Like mother, like daughter: familial patterns of overweight are mediated by mothers' dietary disinhibition[1–3]

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ABSTRACT

Background: Obese parents are more likely to have obese children. Parents provide both the genes and eating environment for their children and familial patterns of adiposity are the result of gene-environment interactions. Environmental factors are implicated in the rapid increases in prevalence of childhood overweight that have occurred in the past 2 decades. Examination of aspects of the family environment may provide insight into increases in childhood overweight over time.

Objective: We examined parental characteristics associated with overweight and eating behaviors in preschool children.

Design: Seventy-five preschool children and their parents were recruited from local daycare centers. Information was obtained on parents' body mass indexes (BMIs), dietary restraint, and dietary disinhibition. A behavioral index of disinhibited eating in children was used to measure children's eating when given free access to palatable snack foods in the absence of hunger. Children's weight-for-height values were also calculated.

Results: Maternal dietary disinhibition ($R^2 = 0.35$, $P < 0.01$) and maternal BMI ($R^2 = 0.19$, $P < 0.05$) positively predicted daughters' overweight. Maternal disinhibition ($R^2 = 0.35$, $P < 0.05$) mediated the relation between mothers' BMI and daughters' overweight when both maternal disinhibition and maternal BMI were used to predict daughters' overweight. Furthermore, when both mothers' disinhibition and daughters' free access intakes were used to predict daughters' overweight, mothers' disinhibition ($P < 0.05$) showed independent prediction.

Conclusions: These findings suggest that familial influences on child overweight differ according to parent and child sex. Also, these results suggest that mothers' dietary disinhibition mediates familial similarities in degree of overweight for mothers and daughters. Am J Clin Nutr 1999;69:608–13.

KEY WORDS Children, mothers, overweight, familial adiposity, dietary restraint, dietary disinhibition, body mass index

INTRODUCTION

Children of overweight parents are more likely to be overweight themselves (1–4). This pattern exists even when children are reared apart from their biological parents (5). These familial patterns of adiposity imply a genetic contribution. However, genetic factors operate in a particular environmental context to produce phenotypic outcomes, as described by Bouchard and Perusse (2), who concluded that the genetic predisposition to fat gain is expressed when the individual is exposed to a specific environment. Increases in the prevalence of overweight among children in the United States (6) suggest the importance of investigating possible environmental factors that can act in concert with genetic factors to produce increases in the prevalence of childhood overweight (7).

Data from the third National Health and Nutrition Examination Survey indicate that the prevalence of overweight among preschool children has doubled in the past 20 y, with the most dramatic increases occurring in girls (6). In addition to the increased prevalence of overweight, dieting and weight concerns have increased during this period and these increases have also been most pervasive in young girls (8–11). Increases in the prevalence of overweight noted in children mirror similar trends in the increased prevalence of overweight among adults (12). Furthermore, the higher prevalence of dieting and weight concerns among school-age girls compared with boys is similar to the sex differences that exist for adults, with the prevalence of dieting and weight concerns substantially higher among women than men (13).

It is widely accepted that parental behaviors and practices shape many aspects of children's development (14). With respect to children's eating and energy balance, a few studies have shown that parents' diet history and eating concerns and child-feeding practices influence the development of children's eating behaviors and weight outcomes (15–19). For example, adolescent girls who diet often learn to do so from their mothers, who may provide explicit advice on dieting (18). For much younger girls, mothers' attempts to control their daughters' eating are linked to daughters' overweight, with mothers of heavier daughters reporting greater use of external control to regulate how much and what their daughters eat (16). One focus of these

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Received March 13, 1998.

Accepted for publication October 20, 1998.

Am J Clin Nutr 1999;69:608–13. Printed in USA.

maternal control attempts is restricting intake, and mothers' reports of restricting their daughters' intake are related to the mothers' own dietary restraint (20). Perhaps because dieting and weight concerns are less pervasive among men and boys, no such relations have been reported for males.

