

Naturalistic Weight-Reduction Efforts Prospectively Predict Growth in Relative Weight and Onset of Obesity Among Female Adolescents

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This study examined the prospective relations of naturalistic weight-reduction efforts to growth in relative weight and onset of obesity with data from a community study of female adolescents ($N = 692$). Initial self-labeled dieting, appetite suppressant/laxative use, incidental exercise, vomiting for weight-control purposes, and binge eating predicted elevated growth in relative weight over the 4-year period. Dietary restraint, self-labeled dieting, exercise for weight-control purposes, and appetite suppressant/laxative use predicted an increased risk for obesity onset. Data imply that the weight-reduction efforts reported by adolescents are more likely to result in weight gain than in weight loss and suggest the need to educate youth on more effective weight-control strategies.

Adolescent obesity is associated with serious medical problems, including high blood pressure, adverse lipoprotein profiles, diabetes mellitus, coronary heart disease, atherosclerotic cerebrovascular disease, colorectal cancer, and death from all causes, as well as completion of fewer years of education, higher rates of poverty, and lower marriage rates (Dietz, 1998; Must, Jacques, Dallal, Bajema, & Dietz, 1992; Pietrobelli et al., 1998). There has been a 75% relative increase in adolescent obesity over the past 3 decades, and 25% of adolescents are currently obese (Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995). However, few prospective studies have examined the relations between naturalistic weight-reduction efforts and the subsequent development of obesity with an adolescent sample. From a public health standpoint, it would be important to know whether such efforts are successful in curtailing weight problems and preventing obesity. Thus, we examined the prospective relation of naturalistic weight-control efforts to weight change during adolescence.

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Despite the paucity of research on the relations between weight-reduction efforts and weight change during adolescence, studies of adult dieting might be used to inform this investigation. High rates of successful weight loss and maintenance have been reported among adults who engage in naturalistic dieting (e.g., Schachter, 1982). However, these investigations relied on retrospective reports and did not keep participants blinded to study hypotheses. The few investigations that used prospective blinded designs suggest either that dieting does not predict weight change over time (Heatherton, Polivy, & Herman, 1991; Klesges, Klem, Epkins, & Klesges, 1991) or that dieting predicts subsequent weight gain (French, Jeffery, & Wing, 1994; Klesges, Isbell, & Klesges, 1992; Klesges, Klem, & Bene, 1989). Dieting may promote weight gain because it leads to binge eating and increased metabolic efficiency (Klesges et al., 1992; Polivy & Herman, 1985). The fact that the studies reporting that naturalistic dieting leads to weight loss were retrospective and did not keep participants blinded, in conjunction with the fact that none of the prospective blinded studies yielded evidence that naturalistic dieting results in weight loss, implies the positive findings are an artifact of the retrospective/nonblinded design. The remaining inconsistencies between the studies suggesting that dieting results in weight gain versus no weight change appear to be due to differences in statistical power. It might be noted that the inconsistent findings are not a function of different dieting measures, sampling frames, or analytic techniques.

It is surprising that little prospective research has investigated the relations between naturalistic weight-reduction efforts and weight change during adolescence. This is a critical developmental period because the natural increases in adipose tissue associated with puberty for girls likely motivates youths to diet. Although data suggest that approximately 60% of female adolescent are currently dieting (Rosen & Gross, 1987), we know of only one study that has prospectively examined the relation between dieting and weight change during adolescence. Paralleling the adult findings, Stice (1998) found that adolescent dieting was positively related to weight gain over a 9-month period but that there was a

quadratic component to this effect wherein extreme dieting predicted weight loss. However, this preliminary study only followed adolescents for a brief period and used self-report measures of height and weight. Accordingly, the first aim of present study was to examine the relation of naturalistic dieting efforts to weight change over time. On the basis of past findings, we hypothesized that dieting efforts would show a positive relation to growth in relative weight and onset of obesity.

