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Validation of the baby eating behaviour questionnaire in a Chilean population

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Abstract

Eating behaviors traits are present from early infancy and are associated with a greater risk for obesity in childhood. The Baby Eating Behaviour Questionnaire (BEBQ) is a tool developed to measure eating behavior in infants. The aim of this study was to (i) translate, (ii) culturally adapt, and (iii) evaluate the psychometric properties of the BEBQ in a Chilean sample. BEBQ was translated into Chilean-Spanish using a forward and back-translation process. Translations were cross-checked for cultural interpretability with mothers and inconsistencies were resolved with an expert panel. 101 dyads were recruited when infants were aged five months. Mothers completed the BEBQ and Infants were weighed and measured. Subscale scores were calculated for BEBQ subscales. Factor analysis was used to identify the structure of the BEBQ. Internal consistency was assessed using Cronbach's alpha (α). Factor analysis identified a good fit for a 4-factor structure of appetite factors, with moderate to good internal consistency: "food responsiveness" (α = 0.83), "enjoyment of food" (α = 0.77), satiety responsiveness (α = 0.61), except for slowness in eating (α = 0.58). All items loaded onto the original factor structure with exception of items 5 and 6, that load on to slowness in eating (ns). Boys (n = 43;42%) reported higher general appetite scores in relation to girls (p-value = 0.007). Infants with obesity BMI z-scores (n = 17; 19%) had lower satiety responsiveness scores compared to infants in the healthy weight range (p-value = 0.006). This study describes the psychometric properties of the Chilean Spanish BEBQ and supports the validity of the factor structure and internal consistency in a population sample of Chilean infants. Level V: Evidence obtained from a cross-sectional descriptive study.

Keywords Infants · Eating Behaviors · BEBQ · Obesity

Abbreviations

BEBQ Baby eating behavior questionnaire
CEBQ Child eating behavior questionnaire
BMI Body mass index

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Introduction

Obesity prevalence continues to rise, with a 2016 report estimating that 650 million adults were living with obesity worldwide, representing an overall prevalence of 13%. Also, this report estimates that 39 million children under the age of 5 were affected by overweight or obesity in 2020 (WHO, 2021), and over 340 million children and adolescents aged 5–19 were affected by overweight or obesity in 2016. Based on the 2016 levels of childhood obesity in the USA, simulated growth trajectories predict that 57% of today's children will have obesity at 35 years of age (Ward et al., 2017). Chile, similar to a number of other high-income and developing countries, is following similar trends with rates of overweight and obesity rising starkly, most notably among preschool and school children. The latest nutritional map 2020 reported that 54% of children under 6 years of age present malnutrition due to excess nutrients (JUNAEB, 2021) and that 27.6% of adolescents aged 15–19 years are affected by overweight, 12.2% by obesity, and 1% by severe obesity (JUNAEB, 2021).

The observed increases in the prevalence of obesity result from the complex interplay of changes in lifestyle and the food environment with genetic, biological, and wider psychological factors. Together these factors have resulted in an environment where daily physical activity is reduced to low levels, professions and free time are mainly sedentary, and food is palatable, cheap, and easily accessible, now more than ever. This is referred to as the 'obesogenic' environment, gradually nudging individuals to consume more energy than they expend, subsequently contributing to a greater risk of obesity in childhood and adulthood (Baird et al., 2005). A systematic review of 21 studies, demonstrated that rapid infancy weight gain is consistently linked to an increased risk of obesity (Ong et al., 2006).

The behavioral susceptibility theory (BST) explains how the food environment interacts with the genetic susceptibility to influence body weight. BST suggests that differences in appetite explain why some individuals overeat, while others undereat, in response to environmental opportunity. The genes that promote an avid appetite can lead to excessive eating and obesity, while those who are genetically predisposed to have a smaller appetite and a less enthusiastic interest in food are protected. We may be able to prevent unhealthy weight trajectories by identifying these traits and their early precursors (Llewellyn & Fildes, 2017).

