Maternal controlling feeding practices and girls' inhibitory control interact to predict changes in BMI and eating in the absence of hunger from 5 to 7 y[1–4]

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ABSTRACT

Background: Mothers use a range of feeding practices to limit children's intake of palatable snacks (eg, keeping snacks out of reach, not bringing snacks into the home), but less is known about the effects of these practices on children's eating and weight outcomes.

Objective: The objective was to identify distinct feeding practice profiles and evaluate the interactive effects of these profiles and girls' temperament (inhibitory control and approach) on girls' eating behaviors and weight outcomes at 5 and 7 y.

Design: Participants included 180 mother-daughter dyads; measures were mothers' reports of controlling feeding practices and girls' height and weight, eating in the absence of hunger (EAH) at 5 y, and inhibitory control (a measure of behavioral inhibition) and approach (a measure of appetitive motivation) at 7 y.

Results: Latent profile analysis of maternal feeding practices showed 4 feeding profiles based on maternal use of limit-setting practices and keeping snacks out of girls' physical reach, a restrictive practice: Unlimited Access to Snacks, Sets Limits+Does Not Restrict Snacks, Sets Limits+Restricts High Fat/Sugar Snacks, and Sets Limits+Restricts All Snacks. Girls whose mothers used Sets Limits+Restricts All Snacks had a higher approach and EAH at 5 y. Low inhibitory control girls whose mothers used Sets Limits+Restricts All Snacks or Unlimited Access to Snacks had greater increases in EAH and body mass index (BMI) from 5 to 7 y.

Conclusions: Effects of maternal control on girls' EAH and BMI may differ by the type of practice used (eg, limit-setting or restrictive practices). Girls with low inhibitory control were more susceptible to the negative effects of low and high control. *Am J Clin Nutr* 2014;99:249–57.

INTRODUCTION

Nearly 40% of total energy consumed by 2- to 18-y-olds in the United States was in the form of "empty calories"—half of which came from foods served as snacks (eg, grain and dairy desserts) (1). Parents may use a variety of feeding practices to limit children's intake of snack foods, including limiting which and how much of these foods are present in the home, when and how frequently they are made available, portion sizes offered, and whether permission is needed to access (2, 3). These practices are typically grouped under the umbrella of restrictive-feeding practices; however, covert (eg, avoid bringing snack foods into the home) and limit-setting approaches for which control is shared between the parent and child (eg, "parent provides, child decides") may differ from coercive forms of control such as restriction, ie, parent maintains complete control over access (4–7). While the shared control approach has been advocated (8), and there is some evidence that coercive strategies have negative outcomes (3), less is known about how to operationalize "shared control" and how this approach actually influences children's eating and weight status.

There is some evidence that the use and effect of restrictive-feeding practices differ as a function of children's temperament—a set of genetically based behavioral tendencies (9). When higher levels of parental restriction were used with daughters who had lower inhibitory control—an aspect of temperament referring to the reduced capacity to suppress inappropriate approach responses under instructions or in novel or uncertain situations (9)—daughters had greater increases in BMI from ages 7 to 15 y (10). In a separate study, when preschool children's access to a palatable snack food was restricted, children with low inhibitory control increased their intake of this food, whereas no change was observed for children with a higher inhibitory control (11). It may be that children with lower inhibitory control have greater difficulty controlling themselves when in the presence of highly palatable restricted foods, and, as a result, they consume more of these foods and experience greater weight gain with age. Children

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with higher approach—a dimension of temperament referring to greater excitement and positive anticipation for expected pleasurable events and activities (9)—may respond similarly and have difficulty controlling their intake of forbidden foods.

This study aimed to identify and describe distinct profiles of maternal feeding practices used to limit daughters' snack intake by using latent profile analysis (LPA)[5]. A secondary aim was to determine how these profiles related to maternal responses on the Child Feeding Questionnaire (CFQ; 12). The final aim was to investigate whether the effects of these profiles on daughters' eating in the absence of hunger (EAH) and weight status at 5 and 7 y were moderated by 2 aspects of daughters' temperament—inhibitory control and approach.

SUBJECTS AND METHODS

Subjects

Participants were from central Pennsylvania and part of a longitudinal study of the health and development of young girls. At study entry, participants included 197 girls aged 5 y (mean ± SD age: 5.4 ± 0.4 y) and their parents, of whom 192 families were reassessed 2 y later when girls were 7 y old (mean ± SD age: 7.3 ± 0.3). Eligibility criteria for girls' participation at the time of recruitment included living with 2 biological parents, the absence of severe food allergies or chronic medical problems affecting food intake, and the absence of dietary restrictions involving animal products. Study recruitment took place in 1996–1997. Families were recruited by using flyers and newspaper advertisements. In addition, families within a 5-county radius received mailings and follow-up phone calls (Metromail Inc).

Families were excluded from the current analyses if mothers reported never having ≥4 of the 7 study snack foods listed on the Restricted Access Questionnaire (RAQ) in their home (n = 5) or had missing data on the key variables of interest (n = 7), which reduced the sample size to 180. The former was done to avoid including participants who had only a few of the study foods in the home. At study entry, the mean family income was $35,000–$50,000. Parents were well educated; mothers' mean level of education was 14.5 ± 2.3 y (range: 12–20 y), and fathers' mean level of education was 14.7 ± 2.6 y (range: 12–20 y). Parents were, on average, slightly overweight when the girls were 5 y old; their mean BMI [weight (kg)/height (m)^2] was 26.4 ± 6.1 for mothers and 28.1.5 ± 28.1 for fathers. The Pennsylvania State University Institutional Review Board approved all study procedures, and parents provided consent for their family's participation.

