

# Weight Suppression Predicts Time to Remission From Bulimia Nervosa

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**Objective:** To investigate whether, at study entry, (a) weight suppression (WS), the difference between highest past adult weight and current weight, prospectively predicts time to first full remission from bulimia nervosa (BN) over a follow-up period of 8 years, and (b) weight change over time mediates the relationship between WS and time to first full remission. **Method:** A well-characterized sample of women with BN ( $N = 110$ ;  $M$  age = 25.58 years,  $SD = 6.48$ ) from the Massachusetts General Hospital Longitudinal Study of Eating Disorders was interviewed at 6–12 month intervals over 8 years. The main outcome measure, a “time to first full remission” variable, was based on psychiatric status ratings generated from the Eating Disorders Longitudinal Interval Follow-up Evaluation. **Results:** WS was significantly associated with time to first full remission ( $p = .01$ ; hazard ratio = .89; 95% confidence interval [0.82, 0.97]), indicating that women who were more weight suppressed at study entry took longer to recover. Weight change did not mediate the relationship between WS and time to remission. **Conclusions:** Results add to a growing body of evidence that WS predicts maintenance of BN symptoms and extend previous short-term findings by demonstrating, over a period of approximately 8 years, that WS predicts longer time to first full remission. Beyond absolute weight status, WS level may significantly inform the treatment of BN.

**Keywords:** bulimia nervosa, weight suppression, remission, outcome

Weight suppression (WS) refers to the difference between highest past weight (since reaching adult height) and current weight. WS levels are elevated in those with bulimia nervosa (BN); outpatients and inpatients had mean WS levels of 9.6 kg and 12.0 kg, respectively, in two studies (Butryn, Lowe, Safer, & Agras, 2006; Lowe, Davis, Lucks, Annunziato, & Butryn, 2006). Because the average

body mass index (BMI) of individuals with BN is in the normal weight range, this suggests that many individuals with BN were once overweight. This conclusion is consistent with past findings (Fairburn, Welch, Doll, Davies, & O'Connor, 1997) and with data showing that roughly one third of one sample and one half of another sample with BN had previously been more than 15% overweight (Garner &

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Fairburn, 1988). In contrast, only 12% of adolescents were overweight during the same time period ("Update," 1997).

It is widely known that obese individuals usually regain weight they lose, but the fact that most individuals with BN have undergone large weight losses in the past, which might similarly make them susceptible to weight regain, has been overlooked. Because WS is positively related to binge eating (Lowe, Thomas, Safer, & Butryn, 2007) and is negatively related to metabolic rate (Stice, Durant, Burger, & Schoeller, 2011), BN individuals with elevated WS may be caught in a biobehavioral bind. Weight loss may reduce feelings of fatness but may also increase binge eating, purging, and metabolic efficiency, leading to weight gain, renewed dieting, and further cycles of binge eating and purging. WS in those with BN predicts weight change over 5 years (Herzog et al., 2010) and increased likelihood of maintaining bulimic symptoms over 10 years (Keel & Heatherton, 2010).

In sum, WS has been found in both cross-sectional and prospective studies to be related to a number of problematic aspects of BN. Furthermore, in these studies, the predictive effects of WS have remained unchanged when a variety of relevant covariates (e.g., dieting frequency, current BMI, weight and shape concerns) have been considered. These findings suggest that WS per se may prolong the duration of the disorder. However, no study has examined the relationship between WS and long-term persistence of full-syndrome BN. If WS does predict remission from BN, it could be because those highest in WS need to gain more weight to reduce biobehavioral pressures maintaining the disorder. Therefore, we also tested whether weight gain between entrance to the study and time to remission mediated any relationship between WS and remission. Novel features of this study include its much longer duration of follow-up, its focus on a treatment-seeking sample, and its frequent assessment of body weight and clinical status. On the basis of previous research findings that higher WS predicts binge eating and weight gain, we predicted that greater WS at study entry would predict a longer time period until full remission from BN occurred.

