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Irregular Menses Linked to Vomiting in a Nonclinical Sample: Findings from the National Eating Disorders Screening Program in High Schools

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Abstract

Purpose—Using data from an eating disorders screening initiative conducted in high schools across the United States, we examined the relationship between vomiting frequency and irregular menses in a nonclinical sample of adolescent females.

Methods—A self-report questionnaire was administered to students from U.S. high schools participating in the National Eating Disorders Screening Program in 2000. The questionnaire included items on frequency of vomiting for weight control in the past 3 months, other eating disorder symptoms, frequency of menses, height, and weight. Multivariable regression analyses were conducted using data from 2791 girls to estimate the risk of irregular menses (defined as menses less often than monthly) associated with vomiting frequency, adjusting for other eating disorder symptoms, weight status, age, race/ethnicity, and school clusters.

Results—Girls who vomited to control their weight one to three times per month were one and a half times more likely (risk ratio [RR] = 1.6; 95% confidence interval [CI] = 1.2–2.2), and girls who vomited once per week or more often were more than three times more likely (RR = 3.2; 95% CI = 2.3–4.4), to experience irregular menses than were girls who did not report vomiting for weight control. Vomiting for weight control remained a strong predictor of irregular menses even when overweight and underweight participants were excluded.

Conclusions—Our study adds to the evidence that vomiting may have a direct effect on hormonal function in adolescent girls, and that vomiting for weight control may be a particularly deleterious component of eating disorders.

Keywords

Eating disorders; Vomiting; Purging; Adolescence; Female; Menses; Menstrual dysfunction

Adolescence is a critical period for growth and development, requiring healthful nutrition to maintain proper bodily function [1]. Adolescence is also the developmental period coinciding with onset of eating disorder pathology, with median age of onset estimated to be between 18 and 21 years old [2]. The lifetime prevalence estimates for anorexia and bulimia nervosa in females in the United States are .9% and 1.5%, respectively [2]. Prevalence is estimated to be as much as 10–20 times higher in community samples [3,4] when including disordered weight control behaviors not necessarily meeting the clinical criteria for an eating disorder diagnosis. In 2005, the Youth Risk Behavioral Surveillance System (YRBSS), the Center for Disease Control and Prevention national survey of nearly 14,000 high school students, found that 6.3% of girls reported vomiting or taking laxatives in the past month to lose or maintain weight [5]. In a statewide survey of more than 40,000 Minnesota adolescent girls, 8.8% reported vomiting to lose or control their weight in the past year [6].

Eating disorder pathology has been closely associated with irregular menstrual function [7–9]. Individuals with anorexia and bulimia nervosa are at increased risk for developing physiologic and endocrine disturbances, including primary or secondary amenorrhea and menstrual dysfunction caused by severe weight loss and/or malnutrition [10]. Amenorrhea is a diagnostic criterion of anorexia nervosa in females and is thought to result from malnutrition-induced alterations in gonadotropin secretion, particularly luteinizing hormone (LH) [11]. Amenorrhea can also occur in healthy-weight females with bulimia nervosa [12], but oligomenorrhea is more common. Oligomenorrhea occurs within the range of 37–64% of women diagnosed with bulimia nervosa [13,14] and has been linked to extremely low [15] or high [1] body mass index (BMI), excessive exercise [10], and other eating disorder psychopathology [10].

Little is known about the relationship between vomiting for weight control and disruption of menses in females who do not meet diagnostic criteria for an eating disorder. Most research on the topic has been carried out with clinical samples of females with known anorexia or bulimia nervosa [14,16,17]. In one community-based study of high school students, Johnson and Whitaker examined the behavioral correlates of secondary amenorrhea in 2544 girls aged 13–18 years and found a positive association between secondary amenorrhea and multiple binge-eating behaviors in combination with laxative use or self-induced vomiting [18].

We carried out the present analyses using data from the National Eating Disorders Screening Program (NEDSP) [19], conducted in high schools nationwide, to examine the relationship between vomiting frequency and irregular menses in a nonclinical sample of adolescent females. In addition we sought to estimate the unique association of vomiting frequency with menstrual irregularity independent of the effects of other eating disorder symptoms, underweight, and overweight on menstrual function.

