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# Assessment of parental overt and covert control of child's food intake: A population-based validation study with mothers of preschoolers

Paulina Nowicka [a,*], Carl-Erik Flodmark [b], Derek Hales [c], Myles S. Faith [c]

[a] Division of Pediatrics, Department of Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden
[b] Childhood Obesity Unit, Childhood Centre Malmö, Skåne University Hospital, Malmö, Sweden
[c] Department of Nutrition, Gillings School of Global Public Health, University of North Carolina - Chapel Hill, USA

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A B S T R A C T

*Introduction:* Overt and covert control are novel constructs representing two different parental feeding practices with regard to the child's ability to detect them. Preliminary research indicates that covert control is linked to a healthier diet and lower child weight status. In this study, we report the first psychometric validation of the original measures of overt and covert control outside the UK in a large sample of parents of preschoolers.
*Methods:* Based on records from the population register, all mothers of 4-year-olds (n = 3007) from the third largest city in Sweden, Malmö, were contacted by mail. Out of those, 876 returned the measures of overt and covert control together with a background questionnaire and the Child Feeding Questionnaire (CFQ). Test–retest data were obtained from 64% (n = 563) of these mothers. The mean age of the mothers was 35.6 years; their mean BMI was 24.1, 31.5% were overweight or obese. The children were on average 4.5 years old; 48% were girls, 12.8% were overweight or obese.
*Results:* While the fit for the original 9-item 2-factor model was poor, shorter 8- and 6-item versions were supported by confirmatory factor analysis (CFI > 0.95, RMSEA < 0.05). Internal and test–retest reliability of the shorter version was good (ICC = 0.65–0.71). Results also suggest that the factor structure and loadings were invariant (i.e., did not significantly differ) over time and between child sexes. Both overt and covert control factors were moderately correlated with CFQ monitoring. Overt control was also moderately related to CFQ pressure and weakly correlated with CFQ restriction. Covert control, on the other hand, was moderately related to restriction and not related with pressure. Correlations of both factors with child and parent BMI were very small.
*Conclusion:* We found good psychometric properties of the revised versions of the overt and control behaviors in a multiethnic sample of mothers from Sweden. Future studies need to establish causal associations between overt and covert control and the obesity related outcomes.


## 1. Introduction

The high prevalence of overweight and obesity in children worldwide has led to increased efforts in understanding parental influences on children's eating behaviors (Birch & Fisher, 1998; Birch & Ventura, 2009; Skouteris et al., 2011; Ventura & Birch, 2008). One of the most important parental feeding practices affecting children's weight development appears to be restriction (Birch & Ventura, 2009; Birch et al., 2001; Faith & Kerns, 2005; Ventura & Birch, 2008), which has been linked prospectively to increased child weight status by several U.S. based research groups (Birch & Fisher, 2000; Faith et al., 2004). Additionally, the impact of restrictive feeding may interact with child attributes such as inhibitory control (Anzman & Birch, 2009; Rollins, Loken, Savage, & Birch, 2014) and obesity risk status at birth (Faith et al., 2004). For example, restrictive feeding predicted excess BMI[1] z-score gain among children born at high-risk but not low-risk for obesity, based on maternal pre-pregnancy BMI. Thus, restrictive feeding may have both direct and indirect effects on child weight gain.

To advance our understanding of the role of restriction in child eating and weight regulation, Ogden and colleagues proposed an alternative model that conceptualizes "overt" and "covert" control (Ogden, Reynolds, & Smith, 2006). Specifically, overt control is defined as '*controlling a child's food intake in a way that can be detected by the child*' and

* Corresponding author at: Division of Pediatrics, Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institutet, Stockholm, Sweden. Tel.: +46 (0) 8 585 873 57.
*E-mail address:* paulina.nowicka@ki.se (P. Nowicka).

[1] List of abbreviations: BMI = body mass index, CFA = confirmatory factor analysis, CFI = Comparative Fit Index, CFQ = Child Feeding Questionnaire, ICC = intraclass correlation, RMSEA = root mean square error of approximation, SD = standard deviation, SEM = structural equation modeling, SRMR = standardized root mean square residual, and TLI = Tucker–Lewis Index.

