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Aspects of Eating Behaviors "Disinhibition" and "Restraint" Are Related to Weight Gain and BMI in Women

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Objective: The causes of adult weight gain leading to obesity are uncertain. We examined the association of adult weight gain and obesity with subscales of eating behavior characteristics in older women.
Methods and Procedures: Current height and weight, eating behavior subscales (disinhibition subscales—habitual, situational, and emotional; restraint subscales—flexible and rigid; hunger subscales—internal and external) as assessed using the Eating Inventory (EI), and self-reported body weight at six prior age intervals were reported by 535 women aged 55–65 years. Multiple regression analysis was used to examine the relationships between EI subscale scores and weight change from the age interval of 30–39 to 55–60 years and current BMI.
Results: The strongest correlate of weight gain over 20 years was susceptibility to overeating in response to everyday cues within the environment (habitual disinhibition; partial correlation coefficient (r) = 0.25, $P < 0.001$); susceptibility to overeating in response to emotional states such as depression (emotional disinhibition) was a quantitatively weaker but significant correlate (partial $r = 0.17$, $P < 0.001$), and susceptibility to overeating in response to specific situations such as social occasions (situational disinhibition) was not associated with weight gain. Flexible control of dietary restraint attenuated the influence of habitual disinhibition in particular on weight gain and BMI, and was less effective in attenuating associations of emotional or situational disinhibition.
Discussion: Lifestyle modification programs for prevention and treatment of adult-onset obesity currently focus on reducing situational and emotional overeating; the results of this study suggest that a stronger emphasis on strategies that target habitual overeating may be warranted.

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INTRODUCTION

Between the ages of 20 and 50 years, the typical adult in westernized countries such as the United States gains ~25 lb in weight (1,2), in direct contradiction to standard government recommendations for preventing any weight gain after full adult stature and muscular development have been achieved (3). This weight gain is associated with substantially increased risk of chronic diseases such as type 2 diabetes (4) and coronary heart disease (5), and contributes both to the worldwide obesity epidemic and to the increasing financial burden of health care. Although at the level of energy balance, weight gain over time clearly occurs because of excess energy intake relative to energy expenditure, the specific causes of this imbalance are not understood.

We and others have previously reported that eating behavior is a very strong predictor of adult weight gain (6,7), in contrast to the controversial predictive value of such dietary composition variables as percentage of energy derived from fat, carbohydrate, and protein (8). Three recognized eating behavior constructs are "disinhibition," "restraint," and "hunger," which are commonly assessed using a psychometric questionnaire developed by Stunkard and Messick (9). In particular, the construct "disinhibition" has been shown to be strongly associated with weight gain over time and obesity in adult life (6,10–13). Disinhibition is the tendency to overeat in response to different stimuli, and can occur in a variety of circumstances such as when an individual is presented with an array of palatable foods or is under emotional distress. Restraint is the conscious restriction of food intake to prevent weight gain or promote weight loss, and hunger is the susceptibility to eat in response to perceived physiological symptoms that signal the need for food; neither restraint nor hunger has been consistently associated with BMI or weight change, in contrast to the strong associations reported for disinhibition (7,12–19).

Subsequent factor analyses of the questionnaire used to assess disinhibition, restraint, and hunger have led to the

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identification of more specific subscales of these primary constructs that define different types of eating styles (20,21). These subscales include: "habitual" disinhibition, which refers to the susceptibility to overeat in response to daily life circumstances; "emotional" disinhibition, which refers to the tendency to overeat in response to emotional states such as anxiety or depression; and "situational" disinhibition, which refers to the susceptibility to overeat in response to specific environmental cues such as social occasions. Subscales for restraint have also been proposed: "rigid" restraint, which is a dichotomous, all-or-nothing approach to dieting, and "flexible" restraint, which is a less strict approach to dieting where "fattening" foods can be eaten in limited quantities without guilt. For the hunger construct, "internal" and "external" hunger have been proposed, which describe whether hunger is interpreted and regulated by internal or external cues, respectively (20,21).