Measures

At age 5 y, we collected data on maternal feeding practices and girls' perception of maternal feeding practices, the girls completed the EAH task, and anthropometric data were collected. At age 7 y, data on temperament, EAH, and anthropometric measures were collected.

Measures of maternal practices used to control snack intake

Distinct profiles of maternal controlling feeding practices when girls were 5 y old were derived by using LPA and mothers' reports on the RAQ (2)—a measure that assesses multiple dimensions of controlling feeding practices used with snack foods (**Table 1**), including limit-setting practices (eg, "In general, do you limit how much of these foods your child is allowed to have?") and coercive strategies (eg, "Do you try to keep any of these foods out of your child's reach?"). All questions were asked for each of 10 snack foods [popcorn, pretzels, chips, chocolate chip cookies, chocolate, fruit-flavored chewy candies (eg, Skittles; Wrigley), ice cream, frozen yogurt, peanuts, and Fig Newtons (Nabisco)]; however, because of a very high percentage of mothers (84–94%) who reported purchasing frozen yogurt, Fig Newtons, and peanuts less than once per month, the data on these 3 foods were excluded from the current analyses. Item responses were averaged across the remaining 7 snack foods to create a subscale for each question.

Girls' perceptions of the extent to which mothers controlled their access to the 7 snack foods (listed above) were assessed via a brief one-on-one interview (2) following the EAH procedure (described in the next section). For each of the 7 snack foods, each girl was asked "Do mom or dad let you have [snack food]?" If the girl answered yes, she was then asked "Is that an anytime food, a snack food, a dessert food, or a special time food?" The response was coded as follows: 4 = "don't allow", 3 = "only special time", 2 = "special time and dessert", 1 = "special time, dessert, and snack", 0 = "anytime". Responses for this question were averaged across foods—higher scores indicate higher controlled access to the 7 snack foods.

To examine how the feeding profiles identified through LPA were related to existing measures of restriction, we used data collected by means of the parent and child versions of the CFQ. Mothers' responses on the CFQ (12) were averaged to create a mean score (on a 5-point Likert scale)—higher scores indicated greater use of restriction. Girls' perceptions of maternal restriction were measured by using the child version of the CFQ (13), which consists of 4 items (eg, "If you ask for a snack, does mommy let you have it?"); response options were 3 = "don't allow", 2 = "sometimes", and 1 = "yes." Responses were averaged across items to create mean scores; higher scores indicated greater perception of maternal use of restriction. In the current sample, internal consistency scores were 0.78 for mothers' reported restriction and 0.85 for girls' perception of maternal restriction.

Eating in the absence of hunger

Girls' EAH calorie intakes at 5 and 7 y were measured by using the EAH protocol—a procedure developed in our laboratory to measure girls' responsiveness to the presence of palatable foods while in the absence of hunger (2). In the protocol, each girl was interviewed one-on-one after the consumption of a self-selected lunch. Because the intention of the larger study was to measure EAH, girls who indicated still being hungry after lunch (using a protocol developed in our laboratory) did not complete the protocol. Next, a food preference assessment was performed to measure each girl's food preferences for the 10 snack foods (same set from the RAQ). After the preference assessment, each girl was shown various toys available for a play session. Generous portions of the same 10 snack foods were presented during the procedure. Each girl was told that she could play with the toys or eat any of the foods while the experimenter did some work in the adjacent room. The experimenter then left the room for 10 min. Caloric intake of each

[5]Abbreviations used: CFQ, Child Feeding Questionnaire; EAH, eating in the absence of hunger; LPA, latent profile analysis; RAQ, Restricted Access Questionnaire.

TABLE 1
Maternal responses (n = 180) on the RAQ[1]

Questions	Mean ± SD	Possible range of scores
Do you deliberately **limit how often you buy** these foods?	0.4 ± 0.3	0–1[2]
When do you allow your child to have these foods?	1.4 ± 0.5	0–4[3]
In general, do you limit **how much** of these foods your child is allowed to have?	2.4 ± 0.9	0–4[4]
Is your child allowed to have **second helpings** of these foods (if served at the house or outside the home)? (reverse coded)	1.3 ± 0.5	0–3[5]
Do you try to keep any of these foods **out of your child's reach**?	0.3 ± 0.3	0–1[2]

[1] The RAQ is a measure of parental controlling feeding practices, developed by Fisher and Birch (2). The questions listed were asked for each of 7 energy-dense snack foods: popcorn, pretzels, chips, fruit-flavored chewy candies, chocolate, chocolate chip cookies, and ice cream; descriptive statistics were computed across foods. RAQ, Restricted Access Questionnaire.
[2] Response options were no = 0 and yes = 1.
[3] Response options were anytime = 0, snack = 1, dessert = 2, special occasions = 3, and don't allow = 4.
[4] Response options were never = 0, rarely = 1, sometimes = 2, usually = 3, and always = 4.
[5] Response options were always = 0, usually = 1, rarely = 2, and never = 3.

snack food was calculated by pre- and post weighing girls' food intakes in combination with manufacturers' information. Total EAH intake was obtained by summing the total calories consumed of the 10 snack foods during the free access period and dividing it by the total amount of calories available (~2500 kcal) to arrive at the percentage of available calories consumed.

Inhibitory control and approach

Girls' inhibitory control and approach were assessed at 7 y by using the parent version of the Children's Behavior Questionnaire (9), which was developed to measure 15 dimensions of temperament. Inhibitory control was measured by using 13 items (eg, "[Child] can wait before entering into new activities if s/he is asked to") and approach by using 13 items (eg, "When s/he sees as toy s/he wants, gets very excited about getting it"). Parents indicated the degree to which the statements were true on a 7-point Likert-type scale (1 = "extremely untrue" to 7 = "extremely true"). Although approach and inhibitory control were measured at 7 y, 2 y after the maternal measures on the RAQ, both dimensions of temperament have been shown to track from early to middle childhood (9, 14). Total scores for each construct were created by averaging the items within each subscale; good internal consistency was observed for inhibitory control (α = 0.74) and approach (α = 0.76).

