ARTICLE

Longitudinal Associations Between Binge Eating and Overeating and Adverse Outcomes Among Adolescents and Young Adults

Does Loss of Control Matter?

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Objective: To investigate the association between overeating (without loss of control) and binge eating (overeating with loss of control) and adverse outcomes.

Design: Prospective cohort study.

Setting: Adolescents and young adults living throughout the United States.

Participants: Sixteen thousand eight hundred eighty-two males and females participating in the Growing Up Today Study who were 9 to 15 years old at enrollment in 1996.

Main Exposure: Overeating and binge eating assessed via questionnaire every 12 to 24 months between 1996 and 2005.

Main Outcome Measures: Risk of becoming overweight or obese, starting to binge drink frequently, starting to use marijuana, starting to use other drugs, and developing high levels of depressive symptoms. Generalized estimating equations were used to estimate associations. All models controlled for age and sex; additional covariates varied by outcome.

Results: Among this large cohort of adolescents and young adults, binge eating was more common among females than males. In fully adjusted models, binge eating, but not overeating, was associated with incident overweight/obesity (odds ratio, 1.73; 95% CI, 1.11-2.69) and the onset of high depressive symptoms (odds ratio, 2.19; 95% CI, 1.40-3.45). Neither overeating nor binge eating was associated with starting to binge drink frequently, while both overeating and binge eating predicted starting to use marijuana and other drugs.

Conclusions: Although any overeating, with or without loss of control, predicted the onset of marijuana and other drug use, we found that binge eating is uniquely predictive of incident overweight/obesity and the onset of high depressive symptoms. These findings suggest that loss of control is an important indicator of severity of overeating episodes.

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THE *DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS* (Fourth Edition) defines binge eating as (1) eating, in a discrete period, an amount of food that is definitely larger than most people would eat in a similar period under similar circumstances and (2) feeling a lack of control over eating during the episode.[1] Binge eating among treatment-seeking obese adolescents is common[2,3] and overweight and obese adolescents are far more likely than their healthy-weight peers to report binge eating.[4,5] Moreover, adolescents who binge have higher levels of eating-disordered attitudes[3] and more symptoms of anxiety.[3] In addition, binge eating has been found to predict excess weight gain[6,7] and obesity onset[8,9] among adolescents. Binge eating disorder, defined as binge eating that occurs at least once a week for 3 months, is strongly associated with mood and anxiety disorders and substance abuse in adolescents.[10] Although binge eating appears to be common in youth,[4,10-14] there is ongoing debate over how it should be defined, in part because determining what portion of food should be considered "larger than normal" is challenging in the present food environment where extra-large portion sizes have become the norm.[15]

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Some have argued that loss of control (LOC), not overeating itself, is the crucial element in binge eating.[16,17]

Loss of control eating (hereafter referred to as binge eating) is cross-sectionally associated with higher weight, greater anxiety, more depressive symptoms, and more body dissatisfaction among children.[18] Children with binge eating also exhibit more impulsivity, lower self-directedness and cooperativeness, and greater novelty seeking.[19] Furthermore, youth who report binge eating consume a greater percentage of energy from carbohydrates, largely because of intake of dessert and snack foods,[20,21] and may have poorer recall of sweet-food consumption.[22] In prospective studies of children, binge eating has been found to predict weight gain,[23] disordered eating attitudes,[24] and higher depressive symptoms.[24]

Among adolescents, binge eating is cross-sectionally associated with obesity,[4] drug and alcohol use,[10,25] negative psychological experiences such as lower body satisfaction and self-esteem,[26] and mental disorders.[10] Prospective studies of adolescent girls find that eating pathology including binge eating predicts weight gain,[7,8] the onset of high depressive symptoms,[27] and increases in substance abuse.[28] However, to our knowledge, there are no prospective studies that separately explore the consequences of overeating and binge eating among adolescents. Such studies could further substantiate the importance of LOC as a diagnostic feature or severity indicator of overeating episodes. The aim of the present study was to explore whether overeating and binge eating are prospectively associated with adverse health outcomes such as overweight/obesity, depressive symptoms, frequent binge drinking, marijuana use, and other drug use. Further, we sought to assess whether the risks are similar for adolescents who did and did not experience LOC during overeating episodes.

