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ORIGINAL ARTICLE

GOCS cohort: children's eating behavior scores and BMI

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BACKGROUND/OBJECTIVE: In Chile, approximately one in three children under 6 years of age reported overweight/obese, while one in four children in elementary school suffer from obesity. There is a paucity of population-based information on the influence of childhood eating behavior on anthropometric measures related to obesity. To assess the association between eating behavior scores and Body Mass Index (BMI) z-scores in 7–10-year-old Chilean children.

SUBJECTS/METHODS: We conducted a cross-sectional study in 1058 children aged 7–10 (51% girls) from the 'Growth and Obesity Chilean Cohort Study' (GOCS). Direct measures of weight and height were used to compute BMI z-scores according to World Health Organization (WHO) curves. Children were classified as normal weight ($-1 < 1$ s.d.), overweight ($1 < 2$ s.d.) and obese ($\geqslant 2$ s.d.). Eating behavior scores were measured through the Child Eating Behavior Questionnaire (CEBQ), previously adapted and validated for Chilean children. Multiple linear regressions were carried out using BMI z-score as the outcome and eating behavior scores as explanatory variables. All models were adjusted by age and gender.

RESULTS: BMI z-scores were positively associated with pro-intake scores in the subscales 'enjoyment of food', 'emotional overeating' and 'food responsiveness' ($P < 0.0001$). Contrary to other studies, 'desire for drinks' scores were also associated with BMI z-scores ($P < 0.0001$). In contrast, food-avoidant 'satiety responsiveness', 'slowness in eating' and 'food-fussiness' scores were negatively associated with BMI z-scores ($P < 0.0001$).

CONCLUSION: We found a significant relationship between eating behavior scores and BMI z-scores in Chilean children, showing that BMI in 7–10-year-old Chilean children is positively associated with pro-intake eating behavior scores and negatively associated with anti-intake eating behavior scores. The identification of specific eating behaviors patterns related to obesity will provide important information for the implementation of prevention programs for this disease.

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INTRODUCTION

Obesity is the result of overeating behaviors coupled with sedentary habits. In Chile, 33% of children under 6 years of age in primary health care reported overweight/obese,[1] while it is estimated that approximately one in four elementary school children suffer from obesity.[2,3] In this context, it is not only important to know the amount of food consumed, but also eating habits.[4,5] It is believed that eating behavior is under biological and social control,[6,7] with temporal stability from childhood to adulthood.[8] It has been shown that obese children display lower response to internal signs of satiety,[9–11] eat faster in the course of a meal[12–14] and are more sensitive to advertising of non-healthy food,[15] compared with normal-weight children. On the other hand, eating behavior scores are strongly and gradually associated with obesity.[16,17]

The Child Eating Behavior Questionnaire (CEBQ)[18,19] is a psychometric tool that covers eight eating behavior dimensions (subscales) measured with high levels of internal consistency.[16,20,21] We have previously evaluated the factorial validity and internal consistency of CEBQ in Chilean children, finding positive associations between specific eating behavior scores and obesity.[22]

In the present study, we wish to confirm the magnitude of associations using independent data from a large sample size of children belonging to the 'Growth and Obesity Chilean Cohort Study (GOCS)'. Thus, the objective of this study was to assess the association between eating behavior scores and body mass index (BMI) z-scores in 7–10-year-old Chilean children.