## Method

### Participants

Between October 1987 and June 1990, the Massachusetts General Hospital (MGH) Longitudinal Study of Eating Disorders recruited participants from MGH and other treatment centers in Boston, MA. Details about the derivation of our final sample of 246 women are provided in Herzog et al. (1999).

Participants were originally selected using the criteria from the third edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 1980)* and were reclassified using the fourth edition of the *DSM (American Psychiatric Association, 1994)*. The sample comprised 51 women with anorexia nervosa (AN) restricting subtype, 85 women with AN binge-eating/purging subtype, and 110 women with BN. (See Herzog, Keller, Sacks, Yeh, & Lavori, 1992, for details about the sample and study procedures.)

### Procedure

Participants were interviewed for follow-up assessments in person when possible or by telephone at 6–12 month intervals over a

mean and median of 8.6 and 9 years, respectively. Intake assessments included current and lifetime Axis I disorders and current and past eating disorder symptomatology, as well as measurement of participants' height to the nearest half-inch using a calibrated stadiometer and weight to the nearest half-pound using a balance beam scale.

This study was approved by the MGH Institutional Review Board, and written informed consent was obtained from all participants.

### Measures

At intake, a modified version of the Schedule for Affective Disorders and Schizophrenia—Lifetime Version (Spitzer & Endicott, 1979), which included a section from the Diagnostic Interview Schedule (Robins, Helzer, Croughan, & Radcliff, 1981) with criteria for AN and BN, was used to assess current and lifetime psychiatric diagnoses. The Eating Disorder Inventory questionnaire (Garner, Olmstead, & Polivy, 1983) provided self-reported highest and lowest past weight since reaching adult height (phrased to exclude pregnancy). Research suggests that women with BN, unlike healthy controls, show little bias in self-reports of current height and weight (Doll & Fairburn, 1998), which may indicate that these women also show little bias in self-reports of recalled past weights. Indeed, a prior study (Herzog et al., 2010) using the present data set found among 82 women, who agreed to provide self-reported weight in addition to being weighed by the assessor, that the mean discrepancy between the two was 0.02 kg ( $SD = 2.68$ ). The validity of recalled past weights has been supported by a study that found a correlation of 0.92 between highest measured premorbid weight from school records and highest recalled premorbid weight in adolescents with AN and BN (there were no differences between diagnostic groups; Swenne, Belfrage, Thurjell, & Engström, 2005). WS was calculated by subtracting participants' measured current weight in pounds at study entry from their self-reported highest past weight in pounds (since reaching their adult or current height). The weights of those with active BN usually fall between their highest and lowest reported adult weights; therefore, we also calculated weight rebound (WR) by subtracting participants' self-reported lowest past weight from their measured current weight for use in covariance analyses.

During follow-up, participants were interviewed with the Longitudinal Interval Follow-up Evaluation—Eating Disorders Version (LIFE-EAT II), a modified version of the LIFE II interview (Keller et al., 1987). This instrument yielded weekly psychiatric status rating (PSR) scores (ordinal, symptom-oriented scale scores based on Research Diagnostic Criteria [RDC] ratings; Spitzer, Endicott, & Robins, 1988) for both AN and BN over the 13 weeks preceding the assessment. Scores range from 0 to 6, where 0 = no history of the disorder, 1 = a past disorder with no current symptoms, 2 = residual symptoms (e.g., minor eating disorder cognitions without current behavioral symptoms), 3 = partial symptoms (i.e., does not meet full criteria), 4 = marked symptoms (just misses full criteria), and 5 and 6 = full criteria, depending on symptom severity or degree of impairment (e.g., for BN, a 5 indicated binge eating/compensatory behaviors two or more times a week, and a 6 indicated daily binge eating/compensatory behaviors).