The second aim of this study was to examine a wider range of naturalistic weight-reducing efforts. Specifically, we explored the relation of exercise and radical weight-reduction efforts, including fasting, appetite suppressant/laxative use, and vomiting, to weight change during adolescence. Given that dieting appears to be positively related to weight gain over time, and given the similarity between these more radical weight-reduction efforts and dieting, we hypothesized that these behaviors would predict growth in relative weight and onset of obesity. Because radical weight-reduction strategies may be used to compensate for the effects of binge eating, as in bulimia nervosa, we also examined the relation between binge eating and weight change. This may shed light on the possibility that dieting is associated with increased binge eating, which might account for the positive relations between dieting efforts and weight gain. Consistent with this assertion, dieting predicted onset of binge eating (Stice & Agras, 1998; Stice, Killen, Hayward, & Taylor, 1998).

Finally, because adiposity is a result of the balance between kilocaloric expenditure, as well as kilocaloric intake, we examined the relation between exercise and weight change. Research with adults indicates that exercise is negatively related to weight gain over time (Taylor, Jatulis, Winkleby, Rockhill, & Kraemer, 1994). However, we are not aware of any prospective studies that examined the relation between naturalistic exercise efforts and weight change during adolescence. We felt that it was important to differentiate exercise aimed at weight control from more incidental exercise (e.g., some youths may walk to school), which may also impact weight. Such teens might be expected to show less weight gain than their more sedentary peers, even though the activities may not be specifically engaged in for weight-control purposes. Given that exercise results in energy expenditure and the findings from past studies with adults, we hypothesized that increased exercise for weight-control purposes and incidental exercise would predict less growth in relative weight and lower rates of obesity onset.

In sum, we investigated the relations of naturalistic dieting, exercise, radical weight-loss efforts, and binge eating to growth in relative weight and onset of obesity in an adolescent sample. We examined these two outcomes because they reflect somewhat different questions. The first reflects variations in the continuum of relative weight growth, whereas the second reflects clinically significant obesity. We hypothesized that dieting efforts, radical weight-loss tactics, and binge eating would be positively related to growth in relative weight and onset of obesity, whereas exercise efforts would be negatively related to these outcomes. We attempted to improve on past research by using a prospective design, a large sample, direct measurements of height and weight, and multiple data-collection methods (structured psychiatric interviews and self-report surveys).

Method

Participants

Participants were 692 female students from three northern California high schools who were in the 9th grade at Time 1 (mean age = 14.9, range = 13.6–17.1). We included only female participants because (a) many of the scales examined here were not administered to male participants and (b) increases in relative weight during adolescence and rates of obesity are greater for girls than for boys (Wing, 1993). Pregnant students were excluded because this condition would distort weight data. Twenty-six percent of the sample was Asian, 3% Black, 45% Caucasian, 13% Hispanic, and 5% Native American; 6% specified mixed racial heritage, and 2% specified "other." Maximum parental education (a proxy for socioeconomic status [SES]) ranged from less than high school (4%) to graduate degree (32%), which was also the mode.

Procedures

The study was presented to participants as an investigation of student health beliefs and behaviors. A passive parental consent procedure was used, resulting in a participation rate of 95%. Time 1 and three annual follow-up assessments were conducted by staff trained by the principal investigators. At each assessment, students completed a self-report questionnaire, had their weight and height measured by research assistants, and participated in a structured clinical interview. Participants were identified by a special identification number to ensure confidentiality. The data for the 692 participants examined in this study were drawn from the 920 female 9th-grade students who provided data at Time 1 and represent participants who provided height and weight data for at least two waves of measurement (the minimum number necessary for the analyses used here). Of the 226 adolescents who were excluded, 63 refused to be weighed at Time 1 and 163 dropped from the study before they provided height and weight data at another assessment. Overall, the average annual attrition rate was 15% (see Hayward, Killen, Kraemer, & Taylor, 1998, for greater detail). Most attrition was due to students moving (10%), but the remainder was due to absenteeism (3%) and refusal to participate (2%).

Measures

Dietary restraint. Participants completed the revised Restraint Scale (Heatherton, Herman, Polivy, King, & McGree, 1988). Items were averaged for analyses. Research suggests that this is a reliable and valid measure (Heatherton et al., 1988). Cronbach's alpha for the Restraint Scale was .79 in the present sample.