Methods

The national nonprofit organization, Screening for Mental Health, that led the initiative sent notices to high schools across the country inviting them to participate in the one-time screening program in 2000. Of the 270 public, private, and parochial schools that enrolled in NEDSP, 152 high schools from 34 U.S. states administered the screening instrument to their students. Of these participating schools, 98 returned completed screening forms for data analysis by Screening for Mental Health. Further details about NEDSP are reported elsewhere [19].

The NEDSP screening questionnaire was administered to students in classrooms and assemblies. The instrument included the Eating Attitudes Test (EAT-26), a validated eating

disorders screening tool with a possible range of 0–78 (highly symptomatic) and a threshold of ≥ 20 considered evidence of a probable eating disorder [20]. The NEDSP questionnaire also included an item assessing vomiting to control weight and exercising to lose or control weight in the past 3 months, with the following response options: never, less than one time per month, one to three times per month, once per week, two to six times per week, once per day, and more than once per day. The item assessing vomiting to control weight was adapted from one used as part of the Youth Risk Behavioral Surveillance System survey from the Centers for Disease Control and Prevention [21]. Girls responding to the NEDSP questionnaire were also asked about the frequency of menses with the question: “How often do you get your period?” with the following response options: have not begun my period, monthly, every other month, less than every other month, only a few times in the past year. The questionnaire also included items on height, weight, race/ethnicity, and grade.

Because of cost constraints, only a subset of the more than 35,000 screening forms received from participating high schools could be included in the data entry. Therefore to ensure that the analytic sample was representative of the larger number of completed screening forms, forms were selected for data entry based on a two-stage, clustered sampling protocol. First, of the 98 schools that returned screening forms, 33 schools were randomly selected. Second, a random sample of screening forms was selected from the schools proportionate to the total number of forms the school provided. All surveys received from eight schools were included in the total rather than a proportionate subset as a result of a protocol change at the data entry site; therefore weighting was used in analyses to account for the oversampling of surveys from these schools. A total of 5740 screening forms from female and male students were included in the study database.

Variables and data analysis

Total scores on the EAT-26 were calculated, and scores for participants missing just one or two items ($n = 199$) were rescaled to correspond to the full range of total scores (0–78) when all items are completed. Because scores were skewed toward the high end of the range, EAT-26 scores were categorized in six levels: 0 to <10 , 10 to <20 , 20 to <30 , 30 to <40 , 40 to <50 , and ≥ 50 . Vomiting frequency to lose or control weight during the past 3 months was categorized into three groups: none, less than once per week, and once per week or more. Irregular menses was defined as periods less often than monthly in the past year. Girls who were aged ≥ 15 years who had not yet reached menarche were included in the irregular menses group ($n = 18$).

Self-reported height and weight were used to calculate BMI (kg/m^2). Categorical cutoffs were coded using standards developed by the International Obesity Task Force (IOTF) for overweight, which has established age- and gender-specific BMI values for children aged <18 years that correspond to a BMI of 25 at age 18 years [22], as well as recent standards developed by Cole et al [23] for thinness, which define age- and gender-specific BMI values for children aged <18 years that correspond to a BMI of 18.5 at age 18 years. We categorized participants into four weight status groups: low BMI (age- and gender-specific BMI corresponding to a BMI <18.5 at age 18 years); low-moderate BMI (age- and gender-specific BMI corresponding to a BMI of 18.5 to <22 at age 18); moderate BMI (age- and gender-specific BMI corresponding to BMI of 22 to <25 at age 18); and high BMI (age- and gender-specific BMI corresponding to BMI ≥ 25 at age 18). To calculate age- and gender-specific values corresponding to a BMI of 22 at age 18, we extrapolated from the age- and gender-specific BMI values corresponding to 18.5 and 25 at age 18. Centers for Disease Control and Prevention guidelines for defining implausible heights and weights (age- and gender-specific z -score values less than -6 or more than $+6$) and BMI (age- and gender-specific z -score values less than -4 and more than $+5$) were used to exclude implausible

values [24]. The exercise variable was dichotomized as exercising more often than once daily in the past 3 months to lose or control weight versus less often.

