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The Association of Restrained Eating With Weight Change Over Time in a Community-Based Sample of Twins

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Abstract

We investigated the association of restrained eating with BMI and weight gain while controlling for the influence of genes and shared environment. Participants were 1,587 twins enrolled in the University of Washington Twin Registry (UWTR). Restrained eating was assessed by the Herman and Polivy Restraint Scale. Height and weight were self-reported on two occasions. Analyses used generalized estimating equations or multiple linear regression techniques. Restraint Scale scores were positively associated with both BMI (adjusted $\beta = 0.39$ kg/m^2; 95% confidence interval (CI) = 0.34–0.44; $P < 0.001$) and weight gain (adjusted $\beta = 0.33$ pounds; 95% CI = 0.17–0.49; $P < 0.001$). High Restraint Scale scorers had an adjusted mean BMI of 27.9 kg/m^2 (95% CI = 27.4–28.4) as compared to intermediate (mean = 25.5 kg/m^2; 95% CI = 25.2–25.8) and low scorers (mean = 23.0 kg/m^2; 95% CI = 22.7–23.3). In within-pair analyses among 598 same-sex twin pairs, the adjusted association between Restraint Scale scores and BMI persisted even when genetic and shared environmental factors were controlled for (adjusted $\beta = 0.18$; 95% CI = 0.12–0.24; $P < 0.001$), as did the association with weight gain (adjusted $\beta = 0.37$; 95% CI = 0.13–0.61; $P = 0.003$). In stratified analyses, dizygotic (DZ) twins differed more in BMI for a given difference in the Restraint Scale score than monozygotic (MZ) twins, for whom genetics are 100% controlled (adjusted $\beta = 0.32$; 95% CI = 0.20–0.44 vs. adjusted $\beta = 0.10$; 95% CI = 0.04–0.16; $P = 0.001$ for test of interaction). These data demonstrate that observed relationships between BMI, weight gain, and restrained eating, as assessed by the Restraint Scale, have a strong environmental influence and are not solely due to shared genetic factors.

Introduction

The prevalence of obesity (1) and obesity-related health complications (2) remains high, even though many Americans report attempts to manage their body weight (3). Restrained eating is a construct that investigators have developed to describe an individual's attempt to manage body weight by cognitively controlling food intake (4). Conversely, unrestrained eaters self-regulate eating based on appetite and satiety. Studies have prospectively linked restrained eating to a higher risk of developing obesity in preadolescent and adolescent girls (5,6), as well as greater weight gain in adults (7,8). As some degree of cognitive restraint is

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Disclosure

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necessary for weight control for most people, further research is warranted into the potential mediating factors behind the association between restrained eating and obesity.

The alterations in eating habits among restrained eaters are chronic and persistent, but they fall short of the degree of pathology exhibited in clinical eating disorders. Evidence is mixed as to whether restrained eaters are in a hypocaloric state (9–11), and their success in achieving weight loss varies (12,13). Their weight fluctuates and both BMI and maximal lifetime weights are higher than those observed in unrestrained eaters (13). Paradoxically, some restrained eaters also display a propensity toward overeating (9). In particular, the Herman and Polivy Restraint Scale (14) tends to identify individuals who have a high degree of concern about weight and dieting, but also disinhibit their eating in certain situations (15). The mechanisms by which restrained eating and repeated attempts at dieting may encourage weight gain or overeating are uncertain (16), but one possibility is that genetics predisposes individuals toward both weight gain and the behavioral response of recurrent dieting (17). Twin research methods can be useful in exploring such hypotheses.

Twin studies have provided insights into the epidemiology, etiology, pathophysiology, psychology, and natural history of many medical and psychiatric conditions (18). Because their genetic similarities are easily understood, twins are useful in elucidating the relative contributions of genetic and environmental factors to illness and health. Twins are identical in age, and if reared together, are typically extraordinarily well-matched for shared family background and numerous childhood/adolescent exposures. Because twins tend to be very similar on many variables that differ among unrelated individuals, the study of phenotypically discordant twins can potentially detect subtle environmental effects.