Self-labeled dieting. Because past studies have measured dieting according to whether people self-label themselves as dieters (e.g., Lowe et al., 1996), participants were also asked if they were currently on a diet (0 = no, 1 = yes). The temporal reliability and convergent and discriminant validity of such self-labeled dieting items has been documented (French et al., 1994; Lowe et al., 1996; Stice, 1998).

Exercise for weight control. Participants reported the frequency of exercise for weight-loss and weight-control purposes using two items (e.g., "How often do you exercise in order to lose weight?"). Seven response options ranged from "I don't exercise to lose weight" to "I exercise to lose weight once a day or more." Items were averaged for analyses. These items were similar to those recommended by Heath, Pate, and Pratt (1993) to reflect exercise for weight-control purposes. Cronbach's alpha for this measure was .81.

Incidental exercise. To assess exercise behaviors that might affect adiposity, but which were not explicitly engaged in for weight-control purposes, we included questions asking whether the youth typically walked or biked home from school (0 = no, 1 = yes). We selected these two activities because research indicates that these are two of the most common light to moderate physical activities practiced by adolescents (Heath et al.,

1993). These items had the advantage that they were not asked in specific reference to weight-reduction efforts and thus should be less susceptible to the social desirability biases found in obesity research.

Fasting. Adolescents also self-reported the frequency with which they have fasted for weight-loss purposes ("How often do you fast [stop eating completely] to control your weight?"). Seven response choices ranged from "I don't stop eating completely in order to control my weight" to "I skip at least 2 meals every day."

Appetite suppressants/laxative use. Adolescents' use of appetite suppressants, laxatives, and diuretics was assessed with a composite of items. First, two questions concerning frequency of laxative and diuretic use (e.g., "Over the past 3 months, how many times have you taken laxatives in order to control your weight or body shape?") were drawn from an adolescent adaptation of the Eating Disorders Examination (EDE), a validated structured psychiatric interview for assessing bulimia nervosa (Z. Cooper, Cooper, & Fairburn, 1989). Second, we created three self-report items assessing frequency of diet pill use, laxative use, and diuretic use (e.g., "How often do you use diet pills [Dexatrim, Dietac, Acutrim] to control your weight?"). Items used a 7-point response scale ranging from 1 (*I don't use diet pills to control my weight*) to 7 (*I use diet pills to control my weight about once a day or more*). Finally, a self-report item from the Body Shape Questionnaire (P. J. Cooper, Taylor, Cooper, & Fairburn, 1987) assessed laxative use ("Have you taken laxatives in order to feel thinner?") on a 6-point scale ranging from 1 (*never*) to 6 (*always*). Items were averaged for analyses, resulting in a Cronbach's alpha of .82.

Vomiting. The frequency of vomiting for weight-control purposes was assessed with a question from the adolescent adaptation of the EDE ("Over the last 3 months, how many times have you made yourself sick [throw up] in order to control your weight or body shape?"). Again, the EDE has been shown to have acceptable reliability and validity (Z. Cooper et al., 1989).

Binge eating. A series of questions from the adolescent adaptation of the EDE assessed the frequency of binge eating ("Over the last 3 months, about how often have you eaten a large amount of food [an eating binge] over a short period of time?") and verified that the amount of food typically consumed was large and that the episodes were accompanied by a perceived loss of control. Again, the EDE possesses adequate reliability and validity (Z. Cooper et al., 1989).

Tanner stage. Stage of pubertal development was assessed using the drawings and descriptions of Tanner stages developed by Duke, Litt, and Gross (1980). Tanner stages represent a validated assessment procedure measuring growth of breasts and pubic hair on 5-point scales (Morris & Udry, 1980). Self-reported development using drawings correspond well with physician ratings (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987). Self-reported scores for breast development and growth of pubic hair were averaged to form a single sexual maturation score.