Completed NEDSP questionnaires from 3307 girls were included in the database. Respondents were excluded from analyses if they were missing more than two items on the EAT-26 ($n = 21$), missing age ($n = 51$), missing information on vomiting ($n = 26$) to control weight, missing height, weight, or reported implausible values ($n = 347$), or missing information on menstrual frequency ($n = 52$). In addition girls who were aged <15 years and reported that they had not yet reached menarche were excluded ($n = 19$), as the age of 15 is a diagnostic age threshold for primary amenorrhea [25]. The analytic sample included 2791 girls, comprising 84.4% of the original female sample.

We conducted multivariable regression using the modified Poisson method [26] to estimate risk ratios (RR) and 95% confidence intervals (CI) for irregular menses associated with vomiting frequency and EAT-26 score, controlling for age, race/ethnicity, weight status, and exercising more often than once per day to control weight in the full sample of girls. Risk ratios are preferred over odds ratios for binary outcomes when the prevalence of the outcome exceeds 10%. In secondary analyses, because we were concerned about the possibility that residual confounding by either low body fat or high body fat may bias the observed relationships between eating disorder symptoms and menstrual irregularity, we tested the multivariable models described above in the low-moderate and moderate weight subsample ($n = 1991$). To account for the clustered sampling design, all analyses used generalized estimating equations methods (SAS PROC GENMOD) to adjust variance estimates [27]. The human subjects protection board of Children's Hospital Boston approved this study.

Results

Table 1 presents selected characteristics, eating disorder symptoms, and menstrual irregularity in the full sample and subsample of girls with BMI in the low-moderate/moderate weight range. For the full sample, the mean age was 15.8 years, and 85.8% were of white race/ethnicity. Vomiting one to three times per month to control their weight in the previous 3 months was reported by 8.9% of girls, and an additional 3.1% reported vomiting once per week or more often. More than 14% of the girls scored ≥ 20 on the EAT-26, which is the instrument threshold for a probable eating disorder, and an additional 19.1% scored in the interim range of 10–19 on the EAT-26. Irregular menses were reported by 14.9% of girls. Characteristics of the low-moderate/moderate weight subsample were very similar to those seen in the sample overall, as shown in Table 1.

Table 2 displays the proportion of girls reporting irregular menses in each of the vomiting frequency and EAT-26 score categories. In addition the table presents partially and fully adjusted multivariable model results estimating the risk of irregular menses associated with vomiting frequency and EAT-26 score. In the full sample, girls who vomited to control their weight one to three times per month were one and a half times more likely (RR = 1.6; 95% CI = 1.2–2.2), and girls who vomited once per week or more often were more than three times more likely (RR = 3.2; 95% CI = 2.3–4.4), to experience irregular menses than were girls who did not report vomiting for weight control. Estimated risk ratios were attenuated somewhat when adjusting for EAT-26 score. Even when restricted to girls within the low-moderate/moderate weight range, vomiting remained a strong predictor of irregular menses: Girls who vomited to control their weight one to three times per month were two times more likely (RR = 2.0; 95% CI = 1.3–3.0) and girls who vomited once per week or more often were three and a half times more likely (RR = 3.5; 95% CI = 2.4–5.2) to experience irregular

menses than were girls who did not report vomiting for weight control. Risk ratios were again somewhat attenuated when adjusting for EAT-26 score but remained significant.

EAT-26 score was found to be positively associated with irregular menses in partially adjusted models, and this association was attenuated substantially when vomiting frequency was included in fully adjusted models. Of note is our finding that even modestly elevated EAT-26 scores, i.e., those falling between 10 and 20, were associated with an increased risk of irregular menses. Exercising more often than once daily to control weight was not associated with menstrual irregularity and did not confound the relationship between the primary predictors and the outcome; therefore it was not included in our final models.

Discussion

In a national eating disorders screening initiative in U.S. high schools, we found a strong association between vomiting frequency and irregular menses in adolescent females aged 14–19 years. When restricting analyses to girls within a healthy weight range, the associations persisted at a similar magnitude, indicating that vomiting, rather than anthropometric characteristics such as extreme BMI, may be likely to explain observed associations. In girls within the low–moderate/moderate weight range, frequent vomiting, defined as once per week or more often, was associated with two and a half times the risk of irregular menstrual cycles, independent of other eating disorder pathology, as assessed by the EAT-26. Even occasional vomiting of one to three times per month was associated with one and a half times the risk of irregular menstrual cycles independent of EAT-26 score.