This project uses the University of Washington Twin Registry (UWTR) to investigate the cross-sectional association of restrained eating, BMI, and weight change while controlling for the effects of age and genetics by using twin analysis methodology. We hypothesize that, compared to unrestrained eaters, a restrained eating pattern will be associated with higher BMI and greater recent weight gain.

Methods and Procedures

Participants

All twins are participants in the UWTR, a community-based registry of twin pairs derived from drivers' license applications in Washington State. Briefly, because drivers' license numbers in this state are assigned on the basis of an individual's name and date of birth, the Department of Licensing asks each new applicant whether s/he is a member of a twin pair to avoid issuing duplicate license numbers (19). The University of Washington receives lists of applicants who are twins, and each member of the pair is invited to join the UWTR and to complete an initial enrollment survey. The 2006 Health Survey was mailed to all members of the UWTR in August 2006, and achieved a 55% overall response rate.

Members of same-sex pairs in the UWTR who responded to the Health Survey in 2006 were eligible for the present study. The specific criteria for inclusion were: (i) no history of gastric bypass or other weight-reduction surgery, (ii) ages 18–65 at the time of the baseline initial survey with the UWTR, and (iii) known zygosity assignable from a similarity questionnaire. These criteria resulted in an initial sample of 1,714 individual twins. We further excluded 21 twins because they were missing ≥2 responses on the Restraint Scale. An additional 106 twins were excluded for missing data for covariates, with a final analytic data set of 1,587 individual twins.

Measures

Restrained eating—Restrained eating was assessed by the Restraint Scale. The Restraint Scale is derived from a 10-item self-report questionnaire designed to identify individuals with high levels of concern about dieting and weight (14). Questions ask about the frequency of dieting (e.g., "How often are you dieting?"), weight fluctuations (e.g., "In a typical week, how much does your weight fluctuate?"), and overeating (e.g., "Do you eat sensibly in front of others and splurge alone?). Responses are scored on a Likert scale from 0 to 3 or 0 to 4, and scores for all 10 items are summed to create the scale score. Test– retest reliability is high ($r = 0.95$) (20). Internal consistency has been estimated at $\alpha = 0.78–0.83$ (20,21). Intercorrelations with other measures of dietary restraint vary between $r = 0.35–0.74$ (20–22). Some have argued that the Restraint Scale identifies "unsuccessful" dieters who have a higher tendency toward overeating (4,21). The Restraint Scale may overestimate restraint in obese (4) and overweight (22) populations. All twins completed the Restraint Scale as part of the UWTR 2006 Health Survey.

Weight gain and BMI—The UWTR database includes self-reported weight and height from two time points: twins' enrollment in the UWTR (between 2002 and 2006) and completion of the 2006 Health Survey. Weight change is calculated as the difference between the reported weights on the initial enrollment survey and the 2006 Health Survey. Twins self-reported their lifetime maximum weight, excluding pregnancy ("Up to the present time, what is the most you have ever weighed?").

Zygosity—All twins completed a questionnaire about childhood similarity to assess zygosity. Studies show that questions about childhood similarity in twin pairs can be used to correctly differentiate among monozygotic (MZ) and dizygotic (DZ) twin pairs with an accuracy that is 95–98% of that achieved by using biological indicators (23,24). We asked the following: "As children were you and your twin as alike as two peas in a pod or of ordinary family resemblance?" and "When you were children how often did (parents, other relatives, teachers, strangers) have difficulty in telling you apart?" The responses to these similarity questions were then used to assign zygosity (19).

Habits—Questions from the International Physical Activity Questionnaire (www.ipaq.ki.se) were used to assess the self-reported frequency of exercise. From these responses, the total minutes per week of moderate or vigorous activity was calculated as a measure of physical activity. Smoking history was assessed with the question, "Have you smoked >100 cigarettes in your lifetime?" and encompasses both past and present smokers. Current smoking was assessed with the question, "Do you now smoke cigarettes every day, some days, or not at all?" Twins were asked, in the past 12 months, how many times they had attempted to lose weight, if they were trying to lose weight continuously, and how they had tried to lose weight (reduced the number of calories or the amount of food you ate; switched to food with lower calories or less fat, but ate a normal amount; followed a special diet such as Atkins or Zone; increased exercise; skipped meals/fasted; took diet pills prescribed by a doctor; took laxatives or vomited) (25). Finally, twins reported how many times during the past 12 months they had lost ≥5 pounds on purpose (none, 1–2, 3–4, ≥5).