Anthropometric measurements

Mothers' and girls' heights and weights were measured in triplicate when girls were 5 and 7 y old and were used to compute BMI scores. Girls' BMI percentiles at 5 and 7 y were calculated by using the 2000 CDC Growth Charts (15); BMI percentiles of ≥85th were used to classify girls as overweight.

Analysis plan

Except where noted, all data analyses were completed by using SAS version 9.2 (SAS Institute Inc). LPA is a mixture modeling technique that uses maximum likelihood algorithms to identify underlying subgroups in the data that are qualitatively distinct (16, 17). Although similar to latent class analysis, LPA can accommodate continuous data whereas categorical data are only appropriate in latent class analysis (16). LPA was performed in Mplus (Muthen & Muthen) by using 5 items (Table 1) from the RAQ as indicators (18). Solutions were identified for models containing 1 to 5 classes. Each model was run with 10,000 random starting values to find the best-fitting model. Model fit was assessed by using the Akaike information criterion, Bayesian information criterion, and Lo-Mendell-Rubin Likelihood Ratio Test (16, 19). The lowest Akaike information criterion and Bayesian information criterion values indicate the best model fit. The Lo-Mendell-Rubin tests the parsimony of the current model against a model with one less class (eg, 3 classes or 2 classes). A significant P value indicates that the current model is a significant improvement on the model containing one less class. On the basis of the fit statistics, the best-fitting model had 4 profiles. Mother-daughter dyads were assigned to 1 of these 4 profiles by using posterior probabilities; the average posterior probabilities for the 4 classes were 0.86, 0.90, 0.89, and 0.98. To aid the interpretation of these classes, ANOVAs were used to assess mean differences in mothers' and daughters' reports on the child feeding strategies subscales across profiles.

Next, a series of ANOVAs (PROC GLM; SAS Institute) were used to compare the identified profiles on the background and key variables of interest. ANCOVAs (PROC MIXED; SAS Institute) were used to investigate the main and interactive effects of profile membership and girls' inhibitory control and approach on BMI and EAH at 5 y and on the change in these variables from 5 to 7 y. BMI scores were used in these analyses because the girls' were of the same age and sex. In the cross-sectional models, for example, BMI at age 5 y was set as the dependent variable, and the following variables were set as between-subjects variables: profile membership, inhibitory control, and a profile × inhibitory control interaction term. When the interaction term was not significant, the main effects were examined. The longitudinal models were similar except that EAH at 7 y and percent change in BMI from 5 to 7 y ([BMI at 7 y] – [BMI at 5 y])/[BMI at 5 y]) were dependent variables, and the models were adjusted for EAH and BMI at 5 y, respectively. The ANCOVA models were rerun with mother's BMI and education and family income as covariates. Given the small size of each profile, moderators showing at least marginal significance ($P < 0.10$) were explored. To help interpret significant interaction terms, the sample was divided into groups by using median splits on the appropriate moderator (eg, low and high inhibitory control groups), and the ANCOVA models were rerun with this grouping variable as a dichotomous predictor in place of the original continuous variable. This allowed us to run contrasts comparing the outcomes by level of inhibitory groups

within each profile. All ANCOVA models were rerun with approach in place of inhibitory control. Estimates of effect size (*d*) are provided in the text for when mean differences between groups reached statistical significance ($P < 0.05$).

RESULTS

Sample descriptives

On average, at 5 y (mean ± SD), girls had BMI percentiles of 60.0 ± 26.7, and 19.4% of the sample was overweight or obese, which was below national estimates (20). Girls' mean levels of inhibitory control (5.0 ± 0.8) and approach (5.2 ± 0.6) were similar to the normative data provided for 3–5-y-olds by Rothbart et al (9). Girls with lower inhibitory control had higher BMI scores ($r = -0.18$, $P < 0.01$) and higher levels of approach ($r = -0.20$, $P < 0.001$). Heavier mothers tended to have daughters with higher levels of approach ($r = 0.17$, $P < 0.05$) and lower EAH ($r = -0.18$, $P < 0.01$) at 5 y. EAH was not associated with approach or inhibitory control at 5 y.

Profiles of maternal controlling feeding practices and their relation to feeding measures

Results of the LPA identified 4 distinct patterns of controlling feeding practices when girls were 5 y old (**Table 2**). The profiles were labeled based on mothers' responses on the RAQ. To inform the labeling of the profiles, mothers' and girls' reports of restriction use were also used; summary descriptive statistics of these measures appear in **Table 3** and are discussed in the following paragraph.