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**Table 1**
Means, standard deviations, frequencies, and correlations from Time 1 data for overt and covert item responses.

| Scale | Item | Mean (SD) | Percent of participants selecting each of the response categories | | | | | Correlation among items | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 Never | 2 Seldom | 3 Sometimes | 4 Often | 5 Always | Ov1 | Ov2 | Ov3 | Ov4 | Cov1 | Cov2 | Cov3 | Cov4 |
| OVERT | How often are you firm about … | | | | | | | | | | | | | | |
| Ov1 | What your child should eat? | 3.96 (0.71) | 0.18 | 3.56 | 15.66 | 61.39 | 19.22 | | | | | | | | |
| Ov2 | When your child should eat? | 4.09 (0.69) | 0.18 | 2.67 | 9.96 | 61.92 | 25.27 | 0.46 | | | | | | | |
| Ov3 | Where your child should eat? | 4.09 (0.85) | 0.90 | 3.78 | 14.93 | 45.68 | 34.71 | 0.37 | 0.52 | | | | | | |
| Ov4 | How much your child should eat? | 3.13 (0.96) | 4.37 | 22.04 | 34.43 | 34.06 | 5.10 | 0.40 | 0.33 | 0.22 | | | | | |
| COVERT | How often do you … | | | | | | | | | | | | | | |
| Cov1 | Avoid going to cafes or restaurants with your children which sell unhealthy food? | 2.96 (1.10) | 13.37 | 18.72 | 30.48 | 33.69 | 3.74 | 0.16 | 0.10 | 0.18 | 0.07 | | | | |
| Cov2 | Avoid buying sweets and chips and bringing into the house? | 3.22 (0.97) | 6.62 | 13.77 | 34.88 | 40.25 | 4.47 | 0.09 | 0.10 | 0.13 | 0.04 | 0.44 | | | |
| Cov3 | Not buy foods that you would like because you do not want your children to have them? | 2.35 (1.17) | 32.56 | 21.82 | 27.91 | 14.49 | 3.22 | 0.08 | 0.03 | 0.06 | 0.11 | 0.36 | 0.36 | | |
| Cov4 | Try not to eat unhealthy foods when your children are around? | 3.11 (1.20) | 13.62 | 17.2 | 23.12 | 36.92 | 9.14 | 0.15 | 0.07 | 0.14 | 0.13 | 0.39 | 0.34 | 0.54 | |
| Cov5 | Avoid buying cookies, biscuits and cakes, and bringing them into the house? | 3.18 (1.03) | 8.02 | 16.22 | 30.66 | 39.75 | 5.35 | 0.06 | 0.08 | 0.20 | 0.06 | 0.36 | 0.59 | 0.37 | 0.38 |

covert control is defined as '*controlling a child's food intake in a way that cannot be detected by the child*' (Ogden et al., 2006). When restrictive feeding practices were distinguished as covert versus overt control, they found differing patterns of associations with parent and child characteristics, as well as child snacking behaviors. For example, greater intake of healthy snacking was related to overt control while decreased unhealthy snacking was related to covert control (Brown, Ogden, Vogele, & Gibson, 2008; Ogden et al., 2006). Parents with higher education used covert control practices more often (Brown et al., 2008). In a recent longitudinal study, both forms of control predicted unhealthy snacking as they both were negatively associated with the intake. However, only covert control was associated with lower BMI SDS (i.e., standardized for age and sex) and increased fruit intake in children (Rodenburg, Kremers, Oenema, & van de Mheen, 2014). This may imply that covert control may have a protective influence on child's weight status and eating habits.