Demographics—Several demographic factors were considered potential confounding variables. Age and gender were determined from UWTR records. Race was determined by self-report from the initial enrollment surveys ("Do you consider yourself to be Hispanic or Latino?" and "What race do you consider yourself to be?), as was education ("What is the highest level of school you completed?").

Statistical analysis

Descriptive statistics were calculated as means and s.d. for continuous variables and proportions for categorical variables. Response bias to the 2006 Health Survey was assessed by comparing baseline BMI among health survey responders to nonresponders. Cronbach's α was calculated for the Restraint Scale score. Total Restraint Scale scores were imputed for twins missing 1 (n = 51) or 2 (n = 12) responses for the scale by calculating the percentage of total possible points for the nonmissing responses and multiplying this percentage by 32 (the total possible points for the complete 10-item scale). We divided the sample into tertiles by Restraint Scale score (high ≥ 16, intermediate = 12–16, and low ≤ 11). Group differences by gender and by Restraint Scale score category were tested by using generalized estimating equations regression models with robust s.e. to account for the clustered structure of the twin pairs. Linear, logistic, and multiple logistic regression models were used as indicated to evaluate continuous and categorical variables, respectively. Significance was determined by Wald tests.

For initial analyses, all individual twins were included in a linear regression to assess the cross-sectional relationship between the Restraint Scale score and BMI as assessed in the 2006 Health Survey. Again, generalized estimating equations with robust s.e. were used to account for the clustered structure of the twin pairs. The covariates of age, gender, education, race, smoking, and physical activity were chosen *a priori* and included in adjusted regression models. We present predicted adjusted least squared mean BMIs from regression results.

The initial cross-sectional analysis of individual twins, described above, does not directly compare BMI within twin pairs. For twin pairs in which both members completed the 2006 Health Survey, we calculated the within- pair differences in Restraint Scale, BMI, and covariates by randomly identifying one index twin in the pair and comparing the co-twin to the index twin across all measures. Thus, within-pair differences have both positive and negative values. These within-pair difference measures were used in a multiple linear regression model. Within-pair analyses account for potential genetic and family environmental confounding factors, as well as age and gender. Further analysis stratified by twin zygosity examined these within-pair effects in separate regression models for MZ and DZ pairs. Because MZ pairs share 100% of their DNA, these within-pair comparisons are fully controlled for genetic factors.

We continued our analysis by examining the relationship of the Restraint Scale score to recent weight change. In this analysis, we used the difference in weight between individual twins' initial enrollment survey and the 2006 Health Survey as our primary outcome. As with the cross-sectional analysis of BMI, we performed adjusted analyses of the relationship between the Restraint Scale score obtained on the 2006 Health Survey and weight change over time. *A priori* covariates included baseline age, smoking status, and education. We also adjusted for BMI at baseline and included a term for the length of time between the baseline weight and the 2006 assessment. Physical activity data were not available at baseline and were not included in the model. As described above for the BMI outcome, we again used a within-pair analysis of the Restraint Scale score and weight change to account for genetic and familial factors. Finally, because natural growth might have occurred among the younger twins in the sample, we also conducted a sensitivity analysis restricted to twins age 25 and older.

Results

Twin participants

Sixty-eight percent of the participants were women. Women had higher average (±s.d.) Restraint Scale scores (14.4 ± 5.4 vs. 11.0 ± 5.7; $P < 0.001$), but men and women were similar on other characteristics (data not shown). Among all twins, the mean BMI was 25.3 ± 5.3 kg/m^2 with a range of 15.3–55.4 kg/m^2. Fifty-three percent of the sample were normal weight, 24% overweight, and 16% obese. Twins gained a mean of 4.7 ± 14.0 pounds over the average of 3.1 ± 1.0 years between their initial survey and the 2006 Health Survey. There was no indication of response bias by BMI among twins responding to the 2006 Health Survey; responders' mean BMI at the time of their initial enrollment survey was 24.7 kg/m^2 (95% confidence interval (CI) 24.5–24.9) and nonresponders' mean BMI was 24.6 kg/m^2 (95% CI 24.4–24.8). Seventy-three percent of twin pairs were MZ and 27% were DZ. The majority of twins were white (89%), and 45% had completed an undergraduate degree or higher. Obesity rates were consistent with available data on white, well-educated persons in Washington State and King County (26,27). Sixty-eight percent of twins had never smoked cigarettes. The Restraint Scale was internally reliable, with a Cronbach's α of 0.76 in our twin sample.