STUDY DESIGN, SUBJECTS AND METHODS

Study design

The Growth and Obesity Cohort Study (GOCS)[23] was initiated in 2006 in collaboration with the Chilean National Preschool Program (JUNJI) as well as the Chilean National School Board Program (JUNAEB) and financed by FONDECYT 1100206. All children aged 2.6–4.0 years attending public nursery schools in six neighborhoods in Santiago were invited to participate in the study if they met the following inclusion criteria: (i) single births with birthweight between 2500 and 4500 g and (ii) absence of physical and psychological conditions that could alter growth. The mothers of 1195 children (from 1498 eligible participants, ~80%) were included in the study. No significant differences were found in terms of age, gender and birth anthropometry of those enrolled and not enrolled. Public nursery schools in Chile serve low- to middle-income children providing free early education and food 5 days per week (from 8 AM to 5 PM) during 11 months of the year. GOCS participants did not significantly differ from the population of children attending public nursery schools in 2006 in terms of gender (53% girls), socioeconomic status (15% vulnerability) and anthropometry at birth (weight = 3420 g, height = 49.9 cm, BMI = 13.7 kg/m^2). In this study, we conducted a cross-sectional analysis of children with available data on anthropometry, eating behavior scores and physical fitness measured in 1058 children who were 7–10 years of age (50.8% girls), evaluated during 2010 and 2011. The sample size provides

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adequate power (>80%; with a confidence >90%) to detect significant differences in eating behavior scores based in previous studies.[22] Written informed consents were obtained from parents or guardians together with the assent of the child in a protocol approved by the Ethics Committee of the Institute of Nutrition and Food Technology (INTA), University of Chile.

Anthropometric measurements

Anthropometric measurements (weight, height) were carried out using standardized techniques by trained personnel, as described elsewhere.[24–26] BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). We estimated BMI for age (BMI z-scores) based on the World Health Organization (WHO) 2007 growth reference,[27] with normal weight defined as between −1 and 1 s.d.; overweight as >1 and 2 s.d.; and obese as >2 s.d.

Child eating behavior questionnaire (CEBQ)

Eating behavior was assessed with the CEBQ, as described elsewhere. The Chilean version of this questionnaire is available under request from the authors.[18,22] The questionnaire consists of 35 items measuring eight subscales of eating behavior. The items are statements about child behavior answered by the mother or guardian on a Likert scale (1: never; 5: always) (Table 1). Four subscales refer to positive inclinations for eating (Pro-intake): Enjoyment of food (EF), Food Responsiveness (FR), Emotional Overeating (EOE) and Desire to Drink (DD); while the other four subscales evaluated negative inclinations of food intake (Anti-intake): Satiety Responsiveness (SR), Slowness in Eating (SE), Emotional Undereating (EUE) and Food Fussiness (FF). For each participant, the score for each subscale was calculated as the sum of individual scores for each subscale, divided by the total number of items (Figure 1). When only two items were missing, a mean-imputation method was applied. The sum of the pro-intake scores (four subscales) and the sum of anti-intake scores (four subscales) were calculated as a measure of child eating behavior. Pro-intake/anti-intake scores were represented as a radar chart in which the top part shows the four pro-intake subscales while the bottom part shows the four anti-intake subscales. Finally, an individual summary measure of eating behavior, the ratio between these two sums (Ratio Pro-intake/Anti-intake or RPA) was calculated.

Statistical analysis

Results are shown as median ± interquartile range or average ± s.d., as appropriate. Analysis of variance and Kruskall–Wallis tests were used to compare summary statistics of continuous variables by gender and nutritional status groups.

Multiple linear regression analysis was carried out to assess the association between eating behavior scores and BMI z-scores, and was adjusted by age and gender. Initially, nine bivariate models were considered using BMI-z as the outcome and each eating behavior subscale. A significant result was considered when $P < 0.05$. All statistical analyses were carried out with the STATA 9.

RESULTS

Table 2 shows summary statistics of the 1058 participants in this study. The prevalence of obesity in the whole group was 23.9% and BMI-z was significantly higher in boys compared with girls (1.80 ± 0.84 versus 1.69 ± 0.77 respectively; $P = 0.013$). As we expected, most anthropometric variables differed by obesity status after adjusting for age and sex. In our study, pro-intake eating behavior scores were strongly associated with gender, after adjusting for age and BMI-z (P-value < 0.001 for all pro-intake subscales), with higher scores of these subscales in boys compared with girls. In addition, higher scores of SE were found in girls compared with boys ($P < 0.001$) while lower scores of EUE were estimated in girls than in boys ($P = 0.02$). No significant differences by gender were found for SR and FF. Figure 2 shows a graded and direct association between pro-intake scores (EOE, EF, FR, DD) and obesity status ($P \leqslant 0.001$).