In a countywide school-based sample of more than 2000 high school girls, Johnson and Whitaker found that compared with girls who did not vomit to control their weight, those who reported frequent self-induced vomiting (4.0% of the cohort) experienced two and a half times (odds ratio [OR] 2.6; 95% CI = 1.6–3.9) the odds of secondary amenorrhea during the previous year, and those who reported infrequent self-induced vomiting (11.7% of the cohort) experienced two times (OR = 2.1; 95% CI = 1.5–2.9) the odds of secondary amenorrhea [18]. These findings are similar to our own in both the proportions reporting frequent and infrequent vomiting to control weight and in the magnitude of associations between vomiting and disruption of menses.

In a study designed to assess the nutritional and psychiatric status and menstrual function of 82 healthy weight women diagnosed with bulimia nervosa, Gendall et al found that vomiting to control weight was associated with menstrual irregularity independent of other disordered eating behavior [7]. The authors concluded that vomiting may be an aspect of eating disorder symptomatology that is most strongly linked with menstrual dysfunction in women with bulimia nervosa [7].

Excessive exercise has also been linked to menstrual abnormalities in disorders termed exercise-related menstrual irregularities, possibly caused by the suppression of pulsatile release of gonadotropin releasing hormone from the hypothalamus, increased cortisol secretion, and other neuroendocrine abnormalities [28,29]. In our study we did not find exercising more than once daily to be associated with irregular menses or to confound the relationship between vomiting or EAT-26 score and menstrual cycle disruption. The survey item on exercise frequency, however, did not evaluate in sufficient detail whether the respondents' exercising patterns were in fact excessive, which has been defined in other studies as exercising while seriously injured, at inappropriate times, in duration of >3 hours per day, or in a way that severely interferes with other important activities [10].

The specific biochemical etiology of menstrual dysfunction in healthy-weight females with bulimia nervosa has yet to be clarified. Studies have shown that menstrual disturbances in

bulimia nervosa are associated with reduced estradiol [30], reduced luteinizing hormone concentrations, and reduced pulsatile release of luteinizing hormone by the anterior pituitary [31]. Irregular menses or oligomenorrhea may reflect an underlying estrogen deficiency, which may be associated with increased risk for other negative health consequences such as the compromise of an adolescent girl's peak bone mass and overall skeletal health, which may predispose her to future osteoporosis [32]. Other research provides suggestive evidence of a starvation pathway linking purging and menstrual cycle disruption. Previous studies have identified two indicators of starvation, high serum beta-hydroxybutyrate and low total triiodothyronine (T3), in women with bulimia nervosa and anorexia nervosa [12,33,34]. Importantly women with bulimia nervosa who are of normal weight can nonetheless manifest hormonal alterations characteristic of emaciated women with anorexia nervosa [35]. These data are relevant to the current findings given that, although our participants were of a normal weight, there was a compelling association between purging behavior and menstrual irregularity.

Our findings point to several important implications. First, our study adds to the evidence that vomiting may have a direct effect on normal hormonal function. In our study, the observed irregularity of menstrual cycles in low-moderate/moderate weight girls suggests that vomiting to control weight, not only when engaged in frequently but also at the lower frequency range assessed, may directly disrupt physiologic processes that control timing of menstrual cycles. Several plausible mechanisms may underlie a link between vomiting for weight control and menstrual dysfunction independent of weight status. Vomiting may result in an increased insulin secretion [36], which appears to mediate hyperandrogenism in young women with polycystic ovary syndrome [37]. Furthermore menstrual irregularity and vomiting may be linked through dopamine and opioid activity. The emesis center in the medulla has been suggested to be the chemoreceptor trigger zone in the postrema area known to contain a high density of opioid and dopamine receptors [7]. A rise in dopaminergic and opioid activity has been associated with menstrual dysfunction [7].

Second, we found that EAT-26 score was positively associated with the risk of irregular menses and that, when vomiting frequency was added to the multivariable model, effect estimates for EAT-26 score categories were attenuated substantially. These results provide support for the argument of Gendall et al [7] that vomiting for weight control may be a particularly deleterious component of eating disorders.