The Child Eating Behavior Questionnaire (CEBQ) was developed 20 years ago to test the Behavioral susceptibility theory. The CEBQ is a parent-reported psychometric measure developed by Wardle et al. (2001) to reliably measure eight different appetitive traits (Food Responsiveness, Enjoyment of Food, Slowness of Eating, Emotional Overeating, Emotional Undereating, Satiety Responsiveness, Desire to Drink, and food fussiness). It has been used to investigate associations of child-eating behavior with environmental and genetic factors. This tool comprises four "food approach" traits that characterize a larger, more avid appetite and a greater interest in food. Four "food avoidant" traits characterize a smaller appetite and lower interest in food. A recent review and meta-analysis show that the CEBQ has been robustly associated with appetite and weight in children (Kininmonth et al., 2020). Following the strong psychometric properties, Llewellyn et al. (2011) adapted the CEBQ for the measure of appetite during the exclusively-milk fed phase of infancy.

The Baby Eating Behavior Questionnaire (BEBQ) is an infant version of the CEBQ that evaluates four appetitive traits and has been developed to capture variation in appetitive traits tendencies during the first 6 months of life. There have been far fewer studies using the infant measure of appetite, and none in Chile or other Hispanic countries.

We are translating the BEBQ into Chilean Spanish to provide the opportunity for a whole new area of research into infant appetite and weight in this country. As an important point to note, standardized psychometric measures have the advantage of characterizing habitual eating behavior over several meals and situations. In this sense, these measures capture the persistent appetitive trait rather than a measure of hunger or fullness in laboratory studies. At this age, infants are completely unable to report their own behaviour, but parents tend to know them very well, arguably making them the most accurate informants of their children's behaviour (Llewellyn & Fildes, 2017).

Decades of research on adults and children have established that appetite avidity is a key risk factor for obesity. A large experimental literature on children has identified certain eating behaviors that predispose to obesity in children. In particular, children living with obesity have been found to be more susceptible to initiate an eating episode when compared to peers with a healthy weight (Fisher et al., 2007; Jansen et al., 2003) and it has been shown that the degree of adiposity is inversely related to energy intake regulation (Johnson & Birch, 1994). Eating rate is also a risk factor for obesity insofar as children living with obesity or overweight tend to eat at a faster speed (Barkeling et al., 1992; Drabman et al., 1979; Llewellyn et al., 2008) and show higher reinforcing value of food (Hill et al., 2009; Temple et al., 2008).

More recently, specific appetitive traits have been consistently linked to adiposity in children e.g. higher 'food responsiveness', 'enjoyment of food' and 'emotional overeating'

scores have been associated with higher adiposity, whilst greater 'satiety responsiveness' and 'slowness in eating' relate to lower adiposity (Carnell & Wardle, 2008; Sleddens et al., 2008; Webber et al., 2009, Obregón et al., 2017; Kininmonth et al., 2020, Hunot-Alexander et al., 2022).

Little research has focused on appetite in early infancy. In this context, some experimental research shows that in early infancy we can observe almost the same eating traits as in primary-school aged children (Llewellyn et al., 2011). For example, it has been described those infants with a higher risk of obesity have a more fervent sucking style (Millstein, 1980; Stunkard et al., 2004) and that an energetic milk-feeding style at 2–4 weeks of age is associated with higher adiposity 2 years later (Agras et al., 1990). In relation to this, Li et al. (2008) showed that infant-initiated bottle emptying in the first six months of life predicted excess weight from 6–12 months of age.

The BEBQ is a validated measure of four appetitive traits (enjoyment of food, 'food responsiveness', 'slowness in eating', and 'satiety responsiveness') linked to variation in weight gain in infancy (Van Jaarsveld et al., 2014). The BEBQ is the first standardized measure of infant appetite which reliably characterizes appetite, but it is currently only been validated in English, highlighting the need for validation in other languages, including Chilean Spanish, to extend its use to many parts of the United States, South America and Latin America where pediatric obesity rates are rising rapidly.

We hypothesized that the original factor structure and the internal reliability of the concurrent version of the BEBQ will replicate in a Chilean sample.

The aim of this study was to (i) translate, (ii) culturally adapt, and (iii) evaluate the psychometric properties of the BEBQ in a Chilean sample of mother–child dyads.