METHODS

SAMPLE

Participants are members of the Growing Up Today Study, an ongoing cohort study of adolescents throughout the United States that was established in 1996. The Growing Up Today Study recruited children of women participating in the ongoing Nurses' Health Study II, a cohort study of more than 116 000 female registered nurses established in 1989.[29] At enrollment in 1996, Growing Up Today Study participants were 9 to 15 years old. Approximately 68% of the invited female participants (n=9039) and 58% of the invited male participants (n=7843) returned completed questionnaires, thereby assenting to participate in the cohort study. Growing Up Today Study participants were asked to complete questionnaires annually from 1996 to 2001, and then biennially through 2007. The data collection periods in the 2001, 2003, 2005, and 2007 cycles spanned approximately 2 years. The study was approved by the human subjects committees at Children's Hospital Boston and Brigham and Women's Hospital in Boston, Massachusetts.

Participants who provided information in 1 or more consecutive questionnaire cycles between 1996 and 2007 were included in the present analysis. Participants who were prevalent cases at baseline were censored from the analyses for that outcome. Incident cases were censored from analyses of subsequent periods. After these exclusions, 10 246 participants remained for the analyses predicting becoming overweight or obese, 7694 participants remained for the analyses predicting the development of high levels of depressive symptoms, 10 100 participants remained for the analyses predicting starting to binge drink frequently, 7513 participants remained for the analyses predicting the onset of marijuana use, and 8000 participants remained for the analyses predicting starting to use other drugs. Of the 16 882 participants who completed the baseline questionnaire, 14 166 (83.9%) were included in the analyses of at least 1 of the 5 outcomes.

MEASURES

Overeating Status

Overeating status is a 3-level variable representing no overeating, overeating, or binge eating. Overeating and binge eating were assessed on all questionnaires using a 2-part question. Participants were first asked how often during the past year they had eaten a very large amount of food. Participants who reported eating a very large amount of food at least occasionally were asked a follow-up question about whether they felt out of control (yes/no) during these episodes, like they could not stop eating even if they wanted to stop. We defined overeating as at least weekly episodes of eating a large amount of food, but with no LOC during the episodes. We defined binge eating as at least weekly episodes of eating a large amount of food with LOC during the episodes based on frequency criteria for binge eating disorder proposed for the fifth edition of *Diagnostic and Statistical Manual of Mental Disorders*.[30]

Weight Status

We calculated body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) using self-reported weight and height, which were assessed on all questionnaires. Children and adolescents younger than 18 years were classified as overweight or obese based on age- and sex-specific International Obesity Task Force cutoffs.[31] Participants 18 years or older were classified as overweight if they had a BMI between 25 and 30 and obese if they had a BMI greater than 30. Studies of the validity of self-reported weight and height find that adolescents generally provide valid information.[32-35]

Depressive Symptoms

We assessed depressive symptoms in 1999, 2001, and 2003 using the 6-item validated scale of the McKnight Risk Factor Survey IV.[36] All responses were scored on a 5-point Likert-type scale ranging from never to always. In 2007, we used the Center for Epidemiologic Studies Depression Scale to measure depressive symptoms.[37] Participants in the top decile of depressive symptoms were considered cases. We classified females who were in 1 of the bottom 9 deciles of depression symptoms on 1 assessment and in the top decile on the next assessment as incident cases of high levels of depressive symptoms.

Binge Drinking

A question on binge drinking was asked on the 1998, 1999, 2000, 2001, 2003, and 2007 questionnaires. Participants who reported that they ever consumed alcohol were asked a series of questions about their drinking behavior. We assessed binge drinking using 1 question that asked about the frequency of

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drinking 4 (female)/5 (male) or more drinks over a few hours in the past year.[38] Although studies of adult binge drinking use a monthly frequency cutoff,[39] we used a more conservative cutoff given the young age of our sample and the related low prevalence of monthly binge drinking during the early waves of assessment. Instead, we used a frequency cutoff of at least 6 episodes of binge drinking per year, which would be appropriate across the ages represented in all waves of analyses.

