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Bulimic Symptom Onset in Young Girls: A Longitudinal Trajectory Analysis

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Abstract

To investigate whether there are different patterns of development for binge eating and purging behavior among pre-adolescent and early adolescent girls, we conducted trajectory analyses of those behaviors in 938 girls across eight waves of data from the spring of 5th grade (the last year of elementary school) through the spring of 9th grade (the first year of high school). Analyses revealed four separate developmental trajectories for binge eating behavior (labeled none, increasing, decreasing, and high steady) and three separate developmental trajectories for purging behavior (labeled none, dabble, and increasing). Fifth grade scores on risk factors that were both transdiagnostic (negative affect and negative urgency) and eating disorder specific (expectancies for reinforcement from eating and from thinness) differentiated among the trajectory groups, in some cases before the groups differed in the target behaviors. These findings are the first, to our knowledge, to examine developmental trajectories for bulimic symptom onset in youth as young as elementary school. Clinical implications are discussed.

Keywords

developmental trajectories; binge eating; purging; risk; negative affect

The bulk of bulimia risk research has been conducted with adolescent girls around the peak age of onset, which is estimated to be age 16 for binge eating (Day, Schmidt, Collier, Perkins, Van Den Eynde et al., 2001; le Grange & Loeb, 2007; Stice, Marti, & Rohde, 2013) and age 18 for purging (Stice, Killen, Hayward, & Taylor, 1998). Consistent with these estimates for the emergence of these symptoms, Stice et al. (2013) found the peak age of onset for bulimia nervosa (BN) to be between 16 and 20 years of age, although the age of onset for BN may be decreasing (Smink, van Hoeken, & Hoek, 2012).

However, girls engage in bulimic behaviors at much earlier ages. There is evidence that binge eating occurs in girls as young as 6 years old (Morgan, Yanovski, Nguyen, McDuffie, Sebring et al., 2002; Nicholls, Lynn, & Viner, 2011) and that the average age of a girl's first loss of control over eating episode is 8.4 years old (Tanofsky-Kraff, Faden, Yanovski, Wilfley, & Yanovski, 2005). Though the rates of binge eating and purging are lower in pre-adolescent girls, they do increase with age and puberty, such that 14% to 25% of mid-late

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adolescent girls binge eat (Combs, Pearson, Zapolski, & Smith, 2013; Croll, Neumark-Sztainer, Story, & Ireland, 2002; Neumark-Sztainer, Wall, Larson, Eisenberg, & Loth, 2011). The development of binge eating and purging are related. Approximately half of those who binge eat by age 14 go on to develop compensatory behaviors, including purging, by the age of 17 (Allen, Byrne, & McLean, 2013), thereby increasing their risk for BN.

This early engagement in bulimic behaviors is quite important for understanding the emergence of BN and concurrent psychopathology. Early emerging symptoms are highly predictive of later, diagnosable disorders (Kotler, Cohen, Davies, Pine, & Walsh, 2001). In fact, BN symptoms at the beginning of adolescence correlate greater than $r = .40$ with symptoms during adulthood, and diagnosable BN at the beginning of adolescence is associated with a nine-fold increase in BN during late adolescence (Kotler et al., 2001). In addition, early binge eating and purging are concurrently associated with other forms of dysfunction, including elevated negative affect and depression (Hughes, Goldschmidt, Labuschagne, Loeb, Sawyer, et al., 2013; Leon, Fulkerson, Perry, Keel, & Klump, 1999; Pearson, Zapolski, & Smith, 2015a).

The intent of this study was to examine the emergence of binge eating, purging, and their co-occurrence in a sample of young girls over the years leading up to the age of peak occurrence; that is, from elementary school through the first year of high school. To introduce this empirical test, we briefly review relevant findings on eating disorder onset in youth and key factors of risk.

Trajectories of Eating Disorder Behavior

Although risk increases overall across the adolescent years, there is evidence that different girls progress along different trajectories of change in eating pathology during those years. However, this past research has two important limitations. First, these studies focus on the mid to late adolescent years (i.e., ages 15-16 at study initiation or even older). They found that binge eating and purging appear to peak during adolescence and then decline gradually as girls progress into adulthood (Abebe, Lien, & Soest, 2012; Keel, Baxter, Heatherton, & Joiner, 2007). Second, these studies have examined overall eating problems (Aime, Craig, Pepler, Jiang, & Conolly, 2008) or cognitive symptoms/risk factors (e.g., drive for thinness and body dissatisfaction: Fay & Lerner, 2013)[1], rather than specific eating disorder behaviors like binge eating and purging. Aime et al. (2008) assessed high school-aged girls and boys for four years (mean age at study initiation was 15.2) and identified five trajectories for eating problems (as measured by the EAT-26: Garner & Garfinkel, 1979). They found an asymptomatic group; a group showing stable but low levels of eating problems; a group starting out at high levels of eating problems that then decline over time; a group characterized by high, chronic levels of eating problems; and a group that displayed increased eating problems over time (Aime et al., 2008). This work has been highly