Table 1. Eight subscales of eating behavior measures from CEBQ

Subscales	*Definition*
Enjoyment of food (EF)	Condition positively associated with hunger, desire to eat and pleasure by the food
Food responsiveness (FR)	Eating in response to environmental food cues.
Emotional overeating (EOE)	Tendency to increase the intake in response to negative emotional contexts
Desire to drink (DD)	Desire to drink and generally tends to choose sugary drinks
Satiety responsiveness (SR)	Decreased sense of hunger caused by food consumption
Slowness in eating (SE)	Tendency to eat more slowly over a meal and prolong meal duration
Emotional undereating (EUE)	Tendency to reduce intake as a result of negative emotional contexts
Food fussiness (FF)	Limits the range of food products that are accepted

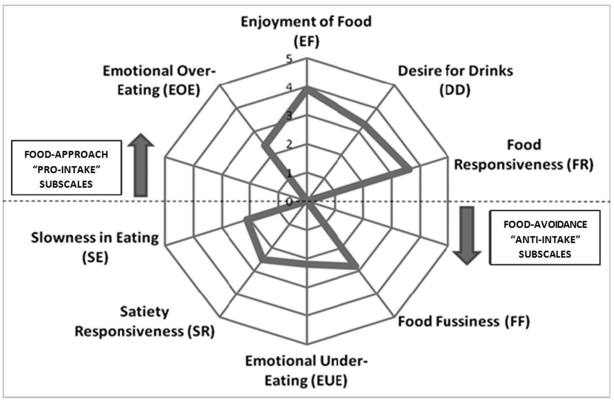

Figure 1. Multidimensional chart of eating behavior measured by child eating behavior questionnaire (CEBQ).

A negative association was observed between the anti-intake eating behavior scores and obesity ($P \leqslant 0.001$), with lower scores in obese children compared with normal-weight of overweight children, with the exception of EUE scores. The pro-intake/anti-intake ratios differed significantly by gender, with slightly higher scores in girls (median: 0.96; interquartile range: 0.72–1.29) than in boys (median: 1.12; interquartile range: 0.82–1.55). No differences in eating behavior scores were observed by gender in the subset of obese children. Table 3 shows the association between BMI score and eating behavior scores, adjusting for age and gender.

DISCUSSION

Our study shows that obese and overweight children in our sample have higher scores on pro-intake subscales of eating behavior and lower scores on anti-intake subscales compared with normal-weight children, independent of gender and age.[29–31] At the same time, important differences in eating behavior scores were found by gender. For this reason, results are presented separately for boys and girls. Different hypotheses have been proposed to explain why children with higher BMI show higher scores in pro-intake subscales. Higher scores of FR and EF may be explained by increased response among obese children to external food signals like advertising, which is related to unhealthy food choices and/or increased episodes of 'eating without hunger'.[20,29] Reyes *et al.*[32] found that an important proportion of Chilean

Table 2. Anthropometric and eating behavior variables, according to nutritional status and sex

	Girls n = *538*			*Boys* n = *520*		
	Normal weight N = *270* *50.1%*	*Overweight* N = *162* *30.1%*	*Obesity* N = *106* *19.7%*	*Normal weight* N = *246* *47%*	*Overweight* N = *127* *24.4%*	*Obesity* N = *147* *28.2%*
Age (years)	8.79 ± 0.4	8.78 ± 0.4	8.72 ± 0.4	8.73 ± 0.4	8.72 ± 0.4	8.77 ± 0.4
BMI-z	0.08 ± 0.6	1.50 ± 0.2	2.50 ± 0.4	0.01 ± 0.6	1.46 ± 0.2	2.72 ± 0.6
Weight (Kg)	27.9 ± 3.5	34.7 ± 4.1	42.5 ± 5.9	27.2 ± 3.0	33.3 ± 3.2	41.4 ± 5.6
Height (cm)	130.9 ± 5.6	132.8 ± 6.2	134.4 ± 5.9	130.0 ± 5.5	132.9 ± 5.3	134.8 ± 5.7