The PSR scores were used in the present study to determine when participants reached full remission from BN. Full remission is defined as the absence of symptoms or the presence of only residual symptoms for at least 8 consecutive weeks (PSR of 1 or 2). Time to first full remission was the amount of time that transpired before a participant first received a score of 1 or 2 for 8 consecutive weeks.

A rigorous training program for interviewers involved (a) learning the RDC nosological categories, (b) conducting mock interviews, (c) observing and scoring training tapes of senior interviewers and resolving any deviations, (d) observing actual interviews, and (e) conducting interviews under the observation of a senior interviewer. A semiannual monitoring and recertification program for interviewers was implemented to ensure high interrater reliability.<sup>1</sup> Further details about interviewer training and supervision methods can be found in Herzog et al. (1992).

Participants contributed person-time in all included models until they became pregnant, remitted, or requested to no longer participate in the study. A total of 29 participants became pregnant during the follow-up period, but only six women became pregnant before their first remission or the date of pregnancy was unknown, and results of analyses excluding these six women did not differ from those including them. Overall, there were only 12 BN participants who requested to no longer participate in the study (10.9%); of these, eight reached full remission status before requesting to no longer participate. Thus, attrition was only relevant for four participants in the full remission models. One participant was excluded from all analyses because she underwent bariatric surgery.

## Statistical Analysis

Cox proportional hazards (CPH) models were used to assess the effect of WS on time to first remission. Transformations of the WS variable were performed, including analyzing WS as a continuous variable, taking a square-root transformation, and dichotomizing as the presence of nonzero WS. The most appropriate variable transformation was chosen based on model fit and lack of violation of the proportional hazards assumption. Models were further adjusted for potentially confounding covariates, including age, baseline weight, and highest weight. Time-dependent CPH models were used to examine the mediating role of weight change on the association between WS and time to remission. Hazard ratios (HRs) with 95% confidence intervals (CIs) and their associated *p* values were estimated.

## Results

Sample characteristics of BN study participants at study entry are presented in Table 1. A square-root transformation of the WS variable was most appropriate in terms of both model fit and avoiding violation of the proportional hazards assumption. Results using this transformation are the focus of this article, although the direction and significance of most associations are consistent with the nontransformed models.

Root-transformed WS was significantly associated with time to first full remission ( $p = .01$ ). The HR is 0.89 (95% CI [0.82, 0.97]), indicating that more weight-suppressed individuals took longer to recover. Survival curves comparing time to first full remission of participants by tertiles of WS are presented in Figure

Table 1  
*Sample Characteristics of Bulimia Nervosa Participants at Study Entry*

Characteristic	<i>M (SD)</i>
Age (years)	25.58 (6.48)
Duration of bulimia nervosa (years)	6.13 (6.34)
Weight (lb)	138.18 (20.72)
Weight suppression (lb)	24.41 (27.72)
Highest past weight (lb)	162.59 (35.31)
Lowest past weight (lb)	116.68 (12.49)

1. The tertile WS cutoffs were at 9 lb and 25 lb, respectively. By tertiles, the median times to first full remission were 1.00, 1.29, and 3.12 years, respectively. The effect of tertile membership on time to first full remission is statistically significant,  $\chi^2(2, N = 110) = 6.8, p = .034$ , and a comparison of the lower two tertiles with the highest tertile indicated a significantly longer time to first full remission for the upper tertile group,  $\chi^2(1, N = 110) = 6.5, p = .011$ . This pattern is consistent with the use of a root transformation in the CPH model.<sup>2</sup>

Age, highest past weight, baseline weight, and WR were tested as covariates, and results from these models are presented in Table 2. With the inclusion of these covariates in models with root-transformed WS, the association between WS and time to first full remission only changed marginally and remained significant at the  $p < .05$  level in all models. Age, highest weight, baseline weight, and WR were not significantly associated with time to first full remission in models including WS ( $p = .51, .93, .80$ , and  $.29$ , respectively).<sup>3</sup>

Additionally, the effect of weight change at follow-up was included in time-dependent CPH models to examine whether this affected the association between WS at baseline and time to first full remission. Weight change itself was not associated with time to first full remission (HR = 1.00,  $p = .85$ ) while root-transformed WS remained significant (HR = .88,  $p = .01$ ). Testing an interaction between weight change and WS, the main effect of WS remained statistically significant (HR = .88,  $p = .007$ ) while the interaction was not (HR = 1.00,  $p = .73$ ).