Body mass. The body mass index (BMI) was used as a proxy measure of adiposity. The BMI divides weight by height (kg/m^2) to control for variations in weight due to height and is thus considered a measure of

"relative weight." Height was measured to the nearest millimeter using a portable direct-reading stadiometer. Students were measured without shoes and with the body positioned such that the heels and buttocks were against the vertical support of the stadiometer and the head aligned so that the auditory canal and lower rim of the orbit were in a horizontal plane. Weight was assessed to the nearest 0.1 kg using digital scales with participants wearing light clothing, without shoes or coats. At each of the four annual assessments, two measures of height and weight were obtained and averaged. The validity of the BMI is supported by the fact that it shows correlations between .80 and .90 with direct measures of total body fat, such as dual-energy X-ray absorptiometry (Goran, Driscoll, Johnson, Nagy, & Hunter, 1996; Pietrobelli et al., 1998), and correlates with health measures, including blood pressure, adverse lipoprotein profiles, atherosclerotic lesions, serum insulin levels, and diabetes mellitus in adolescent samples (Dietz & Robinson, 1998; Pietrobelli et al., 1998). The BMI is also reliable, as reflected by a 9-month test-retest coefficient of .92 in an adolescent sample (Stice, 1998). Because of the ease of assessment of the BMI, it has been recommended as the measure of choice for epidemiologic research (Kraemer, Berkowitz, & Hammer, 1990). Following Dietz and Robinson (1998), adolescent obesity was defined as a BMI exceeding 25.

Data-Analytic Plan

Preliminary analyses first examined the bivariate relations among the Time 1 naturalistic weight-reduction efforts and assessed whether there were any effects of demographic factors or sexual maturation level on weight change over time that would necessitate the inclusion of these factors as covariates in the models. Next, random regression models (Rogosa, Brandt, & Zimowski, 1982) tested whether Time 1 weight-reduction efforts predicted growth in BMI scores over time. Finally, Cox (1970) proportional hazards models examined whether Time 1 weight-reduction efforts predicted onset of obesity over the study period among initially nonobese participants.

Results

Preliminary Analyses

Attrition analyses indicated that the 692 participants who provided data had a significantly higher level of parental education than did the 226 participants who dropped from the study or refused to be weighed (accounting for 1% of the variance) but that the two groups did not differ on Time 1 age, BMI, or ethnicity. The correlations between the Time 1 predictors and BMI are presented in Table 1, along with the means and standard deviations for all of the variables. There were modest correlations between various weight-reduction efforts. The low correlation between exercise for

Table 1
Means, Standard Deviations, and Bivariate Correlations Among Predictors and Body Mass Index (BMI) at Time 1

Variable	1	2	3	4	5	6	7	8	9	M	SD
1. Restraint Scale	—	.32	.57	.04	.29	.14	.14	.20	.47	2.08	0.57
2. Self-labeled dieting		—	.32	-.04	.32	.12	.19	.16	.22	0.16	0.37
3. Exercise for weight control			—	.07	.26	.08	.08	.08	.37	3.40	2.06
4. Incidental exercise				—	.08	.11	.05	.08	.09	0.33	0.47
5. Fasting for weight control					—	.29	.29	.23	.18	1.41	1.08
6. Appetite suppressant/laxative use						—	.41	.35	.10	0.71	0.32
7. Vomiting for weight control							—	.36	.07	0.06	0.45
8. Binge eating								—	.09	0.10	0.62
9. Time 1 BMI									—	21.90	4.02

Note. $N = 692$. All correlation coefficients with an absolute value of .08 or greater are statistically significant at the .05 level.

weight loss and incidental exercise suggests that the latter questions tapped something distinct from exercise for weight-reduction purposes. Interestingly, several of the weight-reduction efforts were positively correlated with binge eating. Most of the weight-control methods showed significant positive correlations with BMI at Time 1, although there was a tendency for these effects to be stronger for dieting and exercise for weight control than for the more pathological methods. Sixteen percent of the participants reported being currently on a diet, 75% endorsed at least minimal exercise for weight-control purposes, 33% engaged in incidental exercise, 20% reported at least some fasting, 12% endorsed at least some use of appetite suppressants and/or laxatives, 3% reported vomiting, and 4% engaged in binge eating. Consistent with national data (Hammer, Kraemer, Wilson, Ritter, & Dornbusch, 1991), the average BMI score increased over time (21.9, 22.2, 22.5, and 22.9 for Times 1–4, respectively). Similarly, the rates of obesity increased over the study period (16%, 18%, 20%, and 21% for Times 1–4, respectively). Obesity showed high temporal stability, in that 90% of the initially obese participants were still obese at all subsequent assessments over the study period for which they provided data. Because research has found that SES, ethnicity, and sexual maturation level are related to relative weight during adolescence (e.g., Hammer, Wilson, et al., 1991; Troiano et al., 1995), preliminary analyses tested for these effects. Results indicated that Time 1 sexual maturity level predicted growth in BMI ($\beta = 0.09, p < .10$) and onset of obesity ($\exp\beta = 2.01, p < .05$) but that parental education and ethnicity were not significantly related to these criteria. Accordingly, all of the analyses included Time 1 sexual maturity level as a covariate.