Dietary restraint and dietary disinhibition are psychometric constructs designed to capture individual differences related to eating and weight control. Dietary restraint reflects the extent to which individuals attempt to cognitively control their food intake and dietary disinhibition reflects individual differences in the extent to which release from the cognitive suppression of eating occurs in response to the presence of palatable food or other disinhibiting stimuli, such as emotional distress (21). Dietary disinhibition has been described as overeating that occurs in the absence of hunger and has been linked to binge eating, bulimic episodes, and higher weight outcomes in adults (22–24). There are sex differences in restraint and disinhibition, with women tending to score higher on measures of dietary restraint and disinhibition than men.

This study was designed to determine whether parent-child similarities in overweight are mediated by parents' dietary restraint and disinhibition. Because the literature has revealed sex differences in trends in childhood overweight, dieting, and weight concerns; in adults' dietary restraint and disinhibition; and in parental influences on children's eating, we conducted analyses designed to examine parent-child similarities in overweight and their links to restraint and disinhibition separately for mothers and fathers and sons and daughters.

SUBJECTS AND METHODS

Subjects

Participants were seventy-five children (40 boys and 35 girls) aged 3–6 y ($\bar{x}$: 59.4 mo) and their parents. The mothers' mean age was 37.7 y and the fathers' was 39.4 y. Inclusion criteria included consent to participate and the absence of chronic medical issues and food allergies. Families were predominantly white (mothers were 87% white, 6.4% Asian, 2.1% African American, and 4.3% Hispanic; fathers were 89.2% white, 5.4% Asian, 2.7% African American, and 2.7% Hispanic), were intact (contained both a father and a mother), and were recruited from The Pennsylvania State University's Child Development Laboratory and a local daycare center. Only one child per family participated in the study. These families were relatively highly educated: the mean education levels of the mothers and fathers were 16.6 ± 2.9 and 17.2 ± 2.5 y, respectively. Families were paid $20 for their participation. All procedures were reviewed by The Pennsylvania State University Office for Regulatory Compliance.

Measures in parents

Parents' restraint and disinhibition were assessed by using the subscales of the Eating Inventory questionnaire (21). The dietary restraint subscale is designed to measure cognitive control of food intake and assesses the restriction of certain foods, energy intake, or macronutrients (eg, "I count calories as a conscious means of controlling my weight"). The disinhibition subscale measures overeating (22) and the extent to which eating is triggered by emotional, social, and environmental influences (21) (eg, "Sometimes things just taste so good that I keep on eating even when I am no longer hungry"). Parents' heights and weights were measured and their body mass indexes (BMIs; in kg/m^2) calculated.

Measures in children

Overview

A free access protocol was designed to capture specific behavioral aspects of dietary disinhibition in young children, namely the extent to which children eat or overeat in response to palatable snack foods when not hungry. Although young children would not be expected to display all aspects of disinhibition, such as a sense of being out of control or feeling guilty about overeating, the use of the free access procedure allowed us to explore associations between children's eating in response to the presence of palatable foods when not hungry and the parallel construct tapped by parents' reported dietary disinhibition. The protocol required 30–40 min and was conducted immediately after a standard preschool program lunch. Children were seen individually and given a hunger assessment before the free access session. Only children who indicated that they were not hungry participated in the free access sessions.