Although the use of these subscales is increasing, they have received relatively little attention with regard to their potential relationship with obesity and weight change. The number of previous studies examining the disinhibition and hunger subscales in particular is quite modest, with (to our knowledge) only three reports available (7,20,22). These previous examinations were conducted in community-based populations, including undergraduate university women (20) and adult men and women living in Québec (7,22). The restraint subscales been studied more extensively, with assessments completed in community-based (11,12,22–24), treatment-seeking (24,25), and eating-disordered (26) populations. While subscale reliability data were not provided for each previous report, the available data suggest that all of the subscales are generally reliable, with Cronbach's α values ranging from 0.55 to 0.80 (20,24–26). Previous research examining correlations of rigid and flexible restraint with BMI has been somewhat contradictory; while flexible restraint appears to be consistently negatively correlated with BMI (11,12,23–26), both positive (12,24,25) and negative (23,26) associations of rigid restraint with BMI have been reported.

The objective of the present analysis was to examine the association of various subscales of eating behavior with BMI and reported weight gain during adult life. Based on our earlier examination of the main Eating Inventory (EI) factors in this population (6), we hypothesized that each disinhibition subscale would be positively associated with both BMI and weight gain—a hypothesis that is also consistent with data from Bond *et al.* (20), who reported a positive association between all disinhibition subscale scores and BMI among women dissatisfied with their current weight. We further hypothesized that these associations would be attenuated by flexible but not rigid control of dietary restraint, and that hunger subscales would not be significantly associated with either outcome variable. Similarly, the primary basis for this hypothesis was our earlier examination (6), along with data from Drapeau *et al.* (7), who showed that change in the flexible, but not rigid, restraint score was correlated with change in body weight over 6 years in a small sample of adult women.

METHODS AND PROCEDURES

Subjects

Women were recruited from the New England area using newspaper advertisements and commercially available mailing lists for a study described as examining non-specified eating habits and health, as previously described (6). Previous publications using data from this subject population (6,27) examined eating behavior constructs and their relationship to BMI, adult weight gain, and morbidity, but did not explore subscales of eating behavior, which is a topic that has emerged more recently.

As described elsewhere (6), women in the study population were initially mailed a postcard requesting study participation; those individuals who returned the postcard stating their interest in the study were mailed questionnaires and an informed consent form. Ethical approval for the study was given by the New England Medical Center—Tufts University Institutional Review Board. Subjects were not compensated for their participation, although women with either a high or low level of restraint (EI restraint score ≥13 or ≤5) were invited to participate in a more detailed subsequent study for which compensation was provided (6).

Questionnaires

A medical and lifestyle history questionnaire was used to assess current reported height, weight, and health history. In addition, the EI (9) was used to assess eating behavior characteristics, plus supplemental questions were added to assess body weight at six age intervals (20–29, 30–39, 40–49, 50–55, 55–60, and 60–65 years). Subjects were asked to provide a single estimated weight for each age interval, excluding pregnancy weight or weight 1 year after the birth of a child, if applicable. The EI consists of 36 true/false and 15 multiple-choice questions, with different groupings of questions used to calculate the restraint, disinhibition, and hunger scales and corresponding subscales. Some example true/false questions are: "I deliberately take small helpings as a means of controlling my weight" (restraint); "I usually eat too much at social occasions, like parties and picnics" (disinhibition); "I am always hungry enough to eat at any time" (hunger). Subscales for disinhibition (20) and restraint (21) were also calculated for this new analysis. Questionnaires were obtained from 2,088 women. Although test–retest reliability of the EI questionnaire was not assessed in this study, internal consistency (an assessment of how well a set of items measures a single one-dimensional construct) of the EI scales and subscales for our study population was generally adequate, as indicated by Cronbach's α coefficients ranging from 0.83 to 0.86 for the EI scales and 0.63–0.85 for the subscales. Subjects reporting factors that might confound the relationship between eating behavior and weight were excluded from the database (e.g., smoking, eating disorders, or medical conditions that might influence weight, $n = 1{,}126$), and 427 subjects were excluded due to missing data, to yield 535 women for the present analyses. Analyses were also conducted in the complete sample with no missing EI data ($n = 1{,}661$) to examine the potential influence of these exclusionary criteria on our results. Subject demographic characteristics are shown in **Table 1**. The sample was ~96% white, non-Hispanic, 1% black, non-Hispanic, 1% Asian/Pacific-Islander, and <1% Hispanic or Native American.