As shown in Table 2, the first profile was Unlimited Access to Snacks ($n = 51$), characterized by lower scores on all limit-setting practices, relative to the remaining profiles ($P < 0.05$, effect size $d = 1.20$–1.70), as reported by mothers on the RAQ. This profile also had lower scores on the maternal CFQ restriction subscale, and girls within this profile reported having greater access to the 7 snack foods (during the interview), relative to the remaining profiles ($P < 0.05$, $d = 0.57$–0.95), which suggested that on average this group had very low control (Table 3). The 3 remaining profiles had similarly high scores on limiting when, how much, second helpings, and how often the snack foods were purchased; however, the 3 profiles differed in the proportion of snack foods mothers reported keeping "out of reach"—a question in which mothers indicated which of the 7 snack foods were kept out of the girls' physical reach. There was a Sets Limits+Does Not Restrict Snacks profile ($n = 42$) in which mothers reported using the limit-setting practices (ie, limiting how often they purchased the snack foods, and once in the home, when access was given and how much was offered), but this profile did not keep any of the snack foods out of their daughters' reach. As shown in Table 3, this profile also had scores similar to the Unlimited Access to Snacks profile on maternal CFQ restriction and girls' reports of restricted access to the 7 snack foods, which indicated that this profile was low on restriction use. The third profile was Sets Limits+Restricts High Fat/Sugar Snacks ($n = 64$); mothers with this profile reported keeping 50% of the snack foods out of their daughters' reach. Further examination showed that, within this profile, >70% of the mothers reported keeping chocolate, fruit-flavored chewy candies, cookies, and chips out of reach, whereas <10% reported keeping popcorn and pretzels out of reach, which suggested that these mothers were more likely to use the coercive practice of keeping snack foods out of reach when foods were high in sugar and/or fat. On average, mothers in the Sets Limits +Restricts High Fat/Sugar Snacks profile scored higher on keeping snack foods out of reach than did mothers in the Sets Limits+Does Not Restrict Snacks profile ($P < 0.05$, $d = 4.00$) or the Unlimited Access to Snacks profile ($P < 0.05$, $d = 4.00$).

TABLE 2
Maternal controlling feeding practices by latent profile ($n = 180$)[1]

	Controlling feeding profiles[2]			
Practices[3]	Unlimited Access to Snacks ($n = 51$)	Sets Limits+Does Not Restrict Snacks ($n = 42$)	Sets Limits+Restricts High Fat/Sugar Snacks ($n = 64$)	Sets Limits+Restricts All Snacks ($n = 23$)
Limit buying[4]	0.2 ± 0.2[a]	0.5 ± 0.3[b]	0.5 ± 0.2[b]	0.6 ± 0.3[b]
Limit when[5]	0.8 ± 0.4[a]	1.6 ± 0.4[b]	1.5 ± 0.4[b]	1.7 ± 0.5[b]
Limit how much[6]	1.7 ± 0.9[a]	2.6 ± 0.9[b]	2.8 ± 0.7[b]	2.8 ± 0.8[b]
Limit second helpings[7]	0.9 ± 0.5[a]	1.5 ± 0.4[b]	1.5 ± 0.4[b]	1.5 ± 0.5[b]
Out of reach[8]	0.1 ± 0.1[a]	0.1 ± 0.1[a]	0.5 ± 0.1[b]	1.0 ± 0.1[c]

[1] All values are means ± SDs. Values in the same row with different superscript letters are significantly different, $P < 0.05$ (ANOVA and post hoc Tukey paired comparisons).

[2] Four controlling feeding profiles were identified by using Latent Profile Analysis and mothers' reports on the Restricted Access Questionnaire (2). The Unlimited Access to Snacks profile was characterized by low scores for the limit-setting variables and keeping snack foods out of reach; the remaining 3 profiles had a high limit setting but differed in how much snack foods were kept out of reach. Mothers with the Sets Limits+Does Not Restrict Snack Foods profile kept almost none of the 7 snack foods out of reach, those with the Sets Limits+Restricts High Fat/Sugar Snacks profile kept snacks high in sugar and/or fat (eg, candy, desserts, and chips) out of reach, and those with the Sets Limits+Restricts All Snacks profile kept all snacks out of reach.

[3] Each practice listed represents a question asked on the Restricted Access Questionnaire for a set of 7 energy-dense snack foods: popcorn, pretzels, chips, fruit-flavored chewy candies, chocolate, chocolate chip cookies, and ice cream; descriptive statistics were computed across foods.

[4] Possible scale values = 0–1; 0 = do not limit buying any of the 7 snack foods, 1 = limit buying all of the 7 snack foods.

[5] Possible scale values = 0–4; 0 = anytime, 1 = snack time, 2 = dessert, 3 = special occasions, 4 = do not allow.

[6] Possible scale values = 0–4; 0 = never limit how much, 4 = always limit how much.

[7] Possible scale values = 0–3; 0 = never limit second helpings, 3 = always limit second helpings.

[8] Possible scale values = 0–1; 0 = no snack foods were kept out of reach, 1 = all snack foods were kept out of reach.

TABLE 3
Background characteristics at study entry and descriptive statistics for key variables, by maternal controlling feeding profiles (n = 180)[1]

	Controlling feeding profiles			
	Unlimited Access to Snacks (n = 51)	Sets Limits+Does Not Restrict Snacks (n = 42)	Sets Limits+Restricts High Fat/Sugar Snacks (n = 64)	Sets Limits+Restricts All Snacks (n = 23)
Background characteristics at study entry				
Family income[2]	1.6 ± 0.9[a]	2.2 ± 0.9[b]	2.0 ± 0.9[b]	2.3 ± 0.8[b]
Mothers' education (y)	13.8 ± 2.1[a]	15.0 ± 2.4[a,b]	14.5 ± 2.1[a,b]	15.7 ± 2.1[b]
Mothers' age (y)	35.1 ± 4.8	35.5 ± 5.0	35.6 ± 5.0	35.6 ± 3.8
Mothers' BMI	27.2 ± 7.1[a]	24.9 ± 4.8[b]	26.7 ± 6.3[a,b]	25.6 ± 4.6[a,b]
Girls' BMI	15.7 ± 1.5	15.6 ± 1.5	16.2 ± 1.6	15.8 ± 1.4
Girls' BMI percentile[3]	56.5 ± 27.9	55.0 ± 26.7	66.2 ± 24.8	59.4 ± 27.6
Girls overweight (%)[3]	15.7	14.3	23.4	26.1
Key variables at study entry				
Maternal restriction (CFQ)[4]	2.6 ± 0.9[a]	2.8 ± 0.7[a,b]	3.2 ± 0.8[b,c]	3.4 ± 0.7[c]
Girls' perception of maternal restriction (KCFQ)[5]	1.8 ± 0.5	2.0 ± 0.5	1.9 ± 0.4	1.8 ± 0.6
Girls' perception of controlled access to study snack foods[6]	2.0 ± 0.7[a]	1.9 ± 0.8[a]	2.0 ± 0.6[a,b]	2.4 ± 0.7[b]
Girls' EAH[7]	4.2 ± 3.6[8]	5.2 ± 4.3	4.8 ± 3.5	6.6 ± 4.6
Girls' approach[9]	5.2 ± 0.6[a]	4.9 ± 0.5[b]	5.2 ± 0.7[a]	5.7 ± 0.5[c]
Girls' inhibitory control[9]	5.0 ± 0.9	5.3 ± 0.7	5.0 ± 0.7	4.9 ± 0.8