Material and methods

a) ***Study design and participants*:** The present study is a cross-sectional study in which we recruited a convenience sample of 101 Chilean parents and their infants (mother-infant dyads) attending their 5-month mandatory healthcare appointment. Dyads were recruited from the Family Health Center Víctor Manuel Fernández (n = 40,000 in the capture area) Concepción, Chile. The sample was 42.5% Female; 57.4% Male (ns). The infants' weight statuses were classified according to the WHO International criteria (WHO, 2006): 17% had obesity; 31% had overweight; 40.8% had a healthy weight; 9% were at risk of underweight, and 1% had underweight. Parents were eligible for study participation if they were male or female, had an infant (5 months of age); and attended the 5-month healthcare control. Exclusion criteria included: a diagnosis of liver or kidney disease; diagnosis of cancer; food allergies; diseases that alter appetite patterns; and infants born prematurely (< 36 weeks of gestation). All procedures were approved by the Ethics Committee of Universidad San Sebastián (31–2017-20) Concepción in Chile.

b) **Eating behavior:** Eating behavior in children < 1 year was measured using the Baby Eating Behavior Questionnaire (BEBQ questionnaire), developed by Llewellyn et al. (2011). The BEBQ is a widely used and validated adaptation of the Child Eating Behavior questionnaire. The BEBQ is an 18-item questionnaire with 17 items designed to measure four aspects of infant milk-feeding behavior and a single item measuring general appetite. Mothers are asked to respond according to how they would describe their baby's milk-feeding style during a 'typical daytime feed'. Response options are collected on a Likert scale, ranging from never (1) to always (5). Scoring requires a calculation of mean scores for each subscale, with higher mean scores indicating greater reported expression of the eating behavior. The four distinct eating behaviors measured by the BEBQ include Enjoyment of food (four items; e.g., 'My baby seems contented while feeding'), Food responsiveness (six items; e.g., 'My baby frequently wants more milk than I provide'), Slowness in eating (four items; e.g., 'My baby takes more than 30 min to finish feeding') and Satiety responsiveness (three items; 'My baby gets full up easily'). The factor structure of the BEBQ has previously been established and confirmed Llewellyn et al. (2011). Internal reliability estimates of the four factors in the original development paper were acceptable (Cronbach's $\alpha = 0.73– 0.81$).

c) **Translation and adaptation:** In accordance with the World Health Organization (WHO) recommendations, we performed a five-step, systematic approach to translate and adapt the questionnaire (WHO, 2016). Briefly, two dietitians who are native speakers of Chilean Spanish and professionally familiar with the relevant concepts undertook two independent forward translations of the BEBQ from English to Spanish (AO and PP) considering the meaning and wording of these drafts. After this step, two independent research group members compared the original version with the two translated versions and merged the translations into one common version, and flagged any inadequately defined concepts or expressions. Two professional dietitians who were native speakers of Chilean Spanish undertook blinded backward translations into English. A consensus expert panel (n = 7) consisting of health and nutrition academics compared the original version and the translated version with respect to conceptual and cultural equivalence. Jointly the panel produced a Chilean version for a pilot pre-test study.

Pilot pre-test We recruited an independent sample of 30 mothers of 5-month-old infants to test the comprehension of the questionnaire including the item 'Which feeding methods did you use in the previous months'. Signed informed consent was obtained from all participants.

iv) **Feeding mode**: The feeding method was assessed by asking mothers to report the proportion of breast-feeding versus formula-feeding using the question: 'Which feeding methods did you use in the previous months', with response options: 'entirely breastfeeding'; 'entirely formula-feeding (never tried breastfeeding)'; 'breastfeeding and formula-feeding Llewellyn et al. (2011). Responses were classified into three groups using the principal feeding method. The three categories were 'breast-fed' (entirely breast-fed), 'formula fed' (entirely formula-fed), and 'mixed-fed' (breast-fed and formula-fed).

v) **Anthropometry**: Infant adiposity was assessed using clinical measures of weight and length. Bodyweight was measured with infants wearing a dry diaper and a pre-calibrated infantile digital scale (Seca 334) with a precision of 5–10 g. Height was measured in a lying position on the back (supine position) with a Seca 334 infantometer. Nutritional classification was assigned using the weight for length index. The WHO Z-score tables were used (WHO, 2006). Clinical cut off criteria to categorize weight status were as follows: i) 'Healthy' (those above the median to the scoring line + 1SD and below the median to the scoring line -1SD); ii) 'Overweight' (above the scoring line + 1SD and below + 2SD) and iii) 'Obese' (above the scoring line + 2DS) (WHO, 2006).