[1]Fay and Lerner (2013) found six trajectories for drive for thinness: a high stable group; an increasing and then decreasing group (initial increase from grades 9-10 and then start to decrease again); an increasing group; a decreasing group; a very low stable group; and a low stable group. They also identified five trajectories for body dissatisfaction: a high stable group; a none stable group; a very low stable group; a low stable group; and a moderate stable group.

informative; however, very little is known about the trajectories of the specific eating disorder behaviors of binge eating and purging, particulary beginning at younger ages.

Only one study has examined trajectories for binge eating and purging in a younger sample (grades 7 through 9, average age 13 at study onset: Smith, Simmons, Flory, Annus, & Hill, 2007). For each behavior, they found groups characterized by no engagement in the behaviors, moderate levels of the behaviors, high levels, and increasing levels over time. Because they found that groups of 7th grade girls could be identified as already engaging in moderate or high levels of binge eating and purging, and because of other evidence that girls are engaging in binge eating behavior as young as 6 years old (Morgan et al., 2002; Nicholls et al., 2011), it is important to study the development of these behaviors in younger girls.

Risk Factors for Early Engagement in Binge Eating and Purging

Recent models of risk for BN (e.g., Pearson et al., 2014; Pearson et al., 2015a; Pearson, Wonderlich, & Smith, 2015b) highlight two transdiagnostic risk factors, negative affect and negative urgency and two eating disorder-specific risk factors, expectancies for overgeneralized life improvement from dieting and thinness and expectancies that eating helps alleviate negative affect. A fifth risk factor is pubertal onset (Klump, McGue, & Iacono, 2003).

Negative affect

Negative affect is associated with many forms of psychological dysfunction, including bulimic symptom onset and maintenance. Negative affect and depression predict binge eating and purging (Leon et al., 1999; Pearson et al., 2015a) and are associated with eating disorder attitudes and cognitions (Pearson et al., 2015a). Several risk models for bulimia nervosa site negative affect as a primary risk factor (e.g., Agras & Telch, 1998; Culbert, Racine, & Klump, 2015; Heatherton & Baumeister, 1991; Pearson et al., 2015b; Stice, 2001).

Negative urgency

Negative urgency, which is the tendency to act rashly when experiencing distress (Cyders & Smith, 2008), concurrently and prospectively predicts both binge eating and purging behavior in elementary and beginning middle school girls (Combs, Pearson & Smith, 2011; Pearson et al., 2015a; Pearson, Combs, Zapolski, & Smith, 2012). When compared to other impulsivity-related traits (such as acting without forethought or sensation seeking) in studies of late adolescents and adults, negative urgency is much more highly associated with bulimic behaviors (Fischer, Smith, & Cyders, 2008).

Expectancies for reinforcement from eating and from thinness

Expectancies represent summaries of individuals' learning histories and are formed based on the multitude of direct and vicarious learning experiences that individuals undergo. They are learned anticipations of the likely consequences of behavioral choices. The expectancies one forms influence one's future behavioral choices. One tends to choose behaviors for which one expects rewards and avoid behaviors for which one expects punishment. Bulimic

symptoms can be understood as extreme eating and thinness-related behaviors, which are thought to stem from extreme or unusual learning histories (Combs & Smith, 2009; Hohlstein, Smith, & Atlas, 1998).

Elevations in the expectancy that eating helps manage negative affect correlate cross-sectionally with both binge eating and purging in child (Combs et al., 2011; Pearson, Combs, & Smith, 2010), adolescent (MacBrayer, Smith, McCarthy, Demos, & Simmons, 2001; Simmons, Smith, & Hill, 2002) and adult samples (Fischer, Settles, Collins, Gunn, & Smith, 2012; Hohlstein et al., 1998). The expectancy also predicts increases in binge eating, including binge eating onset, longitudinally among adolescent girls (Pearson et al., 2012; Smith et al., 2007). Elevations in the expectancy that thinness leads to overgeneralized life improvement also correlates cross-sectionally with child (Combs et al., 2011), adolescent (MacBrayer et al., 2001; Simmons et al., 2002), and adult symptom levels (Fischer et al., 2012; Hohlstein et al., 1998) and predicts both purging and binge eating longitudinally in adolescent girls (Pearson et al., 2012; Smith et al., 2007). In an experimental study, reduction of thinness expectancies produced a reduction in adolescent eating disorder symptoms (Annus, Smith, & Masters, 2008).