Procedure

Immediately after the child consumed a normal lunch in the preschool classroom, he or she was invited to "go to the eating lab to play the tasting game." If the child agreed, he or she was brought to the laboratory. Anthropometric measures were taken by a trained anthropometrist and children's hunger was assessed in a brief interview. Children who indicated they were still hungry were returned to their classroom and the free access procedure was conducted on another day after lunch when the child indicated that he or she was full. This screening procedure was used to reduce the effect of hunger on intake and to reduce individual differences in children's intakes based on differences in hunger. The free access session followed, during which each child was left alone for 10 min in a room with large quantities of palatable snack foods (including 51 g fig bars, 6 g popcorn, 39 g pretzels, 66 g candy chews, 168 g frozen yogurt, 66 g chocolate chip cookies, 44 g cashews, 58 g potato chips, 66 g chocolate bars, and 168 g ice cream) as well as a variety of attractive toys and books. Children were told they were free to play with the toys, look at the books, or eat whatever they liked while the experimenter checked on some things in the other room. During the 10-min free access session, each child's behavior was monitored through a one-way mirror. Free access intakes were determined by weighing the 10 snack foods used in the free access session before and after each session. Amounts eaten were then converted to kilojoules, which served as the free access intake measure.

Anthropometric measurements

Anthropometric measures obtained for the children included height and weight, measured to the nearest 0.5 cm and 0.1 kg, respectively. All measurements were made by one trained professional from The Pennsylvania State Nutrition Center. Weight-for-height, a measure of relative weight and an index of children's overweight, was converted to percentiles by using age-appropriate reference data (25). This allowed for comparisons across sex and age groups.

Statistical analysis

Descriptive statistics were generated for all variables. Dependent t tests were used to examine differences between values for mothers and fathers. Correlational analysis was used to determine

TABLE 1
Parents' BMIs and scores on the three-factor eating questionnaire (TFEQ)[1]

	Mothers (n = 47)	Fathers (n = 37)
BMI (kg/m^2)	24.2 (19–46)	26.2 (19–34)
TFEQ		
Disinhibition	6.7 (0–16)	5.0 (1–14)
Restraint	8.7 (0–20)	6.9 (0–15)

[1] $\bar{x}$; range in parentheses. Maximum scores for disinhibition and restraint were 16 and 21, respectively. There were no significant differences between mothers and fathers by dependent t tests.

relations between the variables measured in parents. Additionally, correlations were performed separately by child sex for anthropometric data and eating behavior variables in children. The differences between daughters' and sons' correlations were tested by using Fisher's r-to-z transformations. Correlational analysis was again used to examine relations between measures in children and parents. The numbers of participants indicated for the analysis reflect only those cases for which complete data were collected from both child and parent. The assumptions of multiple regression were evaluated (26). Mothers' and fathers' BMIs were log transformed to better approximate a normal distribution. Significant correlations were then used to construct standardized regression models with parental and child variables to predict child outcomes. The covariance matrix is available from the authors on request. Multiple regression analysis was used to explore mediator models (27), although the small sample size and consequent moderate statistical power prevented the testing of more complex models. Data were analyzed with SAS (version 6.12; SAS Institute Inc, Cary, NC). Significance was set at $P < 0.05$.

RESULTS

Variables in parents

Means and ranges for mothers' and fathers' BMIs and dietary disinhibition and restraint scores are reported in **Table 1**. Both mothers' BMI ($r = 0.63$, $P < 0.001$) and fathers' BMI ($r = 0.35$, $P < 0.05$) scores were significantly associated with their dietary disinhibition scores, but not with dietary restraint. Thus, heavier parents were more likely to report that their eating was triggered by the presence of palatable foods or emotional factors rather than by hunger.

Variables in children

Overall, sons and daughters in this sample exhibited normal growth, with weight-for-height values slightly above median values (**Table 2**). Mean energy intakes during the free access period showed that children consumed ≈838 extra kJ in the free access setting. Their energy intake in this free access protocol corresponded to ≈12% of the recommended dietary allowance for energy intake for children of this age (28). No significant differences in intake were found between daughters and sons.

Correlations between children's anthropometric and behavioral measures revealed that daughters' free access intakes were related to their weight-for-height values ($r = 0.38$, $P < 0.05$), indicating that the daughters who ate more in the presence of palatable snack foods despite being full had higher weight-for-height ratios. Sons' weight-for-height values were not significantly related to their snack food intakes.