Growth Curve Analyses

Random coefficient models tested whether Time 1 weight-reduction efforts predicted subsequent growth in relative weight over time. Annual BMI scores were used to generate individual linear slopes for each participant, representing the average BMI unit increase per year across time for each adolescent (following Rogosa et al., 1982). Growth of BMI was modeled with a linear term because girls show a general linear increase in BMI during middle to late adolescence (Hammer, Kraemer, et al., 1991). The average BMI slope in the present study was 0.44, indicating that the average female adolescent showed an increase in her BMI score by about 0.5 units per year (which corresponds to approximately 1.4 kg per year, controlling for height gains). The BMI slopes were regressed on the predictors in separate multiple regression models. Predictors were not entered simultaneously because they were intended to capture various facets of the same construct (weight-reduction efforts). All of the predictors were measured at Time 1, and Time 1 BMI and sexual maturation level were used as covariates in all of the models. Time 1 BMI was not significantly related to subsequent growth in relative weight ($\beta = -0.01, ns$), suggesting that initially overweight individuals were no more likely to gain weight than were underweight individuals. The unstandardized regression coefficients, 95% confidence intervals (CIs), and standardized regression coefficients are presented in the upper half of Table 2. Time 1 incidental exercise, appetite suppressant/laxative use, vomiting for weight-control purposes, and binge eating showed significant *positive* relations to growth in relative weight over time. In addition, Time 1 self-labeled dieting

Table 2
Bivariate Relations Between Baseline Predictors and Subsequent Growth in Relative Weight and Onset of Obesity Over the 4-Year Period

Time 1 predictor	β	95% CI for β	β
Random coefficient models predicting growth in relative weight			
Restraint Scale	0.03	-0.14 to 0.19	0.02
Self-labeled dieting	0.23	-0.03 to 0.49	0.08†
Exercise for weight control	-0.02	-0.06 to 0.03	-0.04
Incidental exercise	0.26	0.07 to 0.44	0.13**
Fasting for weight control	0.05	-0.03 to 0.12	0.05
Appetite suppressant/laxative use	0.33	0.03 to 0.63	0.10*
Vomiting for weight control	0.26	0.07 to 0.44	0.12**
Binge eating	0.24	0.02 to 0.45	0.10*
Time 1 predictor	β	95% CI for $\exp\beta$	$\exp\beta$
Cox proportional hazards regression models predicting onset of obesity			
Restraint Scale	1.07	1.74 to 4.89	2.92***
Self-labeled dieting	1.17	1.53 to 6.85	3.24**
Exercise for weight control	0.22	1.08 to 1.45	1.25**
Incidental exercise	0.03	0.53 to 2.00	1.03
Fasting for weight control	0.13	0.95 to 1.37	1.14
Appetite suppressant/laxative use	0.62	0.90 to 3.83	1.85†
Vomiting for weight control	0.14	0.80 to 1.67	1.15
Binge eating	0.07	0.71 to 1.63	1.07

Note. Random coefficient models controlled for sexual maturity level and Time 1 body mass index score. Cox proportional hazards regression models controlled for sexual maturity level and excluded initially obese participants. CI = confidence interval.

† $p < .10$ (marginally significant). * $p < .05$. ** $p < .01$. *** $p < .001$.

status showed a marginal positive relation to growth in relative weight. Because there is evidence of positive quadratic relations between dietary efforts and weight gain (Stice, 1998), we tested for such effects. However, there was only a marginal trend for a quadratic effect for appetite suppressant/laxative use. Although it was similar in form to the positive quadratic effect found in past research, wherein a positive linear relation was qualified by a downward opening curvature, this effect did not appear to be very robust because it was only a marginal trend and was present only for one predictor.