[1] All values are means ± SDs. Four controlling feeding profiles were identified by using Latent Profile Analysis and mothers' reports on the Restricted Access Questionnaire (2). The Unlimited Access to Snacks profile was characterized by low scores for the limit-setting variables and keeping snack foods out of reach; the remaining 3 profiles had a high limit setting but differed in how much snack foods were kept out of reach. Mothers with the Sets Limits+Does Not Restrict Snack Foods profile kept almost none of the 7 snack foods out of reach, those with the Sets Limits+Restricts High Fat/Sugar Snacks profile kept snacks high in sugar and/or fat (eg, candy, desserts, and chips) out of reach, and those with the Sets Limits+Restricts All Snacks profile kept all snacks out of reach. Values in the same row with different superscript letters are significantly different, $P < 0.05$ (ANOVA and post hoc Tukey paired comparisons). CFQ, Child Feeding Questionnaire; EAH, eating in the absence of hunger; KCFQ, Kids' Child Feeding Questionnaire.

[2] Possible scale values = 0–3; 0 = <$20,000; 1 = $20,000–$35,000; 2 = $35,001–$50,000; 3 = >$50,000.

[3] BMI percentiles were calculated with CDC growth charts (15); BMI percentiles ≥85th were used to classify girls as overweight.

[4] Measured by using the restriction subscale from the CFQ (12); range 1 (low) to 5 (high).

[5] Measured by using the restriction subscale from the child version of the CFQ (13); range 1 (low) to 3 (high).

[6] Girls' perception of parental access to 7 palatable snack foods (ie, popcorn, pretzels, chips, fruit-flavored chewy candies, chocolate, chocolate chip cookies, and ice cream) was measured by using a short interview (2) in which children were asked when they were allowed to access each snack food. Possible scale values = 0–4; 0 = anytime, 1 = snack time, 2 = dessert, 3 = special occasions, 4 = don't allow.

[7] Percentage of available calories consumed in the eating in the absence of hunger protocol (2), a task in which children were given free access to consume 10 palatable snack foods [ie, popcorn, pretzels, chips, fruit-flavored chewy candies, chocolate, chocolate chip cookies, ice cream, nuts, frozen yogurt, and Fig Newtons (Nabisco)] after a standard lunch.

[8] Using ANCOVA, a main effect of maternal feeding profile was observed on EAH after adjusting for maternal BMI and educational level and family income ($F_{[63,6]} = 2.56$, $P < 0.02$).

[9] Measured using the Child Behavior Questionnaire (9); range 1 (low) to 7 (high).

This profile had more moderate scores on maternal CFQ restriction, and girls' reports of controlled access to the study snack foods fell in between the other profiles. The fourth profile was Sets Limits+Restricts All Snacks (n = 23) and was characterized by mothers who reported controlling their daughters' access to snack foods by keeping all snacks out of their daughter's reach; scores were higher on this subscale than on the remaining profiles ($P < 0.05$, d = 5.00–9.00). This profile also had the highest scores on maternal reports of CFQ restriction ($P < 0.05$, d = 0.86–0.95) and girls' perceived access to the 7 study snack foods ($P < 0.05$, d = 0.57–0.65), relative to the remaining profiles, which suggested that this profile was the most restrictive.

Overall, the results from the LPA revealed an orthogonal pattern between the limit-setting practices and the more controlling practice of keeping snack foods out of reach. The 3 Sets Limits profiles had similar high scores on the limit-setting variables, yet the degree to which they reported keeping snack foods out of reach increased as their scores on the maternal CFQ restriction subscale and girls' reports of controlled access increased. This suggests that limit-setting practices and the more controlling practice of keeping snack foods out of reach may be qualitatively distinct and differentially associated with mothers' and girls' reports of restriction use. To test this, a Pearson correlation was run between mothers' and girls' reports of restriction use (ie, CFQ restriction subscales and perceived restricted access) and each RAQ subscale entered into the LPA. Of the mothers in the Sets Limits profiles (n = 129), maternal reports of keeping snack foods out of reach correlated with scores on the maternal CFQ restriction subscale (r = 0.32, $P < 0.001$) and girls' reports of controlled access to the 7 snack foods (r = 0.18, $P < 0.05$); in contrast, no relation was observed between maternal reports on the RAQ limit-setting variables and previous restriction subscales.