While there is growing interest in overt and covert control constructs and use of this measurement (de Lauzon-Guillain et al., 2012; Musher-Eizenman & Kiefner, 2013; Vaughn, Tabak, Bryant, & Ward, 2013), psychometric evaluations have been limited to date and the constructs have only been studied in UK (Dickens & Ogden, 2014; Ogden et al., 2006; Rollins et al., 2014) and the Netherlands (Rodenburg et al., 2014). The aim of this study was to provide a detailed examination of the psychometric properties of measures of overt and covert control in a large population-based sample of mothers to preschool children in Sweden. This study focused on preschoolers, a time of life in which child food preferences and eating patterns are still developing (Birch & Fisher, 1998). We measured overt and covert practices at two time points in a large sample of families in order to establish the reliability evidence for the two constructs. Construct validity evidence was developed by examining the factor structure of the scales, factor invariance, and by evaluating the correlations between overt and covert feeding with child BMI, parent BMI, education, and feeding styles from the Child Feeding Questionnaire (CFQ) (Birch et al., 2001). We predicted that correlations with the CFQ monitoring, pressure to eat and restriction subscales would be moderate and in a positive direction for both overt and covert control. We also predicted that covert control would be negatively associated with child BMI and positively with maternal education.

## 2. Method

### 2.1. Data collection

The study was approved by the Regional Ethical Board in the south of Sweden; written consents were obtained from all participating parents. The addresses of all female guardians of children aged 4 years, who had been living in Malmö in July 2009, were obtained from the Swedish Population Registry. Malmö is the third largest city in Sweden, with a population of 280 000. In total 3007 female guardians of children in the targeted age group (from now referred to as "mothers", as 98% reported to be the children's biological mothers) received the questionnaires by mail. One reminder was sent within a week. Out of 3007 mothers, 876 returned the completed overt and covert control questionnaire together with the Child Feeding Questionnaire (Birch et al., 2001) and background questionnaire. The background questionnaire included questions about children's age, gender, weight and height and place of birth and place of birth of both parents. The mothers were asked to answer questions about their age, educational level, weight and height. To examine test–retest reliability, the questionnaires were immediately sent again to those who answered the questionnaire in phase 1. In total 563 mothers responded in phase 2. There was no difference between responders in the two phases in terms of child or parents' characteristics with one exception. Specifically, mothers in phase 2 had a slightly higher education (65% with university education versus non-responders 50%, $p < 0.0001$).

### 2.2. Sample characteristics

The mean age of the mothers was 35.6 years (SD 5.1); their mean BMI was 24.1 (SD 4.2), 31.5% were overweight or obese. The children were on average 4.5 years old (SD 0.3, range 4.0–5.1); 48% were girls, 14.2% were either overweight or obese. While the responding mothers resembled the Malmö population quite well with regard to BMI and country of origin, they were more highly educated (60% had university or college exam versus 42% in the general population) (Statistics Sweden, 2008). Moreover, among the children, a higher percentage than expected was overweight (7.7 vs 6.4) or obese (10.2 vs 2.3), in comparison to primary health care statistics (Child Health Care Centre, 2011). Of the mothers, 67.2% were born in Sweden. Among the non-Nordic birth countries the most common were Iraq, Lebanon, Iran, Poland, and Bosnia and Herzegovina. In total, participants reported 64 different birth countries. Further/additional details on the sample have been provided elsewhere (Nowicka, Sorjonen, Pietrobelli, Flodmark, & Faith, 2014).

### 2.3. Overt and covert control

The original questionnaire consists of 9 items, four representing overt control and five representing covert control (Ogden et al., 2006).

Overt control items assess parent's self-reported *direct* influence on child eating. Covert items ask about *indirect* parental controlling practices aimed to avoid providing or exposing children to unhealthy foods and snacks. The items from each scale can be found in Table 1. Response options for the items were: 1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = always. The total score for each factor was obtained by calculating the mean score for the items. The Cronbach's alpha for overt control was previously reported to be 0.71 and for covert control 0.79 (Ogden et al., 2006).