Relations between variables in parents and children

To determine whether parental dietary restraint, disinhibition, and BMI were associated with children's energy intakes and weight outcomes, mothers' and fathers' measures were correlated with their daughters' and sons' data. The results, shown in **Tables 3** and **4**, indicate that most (21 of 24) of the relations were not significant and that all the significant relations were between variables in mothers and daughters (3 of 6 relations tested), although there was a positive trend in the relation between fathers' BMI and sons' weight-for-height (Table 4). The correlations between measures in mothers and daughters indicated the following: heavier mothers had heavier daughters, maternal disinhibition was positively related to daughters' overweight, and higher maternal disinhibition was related to higher free access intake by daughters.

Regression analysis

As indicated, heavier parents tended to have heavier children, providing additional support for familial patterns of overweight. On the basis of the correlations reported in Tables 3 and 4, only models involving mothers' and daughters' variables were tested. Mothers' BMI and dietary disinhibition were significant independent predictors of daughters' weight-for-height (**Table 5**). To determine whether mothers' dietary disinhibition mediated the relation between mothers' BMI and daughters' weight-for-height, a mediator model was tested according to the method of Baron and Kenny (27). In this instance, a significant mediator relation would provide evidence that familial patterns of overweight in mothers and daughters could be attributed, in part, to mothers' dietary disinhibition. Evidence for mediation would be shown by a pattern of regression equations in which 1) mothers' BMI significantly predicted daughters' weight-for-height, 2) mothers' dietary disinhibition significantly predicted daughters' weight-for-height, and 3) mothers' BMI significantly predicted mothers' disinhibition (Table 5). These 3 relations were observed. Given these 3 relations, evidence for mediation can be obtained when both mothers' disinhibition and mothers' BMI are used in the

TABLE 2
Children's body-composition and outcome variables[1]

Variable	Daughters	Sons
Age (mo)	57.8 ± 12.4 (36–75) [34]	60.7 ± 11.3 (36–83) [40]
Height (cm)	106.9 ± 15.2 (36–122) [33]	111.1 ± 8.3 (95–131) [40]
Weight (kg)	19.1 ± 3.6 (14–27) [34]	21.0 ± 5.0 (14–38) [40]
Weight-for-height (%)[2]	65.1 ± 25.4 (9–99) [32]	69.0 ± 25.5 (10–99) [40]
Free access consumption (kJ)	797.8 ± 498.2 (0–1978) [32]	962.0 ± 496.5 (63–1994) [39]

[1] $\bar{x}$ ± SD; range in parentheses; n in brackets.
[2] Percentiles for age and sex from National Center for Health Statistics data (25).

TABLE 3
Correlations between mothers' BMI and scores on the three-factor eating questionnaire and variables in daughters and sons[1]

	Mothers' variables					
	BMI[2]		Disinhibition		Restraint	
Children's variables	Daughters	Sons	Daughters	Sons	Daughters	Sons
Weight-for-height[3]	0.43 [22][4]	0.32 [24]	0.59 [22][5]	0.23 [24]	−0.20 [22]	0.29 [24]
Free access intake[6]	0.22 [23]	0.14 [23]	0.41 [23][4]	0.21 [23]	0.03 [23]	0.09 [23]

[1]n in brackets.
[2]Log transformed.
[3]Anthropometric measurements used for analysis were converted to percentiles for age and sex by using National Center for Health Statistics data (25).
[4]$P < 0.05$.
[5]$P < 0.01$.
[6]Based on consumption in kJ.

same equation to predict daughters' weight-for-height and when, as a result of entering both predictors, mothers' BMI no longer significantly predicts daughters' weight-for-height. Our findings were consistent with this pattern, indicating that maternal disinhibition mediates the relation between mothers' and daughters' adiposity. This can be seen in Table 5, in which there is a substantial decrease in the parameter estimate for maternal BMI, from 0.43 to 0.08, when mothers' dietary disinhibition was added to the equation with maternal BMI to predict daughters' weight-for-height. The fact that mothers' BMI predicted mothers' dietary disinhibition, which in turn was a significant predictor of daughters' free access consumption ($R^2 = 0.17$, $P < 0.05$), suggests that maternal dietary disinhibition may mediate mother-daughter similarities in overweight.