Girls' temperament and maternal controlling feeding profiles

ANOVA was used to compare differences in girls' temperament across feeding style profiles (Table 3). Mothers in the Sets

Limits+Restricts All Snacks profile had daughters with the highest levels of approach among the profiles ($P > 0.05$, d = 0.76–0.88), whereas the lowest scores were observed among the girls with mothers in the Sets Limits+Does Not Restrict Snacks profile. No significant relations were observed between profile membership and girls' inhibitory control, and the results did not change after adjustment for covariates (ie, maternal BMI and educational level, and family income; $P > 0.05$). In addition, family demographics differed across profiles (Table 3). Mothers in the Unlimited Access to Snacks profile had higher BMIs on average than did mothers in the Sets Limits+Does Not Restrict Snacks profile ($P < 0.05$, $d = 0.37$), and the remaining groups fell in between. All profiles practicing limits reported higher household incomes ($P < 0.05$, d = 0.44–0.80) than did mothers in the Unlimited Access to Snacks profile, and mothers in the Sets Limits+Restricts All Snacks profile had more years of education, on average, than did mothers in the Unlimited Access to Snacks profile ($P < 0.05$, $d = 0.54$).

Interactive effects of mothers' controlling feeding profiles and girls' temperament on girls' EAH and weight status

ANCOVA models were used to test whether girls' temperament (ie, inhibitory control and approach) moderated the relation between feeding profiles and girls' EAH and BMI at 5 y. Girls' inhibitory control and approach did not emerge as moderators at 5 y; however, a main effect of feeding profile was observed on EAH at 5 y after adjustment for maternal BMI and education level and family income ($F_{[63,6]} = 2.56$, $P < 0.05$). As shown in Table 3 (results shown are unadjusted), girls with mothers in the Sets Limits+Restricts All Snacks profile consumed more calories in the EAH protocol at 5 y than did girls with mothers in the Unlimited Access to Snacks profile ($P < 0.05$, $d = 0.75$).

Next, an ANCOVA model was used to examine whether girls' inhibitory control and approach separately moderated the association between feeding profile membership and change in girls' EAH and BMI from 5 to 7 y. No interactive effects were observed for approach, however, inhibitory control marginally moderated the effects of feeding profile membership on girls' EAH. As shown in **Figure 1**, the interaction term for inhibitory control × profile was marginally significant ($F_{[155,3]} = 2.06$, $P < 0.10$) in predicting change in EAH, which suggested that girls' inhibitory control may have moderated the change in girls' EAH from 5 to 7 y. To examine the interaction effects, girls were divided by using median splits into 2 discrete groups: low inhibitory control and high inhibitory control. The mean (±SD) score for low inhibitory control was 4.4 ± 0.6 (range: 2.0–5.0), and the mean score for high inhibitory control was 5.5 ± 0.4 (range: 5.1–6.8); the means differed with an effect size of 2.17. Low inhibitory control girls with mothers in the Sets Limits +Restricts All Snacks profile showed greater increases in EAH than did high inhibitory control girls with mothers in this same profile ($P < 0.05$, $d = 1.10$). Low inhibitory control girls in the Limits+Restricts All Snacks profile also had greater change in EAH than low inhibitory girls in the other profiles: Sets Limits +Restricts High Fat/Sugar Snacks ($P < 0.01$, $d = 0.69$) and Unlimited Access to Snacks ($P < 0.001$, $d = 1.31$).

In the model predicting percent change in BMI, the interaction term for inhibitory control × profile-membership term was significant ($F_{[165,3]} = 3.28$, $P < 0.05$). As shown in **Figure 2**, low inhibitory control girls with mothers in the Unlimited Access to Snacks profile or the Sets Limits+Does Not Restrict Snacks profile had greater percent change in BMI from 5 to 7 y than did high inhibitory control girls with mothers in the same profiles ($P < 0.05$, $d = 0.72$; $P < 0.05$, $d = 0.83$; respectively). However, when change in BMI percentiles by profile membership and level of inhibitory control was examined in an ANCOVA model