<sup>1</sup> Three measures of rater agreement were performed: kappa, percent agreement, and interclass correlations. Interviewers were required to achieve a kappa of at least 0.6; otherwise, retraining was instituted. Interviewers demonstrated high reliability with 90% agreement and a .94 intraclass correlation coefficient for BN.

<sup>2</sup> We also examined WS as a predictor of time to first partial remission, which was defined as a PSR score of 3 or 4 for at least 8 consecutive weeks, and similar results were obtained: The root-transformed model yielded an HR of 0.88 (95% CI [0.82, 0.96],  $p = .002$ ), and results indicated a significantly longer time to first partial remission for the group in the highest tertile of WS,  $\chi^2(1, N = 110) = 7.1, p = .008$ .

<sup>3</sup> Further analyses investigated possible effects of current or past obesity status. There were four participants whose BMI was over 30 at baseline; results of analyses excluding these individuals or controlling for obesity status did not change results (root-transformed WS; HR = 0.89, 95% CI [0.82, 0.98],  $p = .014$ ; HR = 0.89, 95% CI [0.82, 0.97],  $p = .01$ , respectively). Exclusion of these four individuals did not affect tertile comparison analyses. Similarly, 22 participants had a history of obesity (highest BMI > 30), and adjusting for this history did not affect results (root-transformed WS; HR = 0.89, 95% CI [0.80, 0.98],  $p = .02$ ).

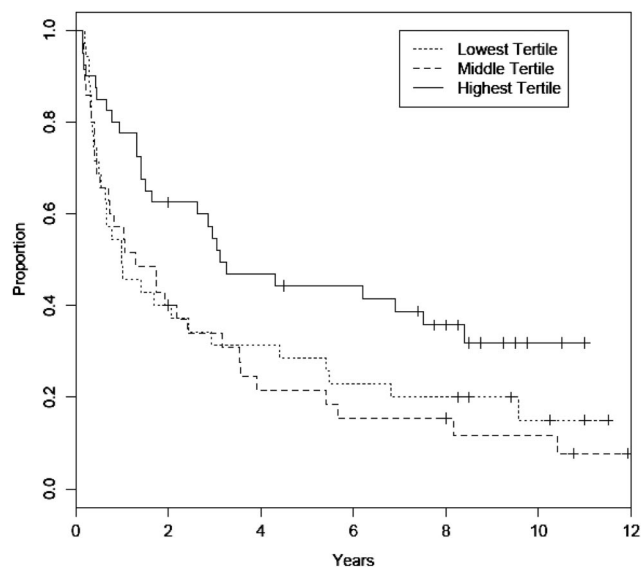


Figure 1. Cumulative survival plots of weight suppression and time to first full remission from bulimia nervosa. Weight suppression tertile membership cutoffs were at 9 lb and 25 lb. The effect of tertile membership on time to first full remission is statistically significant ( $p = .034$ ). Women in the highest tertile demonstrated a significantly longer time to first full remission compared to women in the lower tertiles ( $p = .011$ ). The vertical hash marks indicate that a participant has been censored (either dropped out or was lost to follow-up).