Puberty

Pubertal onset is associated with increased risk for eating disorder-related behaviors in girls and with the developmental emergence of genetic risk for eating disorders (Baker, Thornton, Lichtenstein, & Bulik, 2012; Klump et al., 2003). To date, no study has tested whether early pubertal onset is associated with different trajectories for the development of binge eating and purging behavior.

The Current Study

We studied 938 girls every six months from the spring of their 5th grade year (the last year of elementary school, age 11) through the spring of 8th grade (the last year of middle school) and then one year later in the spring of 9th grade (the end of the first year of high school, age 15). We tested the following hypotheses. First, even at this young age, different girls would proceed along different trajectories of change in binge eating and purging. Second, the presence of elevated negative affect, elevated negative urgency, elevated expectancies for reinforcement from thinness and elevated expectancies for reinforcement from eating among 5th grade girls would predict girls' subsequent developmental trajectories of binge eating and purging. Third, there would be a high rate of co-occurrence in the development of the two behaviors, such that girls in groups characterized by the emergence of binge eating behavior in early adolescence would also tend to be in groups characterized by the emergence of purging behavior during that period. In an exploratory way, we also tested whether early pubertal onset, measured as occurring in the first quartile of one's group (Lynne-Landsman, Graber, & Andres, 2010) would be associated with girls' trajectory group membership.

Method

Participants

The participants were 938 girls who were assessed longitudinally as described above for a total of eight different measurement occasions. The mean age of the participants at the initiation of the study was 10.84 years. Most were European American (60.7%), followed by African American (17.6%); the remainder of the sample identified themselves as Hispanic (6.3%), Asian (4.0%), Middle Eastern (0.5%), or other (10.9%).

Measures

Positive Affect, Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988)—The PANAS measures dimensions of positive and negative affectivity. The scales are internally consistent (alphas range from .84 to .90 in prior research), stable over time, and numerous studies have provided evidence for their validity (Watson & Clark, 1992). For this study, we used only the negative affect scale. Concerning reliability, $\alpha = .90$ in wave 1 and was higher in subsequent time points[2].

UPPS-P Negative Urgency Scale (Lynam, Smith, Cyders, Fischer, & Whiteside, 2007)

We used the self-report child version of the negative urgency scale, which has recently proved to be internally consistent, have good convergent validity across assessment method, good discriminant validity from other impulsivity-related measures, and predictive of criteria in theoretically consistent ways (Zapolski, Stairs, Settles, Combs, & Smith, 2010). In this sample, $\alpha = .85$ at wave 1 and was higher in subsequent time points. An example item is "When I am upset, I often act without thinking."

The Pubertal Development Scale (PDS; Peterson, Crockett, Richards, & Boxer, 1988)—The PDS consists of five questions for girls, using a likert-type rating format. An example item is "Has your skin started to change yet?" This measure correlates highly with physician ratings and other forms of self-report (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Coleman & Coleman, 2002). Used as an interval scale measure, the median internal consistency estimate in this sample was $\alpha = .99$. The PDS permits dichotomous classifications: following prior research, we rated scores of 2.5 or greater as reflective of pubertal onset (Culbert, Burt, McGue, Iacono, & Klump, 2009).

Eating Expectancy Inventory (EEI; Hohlstein et al., 1998)—This five-factor measure reflects expectancies for reinforcement from eating. For this study, we used the measure of the expectancy that eating helps one manage negative mood states. As with past samples, the scale was internally consistent ($\alpha = .93$ at wave 1 and was higher in subsequent time points). An example item is "Eating helps me forget bad feelings, like being sad, lonely, or scared."

[2]Descriptive information on all variables and trajectory group comparisons on the risk factor variables at each wave are available from the authors.

Thinness and Restricting Expectancy Inventory (TREI: Hohlstein et al., 1998)—The TREI measures overgeneralized expectancies for life improvement from thinness and restricting food intake. Scores on the scale were internally consistent in this sample, as they have been in the past (Wave 1 $\alpha = .91$ and higher in subsequent waves). An example item is, "If I were thin, I would feel more worthwhile." Comparisons of multiple possible factor structures indicate the scale is unidimensional (Hohlstein et al., 1998).