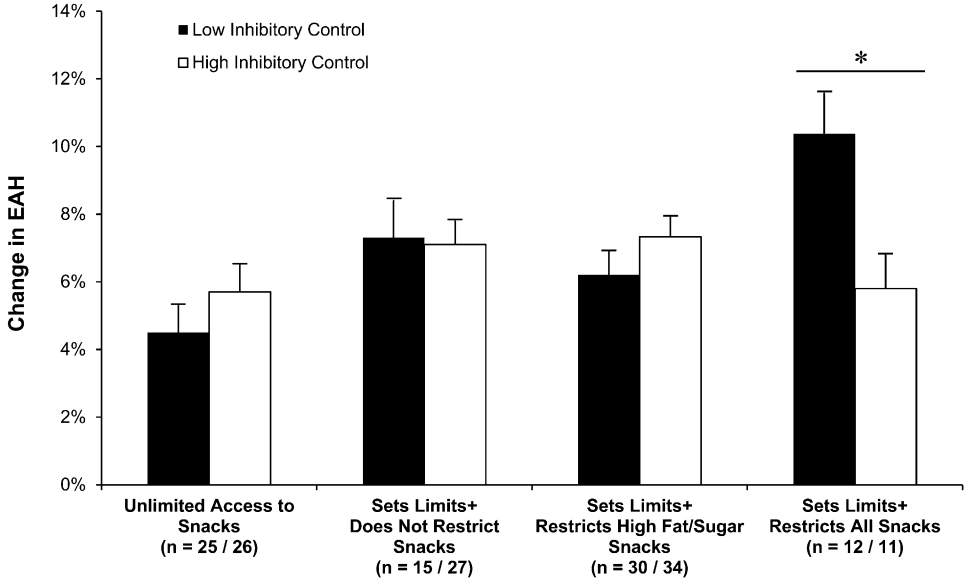

FIGURE 1. Mean (±SE) change in girls' EAH from age 5 to 7 y by maternal controlling feeding profiles and level of inhibitory control (n = 180). EAH is expressed as a percentage of available calories consumed in the EAH protocol (2). Inhibitory control moderated the effect of profile membership on girls' EAH at age 7 y (ANCOVA: $F_{[155,3]} = 2.06$, $P < 0.10$), after adjustment for girls' EAH at age 5 y, maternal education, and BMI and family income. Girls were divided by using median splits: low inhibitory control (mean ± SD: 4.4 ± 0.6) and high inhibitory control (5.5 ± 0.4). Adjusted paired comparisons showed that girls with low inhibitory control with the Sets Limits+Restricts All Snacks profile had a greater increase in EAH than did girls with high inhibitory control with the same profile (*$P < 0.05$). Sample size is shown by profile and level of inhibitory control (low/high). EAH, eating in the absence of hunger.

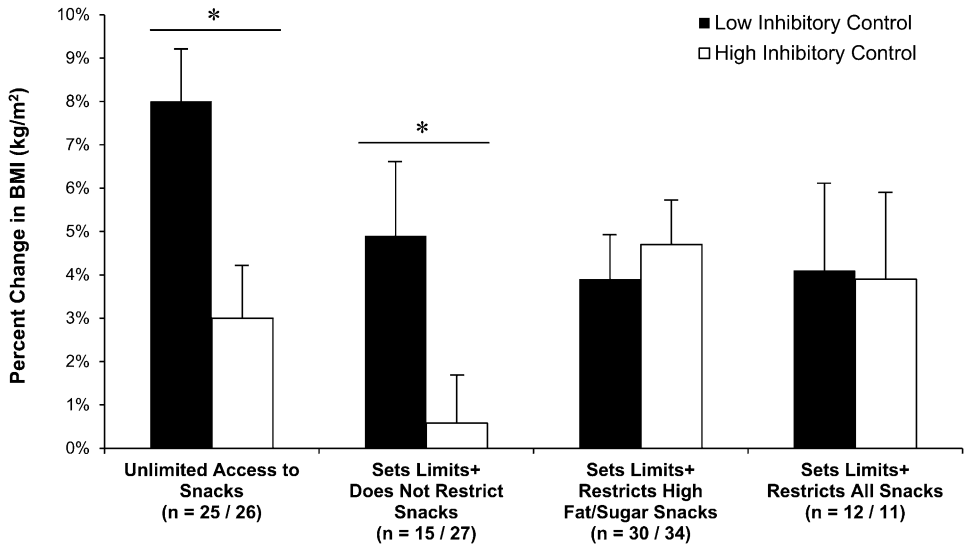

FIGURE 2. Mean (±SE) percent change in girls' BMI percentile from age 5 to 7 y by maternal controlling feeding profiles and level of inhibitory control (n = 180). Inhibitory control moderated the effect of profile membership on girls' BMI at age 7 (ANCOVA: $F_{[165,3]} = 3.28$, $P < 0.05$), after adjustment for girls' BMI at age 5 y, maternal education, and BMI and family income. Girls were divided by using median splits: low inhibitory control (mean ± SD: 4.4 ± 0.6) and high inhibitory control (5.5 ± 0.4). Adjusted paired comparisons showed that low inhibitory control girls in the Unlimited Access to Snack Foods profile or the Sets Limits+Does Not Restrict Snack Foods profiles had a greater change in BMI scores than did high inhibitory control girls within the same profiles (*$P < 0.05$). Analyses were conducted by using percent change in raw BMI scores, which was permissible given that the sample was of the same age and sex. Sample size is shown by profile and level of inhibitory control (low or high).

(data not shown), low inhibitory control girls with mothers in the Sets Limits+Does Not Restrict Snacks profile actually showed no change in BMI percentile from 5 to 7 y (59.6 ± 23.6 to 61.5 ± 22.1; the raw difference change score was not different from zero at the 0.05 level of significance); in contrast, a significant increase was observed for low inhibitory control girls in the Unlimited Access to Snacks profile (62.8 ± 26.3 to 68.3 ± 25.1; $P < 0.05$, $d = 0.48$; the raw difference change score was different from zero at the 0.05 level of significance). In addition, low inhibitory control girls with mothers in the Unlimited Access to Snacks profile had the greatest increases in BMI from 5 to 7 y compared with low inhibitory control girls from the remaining profiles: Sets Limits+Does Not Restrict Snacks ($P < 0.10$, $d = 0.33$), Sets Limits+Restricts High Fat/Sugar Snacks ($P < 0.05$, $d = 0.80$), and Sets Limits+Restricts All Snacks ($P < 0.05$, $d = 0.60$).

DISCUSSION

Our findings suggest that mothers may use limit-setting and/or more controlling practices to limit girls' intakes of palatable snack foods and that the effects of these practices on girls' eating and weight outcomes differ by profile and the girls' own level of inhibitory control. Currently, it is recommended that parents avoid using restrictive-feeding practices (21); however, a clear message on alternative strategies to limit children's intake of snack foods is lacking. The current findings indicate that setting limits on the frequency with which snack foods are brought into the home, when these foods are made accessible, and how much can be consumed—without the use of more controlling practices—may be a successful approach to limiting children's intake of palatable snack foods, even among children with low inhibitory control—a group we found to be at risk for the negative effects of very low and very high control. Although it is possible that, in our study, children with lower inhibitory control—a temperamental disposition linked to excessive weight gain (10)—were eliciting greater maternal use of controlling feeding practices, our findings are consistent with those of Rollins et al (11), in which children with lower inhibitory control showed greater susceptibility to the negative effects of a short-term restriction administered in a preschool setting.