Survival Analyses

Next, we investigated the predictors of the onset of obesity using Cox (1970) proportional hazards regression analyses. This analytic technique models the time to onset of a discrete event and tests whether variables are related to a greater probability (hazard) of onset (Willett & Singer, 1993). This technique has the advantage of allowing for varying lengths of follow-up in longitudinal studies and thus minimizes biases due to attrition (Willett & Singer, 1993). Of the 692 participants, 103 had already become obese during the 14-odd years prior to study entry (16%). These adolescents were excluded from analyses to ensure a truly prospective test of the relations. Of the remaining participants, 63 experienced onset of obesity during the 4-year study. Again, the relations of the various weight-reduction efforts to the onset of obesity were examined in separate equations. All predictors were measured at Time 1, and analyses controlled for Time 1 sexual maturation level. Parameter estimates (β), Exponentials of β , 95% CIs, and significance levels from the hazard models testing the relations between Time 1 predictors and the probability, or hazard, for the onset of obesity over the study period are presented in the lower half of Table 2. Both the Time 1 Restraint Scale and self-labeled dieting significantly predicted earlier onset of obesity during adolescence. The $\exp\beta$, or risk ratio, reflects the estimated percentage of change in the hazard for the onset of obesity for each unit increase of the covariate. The risk ratio of 2.92 for the continuous Restraint Scale indicates that for each unit increase on the Restraint Scale, there was a corresponding 192% increase in the hazard for onset of

obesity. The risk ratio for the dichotomous self-labeled dieting item indicates that the hazard for the onset of obesity over the study period was 324% greater for Time 1 dieters than for Time 1 nondieters. For illustrative purposes, Figure 1 presents the cumulative hazard curves for the onset of obesity for Time 1 dieters versus Time 1 nondieters. There was also a positive significant relation between exercise for weight-control purposes and the hazard for onset of obesity. For each unit increase on the Exercise scale, there was a 25% increase in the hazard for onset of obesity over the study period. Finally, Time 1 appetite suppressant/laxative use showed a marginal positive relation to the hazard for onset of obesity. For each unit increase on the Appetite Suppressant/Laxative Use scale, there was an 85% increase in the hazard for onset of obesity over the study period. We tested for quadratic relations between the continuous predictors and the onset of obesity, but none of these effects were significant, suggesting that there were no reliable curvilinear effects in the present sample for the onset analyses.

Discussion

This study tested whether naturalistic weight-reduction efforts predicted growth in relative weight and onset of obesity during adolescence. Elevated incidental exercise, appetite suppressant/laxative use, vomiting, and binge eating prospectively predicted greater growth in relative weight over the study period. There was also a marginal trend for Time 1 self-labeled dieters to show an elevated growth in relative weight relative to Time 1 nondieters. In addition, elevated restraint scores and exercise for weight control, as well as Time 1 self-labeled dieting, predicted an increased hazard for onset of obesity over the study period. Time 1 appetite suppressant/laxative use also showed a marginally significant positive relation to the hazard for obesity onset. The confidence that can be placed in these findings is bolstered by the fact that we collected direct measures of height and weight, rather than relying on self-reports. Moreover, because predictors were assessed using surveys or structured psychiatric interviews, whereas height and weight were directly measured by research assistants, the possibility that method variance or reporter bias explains the findings is reduced. The longitudinal design, wherein the Time 1 weight-reduction efforts were used to predict growth in relative weight and obesity onset over the study period, permits stronger inferences about the direction of effects. Nonetheless, the nonexperimental nature of this study precludes causal inferences because it is not possible to rule out third-variable explanations that could account for the effects (e.g., a genetic propensity to obesity).