#### 2.3.1. Instrument translation procedures

The process of translation to Swedish was performed according to the recommended guidelines (Beaton, Bombardier, Guillemin, & Ferraz, 2000; de Vet, Terwee, Mokkink, & Knol, 2011). Permission to translate the questionnaire was obtained from the original authors. The questionnaire was translated from English to Swedish by two independent translators. Both translations were checked for any differences between them, and the synthesized version of the translation was back translated into English by two other translators not familiar with the original version of the questionnaire. An expert committee of the four translators together with the researchers and involved health care professionals reviewed all the translations and agreed on a pilot version. The comprehensibility of the items in the pilot version was further examined in a reference group consisting of 38 mothers of preschool age children. No changes were needed after pilot testing. The final questionnaire was reviewed and approved by an expert group including pediatricians, pediatric nurses and dieticians, both from primary care and from the children's hospital in the city (Malmö) where the study was to be performed.

### 2.4. Child Feeding Questionnaire

The mothers were asked to fill out the Child Feeding Questionnaire (CFQ) on parents' perceptions and concerns regarding child obesity, child-feeding attitudes and practices (Birch et al., 2001). The Swedish version of CFQ consists of 29 items, loading on seven factors (Nowicka et al., 2014); two items from the original version of the CFQ assessing if parents reward their children with food (restriction) were excluded due to poor model fit. In this study we used scores from three factors that assess parent feeding practices. The first was restriction, consisting of 6 items that assess the extent to which parents limit their child's access to foods. The second was pressure to eat, 4 items assessing parents' tendency to pressure their children to eat more food. The third was monitoring, consisting of 3 items indicating the extent to which parents supervise their child's eating. The response options were: 1 = disagree, 2 = slightly agree, 3 = neutral, 4 = slightly agree, and 5 = agree.

**Table 2**
Model fit from the confirmatory factor analysis for the original and revised 2-factor overt and covert control scale.

| Model (items) | Time | N | $\chi^2$ | DF | RMSEA | CFI | TLI | SRMR |
|---|---|---|---|---|---|---|---|---|
| Original 9-item | 1 | 869 | 242.09 | 26 | 0.098 | 0.886 | 0.842 | 0.049 |
| Overt 1–4 | 2 | 563 | 184.51 | 26 | 0.104 | 0.897 | 0.857 | 0.052 |
| Covert 1–5 | | | | | | | | |
| Revised (8-item) | 1 | 869 | 110.24 | 19 | 0.074 | 0.936 | 0.906 | 0.042 |
| Overt 1, 2, 3, 4 | 2 | 563 | 60.54 | 19 | 0.062 | 0.962 | 0.943 | 0.038 |
| Covert 1, 3, 4, 5 | | | | | | | | |
| Revised (6-item) | 1 | 869 | 23.39 | 8 | 0.047 | 0.977 | 0.957 | 0.027 |
| Overt 1, 3, 4 | 2 | 563 | 23.71 | 8 | 0.059 | 0.969 | 0.942 | 0.036 |
| Covert 1, 2, 3 | | | | | | | | |

### 2.5. Statistical analysis

The descriptive statistics are presented as means and SDs, or percentages for categorical variables. Cronbach's alpha was calculated for each factor as an indicator of internal consistency. In addition, the data from Time 1 and Time 2 were used to compute test–retest correlations, signed and absolute difference scores, coefficient of variation (expressed as %), and the intraclass correlation (ICC). These values were used to evaluate the reliability evidence for the factors. Each of the above was estimated using SAS v9.3.

Construct validity evidence for each factor was developed using confirmatory factor analysis (CFA) and correlational evidence. The CFA was used to evaluate the fit of the hypothesized constructs and to examine measurement invariance over time. Model misfit was assessed in the conventional manner of examining global fit indices (Hu & Bentler, 1999), parameter estimates, modification indices, and standardized residual estimates. The root mean square error of approximation (RMSEA; (Steiger & Lind, 1980)), Tucker–Lewis Index (TLI), Comparative Fit Index (CFI; (Bentler, 1990)), standardized root mean square residual (SRMR), and $\chi^2$ statistic were used to document global and local model fit. Good fit is indicated by CFI and TLI values of 0.95 or higher, the RMSEA of 0.06 or lower and the SRMR of 0.08 or lower (Hu & Bentler, 1999). These fit indices complement one another, and each reflects a unique and important property of overall model fit (Tanaka, 1993). All model modifications were considered with known features of the indicator items and the original factor development. After modification, all models were fit to the data from the second administration for cross validation. Comparisons of all modified factors to the original versions are provided.