Characteristics of the twin participants categorized by their Restraint Scale scores are presented in Table 1. The mean (s.d.) Restraint Scale scores for the low, intermediate, and high tertiles were 7.6 ± 2.8, 14.0 ± 1.4, and 20.2 ± 3.1, respectively. Physical activity, race, and zygosity did not differ across Restraint Scale categories, but gender, age, education, lifetime history of smoking, time between surveys, BMI category, lifetime maximum weight, and number of weight-loss attempts in the past year did. The high Restraint Scale score group (n = 459) tended to be female, be older, have smoked at some time in their lives, have fewer persons with a high-school education or less, have a higher proportion of obese individuals, and report both higher lifetime maximum weights and a greater number of recent weight-loss attempts. In this group, 81% reported reducing calories or amount of food eaten in order to lose weight in the past year, 56% changed the type of food eaten, 30% used a special diet (i.e., Atkins, Zone), 73% increased exercise, 35% skipped meals or fasted, 4% took diet pills prescribed by a doctor, and 7% took laxatives or vomited. In addition, 47% reported losing ≥5 pounds on purpose one to two times in the past year, whereas 19% reported 3–4 weight-loss episodes and 11% reported losing ≥5 pounds more than five times in the past year.

The association of restrained eating with BMI and weight change over time

We found a significant overall association between Restraint Scale score and BMI in our initial cross-sectional analysis of individual twins (Table 2), controlling for the effects of age, gender, physical activity, education, race, and smoking history (adjusted β = 0.39 kg/m^2; 95% CI = 0.34–0.44; $P < 0.001$). The β value gives the adjusted average difference in BMI per 1-point difference on the Restraint Scale score. In the analysis of weight change over time, restrained eating at the time of the 2006 Health Survey was significantly associated with an increase in weight since the time of the initial enrollment survey (adjusted β = 0.33 pounds; 95% CI = 0.17–0.49; $P < 0.001$), controlling for the effects of age, gender, education, race, smoking history, initial BMI, and time elapsed between self-reported weights. The average recent weight change was almost 7 pounds among the highest Restraint Scale scorers (Table 2), although the study design cannot distinguish between twins whose heightened attempts at cognitive restraint followed the weight gain and those whose heightened attempts preceded it.

In the sensitivity analysis restricted to twins aged 25 or older (n = 1,141), the results remained highly significant for the association of Restraint Scale scores with both BMI ($P < 0.001$) and weight change ($P < 0.001$). Consistent with the older age of the sample, predicted mean BMIs were higher than those shown in Table 1, especially in the high and intermediate Restraint Scale scorers (28.9 kg/m^2, 95% CI 28.3–29.5 and 26.1 kg/m^2, 95% CI 25.8–26.5).

Within-pair assessment of restrained eating and BMI

For the within-pair assessment we included only twin pairs in which both members completed the Restraint Scale. Among these 1,196 individual twins (N = 598 twin pairs), 828 were women and 368 were men. The mean BMI was 25.1 ± 5.4 kg/m^2 with a range of 15.3–55.4 kg/m^2. The mean Restraint Scale score was 13.2 ± 5.7, and women again scored higher than men (14.2 ± 5.4 vs. 10.9 ± 5.7). This subset of twins gained an average of 4.7 ± 14.0 pounds over the mean elapsed time of 3.2 ± 1.0 years between self-reported weights. Most twins were very similar to their co-twins in BMI, with 50% of all twins falling between −1.7 and 1.5 kg/m^2 of their co-twins. The mean difference in BMI between MZ twins was minimal, and was less than that between DZ twins (0.01 ± 3.4 vs. 0.6 ± 5.4 kg/m^2). On average, twins' Restraint Scale scores were almost identical (mean 0.1 ± 4.7); 50% of twin pairs fell within two points of each other and 25% differed by ≥5 points.