The most striking finding was that elevated dieting and radical weight-loss efforts predicted greater subsequent growth in relative weight and an elevated hazard for onset of obesity. When interpreting these results, it should be noted that analyses controlled for initial body mass. Thus, it is not simply the case that initially overweight individuals reported greater weight-loss efforts because of legitimate health concerns or demand characteristics and then proceeded to gain more weight over time. Results indicated that controlling for initial body mass, those adolescents who reported elevated dieting and radical weight-loss efforts were more likely to gain weight than those who did not report these efforts. Although these findings appear counterintuitive, they converge

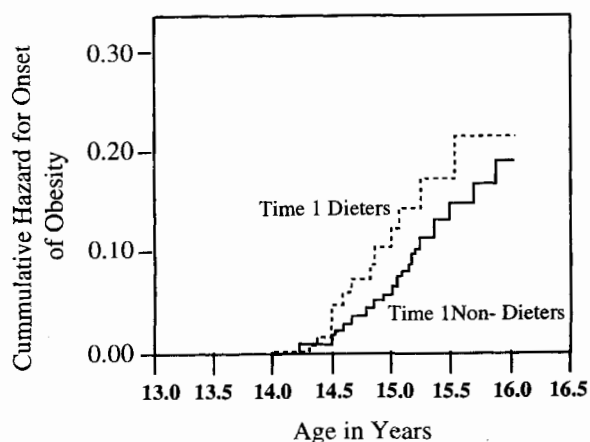


Figure 1. Cumulative hazard curves for the onset of obesity for Time 1 self-labeled dieters versus Time 1 self-labeled nondieters.

with results from prospective studies indicating that dieting predicts weight gain in adulthood (French et al., 1994).

The evidence that exercise for weight-control purposes predicted increased growth in relative weight and that incidental exercise predicted a greater risk for obesity onset was novel, as little research has investigated these relations during adolescence. Although the positive relations between exercise and weight gain were not consistent with expectations or prior findings with adults (Taylor et al., 1994), they did mirror the results for other weight-reduction efforts, such as dieting and radical weight-loss efforts. Nevertheless, there is some possibility that exercise was positively related to growth in BMI because it led to higher bone density or muscle mass, both of which could also result in increased BMI scores.

There are at least two possible accounts for these positive findings. First, the need to reconcile the positive relations between naturalistic weight-reduction efforts and subsequent weight gain reported here with the evidence from controlled obesity treatments indicating that low-calorie diets and regular exercise result in weight loss (e.g., Epstein, Wing, Penner, & Kress, 1985) suggests that naturalistic weight-reduction efforts reported by adolescents may not reflect decreased caloric intake and increased exercise. These youths may perceive that they are dieting or exercising at therapeutic levels when in fact they are not. This account is also compatible with the assertion that weight-reduction efforts result in an elevated risk for the onset of binge eating and subsequent weight gain (Polivy & Herman, 1985). Indeed, the evidence that dieting predicted binge eating onset (e.g., Stice et al., 1998) and that binge eating predicted greater growth in relative weight in the present data is consistent with this possibility. Blundell (1995) argued that dieting results in an erratic delivery of nutrients with aberrant triggering of physiological responses, which leads to a desynchronization between behavior and physiology. This dysregulation of the normal appetite system is thought to promote weight gain because biological regulatory processes oppose underconsumption but not overconsumption. Elevated exercise may similarly create a negative energy balance, which increases the risk for binge eating and consequent weight gain. Weight-reduction efforts may also result in increased metabolic efficiency (Klesges et al., 1992), which could promote weight gain.

A second explanation for our findings is that endorsement of naturalistic weight-reduction efforts serves as a marker for a propensity to become obese. Perhaps individuals with a family history of obesity have already initiated weight-control efforts because they are concerned that they will follow in the footsteps of their parents. Alternatively, endorsement of naturalistic weight-reduction efforts may signal a steep weight-gain trajectory that preceded study entry and continued despite the use of weight-control efforts. Although the fact that we controlled for Time 1 body mass decreases the possibility that initial weight explains the results, we did not assess the weight-change history preceding study entry. Such a steep weight-gain trajectory may be driven by a tendency to overeat, which might motivate the individual to report elevated weight-control efforts. It would be useful for future research to explore these possibilities. However, it will be necessary to use randomized experiments to make definitive conclusions regarding these relations.