Mothers' dietary disinhibition and daughters' free access intakes significantly predicted daughters' weight-for-height, an index of overweight. When these 2 variables were placed in the same regression model predicting daughters' weight-for-height (**Table 6**), both mothers' disinhibition and daughters' free access intakes were significant independent predictors of daughters' overweight, and together accounted for nearly half of the variance in daughters' weight-for-height ($R^2 = 0.49$). This indicates that in addition to daughters' own intakes predicting degree of overweight, maternal disinhibition also predicted overweight in daughters. In contrast with links between maternal dietary disinhibition, maternal overweight, and daughters' free access intakes and overweight, maternal dietary restraint was not significantly related to mothers' or daughters' adiposity or to mothers' disinhibition or daughters' free access intakes.

DISCUSSION

Parents provide both genes and the environmental context for young children's growth and development. Our research suggests ways in which aspects of the family environment may provide a context for the expression of genetic factors to produce familial patterns of overweight. Although this cross-sectional research cannot confirm causal relations between these variables, the findings revealed relations between mothers' and daughters' overweight and between mothers' dietary disinhibition and daughters' eating. First, maternal disinhibition mediated the relation between mothers' BMI and daughters' weight-for-height and accounted for 35% of the variance in daughters' overweight. Maternal disinhibition was also significantly related to daughters' free access intake and both maternal disinhibition and daughters' free access intake predicted daughters' overweight. In contrast with these findings for mothers and daughters, no such relations were observed for mothers and sons or for fathers and daughters or fathers and sons. Finally, we noted no relations between mothers' dietary restraint and daughters' eating or weight outcomes.

During their early years, children learn a great deal about food and eating, including information on the environmental cues that should initiate and terminate meals (29, 30). Much of this information comes from the family environment and from interactions between parents and children related to feeding. Mothers, as primary caretakers of young children, typically provide children with structure for meals by offering some foods and not others and by using child-feeding practices that provide information to the child about how much and what to eat. These maternal control attempts are influenced partly by mothers' own dieting and weight control beliefs and attitudes (16, 20). In addition to child-feeding practices that restrict or encourage daughters' intakes, the present findings suggest that some manifestation of mothers' dietary disinhibition may also serve as a source of

TABLE 4
Correlations between fathers' BMI and scores on the three-factor eating questionnaire and variables in daughters and sons[1]

	Fathers' variables					
	BMI[2]		Disinhibition		Restraint	
Children's variables	Daughters	Sons	Daughters	Sons	Daughters	Sons
Weight-for-height[3]	−0.04 [17]	0.43 [20][4]	0.02 [17]	0.13 [20]	−0.17 [17]	0.29 [20]
Free access intake[5]	−0.06 [17]	0.10 [19]	−0.02 [17]	−0.19 [19]	−0.10 [17]	0.26 [19]

[1]n in brackets.
[2]Log transformed.
[3]Anthropometric measurements used for analysis were converted to percentiles for age and sex by using National Center for Health Statistics data (25).
[4]$P < 0.10$.
[5]Based on consumption in kJ.

TABLE 5
Regression analysis describing mediating relations between mothers' disinhibition, mothers' BMI, and daughters' weight-for-height

Predicted variable	n	Independent variables	Parameter estimate[1]	P	R^2
Mothers' disinhibition	22	Mothers' BMI[2]	0.66	0.0006	0.44
Daughters' weight-for-height	21	Mothers' disinhibition	0.59	0.0040	0.35
Daughters' weight-for-height	21	Mothers' BMI[2]	0.43	0.0442	0.19
Daughters' weight-for-height	21	Mothers' disinhibition	0.54	0.0421	0.35
		+			
		Mothers' BMI[2]	0.08	0.7552	—

