a food even without trying it. •

Table 2. Mean score and internal consistency of the CEBQ in the analysed sample. (n=283).

Dimension	Subscale	Mean (SD)	Cronbach's alpha
Pro-intake	1. Enjoyment of food (EF)	2.90 (0.66)	0.631
	2. Food responsiveness (FR)	1.38 (0.99)	0.879
	3. Emotional overeating (EOE)	1.15 (0.91)	0.814
	4. Desire for drinks (DD)	1.39 (0.934)	0.842
Anti-intake	5. Satiety responsiveness (SR)	1.86 (0.52)	0.701
	6. Slowness in eating (SE)	1.64 (0.55)	0.779
	7. Emotional undereating (EUE)	1.43 (0.89)	0.768
	8. Food fussiness (FF)	2.02 (0.39)	0.515

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Table 3. Comparison of the mean scores of the CEBQ subscales according to nutritional status assessed by BMI, WHtR and %BF.

Dimension	Subscale	BMI			WHtR			%BF		
		No excess weight Mean ± SD	Excess weight Mean ± SD	p-value	No excess abdominal fat Mean ± SD	Excess abdominal fat Mean ± SD	p-value	No excess adiposity Mean ± SD	Excess adiposity Mean ± SD	p-value
Pro-intake	1. Enjoyment of food (EF)	2.79±0.66	3.08±0.59	0.002*	2.84±0.67	2.96±0.63	0.220	2.75±0.65	3.03±0.63	<0.001*
	2. Food responsiveness (FR)	1.15±0.87	1.82±1.06	<0.001*	1.16±0.89	1.63±1.05	<0.001*	1.19±0.87	1.56±1.07	0.005*
	3. Emotional overeating (EOE)	0.98±0.82	1.46±0.98	<0.001*	1.02±0.84	1.30±0.97	0.018*	1.00±0.82	1.29±0.97	0.014*
	4. Desire for drinks (DD)	1.34±0.95	1.49±0.89	0.080	1.28±0.92	1.52±0.94	0.015*	1.30±0.93	1.47±0.93	0.083
Anti-intake	5. Satiety responsiveness (SR)	1.92±0.53	1.74±0.46	0.011*	1.90±0.55	1.80±0.47	0.266*	1.94±0.53	1.77±0.48	0.018*
	6. Slowness in eating (SE)	1.71±0.55	1.50±0.53	0.002*	1.70±0.58	1.56±0.51	0.04*	1.73±0.57	1.55±0.53	0.008*
	7. Emotional undereating (EUE)	1.50±0.92	1.32±0.80	0.219	1.50±0.93	1.34±0.84	0.163	1.46±0.96	1.39±0.81	0.580
	8. Food fussiness (FF)	2.04±0.38	1.98±0.38	0.419	2.03±0.36	2.01±0.42	0.613	2.00±0.39	2.03±0.38	0.272

BMI (Body Mass Index); WHtR (Waist to Heigth ratio). (*) statistical significance (P≤0.05). Test: U-Man Whitney (all variables show non-normal distribution). Excess weight: BMI of overweight or obesity according to the cut-off points of Cole et al. [24,25]. Excess abdominal fat: WHR ≥ 0,47 in males and 0.48 in females [26]. Excess adiposity: %BF >p90 according to the references of Marrodán et al. [30].

Table 4. Association between CEBQ subscales and nutritional status.

Dimension	Subscale	Excess weight by BMI	Excess abdominal fat by WHtR	Excess adiposity by %BF	Subjects with overweight or obesity

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											by three parameters (BMI, WtHR, %BF)		
		B	Exp(B)	p-value	B	Exp(B)	p-value	B	Exp(B)	p-value	B	Exp(B)	p-value
Pro-intake	1. Enjoyment of food (EF)	0.489	1.631	0.057	0.120	1.127	0.619	0.595	1.813	0.014*	0.533	1.703	0.049*
	2. Food responsiveness (FR)	0.869	2.385	<0.001*	0.640	1.897	0.009*	0.420	1.522	0.081	0.797	2.200	0.004*
	3. Emotional overeating (EOE)	0.812	2.253	0.002*	0.461	1.586	0.059	0.508	1.663	0.037*	0.465	1.592	0.088
	4. Desire for drinks (DD)	0.490	1.632	0.055	0.543	1.721	0.025*	0.364	1.439	0.129	0.580	1.786	0.031*
Anti-intake	5. Satiety responsiveness (SR)	-0.661	0.516	0.009*	-0.299	0.742	0.220	-0.498	0.608	0.042*	-0.616	0.540	0.020*
	6. Slowness in eating (SE)	-0.719	0.487	0.006*	-0.374	0.688	0.139	-0.617	0.539	0.016*	-0.668	0.513	0.014*
	7. Emotional undereating (EUE)	-0.161	0.851	0.520	-0.188	0.829	0.432	-0.118	0.889	0.622	-0.228	0.796	0.385
	8. Food fussiness (FF)	0.006	1.006	0.982	-0.082	0.921	0.748	0.605	1.832	0.019*	0.067	1.069	0.813

CEBQ. Children´s Eating Behaviour Questionnaire [17].**FIGURES.**

Figure 1. Mean scores of the pro-intake and anti-intake dimensions according to Body Mass Index (BMI) categories.

The figures represent separately the trend of the mean scores on the pro-ingestion and anti-ingestion scales classified according to the nutritional category of each participant according to the Body Mass Index (BMI) (Cole TJ et al. 2000; Cole TJ et al. 2007). The trend observed is that the higher the level of overweight, the higher the mean score on the pro-intake scales and the lower the score on the anti-intake scales.

Fig. 2 Mean scores of the pro-intake and anti-intake dimensions according to Waist to Heigth Ratio (WHtR) categories.

The figures represent the trend of the mean scores on the pro-ingestion and anti-ingestion scales according to the nutritional category of the sample diagnosed from the Waist to Height Ratio (WHtR) (Marrodán MD et al., 2013). Participants with overweight or abdominal obesity achieved higher mean scores on the pro-intake scales and lower scores on the anti-intake scales.

Figure 3. Mean scores of the pro-intake and anti-intake dimensions according percent Body Fat (%BF) categories.

The figures represent the trend of the mean scores on the pro-ingestion and anti-ingestion scales as a function of the nutritional category established on the basis of body fat percentage (%BF) (Marrodán MD et al., 2006). The general trend observed is that the higher the percentage of body fat, the higher the mean score achieved in the pro-intake scales and the lower in the anti-intake scales.

Program used to create the artwork is R 4.1.2 software.