Eating Disorder Examination- Questionnaire (*EDE-Q*; Fairburn & Beglin, 1994)—The EDE-Q is a self-report version of the Eating Disorders Examination semi-structured interview (Cooper & Fairburn, 1993) designed to assess the full range of behavioral and cognitive or attitudinal features of eating disorders during the preceding four weeks. The EDE-Q has been shown to have good reliability and validity, particularly in clinical samples (Cooper & Fairburn, 1993; Luce & Crowther, 1999; Mond, Hay, Rodgers, Owen, & Beumont, 2004). In this study, the EDE-Q was adapted for use with a younger population by using age-appropriate wording, defining concepts that could possibly be difficult to understand, and shortening the length of time referred to in the questions to the past two weeks, per past recommendations (Carter, Stewart, & Fairburn, 2001). For instance, the word "restrict" was changed to "cut back on;" and terms such as "purging" and "binge eating" were defined.

For a reported behavior to count as a binge eating episode, two EDE-Q items had to be endorsed: one that assessed episodes of eating what most people would regard as an unusually large amount of food and one that assessed loss of control during these episodes. We used a 6-point scale to measure binge eating: 0=absence of binge eating episodes; 1=one to two binge eating episodes; 2=three to four binge eating episodes; 3=five to seven binge eating episodes; 4=eight to 10 binge eating episodes; 5=11 to 13 binge eating episodes; 6= 13 or more binge eating episodes. To measure purging, we assessed self-induced vomiting. We did not include any other compensatory behaviors, like laxative or diuretic use due to (a) the low base rate of use in the current sample and (b) the higher prevalence of self-induced vomiting in the population. We used an analogous 6-point scale for purging.

Procedures

Data collection—The following procedure was approved by the University's IRB and by the participating school systems and was utilized at all eight waves of the study. The questionnaires were administered in school cafeterias or classrooms during school hours in 23 public elementary schools for the first wave, 19 public middle schools for waves two through seven, and seven public high schools for wave eight. A passive consent procedure was used. Out of 994 5^{th} grade girls in the participating schools, 938 (94.4%) participated in the study. A total of 56 girls did not participate due to one of the following reasons: families declined to participate, students declined assent, or a variety of other factors, such as language disabilities that precluded completing the questionnaires.

Participants were informed of confidentiality and signed an assent form before beginning questionnaire completion at each wave. The questionnaire administration took 60 minutes or less. There was no compensation for participations, except for those who moved out of

district. Those who did move out of the study's school districts were contacted and asked to complete the forms by mail and were paid $30 for doing so in 6th, 7th, and 8th grades and $40 for doing so in 9th grade.

Data analytic method—We conducted two primary trajectory analyses across the eight waves of the study, one for binge eating behavior and one for purging behavior. We used SAS Version 9.1 PROC TRAJ (zero inflated poisson: ZIP) and applied finite mixture modeling (Nagin, 2005) to model trajectories as a function of measurement wave. We specified a ZIP model due to the large number of zeros, indicating girls not engaging in the behaviors of interest. When using this method, one assumes that the target population can accurately be described as a mixture of distinct groups defined by their developmental trajectories. In brief, longitudinal data are used to identify the number of groups that best fit the data and to describe the shape of the trajectory for each group. The probability of each individual belonging to each trajectory group in the model is calculated and individuals are then assigned to the group to which they have the highest probability of belonging.

Several fit indices are used to determine the optimal number of groups and the validity of the grouping result. The Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC) become increasingly less negative with improvements in the fit of the group structure. Those statistics can be supplemented by additional statistics and guidelines for selecting the best trajectory solution. When the average probability of group membership is greater than .70 for each group (Nagin, 2005), the identified group structure is thought to fit well. One also avoids group structures with extremely small group sizes, out of concern for the stability of the structure (Nagin, 2005). To test whether identified trajectory groups differed in negative urgency, negative affect, eating expectancies, and thinness expectancies, we used analysis of variance and planned contrasts. To test whether groups differed in pubertal status, we used chi-square.

Results

Attrition and Treatment of Missing Data

Of the full sample of 938 girls, the percentage of participants ranged from 905 (96.5%) at wave 1 to 704 (75.1%) at wave 8. Girls who participated at all eight waves of the study did not differ from those who participated in fewer waves on any study variables. We therefore assumed data were missing at random and used the expectation maximization (EM) procedure to impute values for the missing data points. This procedure has been shown to produce relatively unbiased population parameter estimates and to be superior to traditional methods (Little & Rubin, 1989). As a result, we were able to make full use of the entire sample of $n = 938$.