Third, even occasional vomiting for weight control in healthy-weight females with subclinical eating disorder symptoms or those diagnosed with eating disorders not otherwise specified (EDNOS) [38] may disrupt hormonal functioning. Estimates from a representative, school-based sample of adolescent girls suggest that approximately 9% may engage in vomiting in the past year to control their weight [6]. Rough extrapolations based on U.S. Census Bureau population estimates for 2005 [39] (<http://factfinder.census.gov>) would suggest that almost two million adolescent girls in the United States may engage in vomiting for weight control each year. Given the plausibility of hypothesized physiologic effects of vomiting on hormonal regulation, these girls are potentially being exposed to a cascade of hormonal perturbations that may have a detrimental effect on skeletal health in addition to the myriad other documented health implications of vomiting [40]. Some of these girls may meet criteria for a diagnosis of EDNOS, an understudied amalgamation of eating disorders that include vomiting for weight control as well as other symptoms [41]. Our findings highlight the need for more research to characterize fully the hormonal, skeletal, and other physiologic consequences of vomiting for weight control.

Findings from our study should be interpreted in light of several limitations. We did not have biochemical measurements to support some of the hypothesized mechanisms

underlying our results. For example, reduced estradiol and luteinizing hormone concentrations were likely present in the young women who both purged and exhibited menstrual irregularities; however those serum measurements were not collected in the current study and would be important to include in future studies. We were not able to account for exogenous hormone use, such as oral, injected, dermal administration of contraceptives. These medications may be prescribed for treatment of irregular menses and for females with amenorrhea and oligomenorrhea associated with an eating disorder in an attempt to prevent bone loss [40]. As a result, the magnitude of estimated associations between vomiting frequency or other eating disorder symptoms and irregular menses may have been greater if hormonal treatment had been considered. In addition our analyses used a low threshold of severity to define irregular menses (i.e., menstrual periods less often than monthly), potentially leading to nondifferential misclassification of outcomes, which may result in attenuated estimates of risk [42]. The NEDSP questionnaire gathered self-report data, which may be affected by bias, although the EAT-26 [20] and a measure of vomiting [43] similar to that used with NEDSP have been validated. Furthermore some research suggests that self-report questionnaires may yield more accurate prevalence estimates of eating disorder symptoms than do interviews [44]. In addition NEDSP participants are not a representative sample, but the internal validity of observed associations should not be biased by the reduced generalizability.

Results from a national screening initiative in U.S. high schools, taken together with results of other studies [5,6,45] suggest that vomiting for weight control is not uncommon among adolescent girls. Health providers should be aware that girls with irregular menstrual cycles may be using vomiting as a method to control their weight. Early identification and treatment of vomiting and other disordered weight control behaviors may reduce the negative consequences that result from disruption of normal hormonal function, perhaps preventing irreversible deficits in bone density and reducing the risk of stress fracture and future osteoporosis. However our prior work based on the same sample of high school girls participating in NEDSP [19] indicates that these girls are not likely to be receiving the early identification and treatment that they need. In the NEDSP sample, we found that only 16.5% of girls who reported vomiting to control their weight during the 3 months before the screening had ever received treatment for an eating disorder. Greater efforts are needed for clinicians, parents, school staff, and others working with adolescent girls to recognize warning signs of vomiting for weight control, such as irregular menses, and to help these girls seek clinical care to protect both their current and future health.

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Table 1

Selected characteristics of a high school sample of girls participating in the National Eating Disorders Screening Program

	Full sample (N = 2791)	Low-moderate/moderate weight ^a subsample (N = 1991)
Age (years), weighted mean (SD)	15.8 (1.0)	15.8 (1.0)
	Weighted % (n)	Weighted % (n)
Race/Ethnicity		
African American	3.1 (91)	3.2 (65)
American Indian	1.5 (37)	1.4 (25)
Asian/Pacific Islander	2.3 (59)	2.3 (42)
Latina	5.2 (121)	5.2 (84)
White	85.8 (2419)	85.8 (1731)
No ethnicity reported	2.2 (64)	2.1 (44)
Weight status		
Low BMI ^b	10.0 (278)	NA
Low-moderate BMI ^c	46.6 (1306)	65.2 (1306)
Moderate BMI ^d	24.9 (685)	34.8 (685)
High BMI ^e	18.5 (522)	NA
Exercise for weight control in past 3 months >1×/day	3.1 (81)	3.1 (58)
Vomiting frequency in past 3 months		
Never	88.0 (2463)	88.5 (1767)
1–3×/month	8.9 (246)	8.3 (167)
Once/week or more often	3.1 (82)	3.2 (57)
EAT-26 score		
EAT-26 score <10	66.5 (1855)	67.4 (1339)
10 ≤ EAT-26 score <20	19.1 (542)	18.7 (379)
20 ≤ EAT-26 score <30	8.9 (244)	8.5 (166)
30 ≤ EAT-26 score <40	3.2 (90)	3.3 (68)
40 ≤ EAT-26 score <50	1.2 (34)	1.1 (21)
EAT-26 score ≥50	1.1 (26)	1.1 (18)
Irregular menses		
Menses less often than monthly	14.9 (400)	13.5 (257)