Using our sample of same-sex twin pairs, we found a highly significant association between the Restraint Scale score and BMI using a within-pair method, adjusted for education, smoking history, and physical activity (Table 3). Among MZ twins, the association between the Restraint Scale score and BMI was attenuated but remained significant. We formally tested the differences in β coefficients between MZ and DZ pairs, finding that the BMI difference associated with a difference in Restraint Scale score in DZ twins was significantly greater (P = 0.001) than in MZ twins.

Within-pair assessment of restrained eating and recent weight changes

Members of twin pairs gained very similar amounts of weight between the initial survey and the 2006 Health Survey (mean within-pair difference in weight gain = 0.45 ± 16.5 pounds). The mean difference in elapsed time between completion of the surveys in a pair was 4.7 ± 5.0 months. The within-pair difference in BMI at initial survey was minimal (mean = −0.2 ± 3.6 kg/m^2). However, the within-pair difference in BMI at initial survey was strongly associated with the within-pair difference in weight change over time, such that the heavier twin tended to lose weight and the lighter twin tended to gain weight ($r = -0.20$; $P < 0.001$). In adjusted analyses that controlled for within-pair differences in education, smoking history, initial BMI, and time elapsed between surveys, there was a significant relationship between the within-pair difference in restrained eating and the within-pair difference in recent weight change (Table 3). In stratified analyses among MZ and DZ twins, trends toward increased weight gain in individuals were present when their Restraint Scale scores were higher than those of their co-twins, but the results were of borderline statistical significance.

Discussion

We found a strong relationship between restrained eating and higher BMI in a community-based sample of twins from Washington State. Restrained eating was also related to weight gain. These relationships persisted after adjustment for potential confounders, including age, gender, smoking status, education, race, and physical activity. By comparing individuals within twin pairs to each other, we matched genetics and shared environmental factors, and were able to show that restrained eating was still significantly related to BMI and weight gain independent of these factors. In other words, twins who scored higher on the Restraint

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Scale were heavier than their co-twins, and were more likely to have experienced a recent weight increase, despite their shared genetic and environmental background. Even in MZ twins, where genetics are controlled for 100%, twins who scored higher on the Restraint Scale than their co-twins had higher BMIs. Based on our findings, the 25% of twins who scored 5 points higher on the Restraint Scale than their co-twins would be predicted to be heavier (MZ 0.5 vs. DZ 1.5 kg/m^2) and would have gained more weight (MZ 1.3 vs. DZ 2.4 pounds) than their co-twins. Such differences are notable, considering that they represent weight gains that are three to six times higher than the average difference in weight gain within pairs, and may also represent weight gain in excess of a genetically predisposed weight. We concluded that nonfamilial environmental factors influenced the relationships between BMI, weight change, and the pattern of eating behavior and weight fluctuation that is characteristic of restrained eaters identified by the Restraint Scale.

These analyses also illustrate the strong genetic influence on adiposity: in people who are genetically more similar, a difference in eating behavior is not associated with as great a difference in BMI as in people who are genetically less similar. Thus we found a smaller magnitude of difference in BMI associated with differences in restrained eating within MZ twin pairs than within DZ twin pairs. This finding is not surprising, as body weight and adiposity are under substantial genetic control, and studies consistently demonstrate that genetic factors explain 50–90% of variance in BMI (28). Further, longitudinal data have shown that both maximum lifetime BMI and the trend in weight change over time are largely genetically regulated (29). However, variability around the trend in weight gain—i.e., weight gain that was not steady but fluctuated with many ups and downs—was environmentally determined (29). This weight variability pattern is typical of restrained eaters as identified by the Restraint Scale (22), and both frequent weightloss attempts and weight cycling were present in our sample of restrained eaters. Our findings are consistent with the inherited nature of body composition, while providing further evidence that weight fluctuations and concerns with weight and dieting have substantial environmental influences that our analyses could not account for. Such nonfamilial environmental factors, ranging from birth environment (30) to social circles (31), might differentially influence the development of individual twins' eating behaviors and/or tendencies toward weight gain.