[1]Standardized estimates.
[2]Log transformed.

information for daughters regarding 1) what environmental cues should trigger eating and 2) how much to eat. Although we do not have evidence that the mothers' dietary disinhibition scores were reflected in differences in overt displays of disinhibited eating, dietary disinhibition has been linked to binge eating and to bulimic episodes (22, 24). It is possible that to the extent to which daughters observe their mothers' disinhibited eating, they may adopt similar eating behaviors, which could strengthen the intergenerational similarities in overweight between mothers and daughters. Another possibility is that dietary disinhibition, notably the predisposition to eat in the presence of palatable foods, may have a genetic component with a subsequent behavioral phenotype linked to individual differences in overweight. Additional research is needed to explore these possibilities.

The children's eating behavior in the free access protocol reflects some of the characteristics assessed by the Eating Inventory disinhibition scale, especially that aspect referred to as overeating (22) or eating when not hungry in the presence of palatable foods. The disinhibition item, "When I smell freshly baked cookies or pizza I find it very difficult to keep from eating, even if I have just finished a meal" demonstrates this point. Furthermore, higher dietary disinhibition in adults has been associated with higher BMI, weight gain, binge eating, and bulimia (20–23), and we noted a significant relation between dietary disinhibition and BMI for the mothers in our sample. In a parallel fashion, within this sample, daughters' free access intakes were positive predictors of daughters' weight-for-height values.

Dieting, weight concerns, restrained eating, and dietary disinhibition have all been on the rise in recent decades, especially in women. A substantial proportion of these women are mothers of young children. Our findings suggest that in addition to having adverse effects on a mothers' own health and well being, dieting and weight concerns and dietary disinhibition may also adversely affect daughters' eating styles and weight outcomes. Furthermore, our findings suggest that these adverse effects may begin as early as the preschool period, many years before adolescence, when dieting and eating problems become pervasive in girls.

Recent data have revealed sex differences in trends in the prevalence of overweight among preschool children (6), with girls having much more dramatic increases in overweight than boys. To date, this early sex difference has not been explained. Our use of a small convenience sample limits the generalizability of our findings, but our results do suggest the possibility that linkages between 1) the increased prevalence of overweight, dieting, and weight control practices among women and 2) the increased prevalence of overweight among their daughters could be contributing to the greater increases in overweight among preschool girls than boys. Although causal links are not established by this cross-sectional research, these findings suggest that disinhibited eating may promote overweight in daughters as well as in mothers.

Our results are consistent with previous findings that mothers do influence their daughters' eating and weight outcomes (16–18, 20) and suggest ways in which genetic and environmental factors may work synergistically during children's development to foster childhood overweight. Eating is a social event for young children and involves other eaters who can serve as models and parents and other adults who attempt to shape children's intake patterns. With multiple eating occasions each day, there are certainly many opportunities for environmental factors to influence the development of children's eating behaviors. These findings make a contribution to delineating the way in which mothers affect their daughters' eating and weight outcomes. However, other aspects of parents' beliefs, attitudes, eating behaviors, and parenting styles that may influence the development of children's eating and overweight remain to be investigated. Ideally, such investigations should use longitudinal designs that can establish causal relations between aspects of the family environment and the development of children's eating

TABLE 6
Regression analysis describing independent prediction between mothers' disinhibition and daughters' weight-for-height

Predicted variable	n	Independent variables	Parameter estimate[1]	P	R^2
Daughters' weight-for-height	29	Daughters' free access intake (kJ)	0.38	0.0364	0.15
Daughters' weight-for-height	21	Mothers' disinhibition	0.59	0.0040	0.35
Daughters' weight-for-height	21	Daughters' free access intake (kJ)	0.41	0.0301	
		+			0.49
		Mothers' disinhibition	0.43	0.0236	

[1]Standardized estimates.

and overweight.

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