BMI = body mass index; EAT = Eating Attitudes Test.

Data are weighted percentages with absolute numbers in parentheses unless otherwise stated.

^a Defined as age- and gender-specific BMI corresponding to $18.5 \leq \text{BMI} < 25$ at age 18 years.

^b Low BMI = age- and gender-specific BMI corresponding to $\text{BMI} < 18.5$ at age 18 years.

^c Low-moderate BMI = age- and gender-specific BMI corresponding to $18.5 \leq \text{BMI} < 22$ at age 18 years.

^d Moderate BMI = age- and gender-specific BMI corresponding to $22 \leq \text{BMI} < 25$ at age 18 years.

^e High BMI = age- and gender-specific BMI corresponding to $\text{BMI} \geq 25$ at age 18 years.

Table 2

Frequency of irregular menses and partially and fully adjusted regression model results estimating the risk of irregular menses^a in high school girls: Full sample and low-moderate/moderate weight^b subsample

	Irregular menses Weighted %	Partially adjusted multivariable models^c RR (95% CI)	Fully adjusted multivariable models^d RR (95% CI)
Full sample (N = 2791)			
Vomiting frequency in past 3 months			
Never	13.2	Reference	Reference
1–3×/month	21.5	1.6 (1.2–2.2)	1.4 (1.0–1.9)
Once/week to >1×/day or more often	43.4	3.2 (2.3–4.4)	2.0 (1.2–3.3)
EAT-26 score			
EAT-26 score <10	12.4	Reference	Reference
10 ≤ EAT-26 score <20	15.5	1.2 (1.0–1.6)	1.2 (.9–1.5)
20 ≤ EAT-26 score <30	22.1	1.8 (1.3–2.3)	1.5 (1.1–2.1)
30 ≤ EAT-26 score <40	23.4	1.9 (1.2–2.8)	1.4 (.9–2.3)
40 ≤ EAT-26 score <50	29.4	2.4 (1.5–3.7)	1.7 (1.0–2.8)
EAT-26 score ≥50	58.2	4.7 (3.1–7.1)	2.8 (1.4–5.6)
Low-moderate/moderate weight subsample (N = 1991)			
Vomiting frequency in past 3 months			
Never	11.6	Reference	Reference
1–3×/month	22.2	2.0 (1.3–3.0)	1.6 (1.1–2.6)
Once/week to >1×/day or more often	42.8	3.5 (2.4–5.2)	2.3 (1.3–4.2)
EAT-26 score			
EAT-26 score <10	11.0	Reference	Reference
10 ≤ EAT-26 score <20	15.2	1.4 (1.0–2.0)	1.3 (.9–1.8)
20 ≤ EAT-26 score <30	18.9	1.8 (1.2–2.7)	1.4 (.9–2.1)
30 ≤ EAT-26 score <40	20.6	1.9 (1.2–3.1)	1.3 (.7–2.4)
40 ≤ EAT-26 score <50	33.5	3.2 (1.7–6.0)	2.0 (1.0–4.1)
EAT-26 score ≥50	52.7	5.0 (2.8–9.2)	2.7 (1.2–6.0)

BMI = body mass index; CI = confidence interval; EAT = Eating Attitudes Test; RR = risk ratio.

^a Irregular menses defined as menses less often than once per month.

^b Low-moderate/moderate weight defined as age- and gender-specific BMI equivalent of $18.5 \leq \text{BMI} < 25$ at age 18 years.

^c Partially adjusted models control for factor plus age, weight status, and race/ethnicity.

^d Fully adjusted model controls for both vomiting and EAT-26 score plus age, weight status, and race/ethnicity.