Drug Use

Questions on drug use were included on the 1999, 2001, 2003, and 2007 questionnaires. Participants were asked a series of questions about drug use. The questions regarding illicit drug use asked whether they had used marijuana or hashish, cocaine, crack (1999 and 2001), heroin, ecstasy, phencyclidine (PCP) (1999 and 2001), γ-hydroxybutyric acid (GHB) (1999, 2001, and 2007), lysergic acid diethylamide (LSD), mushrooms, ketamine (1999 and 2001), crystal meth (2007), Rohypnol, and amphetamines. In 2007, questions about the use of prescription drugs such as tranquilizers, pain killers, sleeping pills, and stimulants without a prescription were asked. Participants who reported using marijuana or hashish and had never reported using it at an earlier period were classified as incident marijuana use cases. Participants who reported using any illicit drug, except marijuana or hashish, or prescription drug without a prescription and had never reported using any of those drugs at an earlier period were classified as incident drug use cases.

ANALYSIS

We modeled the log-odds of the hazard rate for the 5 outcomes using PROC GENMOD (SAS version 9.2; SAS Institute Inc). The models were fit using generalized estimating equations with an independent working covariance matrix and empirical variance to account for the correlation between siblings. We conducted a lagged analysis with time-varying covariates so that outcomes were modeled as a function of predictors assessed on the previous questionnaire. All models controlled for age and sex. Additional covariates varied by outcome. In models predicting the development of overweight/obesity, BMI and dieting were adjusted for in the final models. In analyses predicting starting to binge drink frequently, starting to use marijuana, starting to use other drugs, and developing high depressive symptoms, fully adjusted models included having friends who use drugs, having 1 or more friends who drink, having a sibling who uses drugs, and having a sibling who started drinking before age 18 years. Models predicting developing high depressive symptoms additionally adjusted for BMI. We tested for an interaction between overeating status and sex in fully adjusted models for all outcomes. For both overeating without LOC and binge eating, we report the odds ratios (ORs) and 95% CIs for developing our 5 outcomes with individuals who reported no overeating as the referent group.

RESULTS

At baseline in 1996, the mean (SD) age of the participants was 12.0 (1.6) years (**Table 1**). At time of first measurement, 22.3% of participants were overweight or obese, 4.3% of participants were binge drinking frequently, 12.2% had used marijuana, and 9.1% had used a drug other than marijuana. The pattern of overeating and binge eating differed by sex. Among females, the prevalence of binge eating exceeded the prevalence of overeating at all ages (**Figure 1**). Conversely, the prevalence of overeating exceeded the prevalence of binge eating at all ages among males (**Figure 2**). Among females, the prevalence of either overeating or binge eating tended to increase with age, with 0.5% of the sample endorsing either overeating or binge eating at age 9 years and 3.6% of the sample endorsing 1 of the behaviors at age 24 years (Figure 1). The prevalence of either overeating or binge eating also generally increased with age during adolescence among males but peaked at 3.2% at age 19 years (Figure 2). Binge eating was more common among females than males with 2.3% to 3.1% of females and 0.3% to 1.0% of males reporting binge eating between the ages of 16 and 24 years.

Table 1. Baseline Characteristics of Female and Male Participants in the Growing Up Today Study

	Sample Size	Prevalence, No. (%)
Age in 1996, y, mean (SD)	16 882	12.0 (1.6)
Overweight or obese[a]	16 557	3689 (22.3)
Binge drinks frequently[b]	10 558	452 (4.3)
Uses marijuana[c]	10 759	1314 (12.2)
Uses drugs other than marijuana[c]	10 788	977 (9.1)

[a] First assessed in 1996.
[b] First assessed in 1998.
[c] First assessed in 1999.