After CFA models for the original and revised factors were fit, we examined the relative invariance of the measurement model over time and between mothers of girls compared to those with boys. Measurement invariance over time and across groups should be established to support conclusions derived from group difference or change scores. The invariance analysis involved testing and comparing a series of nested models using standard procedures (Horn & McArdle, 1992; Vandenberg & Lance, 2000). Models are considered nested if a simpler model can be obtained by imposing a set of restrictions on a more complex model. The only difference between the models is the number of free and fixed parameters estimated (i.e., the nested, or simpler, model has more fixed, or constrained parameters). While there have been many recommendations about assessing nested differences, an absolute change in CFI of 0.01 and RMSEA of 0.01 to 0.015 between nested models has been reported to work well for testing multi-group invariance (Cheung & Rensvold, 2002).

## 3. Results

### 3.1. Item level summary

Means, standard deviations, and response distributions for each of the overt and covert items are presented in Table 1. Overall, overt control behaviors were more prevalent than covert. For example, as many as 82% of mothers answered that they were often or always influencing what the child should eat and 87% frequently controlled timing of eating. Mothers also reported to be involved in deciding where the child should eat (80% answered often or always), but only 39% answered that they were firm about the amount of food. The most frequent covert behavior was trying not to buy cookies, biscuits or cakes and bringing them into the house (45% of mothers did that often or always), while the least frequent covert behavior was avoiding buying food that the mother would like to have because she didn't want the child to have them (18% answer often or always, while 33% answered never).

Of note, 64% of mothers sometimes or often avoided going to places which sold unhealthy food, and 75% sometimes or always avoided

**Table 3**
Invariance results for 6-item 2-factor models over time (T1 & T2 [n = 563]) and by child sex (T1 only [n = 414 girls; n = 447 boys]).

| Model | | $\chi^2$ | DF | RMSEA | CFI | SRMR | $\chi^2$ Δ | RMSEA Δ | CFI Δ | SRMR Δ |
|---|---|---|---|---|---|---|---|---|---|---|
| Time | Pattern | 43.81 | 16 | 0.056 | 0.970 | 0.035 | | | | |
| | Loadings | 45.12 | 20 | 0.047 | 0.972 | 0.036 | $\chi^2$ (4) = 1.3, p = 0.860 | −0.009 | 0.002 | 0.001 |
| | Intercepts | 63.81 | 26 | 0.051 | 0.959 | 0.043 | $\chi^2$ (6) = 18.7, p = 0.005 | 0.004 | −0.013 | 0.007 |
| | Error Var | 81.45 | 32 | 0.052 | 0.946 | 0.066 | $\chi^2$ (6) = 17.6, p = 0.007 | 0.001 | −0.013 | 0.023 |
| | Var/Cov | 82.77 | 35 | 0.049 | 0.948 | 0.074 | $\chi^2$ (3) = 1.3, p = 0.723 | −0.003 | 0.002 | 0.008 |
| Child sex | Pattern | 39.97 | 16 | 0.059 | 0.965 | 0.034 | | | | |
| | Loadings | 43.49 | 20 | 0.052 | 0.966 | 0.038 | $\chi^2$ (4) = 3.5, p = 0.475 | −0.007 | 0.001 | 0.004 |
| | Intercepts | 52.74 | 26 | 0.049 | 0.961 | 0.041 | $\chi^2$ (6) = 9.3, p = 0.160 | −0.003 | −0.005 | 0.003 |
| | Error Var | 62.12 | 32 | 0.047 | 0.956 | 0.053 | $\chi^2$ (6) = 9.4, p = 0.153 | −0.002 | −0.005 | 0.012 |
| | Var/Cov | 65.08 | 35 | 0.045 | 0.956 | 0.057 | $\chi^2$ (3) = 2.9, p = 0.398 | −0.002 | 0 | 0.004 |

*Note*: Var = variance; Cov = covariance; Δ = change.

buying unhealthy food and bringing them to the house. The highest correlations among items were found between overt items 2 and 3 (r = 0.52) and covert items 3 and 4 (r = 0.54).