Prior studies also indicate a possible inherited component in restrained eating. Some have proposed that shared genetic factors may contribute to both higher restrained eating scores and higher BMIs (17). Several studies, but not all (32), have indicated that restrained eating may be an inherited trait (33,34). A study performed in the UWTR found a heritability of 43% for Restraint Scale scores, adjusted for BMI and sex (95% CI 36–50%) (35). Genes could influence restrained eating and BMI directly or through inherited mediators, such as personality factors or tendencies toward weight gain. The data from the present study cannot rule out shared genetic factors that influence both adiposity and behavioral adaptations to control weight. However, further study is required to distinguish between shared genetic and environmental risk factors and quantify the extent that genetics account for the co-occurrence of restrained eating and obesity.

A major limitation in the interpretation of our data on weight change over time is the absence of a baseline measure of restrained eating. For this reason, we cannot determine whether restrained eating was a response to weight gain or an eating pattern that predated weight gain. The Restraint Scale is designed to measure a stable trait, and some evidence supports the consistency of restrained eating over time (20). However, we cannot be certain that restrained eating was present at the time of the initial weight report. Given this crucial caveat, we did find significantly more recent weight gain among restrained eaters in the sample, controlling for confounding factors including initial BMI. In our within-pair analysis, individual twins who scored higher on restrained eating than their co-twins had also gained more weight recently. This again indicates environmental influence on the relationship between restrained eating and weight gain.

Further limitations bear mention. Self-reported weights and heights may differ from measured weights and heights (36). The use of the weight change variable may alleviate some of this source of error, assuming that individuals consistently underestimate (or overestimate) their weight over time. Nonresponse bias might also be present, given the 55% response rate for the 2006 Health Survey; nevertheless, we found no response bias in BMI. The low rates of obesity in this sample may be related to the predominance of well-educated, white participants, a population in whom obesity rates in Washington State are lower than state-wide averages (26,37). Thus, our results may not be generalizable to twin populations with different racial or educational backgrounds. In addition, individuals who score high on the Restraint Scale tend to report body dissatisfaction and overeating behaviors as well as dietary restraint (22). In overweight women, the Restraint Scale score most closely correlates with overeating, whereas among normal weight women, correlations are highest for body dissatisfaction and dietary restraint (22). Thus, we cannot be certain that the eating behavior pattern exhibited by high Restraint Scale scorers is identical among twins in different weight categories. Finally, existing psychometric measures identify different populations of restrained eaters (15,21), so that findings based on the Restraint Scale may not generalize to restrained eaters who are identified by alternate measures that focus on caloric restriction or “successful” dieting (15).

In summary, we present novel data showing that restrained eating as assessed by the Herman and Polivy Restraint Scale is associated with higher BMIs and greater recent weight change, even when genetics and shared environmental influences are accounted for. These findings indicate the potential for nonfamilial, modifiable factors to be primary mediators connecting this eating pattern to weight gain and obesity. In addition, researchers should be aware that restrained eating may confound analyses of the relationship of BMI to health, nutrition, and body weight outcomes. Efforts should be made to control for and separate the effects of eating behavior from those of adiposity itself. Our analysis of a unique and genetically informative sample provides additional evidence that both genetic and environmental factors underlie the relationships between restrained eating, higher BMI, and weight gain. whereas some studies have demonstrated these relationships prospectively (5,6), we cannot determine from the present work whether restrained eating could be considered a risk factor for or a response to weight gain. Further work is needed to determine whether increases in body weight represent weight regain after intentional weight loss, or weight gain beyond a genetically preferred weight, perhaps due to overeating. Twin populations are an attractive group in which to pursue such critical questions in the study of eating behavior, body-weight regulation, and obesity.