Abbreviation: BMI-z, z-score of body mass index. Results expressed as mean ± s.d., analysis of variance.

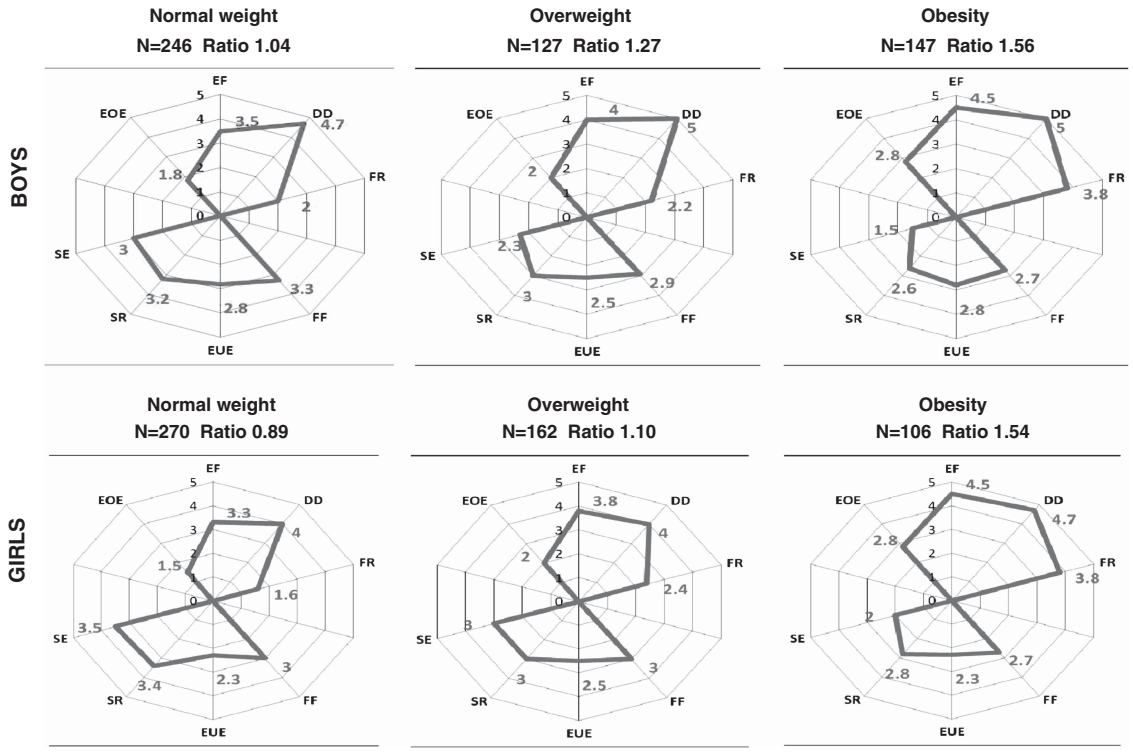

Figure 2. Childhood eating behavior scores according CEBQ. Scores expressed as medians. The 'ratio' was calculated as the ratio between the sum of scores of the pro-intake subscales divided of the sum of scores of anti-intake subscales. DD, Desire to drink; EF, Enjoyment of food; EOE, Emotional overeating; EUE, Emotional undereating; FR, Food responsiveness; FF, Food fussiness; SR, Satiety responsiveness; SE, Slowness in eating.