vi) **Sample size**: A sample of n = 98 is sufficient to estimate a Cronbach's α coefficient of 0.7 in dimensions of 4 items, with a precision of 0.1, without loss of study participants, and with a confidence level of 95% https://wnarifin.github.io/ssc/ssalpha.html. For the association between the BEBQ scales and anthropometric measures a sample size (n = 17 per group) provides 80% statistical power to detect differences in satiety responsiveness score in order of 1 unit (standard deviation: 0.7 unit) considering a type I error of 0.01 (Arifin, 2023) . This estimation was performed using the sampsi command in the STATA 13.0 package.

vii) **Statistical analysis:** All variables were assessed for normal distribution with the Shapiro–Wilk test. Summary statistics for quantitative variables were described by means and standard deviations. Skewed variables will be summarized using the median and interquartile range. To examine differences in BEBQ-Chile subscales by gender and weight status, t-tests were used for parametric data, and Mann–Whitney and Kruskal–Wallis tests for non-parametric data. Additionally, the Pearson correlation coefficient was used to assess associations between eating behavior scales and anthropometric measures. To determine the factor structure of the BEBQ, confirmatory factor analysis was performed using the component extraction method (command "factor", option "pf" in STATA 13.0 package) and an oblique rotation (command "rotate"). The analysis was carried out in STATA version 13.0. Items with factor loadings greater than 0.3 were considered. Factors with an eigenvalue greater than 1.0 were selected. For each subscale, internal consistency was assessed using the Cronbach's alpha statistic (∝).

Results

Participant characteristics

A total of 106 mothers were invited to participate and 101 mothers completed the BEBQ on behalf of their 5-month-old infant. Infants' characteristics are reported in Table 1. The infant sample was 42.5% female and 57.4%, male. Parents reported exclusive breast-feeding as the most common feeding mode (66.3%), followed by entirely mixed-feeding (21.7%), and bottle-feeding (11.8%).

Internal reliability of the BEBQ-Chile and summary statistics

Table 1 supp. shows the summary statistics of the final scales of the BEBQ-Chile. Three of the four scales had moderate to good internal reliability (Enjoyment to food: α = 0.77; Food responsiveness: α = 0.83; and Satiety responsiveness: α = 0.61), but Slowness in eating had a fairly low α (0.58).

Factor structure of the BEBQ-Chile

The analysis identified four factors with eigenvalues of 4.3, 2.4, 2.0, and 1.2. In the aggregate, the four factors explained 56% of the variance in the 18 items. The loadings of the different items following oblimin rotation are shown in Table 2. Factor 1, 'Food Responsiveness, included all the items reported in the original FR sub-scale. Factor 2, included 3 out of 4 items of the original structure BEBQ (except item 6 'My baby became distressed while feeding'). Factor 3, 'Slowness in eating, included the same four items as the original BEBQ, except for the item 5 'My baby finishes feeding quickly'. Factor 4, 'Satiety responsiveness' also includes the same structure as the original BEBQ.

Table 3 shows the results of the Confirmatory Factor Analysis. In the BEBQ-Chilean version, all four original factors were included in the results. Values for RMSEA = 0.07; *p*-value = 0.02, TLI = 0.88 and CFI = 0.90 were below de

Table 1 Characteristics of the sample ($n = 101$)

	Sample
Sex	
Female	43 (42.57%)
Male	58 (57.43%)
Nutritional Status $n = 98$	
Underweight (< − 2SD)	1 (1.02%)
Underweight risk (< − 1 SD)	9 (9.18%)
Healthy weight (-1 SD/ + 1 SD)	40 (40.82%)
Overweight (> + 1 SD)	31 (31.63%)
Obesity (> + 2 SD)	17.3 (17.35%)
Feeding mode	$n = 101$
Breast feeding	67 (66.34%)
Entirely formula feeding	12 (11.88%)
Mixed fed (breastfeeding and formula-feeding)	22 (21.78%)
Gestational age (weeks)	92% (> 37 weeks) (mean 38.5 ± sd 1.4)
Delivery mode	
Vaginal delivery	50 (49.50%)
Caesarean delivery	51 (50.50)

a.-Weight status were as follows: i) 'Underweight' (below the scoring line -2SD); ii) 'Underweight risk' (below the scoring line -2SD and above the median to the scoring line -1SD); iii) 'Healthy' (those above the median to the scoring line + 1SD and below the median to the scoring line -1SD); iv) 'Overweight' (above the scoring line + 1SD and below + 2SD) and v) 'Obese' (above the scoring line + 2DS)