Statistics

Multiple regression analysis was used to examine the relationships between EI subscale scores and weight change from the age interval 30–39 to 55–60 years (calculated by subtracting the weight reported for the 30–39 age interval from the weight reported for the 55–60 age interval) and current BMI. Both main effects and two-way interactions were considered; a step-wise approach was used to eliminate non-significant interactions followed by non-significant main variables (non-significant main variables that were included in significant interactions were retained in the model). Analyses included covariates of current age (years), parity (number of births), current hormone replacement therapy (no, yes), and education level (low: postsecondary education = none, vocational school, or 2 years of college; high: postsecondary education = 4 years of college, graduate school, or professional school) to adjust for the possible confounding influence of these variables. The strength of association between each independent variable and corresponding dependent variable (weight change or BMI) excluding variance produced by other factors was assessed using partial correlations (partial *r*). Statistical analyses were completed with SPSS 12.0 (SPSS, Chicago, IL).

Table 1 Subject demographics (*n* = 535)

	Mean ± s.d.	Observed range
Age (years)	60.1 ± 2.9	55–65
Current weight (kg)	69.2 ± 13.5	40.3–119.9
Current height (cm)	162.9 ± 6.3	142.2–190.5
BMI (kg/m^2)	26.2 ± 5.0	17.4–48.6
Weight difference age (30–39 to 55–60 years (kg)[a])	9.4 ± 9.9	−31.7–61.1
Restraint score	10.6 ± 4.5	0–20[b]
Flexible restraint score	3.3 ± 1.8	0–7
Rigid restraint score	3.4 ± 1.7	0–7
Disinhibition score	6.6 ± 4.0	0–16
Habitual disinhibition score	1.4 ± 1.5	0–5
Emotional disinhibition score	1.4 ± 1.3	0–3
Situational disinhibition score	2.2 ± 1.6	0–5
Hunger score	5.0 ± 3.5	0–14
Internal hunger score	1.9 ± 1.9	0–6
External hunger score	1.9 ± 1.6	0–6

[a]Calculated by subtracting the weight reported for the 30–39 age interval from the weight reported for the 55–60 age interval. [b]Maximum possible score is 21; for all other Eating Inventory (EI) variables, the observed range reflects the maximum possible range for that variable.

RESULTS

The results of the linear regression model examining eating behavior subscales and reported weight change are shown in **Table 2**. Both the unadjusted model, which includes eating behavior subscales alone, and the adjusted model, which includes potentially confounding factors such as age and parity, are displayed. Approximately 25% of the variability in reported weight change in this sample was explained by our adjusted regression model, with the largest partial *r* value obtained for habitual disinhibition. **Figure 1** depicts adjusted model-calculated predicted weight change data using 10th ("low") and 90th ("high") percentile disinhibition and restraint scores, and mean values of other model variables. Thus the figure shows the synergistic and interactive effects of high and low values for different eating behavior sub-scores. High habitual and/or emotional disinhibition scores were consistently associated with weight gain independently and in a synergistic fashion, while situational disinhibition was not significantly associated with weight gain. Based on our model, women with high scores for habitual and emotional disinhibition, and a low score for flexible restraint, gained ~22 kg weight over the 20 year age interval between 30–39 and 55–60 years, compared to only ~6 kg for women with low scores for habitual and emotional disinhibition. Having a high score for flexible restraint attenuated this weight gain (only ~10 kg gain expected with high disinhibition scores), but the general influence of both disinhibition subscales was still apparent.

Concerning current BMI (**Table 3** and **Figure 2**), ~35% of the variability in reported BMI was explained by our adjusted model, with again the largest partial *r* value obtained for habitual disinhibition. High habitual and emotional overeating susceptibilities were associated with substantially higher

Table 2 Relationship between eating behavior subscales and reported weight change (kg) over the age interval of 30–39 to 55–60 years, both unadjusted and adjusted for potential confounding variables