## Discussion

Highly weight-suppressed individuals took longer to recover than their less weight-suppressed peers. WS continued to predict likelihood of achieving full remission after controlling for age, baseline weight, and highest past weight. Moreover, neither the difference between lowest and current weight (WR) nor the constituents of WS (current body weight and highest past weight) provided useful information about recovery from BN. Weight gain did not mediate the predictive effects of WS measured at baseline, but future research should examine whether measuring WS as a time-varying covariate might predict time to remission. These results add to the growing body of evidence that magnitude of WS predicts maintenance of bulimic symptoms (Butryn et al., 2006; Keel & Heatherton, 2010). The current study extends these findings by demonstrating that WS predicts longer time to first remission among a treatment-seeking sample over a period of 8 years. The present results, those of Butryn and colleagues (2006), and

those of Keel and Heatherton (2010) are similar despite the use of different samples, measures, covariates, and follow-up periods.

Examination of Figure 1 indicates that the predictive power of WS was more potent for women in the upper WS tertile than those in the bottom two tertiles. This may indicate that there is a WS threshold that, when crossed, rapidly intensifies the pathological impact of WS on BN. Given that a threshold of 25 lb separated the upper tertile from the bottom two tertiles in the present study, such a threshold might exist in the range of 20–30 lb of WS.

Future research should examine how WS might impede recovery from BN. For example, WS might interfere with a patient's ability to comply with therapeutic procedures. A central component of cognitive behavioral therapy (CBT), which is currently the most effective treatment for BN, is the introduction of a regular pattern of eating in which patients begin to eat three planned meals and two planned snacks each day (Fairburn, 2008). Patients who begin treatment with high levels of WS might find it more difficult to accomplish this goal without losing control of their eating or gaining weight. The weight gain experienced by highly weight-suppressed patients as they tried to normalize their eating might explain why they were found to be more likely than their less weight-suppressed peers to drop out of CBT treatment (Butryn et al., 2006).

The results of the current study imply that gathering weight history information from patients at the beginning of treatment may inform the therapist about the course of the disorder. Because highly weight-suppressed individuals may have more difficulty normalizing their eating patterns (Butryn et al., 2006), knowledge of WS levels may allow for anticipation of this obstacle. To encourage compliance, patients are sometimes told that treatment generally has little effect on body weight in the short term (Fairburn, 2008). Although this is true on average for those who complete trials of CBT, awareness of a patient's level of WS might help clinicians identify patients at risk for weight gain and prepare patients for the possibility of weight gain over time.

Strengths of this study include the use of structured diagnostic interviews, regular assessment of eating disorder symptoms over a long-term period of follow-up, and low rate of attrition. However, this is a treatment-seeking sample of women with BN who were predominantly Caucasian (only 4% of the sample identified as non-Caucasian).

The current findings, in combination with previous research, suggest that high WS may create a biobehavioral bind that fuels binge eating, reduces 24-hr energy expenditure and makes weight gain more likely. They provide further support for the relevance of WS in the understanding and treatment of BN and highlight the

Table 2  
Models Including Root-Transformed Weight Suppression and Covariates

Time to first full remission	Model 1: Unadjusted model	Model 2: WS + age	Model 3: WS + highest past weight	Model 4: WS + baseline weight	Model 5: WS + WR
HR of WS [95% CI]	0.89 [0.82, 0.97]	0.90 [0.82, 0.98]	0.89 [0.80, 0.99]	0.89 [0.82, 0.97]	0.90 [0.93, 0.99]
$p$	.01	.016	.029	.01	.022
HR of covariate [95% CI]		0.99 [0.96, 1.02]	1.00 [0.99, 1.01]	1.00 [0.99, 1.01]	1.01 [1.00, 1.02]
$p$		.507	.932	.80	.29

Note. WS = weight suppression; WR = weight rebound; HR = hazard ratio; CI = confidence interval.

predictive importance of the discrepancy between highest past weight and current weight independent of current weight, lowest weight, or highest weight alone. Future research should investigate time-varying WS and how it might predict time to remission from BN. In addition, further study should explore methods of improving treatment outcome for highly weight-suppressed individuals with BN.

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