b.- Feeding categories: i) 'entirely breastfeeding'; ii) 'entirely formula-feeding (never tried breastfeeding)'; iii) 'breastfeeding and formula-feeding

desirable levels, but showed good to acceptable models fit. All factor variances were significant ($p < 0.05$) and all factor item loadings were significant, with the exception of items (5–6). Most of the results of the standard regressions of the items were greater than 0.3 except for items 5 (p-value = > 0.05) and 6 (p-value = > 0.05). Figure 1 shows the path diagram of the BEBQ Chilean version.

Associations between the BEBQ subscales and infant characteristics

The mean subscale scores by gender are shown in Table 2 supp. There were no statistically significant differences in means of subscale scores by gender except for the general appetite scale where we observed higher general appetite in boys related to girls (p-value = 0.007). Table 4 shows the eating subscale scores by child's nutritional status. In line with our hypotheses, infants with obesity reported lower satiety responsiveness compared to infants with overweight and a healthy weight. When infant anthropometrics were analysed as continuous measures, 'satiety responsiveness' was inversely correlated to both weight-for-length z score (-0.2; p-value = 0.04) and BMI z-score (-0,21; p-value = 0.03) Table 3 supp.

Correlations between BEBQ subscales

'Food responsiveness' was positively correlated with 'general appetite' (0.43; p-value < 0.001) and was negatively correlated with 'satiety responsiveness' (-0.32; p-value < 0.001). 'Satiety responsiveness' was positively correlated to 'slowness in eating' (0.30; p-value < 0.001), and inversely correlated to 'general appetite' (-0.25; p-value = 0.01) Table 4 supp.

Discussion

Given the lack of tools developed in this age group to assess appetite traits in an epidemiologic context, added to the high prevalence of obesity in early life, the aim of this research was to translate and culturally adapt the BEBQ to the Chilean population and evaluate the psychometrical properties in a Chilean sample of mothers with infants of 5 months old. In our sample of Chilean mothers of 5-month-old infants, the proposed four-factor model provided an acceptable fit to the original instrument developed by Llewellyn et al. (2011). Three of the four scales showed moderate to good internal reliability (Enjoyment to food, $\alpha = 0.77$; Food responsiveness, $\alpha = 0.83$; and Satiety responsiveness, $\alpha = 0.61$); however, Slowness in eating had poorer internal reliability ($\alpha = 0.58$) as presented in the BEBQ validation in Mexico. Only 2 items did not show a good correlation to the original factor structure in our sample.

In this study, boys scored higher on general appetite than girls. These results are in accordance with Llewellyn et al. (2011) who reported higher general appetite and food responsiveness and lower satiety responsiveness in males, compared to females. Also, Zheng et al. (2018) in a Chinese sample observed that satiety responsiveness and food responsiveness scores differed significantly according to sex. We also observed that infants with obesity had lower satiety responsiveness compared with infants in the overweight and healthy weight categories. We also find a negative correlation between satiety responsiveness and weight to height z-score and BMI z-score. Mallan et al. (2014) also showed a negative association between satiety responsiveness and infant weight. Hunot-Alexander et al. (2021), found in a Mexican sample an inverse association between BMI-z score and slowness in eating and a positive association with general appetite. We didn't find associations between the other BEBQ traits and anthropometric measures, which is at odds with other previous studies. This could be due to the small sample size and low power.