The results also indicated that initial binge eating predicted growth in relative weight. Although this may seem an obvious

consequence of binge eating, this is a novel finding. It has long been accepted that obese individuals do not consume more food than nonobese individuals on the basis of self-report and observational data from numerous studies. However, this position has been challenged with the advent of blinded strategies to assess caloric intake. Specifically, the introduction of doubly labeled water (Schoeller, 1988), an isotope-based technique that accurately measures 24-hr energy expenditure, has raised serious questions about the veracity of self-reported caloric intake. Research indicates that obese individuals underreport caloric intake by approximately 30% to 35%, which is significantly greater than the underreporting observed in nonobese individuals (Mertz et al., 1991). Similarly, Klesges, Eck, and Ray (1995) found that 31% of individuals reported a caloric intake that was below the minimal needs for survival and that this effect was significantly more pronounced for obese individuals. Our data similarly suggest that when you reduce the potential for reporter bias (by keeping participants blinded), it is possible to find evidence that overeating is a risk factor for subsequent weight gain.

It is noteworthy that the predictors of growth in relative weight were somewhat different than the predictors of obesity onset. There were two differences in the analyses that might have contributed to this state of affairs. First, the survival analyses, but not the growth curve analyses, excluded initially obese individuals. However, when initially obese individuals were also excluded from the growth curve models, the differential findings were not resolved. Second, the growth curve analyses, but not the survival analyses, used initial BMI scores as a covariate. Yet when the survival analyses were reestimated, including initial BMI as a covariate, only one of the inconsistent findings was resolved. Thus, differences in the analyses cannot account for the divergent findings. The differential results are likely due to the fact that the two analyses address different questions: The first assesses the predictors to variations in the continuum of relative weight growth and the second explores the predictors of the onset of clinically significant obesity. In general, radical weight-loss efforts were somewhat more specific to normative growth in relative weight. In contrast, common weight-loss behaviors appeared to be somewhat more specific to onset of obesity. Perhaps common weight-loss approaches, because they are practiced on a regular basis, are more likely to dysregulate the appetite system and result in significant weight gain than are less frequently practiced radical weight-control behaviors, such as vomiting.

It is curious that there was evidence of quadratic relations between dietary efforts and weight gain in a study by Stice (1998) but that there was only a trend for such an effect in the present data. The most likely explanation for this inconsistency is that because the present analyses thoroughly controlled for Time 1 weight, the analyses were more stringent, and it was thus harder to detect higher order effects. Collectively, these results suggest that the quadratic component to the positive relation between dietary efforts and weight gain may not be robust. However, it is possible that the measures examined herein did not capture extremely high levels of dietary behaviors as well as did the measures in the Stice study. It might be useful for future studies to examine this possibility.

The lack of ethnic differences in growth in relative weight and onset of obesity in this study appear to be at odds with cross-sectional research reporting ethnic differences in adolescent obe-

sity (e.g., Troiano et al., 1995). The absence of ethnic differences in the present study is likely due to the fact that there was inadequate statistical power to detect such effects because of the relatively small number of adolescents in high-risk ethnic minority groups (e.g., Blacks).

Although this study improved on past research by using a prospective design, multiple data-collection methods, and direct measures of height and weight, there were limitations. First, the nonexperimental nature of this study precludes causal inferences. Second, although the BMI is the recommended measure of adiposity in epidemiologic research, it can reflect elevations in other aspects of body composition rather than adipose tissue, such as muscle mass. Third, the fact that 7% of the participants refused to be weighed limits the generalizability of these findings because this may be the group that is most overweight or eating disordered. Finally, some of the measures were created for this study and possess limited evidence of reliability and validity (e.g., the incidental exercise measure).

In terms of research implications, future studies should explore the processes that explain the relation between naturalistic weight-reduction efforts and increases in relative weight. Research might test whether the positive findings resulted because weight-reduction efforts lead to binge eating/increased metabolic efficiency or because the endorsement of weight-control behaviors serves as a marker for a propensity to become obese. However, randomized prevention trials that curtail these weight-reduction efforts should be used to provide experimental evidence regarding the relation between these efforts and future weight gain. Although prospective studies are an improvement over retrospective investigations, because they cannot rule out third-variable explanations, it will be important to triangulate the findings with randomized experiments to advance our understanding of the etiology of obesity. If randomized experiments ultimately confirm that naturalistic weight-control efforts result in weight gain over time, these findings could be used to dissuade youths from engaging in ineffective dieting, which may help prevent the onset of both obesity and eating pathology.

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