	Regression coefficient	95% Confidence interval	Partial *r*	*P* value
Unadjusted model (adjusted R^2 = 0.228)				
Intercept	5.619	3.15 to 8.09		<0.001
Habitual disinhibition	4.250	2.85 to 5.66	0.250	<0.001
Emotional disinhibition	1.409	0.72 to 2.10	0.172	<0.001
Flexible restraint	−0.503	−1.06 to 0.05	−0.077	0.076
External hunger	0.589	−0.21 to 1.39	0.063	0.147
Habitual disinhibition × flexible restraint	−0.476	−0.76 to −0.19	−0.141	0.001
Habitual disinhibition × external hunger	−0.413	−0.72 to −0.11	−0.114	0.009
Adjusted model (adjusted R^2 = 0.257)				
Intercept	27.174	11.66 to 42.69		0.001
Habitual disinhibition	4.137	2.75 to 5.52	0.248	<0.001
Emotional disinhibition	1.377	0.70 to 2.06	0.172	<0.001
Flexible restraint	−0.334	−0.89 to 0.22	−0.052	0.234
External hunger	0.228	−0.62 to 1.08	0.023	0.599
Internal hunger	0.514	0.02 to 1.01	0.088	0.044
Age	−0.365	−0.62 to −0.11	−0.122	0.005
Parity	0.401	0.01 to 0.79	0.087	0.045
Education level[a]	−2.391	−3.91 to −0.88	−0.134	0.002
Habitual disinhibition × flexible restraint	−0.514	−0.80 to −0.23	−0.154	<0.001
Habitual disinhibition × external hunger	−0.387	−0.69 to −0.08	−0.109	0.012

[a]Education level was coded as low (0): postsecondary education = none, vocational school, or 2 years of college; and high (1): postsecondary education = 4 years of college, graduate school, or professional school.

Table 3 Relationship between eating behavior subscales and BMI (kg/m²) at age 55–65 years, both unadjusted and adjusted for potential confounding variables

	Regression coefficient	95% Confidence interval	Partial *r*	*P* value
Unadjusted model (adjusted R^2 = 0.332)				
Intercept	23.147	21.92 to 24.37		<0.001
Habitual disinhibition	2.794	2.05 to 3.54	0.305	<0.001
Emotional disinhibition	0.849	0.53 to 1.17	0.220	<0.001
Situational disinhibition	0.569	0.20 to 0.94	0.131	0.003
Flexible restraint	−0.147	−0.41 to 0.12	−0.048	0.272
External hunger	−0.323	−0.62 to −0.03	−0.092	0.034
Habitual disinhibition × flexible restraint	−0.237	−0.37 to −0.10	−0.151	0.001
Habitual × situational disinhibition	−0.276	−0.43 to −0.12	−0.148	0.001
Adjusted model (adjusted R^2 = 0.354)				
Intercept	29.339	22.07 to 36.61		<0.001
Habitual disinhibition	2.778	2.04 to 3.52	0.308	<0.001
Emotional disinhibition	0.827	0.51 to 1.15	0.218	<0.001
Situational disinhibition	0.604	0.24 to 0.97	0.141	0.001
Flexible restraint	−0.078	−0.34 to 0.18	−0.026	0.554
External hunger	−0.336	−0.63 to −0.04	−0.098	0.025
Age	−0.111	−0.23 to 0.01	−0.080	0.068
Hormone replacement therapy[a]	−0.706	−1.40 to −0.02	−0.087	0.045
Parity	0.318	0.14 to 0.50	0.148	0.001
Education level[b]	−0.628	−1.34 to 0.08	−0.076	0.082
Habitual disinhibition × flexible restraint	−0.245	−0.38 to −0.11	−0.158	<0.001
Habitual × situational disinhibition	−0.272	−0.43 to −0.12	−0.149	0.001

[a]Hormone replacement therapy was coded as no (0) and yes (1). [b]Education level was coded as low (0): postsecondary education = none, vocational school, or 2 years of college; and high (1): postsecondary education = 4 years of college, graduate school, or professional school.

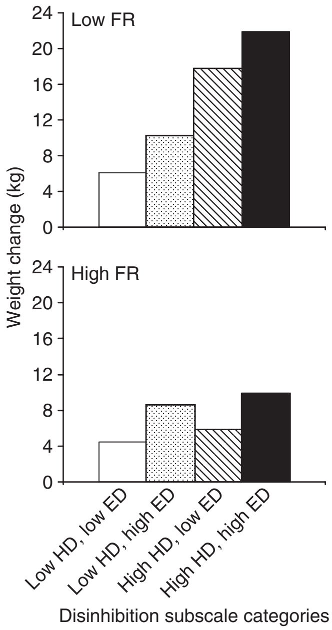

Figure 1 Predicted weight change calculated using the adjusted linear regression model. Calculations were completed using either 10th percentile (low) or 90th percentile (high) scores on flexible restraint (FR), habitual disinhibition (HD), and emotional disinhibition (ED) subscales, and sample means for all remaining model parameters.