Table 2 Factor loading for all items of the BEBQ-Chile

Item	Factors determined through PCA				
	Original sub-scale	Food responsiveness	Enjoyment of food	Slowness in eating	Satiety responsiveness
1. My baby seemed contented while feeding/Mi bebé parecía contento mientras comía	DA/EF		0.64		
2. My baby frequently wanted more milk than I provided/ Mi bebe frecuentemente quería más leche de la que yo le podía dar	FR/RA	0.59			
3. My baby loved milk/A Mi bebe le encanta mi leche	DA/EF		0.64		
4. My baby had a big appetite/Mi bebé tenía un gran apetito	GA/FR		0.47		
5. My baby finished feeding quickly /Mi bebé terminaba de comer rápidamente [a]	LC/SE			Ns 0.11	
6. My baby became distressed while feeding/Mi bebé parecía angustiado o afligido mientras comía [a]	DA/EF	ns-0.01			
7. My baby got full up easily/ Mi bebé se llenaba fácilmente	RS/SR				0.57
8. If allowed to, my baby would take too much milk/Si se le permitiera, mi bebé tomaría demasiada leche	FR/RA	0.79			
9. My baby took more than 30 min to finish feeding/ Mi bebé se tardaba más de 30 minutos en terminar su comida/pecho	LC/SE			0.55	
10. My baby got full before taking all the milk I thought s/he should have /Mi bebé se llenaba antes de tomar toda la leche que yo pensaba que debía recibir	RS/SR				0.61
11. My baby fed slowly/Mi bebé era lento para comer	LC/SE			0.65	
12. Even when my baby had just eaten well, s/he was happy to feed again if offered/ Aun cuando mi bebé haya comido bien, estaría contento (a) de volver a comer si se le ofreciera	FR/RA	0.75			
13. My baby found difficult to manage a complete feed/ A mi bebé le costaba trabajo terminar una comida/pecho					0.59
14. My baby was always demanding a feed/Mi bebé estaba siempre exigiendo comida/pecho	FR/RA	0.47			
15. My baby sucked more and more slowly during the course of a feed/ Mi bebé succionaba cada vez más lento, durante el transcurso de una comida/pecho	LC/SE			0.52	
16. If given the chance my baby would always be feeding/ Si se le diera la oportunidad, mi bebé siempre estaría comiendo	FR/RA	0.85			
17. My baby enjoyed feeding time/Mi bebe disfrutaba la hora de comer			0.91		
18. My baby could easily take a feed within 30 min of the last one / Mi bebé podía fácilmente volver a comer a los 30 minutos del último pecho	FR/RA	0.68			

Abbreviations: *BEBQ* Baby Eating Behaviour Questionnaire

EF Enjoyment of food; *DA* Disfrute de los alimentos; *FR* Food responsiveness; *RA* Respuesta a los alimentos; *SE* Slowness in eating; *LC* Lentitud en el comer; *SR* Satiety responsiveness; *RS* Respuesta a la saciedad; *GA* General appetite; *AG* Apetito en general; [a] Reverse scored item

These results are somehow consistent with studies conducted in older children, where it has been observed that children and adolescents with obesity have lower satiety responsiveness (Webber et al., 2009; Obregón et al., 2017; Kininmonth et al., 2021). This association observed in early infancy could be explained by genetic inheritance, given that genetic influence on infant feeding behavior appears to be strong Llewellyn and Wardle (2015). In relation to this, Llewellyn et al. (2012) previously found that differences in weight may be due partly to genetically determined differences in appetite traits that confer differential susceptibility to obesogenic environments.

In relation to the association between appetite traits and weight gain, Van Jaarsveld et al. (2011) previously showed in a bidirectional prospective study from 3 to 15 months of age that the associations between appetitive traits and subsequent weight gain were stronger than those between weight and subsequent change in appetitive traits, supporting the

Table 3 Confirmatory factor analysis and model fit indices of the BEBQ-Chilean version ($n = 101$)

Model fit Indices	Model 1 (original structure) $n = 101$	Model 2 (without item 5,6)	
X^2p	1,506 (0.002)	1.65 (0.002)	Near to Zero
RMSEA	0.14	0.07	
GFI	0.858	0.872	
AGFI	0.814	0.810	
RMR	0.154	0.147	
SRMR	0.093	0.082	
NFI	0.756	0.784	
NNFI	0.858	0.891	
CFI	0.90	0.90	
TLI	0.88	0.88	

chi-square ($\chi 2$); *RMSEA* Root mean square error of approximation; *GFI* Goodness-of-fit index; *AGFI* Adjusted goodness-of-fit; *RMR* Root mean square residual; *SRMR* Standardized root mean square residual; *NFI* Normed fit index; *NNFI* Bonett's nonnormed fit index; *CFI* Comparative fit index; *TLI* Tucker– Lewis index; *BEBQ-Chilean* Baby Eating Behavior Questionnaire, Chilean version