### *3.2. CFA and model modifications*

The fit for the original 9-item two factor model was moderate to poor (RMSEA = 0.098, CFI = 0.886, SRMR = 0.049). However, two models (i.e., 8-item and 6-item models) provided a good fit to the data, while retaining variance and the intended "meaning" of the original factors. For the 8-item 2-factor model (RMSEA = 0.074, CFI = 0.936, SRMR = 0.042), the covert item "Avoid buying cookies, biscuits and cakes and bringing them into house" was removed, resulting in two 4-item factors. For the 6-item 2-factor model (RMSEA = 0.047, CFI = 0.977, SRMR = 0.027), we eliminated one overt factor item ("Firm about when your child should eat") and two covert factor items ("Try to not eat unhealthy foods when your children are around" and "Avoid buying cookies, biscuits and cakes and bringing them into the house"). The fit indices were very similar for each model using data from the second administration. Model fit for the original and revised scales using data from both administrations can be found in Table 2.

### *3.3. CFA invariance*

Results of the invariance analysis for the 6-item 2-factor model can be found in Table 3. These results are presented because the 6-item scale is the simplest and had the best overall fit. The results and conclusions with respect to invariance are nearly identical to the 9-item and 8-item models. We found that the item loadings, factor variance, and factor covariance were similar over time. The CFI, SRMR and chi-square difference showed a slight change in the intercepts and error variance over time. This difference was likely minimal and does not negate measurement invariance. Invariance results for mothers of girls (n = 414) compared to those with boys (n = 447) are also presented in Table 3. The change in fit across increasing model constraints suggests strong measurement invariance between mothers with girls compared to boys. Stated differently, the models did not significantly differ for boys and girls.

### *3.4. Factor descriptive statistics and reliability evidence*

Two-week test–retest reliability information for each factor was examined using the data collected at two time points, T1 and T2 (n = 563). Evidence for reliability was strong for single administration of each factor (see Table 4). Specifically, low coefficients of variation and deviations with single measure ICC >0.60 support this conclusion. Test–retest reliability information for individual items was also computed and found to be satisfactory. As expected, the internal consistency was slightly better for the original versions of the factors, but was moderate to good for the revised factors. Revised overt and covert scores were strongly correlated with the original factor scores.

### *3.5. Relationships between measures and child and parent characteristics*

Additional construct validity evidence and support for the revised version was provided by examining the correlations between overt

**Table 4**
Reliability information for original and revised overt and covert control scales.

| Factors | Mean (SD) | | Reliability evidence for factors (*comparing Time 1 to Time 2*) | | | | | | | Cronbach's alpha | | Correlations among factor scores (*Time 1 data*) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time 1 | Time 2 | p-Value (*test of mean diff*) | CV (%) | PPM | ICC single | ICC Avg | Mean signed diff | Mean abs diff | Time 1 | Time 2 | OV 1–4 | OV 1, 3, 4 | COV 1–5 | COV 1, 2, 3 |
| *Overt* | | | | | | | | | | | | | | | |
| Original 1–4 | 3.82 (0.58) | 3.78 (0.57) | 0.29 | 6.37 | 0.67 | 0.668 | 0.801 | −0.04 | 0.33 | 0.697 | 0.712 | | | | |
| Revised 1, 3, 4 | 3.73 (0.61) | 3.71 (0.59) | 0.60 | 6.88 | 0.65 | 0.652 | 0.789 | 0.07 | 0.35 | 0.582 | 0.587 | 0.97 | | | |
| *Covert* | | | | | | | | | | | | | | | |
| Original 1–5 | 2.96 (0.80) | 2.87 (0.81) | 0.07 | 11.63 | 0.73 | 0.720 | 0.840 | −0.09 | 0.44 | 0.774 | 0.820 | 0.19 | 0.20 | | |
| Revised 1, 2, 3 | 2.84 (0.83) | 2.76 (0.82) | 0.08 | 13.74 | 0.67 | 0.664 | 0.798 | −0.09 | 0.50 | 0.646 | 0.692 | 0.17 | 0.18 | 0.94 | |
| Revised 1, 3, 4, 5 | 2.90 (0.84) | 2.81 (0.84) | 0.09 | 12.86 | 0.71 | 0.706 | 0.828 | −0.09 | 0.47 | 0.727 | 0.776 | 0.19 | 0.21 | 0.98 | 0.90 |