Currently, in the parental feeding literature, the construct of restriction is thought to represent a variety of practices used to limit children's intake of foods, including controlling the type and quantity of foods that children are offered, when these foods are offered, etc (2, 3). However, how parents go about using these practices can range from setting limits and routines to using more controlling practices that enforce compliance (eg, keeping snack foods out of reach). On the basis of our findings, it may be that restriction only refers to the latter type of practice. Tschann et al (22) found that parents' use of monitoring/limit setting and restricting the amount of food, which emerged as 2 separate factors in an exploratory factor analysis, were differentially associated with children's BMIs and, as the authors suggest, may be qualitatively distinct. Grolnick and Pomerantz (4) argue that parental control consists of 2 orthogonal dimensions of structure (eg, setting limits, routines, and clear expectations for behavior) and control (eg, coercive practices such as hiding desirable items). Whereas structure-based parenting has been shown to be supportive of children's self-regulation development, the opposite has been observed for control coercive parenting (5, 23). It may be that offering supportive guidance and setting routines to limit children's access and intake of palatable snack foods without the use of more controlling practices provides an environment that promotes children's self-regulation and compliance, even among children with lower inhibitory control. The growing evidence on parental feeding styles supports this notion, which suggests that an authoritative feeding style may promote positive eating behaviors in children (24). Intervention work

promoting parent's use of authoritative feeding practices may benefit from including more structure-based practices around children's snack food consumption as a way to limit children's intake of these foods.

We found that the effects of the feeding profiles on girls' eating and weight outcomes differed by the girls' own level of inhibitory control. Very high levels of control and very low levels of control were associated with greater weight gain and increases in EAH among children with lower inhibitory control, whereas no change was observed among girls with higher inhibitory control. This finding is consistent with that of Anzman and Birch (10), who found that girls with lower inhibitory control and perceived greater parental restriction showed greater increases in BMI from ages 7 to 15 y, whereas restriction did not have an effect among girls with higher inhibitory control. Girls with lower inhibitory control may show greater susceptibility to the negative effects of very high restriction, whereas girls with higher inhibitory control may not be susceptible at all. In addition, our findings suggest that girls with lower inhibitory control may also be susceptible to the lack of control in the home. Children with lower inhibitory control may have difficulty self-regulating their intake when in the presence of palatable foods, such as in homes where parents practice permissive feeding styles. These children may require more guidance and structure to help navigate food environments and may require opportunities to practice self-regulating their intake (25). Given that lower behavioral inhibition, in general, is associated with greater intake of palatable foods (26) and weight gain during childhood (27), parents of children with lower inhibitory control may need alternative strategies that not only effectively limit children's intake of palatable foods but that also support their self-regulation development.

It is important to note that children of certain regulatory and reactivity temperaments may also elicit the use of controlling feeding practices from their parents. For example, we found that the highest levels of approach and EAH calorie intake were observed among girls with mothers in the Sets Limits+Restricts All Snacks profile. This finding is consistent with the model of domain-specific parenting of Woody and Contanzo (25), in which it is argued that children's own eating behaviors and more limited self-regulation abilities may elicit more controlling strategies from their parents. Given that this approach is observed early in childhood (9), it is possible that maternal use of keeping all snack foods out of girls' physical reach was in response to girls' heightened behavioral response to rewarding stimuli, such as palatable foods. However, because we did not measure temperament and parenting feeding practices before age 5 y, it remains unclear whether they interactively influenced the feeding practices and child eating behaviors that we observed in middle childhood.

The current study had several strengths. It was the first study to identify multiple profiles of maternal controlling feeding practices by using LPA—a more person-centered methodologic approach. We were able to assess how the identified profiles mapped onto existing measures of restriction, thereby establishing a link to past studies that have used the parent version of the CFQ. The current study also contributes to our understanding of the relation between child temperament and parents' use of restriction and its moderating role in the effects of restriction on child weight outcomes and eating behaviors. The current study had several limitations. The sample consisted of only mothers and daughters. It is possible that the results differ between father-son, mother-son, or father-daughter dyads. The sample was homogeneous—white, from middle-class families—and thus the results may not generalize to other populations. In addition, the feeding profiles were defined based on the set of practices included in the RAQ. It is possible that this list of practices do not include other restrictive-feeding or limit-setting practices used in the home. This is also encouraging because of the small sample size. Although there are no current sample size guidelines for LPA models, it is possible that the current sample was limited by power issues.

In summary, mothers reported using a variety of strategies to limit their daughters' intake of snack foods high in sugar and fat, including limit setting and more restrictive controlling feeding practices (eg, keeping snack foods out of reach). When very low or very high use of controlling feeding practices were coupled with girls' low inhibitory control, girls showed increased EAH and weight gain, which suggests that children with low inhibitory control may be at greater risk for the negative effects of lack of control or high control in feeding. In contrast, more positive outcomes were observed among girls with low or high inhibitory control whose mothers took a more limit-setting approach, ie, limits were set on how often snacks were purchased, and, once in the home, when and how much of these foods girls could consume, without forbidding access to these foods. Consistent with evidence from the broader parenting literature, which suggests that limit setting tends to foster the development of self-regulation (4, 5), the use of limit setting in the feeding domain may be a more effective approach to helping children learn to successfully manage their intake of energy-dense snacks.

The authors' responsibilities were as follows—LLB (Principal Investigator; NIH grants M01 RR10732 and HD32973): designed the larger longitudinal study; BYR: developed the research question, analyzed the data, and drafted the manuscript; LLB and EL: supervised the drafting of the manuscript; and JSS: contributed to the design of the study and data collection. All authors contributed to revising and approving the final manuscript. None of the authors had a conflict of interest.

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