Between 1996 and 2007, 30.7% (n = 3143) became overweight or obese. Between 1999 and 2007, 60.0% (n = 6065) started binge drinking frequently. From 2001 to 2007, 40.7% (n = 3061) of participants started to use marijuana, 31.9% (n = 2549) started to use other drugs, and 22.5% (n = 1732) developed high levels of depressive symptoms.

As shown in **Table 2**, binge eating, but not overeating, was associated with incident overweight/obesity in age- and sex-adjusted models (OR, 1.74; 95% CI, 1.18-2.57) and in fully adjusted models (OR, 1.73; 95% CI, 1.11-2.69). Similarly, binge eating, but not overeating, was significantly associated with the onset of high depressive symptoms in age- and sex-adjusted models (OR, 1.98; 95% CI, 1.33-2.93) and in fully adjusted models (OR, 2.19; 95% CI, 1.40-3.45). Neither overeating nor binge eating was associated with starting to binge drink frequently in either age- and sex-adjusted or fully adjusted models, while both overeating and binge eating predicted starting to use marijuana and starting to use other drugs. In fully adjusted models, both overeating (OR, 2.67; 95% CI, 1.68-4.23) and binge eating (OR, 1.85; 95% CI, 1.27-2.67) were significantly associated with starting to use marijuana. Both overeating (OR, 1.89; 95% CI, 1.18-3.02) and binge eating (OR, 1.59; 95% CI, 1.08-2.33) were significantly associated with starting to use drugs in fully adjusted models.

We saw no significant interactions between overeating status and sex, although the *P* value for the interaction term between overeating status and sex approached significance in the models predicting the onset of high depressive symptoms ($P = .08$) and frequent binge drinking ($P = .08$). In sex-stratified analyses, overeating

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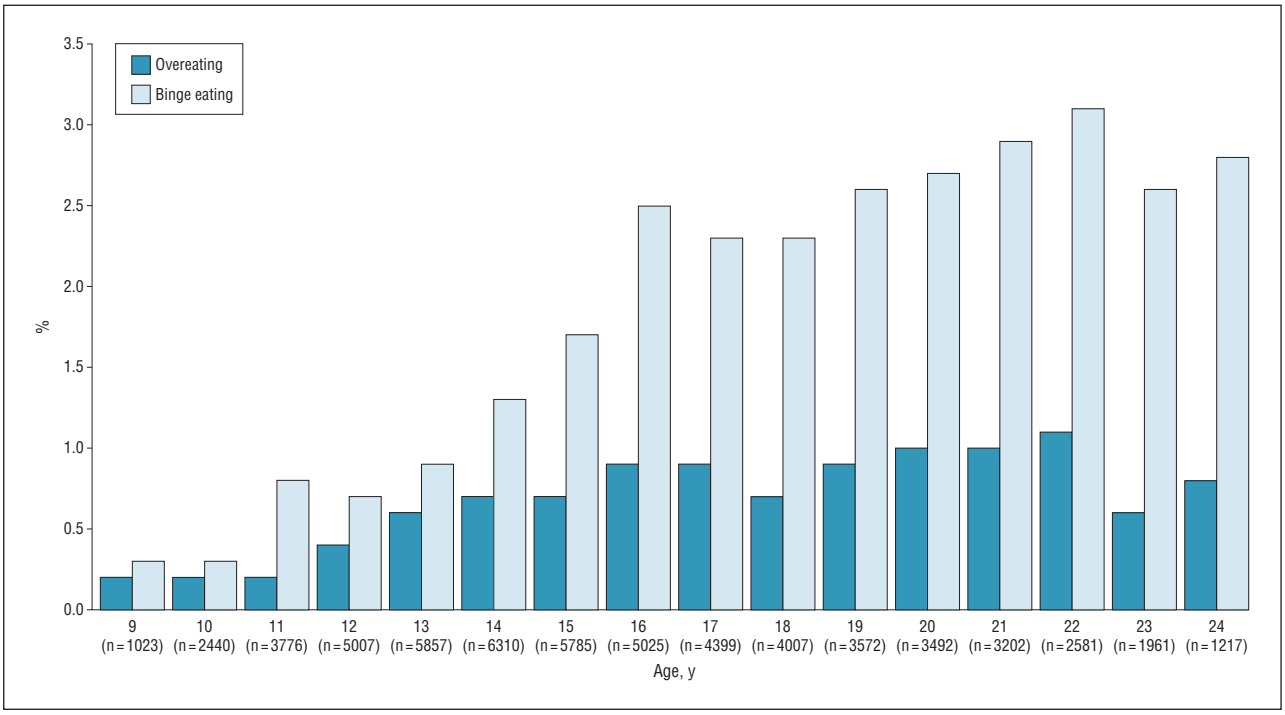