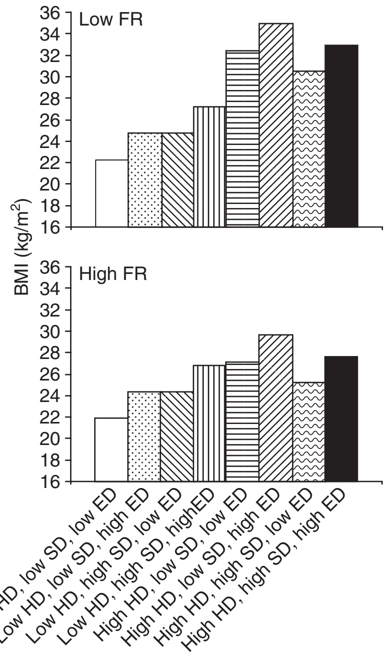

Figure 2 Predicted BMI calculated using the adjusted linear regression model. Calculations were completed using either 10th percentile (low) or 90th percentile (high) scores on flexible restraint (FR), habitual disinhibition (HD), situational disinhibition (SD), and emotional disinhibition (ED) subscales, and sample means for all remaining model parameters.

BMI values (~33 vs. 22 kg/m² based on model calculations), with no apparent synergistic influence of situational disinhibition. In parallel with the weight gain results, flexible control of dieting behavior partially attenuated the influence of overeating on BMI. Qualitatively similar results were obtained in the complete dataset of subjects with non-missing data for the BMI (n = 1,421) and weight change (n = 1,141) models, but who were originally excluded from our main analysis based on the reported presence of health conditions or eating disorders.

DISCUSSION

We examined the association of adult weight gain and obesity with eating behavior subscales in older women. Our data suggest that the strongest behavioral correlate of adult weight gain and obesity at age 55–65 years is a high level of habitual disinhibition. Emotional disinhibition is a significant but quantitatively less important correlate of weight gain and BMI and, in contrast to widespread perception, situational disinhibition was not appreciably associated with either outcome variable. Although hunger was an overall minor correlate of weight gain and BMI in this population, external hunger was more important relative to internal hunger. Our results also indicate that flexible control of dietary restraint primarily attenuates the influence of habitual rather than emotional disinhibition on weight gain and BMI, and that rigid restraint is not significantly associated with either parameter.

Most previous examinations of eating behavior and body weight status from our laboratory and others indicate that disinhibition is positively associated with both adult weight gain (6) and current BMI (11–13,19,28), although one study (7) found no greater weight gain over a 6-year interval in subjects with a higher disinhibition score at baseline compared to those with a lower score. The current results again emphasize the apparently central role of disinhibition in adult-onset weight gain, and in particular indicate that disinhibition that occurs habitually may be quantitatively the most important correlate of weight gain and high BMI, followed by disinhibition in response to emotional stimuli as a secondary and quantitatively less important correlate. Our current findings are novel in that we examined sub-factors of disinhibition, restraint, and hunger in an attempt to more clearly specify the primary eating behavior characteristics most associated with weight gain over adulthood. The influence of disinhibition on weight gain observed in this study was substantial, with ~22 kg gain predicted to occur over 20 years in women with high habitual and emotional disinhibition scores. In contrast, studies examining associations of other factors predictive of adult weight gain, such as dietary fat, are conflicting but generally report a much smaller influence (29).

Habitual disinhibition may be the most important correlate of weight gain leading to obesity simply because of the high number of daily overeating opportunities it provides in the typical western food environment. In contrast, situational and emotional disinhibition may occur less frequently, with resulting reduced potential for a quantitatively important effect. An individual with a susceptibility to overeating habitually, who is then faced with large portions of inexpensive, varied, and palatable foods multiple times in a typical day, is likely to gain weight as all of these factors have been independently linked to increased energy intake and weight gain (30–33). Whether it is possible to reduce responsiveness to these habitual cues, however, is not known at this time and further research in this area is urgently needed. For example, it is currently unknown which disinhibition subscale score decreases most strongly in response to standard clinical interventions to promote weight loss, nor is it understood how (or if) disinhibition traits are specifically related to food-intake and/or appetite regulatory mechanisms.