Table 3. Multiple linear regressions testing association between eating behavior subscales and BMI-z

	Pro-intake subscales Beta (95% CI)		*Anti-intake subscales Beta (95% CI)*
EF	0.31 (0.25 to 0.37)	SR	−0.37 (−0.44 to −0.29)
FR0	0.33 (0.28 to 0.38)	SE	−0.28 (−0.33 to −0.23)
EOE	0.33 (0.26 to 0.39)	FF	−0.16 (−0.23 to −0.09)
DD	0.09 (0.04 to 0.15)	EUE	−0.004[a] (−0.06 to 0.05)
Ratio Pro-intake/Anti-intake	0.87 (0.75 to 1.00)		

Abbreviations: BMI-z, z-score of body mass index; CI, confidence interval; DD, Desire to drink; EF, Enjoyment of food; EOE, Emotional overeating; FF, Food fussiness; FR, Food responsiveness; SE, Slowness in eating; SR, Satiety responsiveness. Results are expressed as B coefficient of BMI-z. All values are significant $P \leqslant 0.05$. [a]Value not statistically significant.

adolescents showed unhealthy satiety responsiveness and, in fact, they did eat when exposed to a permissive environment. The higher scores in EOE and DD in obese children might be explained by differential reaction against stress.[17] The lower score in SR in obese children may reflect their lack of capacity to regulate their food consumption once the meal is initiated, as it has been demonstrated in observational studies of obese and normal-weight adults.[33] Lower scores of FF and SE in obese children may indicate that, as BMI-z increases, children are less restrictive in food choices and eat faster than lean children.[34,35] Similar to the findings of Sleddens *et al.*[35] and Santos *et al.*[22] in our study, EUE did not achieve statistical significance in relation to BMI-z, which may indicate that these scores are not relevant in the determination of body weight. In our study, DD was significantly associated with BMI-z in contrast to the findings of Sleddens *et al.*[35] and Santos *et al.*[22] This may reflect the large sample size of our study and the relation of DD scores with consumption of sugar-sweetened soft drinks.[36] In normal-weight children, we found that girls showed a greater

tendency towards anti-intake behavior relative to boys, which represents a common pattern of eating behavior found adolescent girls compared to boys in girls compared with boys. Further research is required to define the role of gender in eating behavior during childhood. In general, the results of our research are similar to the case–control study published by Santos *et al.*[22] in Chilean children. We have replicated most of these associations using a larger sample size in the context of a population-based cohort study in Chilean children. In addition, we report how eating behavior profiles differ by nutritional status, thus contributing to obese/overweight subjects have greater susceptibility to gain weight faster than normal-weight children. It is important to analyze the magnitude of the pro-intake/anti-intake ratio, as it serves to signal a balanceserves to signal a balance between pro-intake inclinations related to how much children may eat versus satiety signals. Using this pro-intake/anti-intake ratio as an indicator of pro-obesity behavior might provide important information in support of obesity preventive programs a useful tool for evaluating children in clinical practice and/or at the population level.

Our study has some strengths and several limitations. For strengths, it is worth noting that the large sample size (>1000 children) provides sufficient statistical power to detect significant associations between eating behavior scores and obesity, given our preliminary research work on CEBQ validation.[28] In any case, there are unavoidable limitations derived from the cross-sectional nature of this study (rather than longitudinal) and the subjective information derived from eating questionnaires.

In conclusion, we have found a significant and gradual relationship between eating behavior scores and BMI z-scores in Chilean children, showing that BMI in 7–10-year-old Chilean children is positively associated with pro-intake eating behavior scores and negatively associated with anti-intake eating behavior scores. The identification of specific eating behaviors patterns related to obesity.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTIONS

The authors' responsibilities were as follows—US, GW and JS designed the research and wrote the manuscript; US analyzed the data and had primary responsibility for the final content. CC and RU were final reviewers for scientific content and language. All authors read and approved the final manuscript.

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