idea that appetite traits in early infancy may play a causal role in the rate of infant weight gain. In a follow-up study in the same sample, that took advantage of the twin design, Van Jaarsveld et al. (2014) found that differences in infant appetite between non-identical twin pairs at 3 months of age-predicted differential weight gain from 3 to 15 months of age. Specifically, the twin with higher food responsiveness was 654 g heavier than his or her co-twin at 6 months of age, and ~ 1 kg heavier at 15 months of age. For twins discordant for satiety responsiveness, the weight difference between siblings was virtually the same—637 g at 6 months and ~ 1 kg g at 15 months of age. Furthermore, Quah et al. (2015), studied 210 infants and showed that higher scores for food responsiveness at 3 months of life were associated with a higher BMI between 6 and 15 months of age, and with greater weight gain between 3 and 6 months. At the same time, higher scores for slowness in eating and satiety responsiveness at 3 months of age were associated with lower BMI at 6 months of age, and lower weight gain between 3 to 6 months.

In our study, we observed that infants with higher general appetite also showed higher food responsiveness (*related to the demand of the infant regard to being fed and his or her level of responsiveness to cues of milk and feeding*). Also, food responsiveness was inversely associated with satiety responsiveness (*how easily the infants get full during the feed*). On the other hand, satiety responsiveness was positively associated with slowness in eating (the *speed with which an infant typically feeds*) and negatively associated with food responsiveness, z-score of weight to height, and BMI. We also found a positive association was observed between satiety responsiveness and slowness in eating; and food responsiveness and general appetite.

All these associations indicate that infants who are more demanding for food, are more responsive to food cues and have lower satiety sensitivity, possibly due in part to a mechanism that involves the speed of eating (eat fast).

Strength and limitations

The BEBQ is a parent-report measure and could therefore be subject to bias. The original tool developed by Llewellyn et al. (2011) asked parents to respond retrospectively to the period of exclusive milk-feeding during which their infants were about 3 months old or less (infants were on average

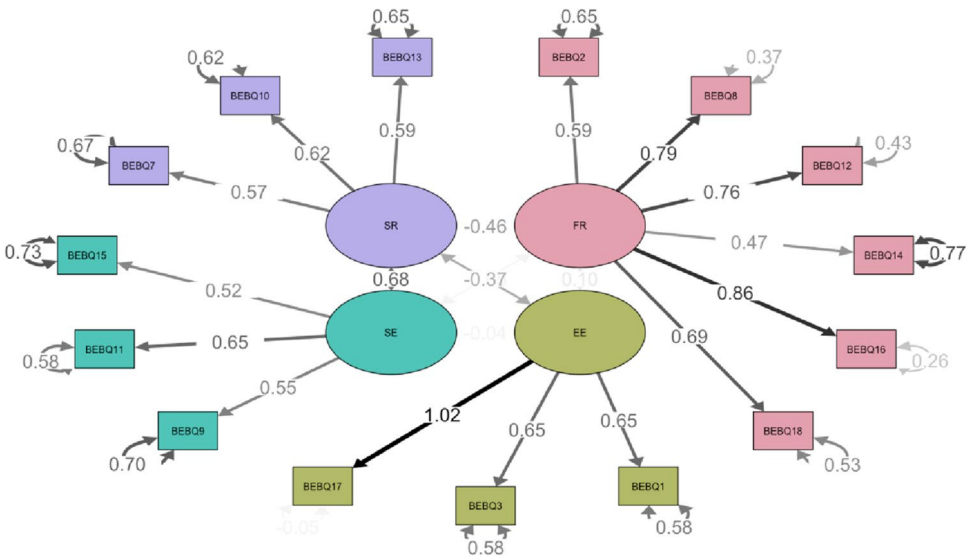

Fig. 1 Path diagrams of the four-factor models of the Baby Eating Behaviour Questionnaire (Llewellyn et al., 2011) with standardised estimates (factor–factor and item–factor loadings, item squared multiple correlations and error-covariances) fitted in sample of 101 mother–infant dyads