*Note*: CV = coefficient of variation (expressed as %); ppm = Pearson correlation; ICC = intraclass correlation (ICC single is ICC for single administration; ICC avg is ICC if average of T1 and T2 used); abs diff = absolute value of difference score.

**Table 5**
Correlations* between overt and covert control scores and parental feeding practices, BMI and education.

| Scale | | CFQ | | | BMI | | | Mother's |
|---|---|---|---|---|---|---|---|---|
| | | Res | Pre | Mon | Child[a] | Mom | Dad | Edu |
| Overt | Original 1–4 | 0.13** | 0.25** | 0.29** | −0.02 | −0.05 | −0.01 | −0.05 |
| | Revised 1, 3, 4 | 0.15** | 0.28** | 0.29** | −0.02 | −0.02 | 0.01 | −0.07* |
| Covert | Original 1–5 | 0.37** | −0.00 | 0.27** | 0.05 | −0.01 | 0.04 | 0.03 |
| | Revised 1, 2, 3 | 0.37** | −0.01 | 0.26** | 0.07* | −0.00 | 0.05 | 0.02 |

*Note*: CFQ Res = restriction, CFQ Pre = pressure, CFQ Mon = monitoring, Edu = 4-level education, NAT = place of birth (Sweden = 0, other = 1). Pearson correlations, except for mother's education and place of birth where Spearman correlation was used.
[a] The correlations with child BMI didn't change when partially controlled for child sex.
* $p < .05$.
** $p < .001$.

and covert factor scores and parenting feeding practices (restriction, monitoring and pressure to eat) measured using the CFQ (Birch et al., 2001), child BMI, and parent BMI and education (Table 5). As predicted, both overt and covert control factors were moderately correlated with CFQ monitoring. Overt control was moderately related to CFQ pressure and had correlations of ~0.14 with CFQ restriction. Covert control, on the other hand, was moderately related to restriction and not related with pressure. Correlations with both factors were very small for parent BMI. Post hoc analysis showed that mothers born in Sweden had significantly lower covert control scores for both factor versions ($p < 0.0001$; effect size = 0.35). Correlations for Time 2 data were very similar to those presented (data available upon request from authors).

## 4. Discussion

In a large multiethnic sample of mothers of 4-year-old children in Sweden we found strong evidence for the reliability and validity of the original and revised overt and covert feeding scales. Our findings demonstrated that a shorter 6-item version of the overt and covert control scales was just as good, if not better, at assessing the two parental feeding behaviors. The two controlling behaviors were moderately related to parent feeding practices, but in different ways, thus providing additional evidence that these novel concepts capture two distinct parental behaviors. Both versions of the scales had good internal consistency and strong test–retest reliability and construct validity evidence; the fit of the CFA model for the original 9-item version was, however, poor. In addition, measurement invariance of the scale over time, and between parents of boys compared to parents of girls, was supported.