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Table 1

Characteristics of 1,587 individual twins stratified by tertile of Restraint Scale score

	Low (≤11)	Intermediate (12 ≤16)	High (>16)	*P* value[a]
Number, *N* (%)	610 (38)	518 (33)	459 (29)	
Gender				<0.001
Male, *N* (%)	274 (54)	138 (27)	91 (18)	
Female, *N* (%)	336 (31)	380 (35)	368 (34)	
Age, mean years (s.d.)	33 (13)	36 (13)	38 (14)	< 0.001
White, *N* (%)	547 (90)	463 (89)	409 (89)	0.9
Education				0.02
High school or less, *N* (%)	78 (13)	55 (11)	40 (9)	
Some college or technical school, *N* (%)	267 (44)	209 (40)	227 (49)	
College or graduate, *N* (%)	265 (43)	254 (49)	192 (42)	
Physical activity, mean min/week (s.d.)	133 (92)	137 (91)	136 (92)	0.8
Ever smoked, *N* (%)	162 (27)	169 (33)	171 (37)	0.003
Current smoking				0.09
None, *N* (%)	513 (84)	441 (85)	378 (83)	
Some days, *N* (%)	19 (3)	29 (6)	28 (6)	
Every day, *N* (%)	77 (13)	48 (9)	52 (11)	
Time between surveys, mean years (s.d.)	3.0 (1.0)	3.2 (1.0)	3.2 (0.9)	0.01
Number of MZ pairs, *N* (%)	443 (73)	381 (74)	329 (72)	0.8
BMI category				<0.001
Underweight (<18.5 kg/m^2), *N* (%)	22 (4)	11 (2)	7 (1.5)	
Normal weight (18.5–24.9 kg/m^2), *N* (%)	459 (75)	284 (55)	161 (35)	
Overweight (25–29.9 kg/m^2), *N* (%)	103 (17)	147 (28)	137 (30)	
Obese (≥30 kg/m^2), *N* (%)	26 (4)	76 (15)	154 (34)	
Lifetime maximum weight, mean pounds (s.d.)	157 (31)	173 (40)	195 (49)	<0.001
Number of attempts to lose weight in past year				<0.001
None, *N* (%)	465 (78)	173 (34)	52 (11)	
1–2 times, *N* (%)	87 (15)	161 (32)	111 (25)	
3–5 times, *N* (%)	14 (2)	65 (13)	71 (16)	
>5 times, *N* (%)	3 (0.5)	22 (4)	34 (7.5)	
Was trying to lose weight continuously, *N* (%)	30 (5)	87 (17)	184 (41)	

MZ, monozygotic.

[a] *P* values were calculated by Wald tests from regression models using generalized estimating equations estimation and robust s.e. to account for the clustered nature of the twin data.

Table 2

Association of Restraint Scale scores with BMI and weight change among 1,587 individual twin participants

	BMI[a]			Weight change[b]		
	Mean[c] kg/m^2	95% CI	*P* value[d]	Mean[c] pounds	95% CI	*P* value[d]
Restraint Scale Score category			<0.001			<0.001
High (>16)	27.9	(27.4–28.4)		6.9	(5.4–8.4)	
Intermediate (12≤16)	25.5	(25.2–25.8)		4.9	(4.1–5.6)	
Low (≤11)	23.0	(22.7–23.3)		2.8	(1.8–3.8)	

CI, confidence interval.

[a] Adjusted for age, gender, education, race, smoking history, and physical activity.

[b] Adjusted for age, gender, education, race, smoking history, initial BMI, and time elapsed between self-reported weights.

[c] Means are adjusted least squared means.

[d] *P* values are from linear regression using general estimating equations with robust s.e.

Table 3

Within-pair adjusted associations of differences in Restraint Scale scores with differences in BMI and weight change among 598 same-sex twin pairs

	BMI[a]			Weight change[b]		
	β	**95% CI**	***P* value[c]**	*β*	**95% CI**	***P* value[c]**
Overall	0.18	(0.12–0.24)	<0.001	0.37	(0.13–0.61)	<0.001
MZ twins (*n* = 451 pairs)	0.10	(0.04–0.17)	<0.001	0.26	(0.02–0.54)	0.06
DZ twins (*n* = 147 pairs)	0.31	(0.19–0.43)	0.001	0.48	(0.01–0.97)	0.05

CI, confidence interval; DZ, dizygotic; MZ, monozygotic.

[a] Adjusted for within-pair differences in education, smoking history, and physical activity.

[b] Adjusted for within-pair differences in education, smoking history, initial BMI, and time elapsed between self-reported weights.

[c] *P* values are from multivariate linear regression.