Figure 1. Prevalence of at least weekly overeating and binging episodes among females in the Growing Up Today Study from 1996 to 2007.

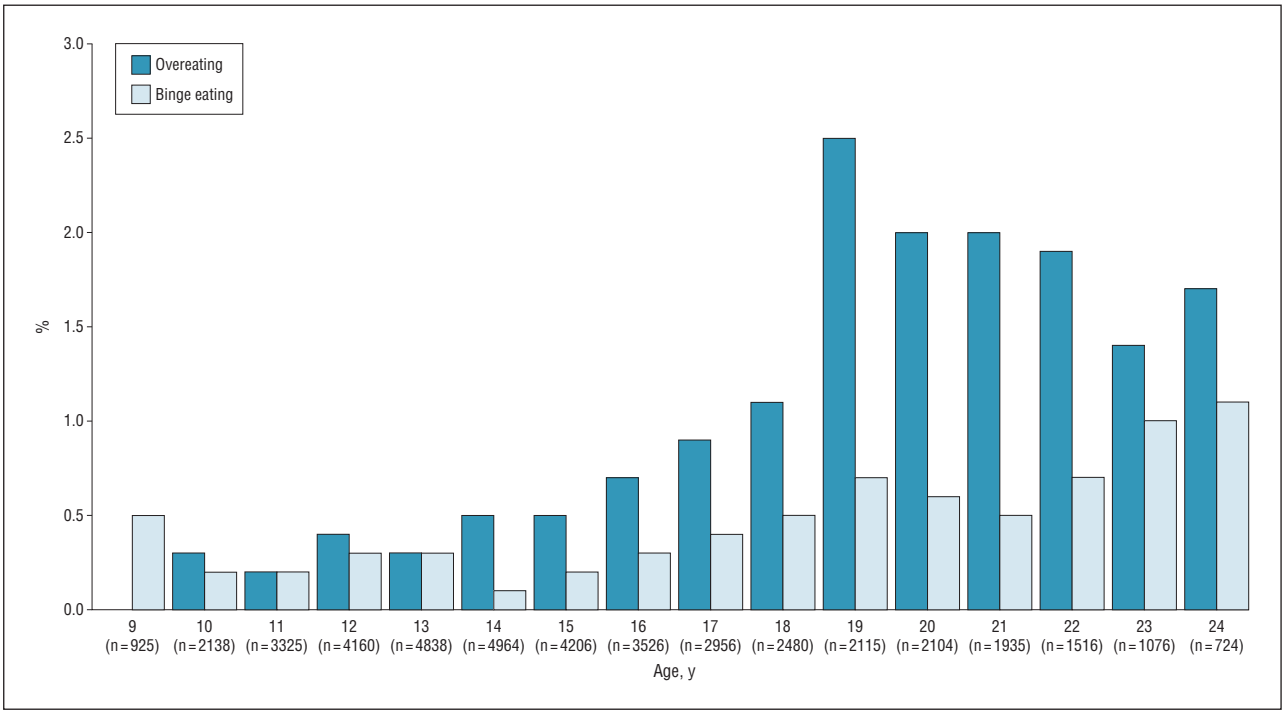

Figure 2. Prevalence of at least weekly overeating and binging episodes among males in the Growing Up Today Study from 1996 to 2007.