Previous evidence for a relationship between dietary restraint and body weight is more conflicting, with positive (14–16), negative (11,17,18), and no significant association (7,10,12,19,34) with either BMI or weight gain being reported. In this study, we found that flexible dietary restraint attenuated the associations between habitual disinhibition and weight change and BMI, and that rigid restraint was not significantly associated. Provencher *et al.* (12) reported that rigid restraint was positively and flexible restraint was negatively associated with BMI, but the overall restraint score was not significantly associated with any anthropometric variable. These data are in contrast to those of McGuire *et al.* (23), who reported that overall, flexible, and rigid restraint were each equivalently negatively associated with body weight among male and female participants of a community-based obesity prevention trial. Young women with higher flexible restraint scores have been shown to reduce subsequent ice cream intake following a milkshake preload, while women with high rigid control scores did not change intake following the preload (35). These findings combined with the results presented here emphasize the importance of differentiating the individual subscales of this eating behavior characteristic.

This study has several limitations. First, self-reported rather than measured current height and weight values were obtained, and could have led to bias. However, a subpopulation of women in the study (n = 67) were invited to participate in a more detailed study involving visits to our research center (36), and only small differences between reported and measured weight (but not height) were observed, resulting in a small mean difference (−0.21 kg/m^2) in BMI calculated using reported vs. measured values (6). Another potential limitation of our study is the use of retrospective assessments of body weight to calculate weight change, rather than prospective measurements. However, moderate-to-high correlations between self-reported and actual past weights have been observed previously, with the magnitude of difference between values being typically small (37,38). Similarly, the EI data obtained in this study reflect current levels of disinhibition, restraint, and hunger, with the assumption that these characteristics are stable over adulthood and thus may be accurately correlated with body weight change reported over a ~20-year interval. Limited data from our group (39) and others (7,20,23) suggest that EI scores are generally stable over relatively short (1–6 years) intervals, with significant but small changes in restraint, disinhibition, external hunger, and habitual disinhibition previously observed. We were also unable to identify or exclude subjects with diagnosed or self-reported depression, and this may be a confounding factor influencing our results.

Finally, our study only examined women, the majority of whom were white, and thus conclusions about men or other racial/ethnic groups cannot be made. Relatively few previous studies have compared EI scores and weight change among different racial groups. Atlas *et al.* (40) reported that restraint and disinhibition (but not hunger) scores were slightly but significantly lower in African American (n = 200) compared to white (n = 300) college students, but body weight data were not provided. Among severely obese women seeking bariatric surgery, disinhibition (but not restraint or hunger) scores were lower in African American/Latina women compared with whites (41). These data suggest that disinhibited eating behaviors may be less prevalent among African American women, and thus our results may not be applicable to this racial group. Similarly, several studies have reported that restraint and disinhibition scores are lower in men compared to women (12,13,24), and that the associations between the flexible and rigid control subscales of restraint and anthropometric variables differ between men and women (12). These findings also suggest that disinhibition might be a more important correlate of adult weight gain in women compared to men. Further examinations of EI data and body weight in males and non-white racial/ethnic populations are needed.

In conclusion, high levels of habitual disinhibition were associated with substantial weight gain and obesity in older women, but in contrast disinhibition initiated by specific environmental cues such as social occasions did not appreciably contribute to weight gain and high BMI in this population. Emotional disinhibition had a significant but modest association with these outcome variables. Flexible, but not rigid, control of dietary restraint attenuated the influence of habitual disinhibition on weight gain and BMI. Our results, combined with recent evidence indicating that habitual disinhibition scores in particular are associated with psychological well-being in older women (regardless of weight status) (22), suggest a need for further research examining the potential influences of habitual vs. emotional and situational disinhibition on body weight and health. Lifestyle modification programs for prevention and treatment of adult-onset obesity currently focus on reducing situational and emotional overeating but the results of this study indicate that a greater emphasis may be warranted on reducing habitual overeating. Strategies that may reduce habitual disinhibited overeating include either group or individual cognitive behavior therapy (42), reduced availability of dietary entrée/side/snack/dessert variety (33), and sibutramine treatment (43). Intervention studies testing the effectiveness of lifestyle modification and other treatment programs that focus on reducing habitual disinhibition to prevent adult weight gain are now needed.

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DISCLOSURE

The authors declared no conflict of interest.

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