While the concept of overt and covert control, first introduced in 2006 (Ogden et al., 2006), generated considerable attention, rigorous psychometric evaluation of this novel concept of parental control has been lacking. Our study contributes to the field by providing detailed examination of the psychometric properties of the original and revised versions of the overt and covert feeding scales. Using confirmatory factor analysis we demonstrated that the original 9-item questionnaire did not show a good fit. However, we were able to obtain a good fit by removing 3 items: one overt control item and two covert. The overt item that was removed focused on parental control of timing of meals (i.e., "How often are you firm about when your child should eat?"). Among all items, this is the item in which the highest ceiling levels in responses were seen, as nearly 90% of mothers chose the highest response categories. The two covert items removed were "How often do try not to eat unhealthy foods when your children are around" (item 4) and "How often do you avoid buying biscuits, cookies and cakes and bringing them into the house?" (item 5). Of note, item 4 was strongly correlated (0.54) to item 3, which was kept, "How often do you avoid buying unhealthy food and bringing them to the house." Although excluding these 3 items resulted in some loss of information, our evaluation indicated that the 6-item measure has very similar means and correlate very strongly with the original scale scores. Additionally, the 6-item measure is related to several external outcomes (BMI, CFQ) in the same way as the original scale. It could be argued that the simplified version provides a measure of two separate conceptual constructs with less extraneous variance.

When comparing overt and covert control behaviors to parental feeding practices, overt control was moderately correlated with pressure while covert control was moderately correlated with restriction. Both scales were similarly related to monitoring. All associations were in positive directions. The strengths of correlations were similar to those seen in the original study (Odgen et al., 2006) with exception of pressure to eat. In the present study, pressure was uncorrelated with covert control, while Ogden et al. found them to be positively related ($r = 0.26$). Our results are more in line with the conceptual assumptions behind the construct of covert control, defined as behaviors that the child cannot detect. The developers of the study also hypothesized that the covert control would be more associated with healthy eating behaviors and were able to demonstrate a link to decreased snacking (Birch & Fisher, 2000; Ogden et al., 2006) in 4 to 11 year olds. However, in a recent study of parents and adolescents aged 17–18 years, overt and covert control did not predict youth's snacking and meals once they left home (Dickens & Ogden, 2014).

An unexpected finding was that parental characteristics had very small correlations with the two types of control. This is in contrast to earlier studies with the original questionnaire that showed more highly educated mothers were more likely to exert covert control over child eating (Brown et al., 2008; Ogden et al., 2006). These earlier studies and ours did not detect strong associations with the child weight, potentially because weight status was self-reported. However, in the most recent study in which the weight status in school children (average age 9 years) was measured (Rodenburg et al., 2014), covert control was associated to child weight status both cross-sectionally and prospectively. Moreover, greater covert control was linked to lower weight status in children over one-year time, adding further evidence that the theory that parental feeding behaviors may be responsive to child characteristics such as weight status (Webber, Cooke, Hill, & Wardle, 2010; Webber, Hill, Cooke, Carnell, & Wardle, 2010).

Our study has several limitations. The cross-sectional nature of data cannot establish temporal causality between the studied variables. Second, all variables were self-reported; parental reports of child weight and height in particular should be interpreted with caution (Himes, 2009; Huybrechts et al., 2011). Finally, although only 4-year-olds were included in this study, this age likely captures and is representative of preschool aged children.

In conclusion, in this first population-level psychometric evaluation of the novel measures of parental overt and covert feeding control, both revised versions demonstrated good reliability and validity. This new evidence supports a quick and simple way to capture two meaningful influences on child weight and child perception of food. We encourage researchers, especially those designing prevention and treatment interventions related to childhood obesity, to consider using these measures to examine the dynamic relationship between parents and children in food-related contexts. Future research should examine how overt and covert feeding practices might casually influence preschool children's eating behaviors and adiposity.

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**Contributors**

PN conceived of the study, collected data, designed the statistical approach together with DH and wrote the manuscript. CEF made a substantial contribution to conception and design, and to interpretation of data. DH performed the statistical analyses and contributed to the writing of the manuscript. MSF supervised the coordination of the study and manuscript process. All authors read and approved the final manuscript and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Conflict of interest**

The authors declare no competing interests.

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