predicted the onset of high depressive symptoms among females (OR, 2.85; 95% CI, 1.31-6.20), but not males (OR, 0.52; 95% CI, 0.12-2.21), while binge eating was associated with the onset of high depressive symptoms among both females (OR, 2.12; 95% CI, 1.32-3.40) and males (OR, 3.21; 95% CI, 0.68-15.27). The nonsignificant association seen among males is likely a reflection of limited power due to low prevalence of binge eating among males. Although the main effect of overeating status on the onset of frequent binge drinking was null, overeating predicted the onset of frequent binge drinking among males (OR, 2.02; 95% CI, 1.05-3.89), but not females (OR, 0.68; 95% CI, 0.37-1.25). Binge eating was not associated with the onset of frequent binge drinking among either females (OR, 1.15; 95% CI, 0.83-1.59) or males (OR, 1.13; 95% CI, 0.36-3.55).

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Table 2. Associations of Weekly Overeating or Binging and the Onset of Adverse Outcomes Among Males and Females in the Growing Up Today Study

	OR (95% CI)[a]					
	Age- and Sex-Adjusted			Fully Adjusted		
	No Overeating	Overeating	Binge Eating	No Overeating	Overeating	Binge Eating
Overweight/obesity[b]	1 [Reference]	1.48 (0.96-2.29)	1.74 (1.18-2.57)	1 [Reference]	1.24 (0.70-2.21)	1.73 (1.11-2.69)
High depressive symptoms[c]	1 [Reference]	1.58 (0.95-2.62)	1.98 (1.33-2.93)	1 [Reference]	1.58 (0.83-3.03)	2.19 (1.40-3.45)
Frequent binge drinking[d]	1 [Reference]	1.15 (0.80-1.67)	1.38 (1.06-1.80)	1 [Reference]	1.01 (0.64-1.57)	1.14 (0.83-1.57)
Marijuana use[d]	1 [Reference]	2.32 (1.60-3.36)	2.16 (1.58-2.96)	1 [Reference]	2.67 (1.68-4.23)	1.85 (1.27-2.67)
Other drugs use[d]	1 [Reference]	1.52 (1.01-2.29)	1.91 (1.39-2.62)	1 [Reference]	1.89 (1.18-3.02)	1.59 (1.08-2.33)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); OR, odds ratio.
[a] Lagged analysis, using generalized estimating equations.
[b] Fully adjusted model for overweight/obesity adjusted for sex, age, BMI, and dieting.
[c] Fully adjusted model for developing high depressive symptoms adjusted for sex, age, BMI, having 1 or more parents who drink, having a sibling who started drinking before age 18 years, having 1 or more friends who drink, having a sibling who uses drugs, and having friends who use drugs.
[d] Fully adjusted model for starting to binge drink frequently, starting to use drugs, and starting to use marijuana adjusted for sex, age, having 1 or more parents who drink, having a sibling who started drinking before age 18 years, having 1 or more friends who drink, having a sibling who uses drugs, and having friends who use drugs.

COMMENT

Among this large cohort of adolescents and young adults, binge eating was more common among females than males, with 2.3% to 3.1% of females and 0.3% to 1.0% of males reporting binge eating between the ages 16 and 24 years. Excluding prevalent cases at first measurement, about 20% of participants developed high depressive symptoms, about 30% became overweight/obese or started to use drugs other than marijuana, about 40% started using marijuana, and about 60% started binge drinking frequently during the 6 to 10 years of follow-up.

We observed that the association between binge eating and overeating and the development of adverse outcomes differed by outcome. We found that overeating, but not binge eating, predicted incident overweight/obesity and the onset of high depressive symptoms. In accordance with a recent review[40] and previous research that suggests that the presence of LOC, rather than quantity of food consumed, is associated with eating-disordered cognitions[16,24,41,42] and greater distress,[18,43] these findings suggest that LOC is a unique and important feature of overeating episodes and should be retained as a diagnostic criterion. In contrast, we did not observe differences in the association between overeating and binge eating for binge drinking, starting to use marijuana, or starting to use other drugs. We observed that participants who reported either binge eating or overeating were more likely to start using marijuana or other drugs than those who reported no overeating episodes. Neither binge eating nor overeating was associated with starting to binge drink frequently.