Table 4 Eating behaviour traits in Infants by nutritional status

	Underweight/at risk of underweight ($n=10$) Mean ± SD	Healthy weight ($n=37$) Mean ± SD	Over—weight ($n=34$) Mean ± SD	Obesity ($n=17$) Mean ± SD	*p*-value
BEBQ sub-scales					
Food responsiveness	3.2 ± 1.31	2.97 ± 1.34	3.17 ± 1.21	3.67 ± 1.21	0.31
Enjoyment to food	4.9 ± 0.07	4.93 ± 0.14	4.89 ± 0.28	4.95 ± 0.13	0.72
Satiety responsiveness	1.93 ± 1.09	2.37 ± 0.98 [b]	2.05 ± 1.01[c]	1.35 ± 0.39 [b,c]	< 0.01
Slowness in eating	2.35 ± 1.22	2.28 ± 0.86	2.21 ± 0.83	2.26 ± 0.77	0.94
General Appetite	4.4 ± 1.07	4.25 ± 1.10	4.35 ± 0.95	4.58 ± 0.71	0.79

[*] Significant differences were analyzed with the nonparametric Kruskal–Wallis test and the Dunntest

[a] Significant difference between Healthy weight and Overweight; [b] Significant differences between Healthy weight and Obesity; [c] Significant differences between Overweight and Obesity

8 months old at the time the parents completed the retrospective questionnaire). We performed this study in infants aged 5 months, asking parents to report on the child's current appetite for milk. We chose this particular age because in Chile the national infant program has established a mandatory 5 [th] month visit with a dietitian, that aims to incorporate complementary feeding in infants, so previous to this age they are exclusively milk feeding. We reported cross-sectional associations between appetitive traits and anthropometric measurements, but more work is required to explore prospective associations to understand better the direction of the relationships between appetite and weight gain in the Chilean context.

It is possible that some of our null findings related to the appetitive traits and anthropometric variables were due to our limited sample size. Moreover, the use of a convenience sample limits the generalizability to all Chilean infants. Our study also has the limitation, that some of the model fit indices are within the acceptable range while others are borderline.

The study also had several strengths. It is the first study of infant appetite in a Latin American population. Weight and height were directly measured by trained registered dietitians known to participants, in a face-to-face consultation in their familiar clinic. Lastly, the validation of this psychometric tool allows for the collection of large sample appetite data, enabling research to establish more clearly the associations between infant feeding, weight gain, and obesity based on maternal perceptions, in the Chilean population.

There are a number of theoretical implications associated with the validation of this scale.

Appetitive traits have been associated with weight gain over time, for example, infant appetitive traits measured by the BEBQ at 3 months (*food responsiveness*) significantly correlated with higher BMI z-scores at 6 months and 15 months. In light of the fact that certain appetite traits can predict future weight gain, it is likely that these traits will contribute significantly to obesity risk over time. As a result, assessment of these characteristics during infancy may allow the identification of infants with high-risk appetite characteristics who are particularly prone to becoming overweight in the future.

Conclusions

This study provides evidence of moderate to strong factorial validity, internal consistency, and concurrent validity of the BEBQ-Chile questionnaire in a sample of Chilean infants. Thus, the BEBQ-Chile can be used in epidemiologic and interventional research examining infant feeding traits and relationships to obesity and health outcomes. Given the rising prevalence of pediatric obesity, combined with the fact that obesity tracks from early infancy to later development and into adulthood, the BEBQ-Chile version can advance research aimed at identifying early determinants of feeding-related obesity, thus optimally informing primary prevention and early intervention strategies.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12144-023-04679-x.

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Author contributions

Term	Obregón AM	Valladares M	Guzman E	Pettinelli P	Hunot C	Smith A	Llewellyn C	G Goldfield	Definition
Methodology	X	X						x	Development or design of methodology; creation of models
Software									Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components
Validation	X								Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/ experiments and other research outputs
Formal analysis	X	X	X	X					Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
Investigation	X	X							Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection
Resources	X								Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools
Data Curation	X	X		X					Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse
Writing—Original Draft	X			X					Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)
Writing—Review & Editing		X	X	X	X	X	X	X	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre-or post-publication stages
Visualization	X	X		X					Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation
Supervision	X								Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team
Project administration	X								Management and coordination responsibility for the research activity planning and execution
Funding acquisition	X								Acquisition of the financial support for the project leading to this publication

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Data availability The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval The study protocol was approved by the Research Scientific Ethics Committee of San Sebastián University.

Informed consent Written consent was obtained from each participant.

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

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What is already known on this subject? The BEBQ is a new instrument for the assessment of infant eating behavior, but it is only available in English and has not been validated in a Chilean sample.

What does your study add? This study demonstrated good psychometric properties of the BEBQ Chilean version with a Chilean sample. Also, this tool could be used for the assessment of eating behavior in the Chilean health system.