To our knowledge, this is first study to prospectively examine the associations of both overeating and binge eating and adverse outcomes among adolescents. Our findings align with those of a cross-sectional study of adolescents from Minnesota that found that binge eating, but not overeating, was associated with negative psychological experiences.[26] Specifically, girls who reported binge eating had greater body dissatisfaction, lower self-esteem, more depressed mood, and higher suicide risk than those who reported overeating, but not binge eating.[26] Our study adds to the growing literature exploring the consequences of binge eating among adolescents. Our findings that binge eating predicts the onset of high depressive symptoms replicates previous work in children[24] and adolescent girls[27] that suggests that elevated binge eating predicts an increase in depressive symptoms, perhaps because of the shame and guilt associated with these behaviors,[27] although 1 longitudinal study of children found that baseline binge eating predicted subsequent elevated depressive symptoms only if participants engaged in binge eating throughout the follow-up.[24] Our finding that binge eating predicts later weight gain is supported by most,[7,8,23] but not all,[44] prospective studies of children and adolescents. Similarly, a longitudinal association between eating pathology and substance abuse has been reported in a previous study of adolescents.[28]

This investigation has several limitations. Our sample was more than 90% white and likely underrepresents youth of low socioeconomic status because our sample consists of children of nurses; thus, it is unclear if our results are generalizable to racial/ethnic minorities or adolescents of low socioeconomic status. Further, we relied on self-reports, which may have resulted in some misclassification. Self-reported weight and height, which were used in the ascertainment of weight status, have been observed to be highly valid.[32-34] Although our measure of binge eating has been validated,[45] studies have demonstrated a number of limitations of self-reported binge eating in children and adolescents.[46] The inclusion of instructions defining "large amount" has been useful in reducing these limitations,[46,47] though such instructions were not included in our study. As such, our measurement of overeating should more accurately be described as perceived overeating and may not represent objective overeating episodes. Although assessing LOC eating, rather than binge eating, is preferred when working with children and adolescents to be inclusive of all episodes involving LOC,[16] we were not able to identify participants who experienced LOC while eating in the absence

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of perceived overeating episodes because participants who did not report overeating were not asked whether they ever felt LOC while eating. Although interactions between overeating status and sex failed to meet significance, females made up the majority of binge eating cases in our sample. Known sex differences in the experience of a binge may contribute to the disproportionate prevalence observed[48] and ongoing research is needed to explore differences in definition and assessment of binge eating between males and females.

The strengths of the study outweigh the limitations. To our knowledge, this is the largest prospective study to follow up a sample through adolescence and into young adulthood, a period of high risk for developing overweight/obesity and high depressive symptoms and for starting to use drugs or binge drink frequently. Binge eating and overeating were assessed every 12 to 24 months and we had multiple measurements of adverse outcomes in addition to information on a wide range of confounders. Moreover, to our knowledge, this is the first study to examine whether perceived overeating without LOC is predictive of adverse outcomes.

In summary, we found that binge eating, but not overeating, predicted the onset of overweight/obesity and worsening depressive symptoms. We further observed that any overeating, with or without LOC, predicted the onset of marijuana and other drug use. Findings from this investigation and previous research suggest that LOC is an important indicator of severity of overeating episodes and highlight the importance of ascertaining LOC, in addition to whether adolescents engage in overeating episodes. Given that binge eating is uniquely predictive of some adverse outcomes and because previous work has found that binge eating is amenable to intervention,[49,50] clinicians should be encouraged to screen adolescents for binge eating. Moreover, school and community-based interventions focused on prevention of binge eating might prevent both eating disorders and obesity among children, adolescents, and young adults.

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