Descriptive Statistics

By the end of 5thgrade (wave 1), 222 girls (23.7%) had experienced pubertal onset. We considered pubertal onset by that time to be early, because 23.7% constitutes roughly the first quartile of girls. Table 1 presents the frequencies of binge eating and purging behavior over the two weeks preceding each assessment. As the table shows, at each wave, over 8%

of girls reported at least one objective binge eating episode and over 3% of girls reported at least one purging episode in the preceding two weeks. There was a change in self-reported binge eating: the rate of binge eating began to increase around wave 5, the spring of 7th grade.[3] Thus, comparing wave 5 to wave 8 (the spring of 9th grade), there was a significant increase ($\chi^2 = 149.12$, $p < .001$). The increase consisted primarily of more girls reporting 1-2 binge episodes in the preceding two weeks: from waves 1 to 4, the average percentage of girls reporting that rate of binge eating was 3.1%; from waves 5 to 8, the percentage increased steadily from 4.7% to 10.1%. For purging, rates appeared to be low from spring of 5th grade (wave 1) through spring of 7th grade (wave 5) and then increase through spring of 9th grade (wave 8). This increase in purging behavior from wave 5 through wave 8 was significant ($\chi^2 = 199.71$, $p < .001$). The increase in purging behavior consisted primarily of more girls reporting 1-2 purge episodes in the preceding two weeks: from waves 1 to 4, the average percentage of girls making such reports was 2.1%. Across waves 5 to 8, the average percentage increased to 5.8%.

The means and standard deviations for negative affect, negative urgency, eating expectancies, and thinness expectancies at each wave are very similar to means reported elsewhere for youth (Fischer et al., 2012; Fischer & Smith, 2008; Hohlstein et al., 1998; Laurent, Catanzaro, Joiner, Rudolph, Potter, Lambert, Osborne, et al., 1999). Table 2 presents correlations among study risk variables at the first wave. All correlations reported are Pearson coefficients except for those correlations with puberty, which are point biserial correlations[4].

Developmental Trajectories of Eating Disorder Behavior

We used Nagin's (2005) procedure to determine (a) whether individual differences in girls' trajectories of binge eating and purging could be accurately characterized in terms of subgroups and (b) the number and shapes of the binge eating and purging trajectory groups. We separately developed trajectory groups for binge eating and purging. For each behavior, we assigned each participant to the group for which she had the highest probability of belonging.

Using SAS Version 9.1 PROC TRAJ (zero inflated poisson (ZIP) modeling; Jones, Nagin, & Roeder, 2001), we conducted two trajectory analyses, each on eight waves to model the trajectories as a function of a measurement wave. For the analyses, we first specified two groups and then tested a series of models in which we increased the number of groups and used the BIC, the AIC, the average probability of group membership, and the group sample size to evaluate model fit (Nagin, 2005). For binge eating, the five-group solutions produced less negative BIC and AIC values, but they included groups with very small sample sizes and groups with very similar trajectories as those in the four-group solutions. The same was

[3] 5th grade girls reported higher levels of binge eating than they reported in subsequent waves. Similar findings at this age have been reported by others (Tanofsky-Kraff et al., 2011). The degree to which this occurs due to increased error in the assessment of young children or represents valid developmental variation in the behavior over time is not yet known.

[4] In order to determine whether there was significant covariance among the study variables due to participants attending the same school, we calculated intraclass coefficients for each variable (using elementary school membership, n = 23, as the nesting variable). Intraclass coefficients ranged from .03 to .00; therefore, we concluded that school membership was essentially unrelated to study variables.

true for the four-group solutions for purging behavior. We therefore adopted a four-group solution for binge eating (BIC = -4177.71; AIC = -4141.39; average group membership probabilities from .73 to .92) and a three-group solution for purging behavior (BIC = -2309.34; AIC = -2289.97; average group membership probabilities from .76 to .92). These groups produced clear, straightforward assignments of girls to trajectory groups for each behavior. We report the smoothed curves as modeled by the trajectory analysis.

Binge eating behavior—As shown in the Figure 1, 517 (55.12%) of the 938 girls reported essentially no binge eating behavior at each of the eight data collections from 5th grade through 9th grade (non-binge eating group). A group of 218 girls (23.24%) reported decreasing binge eating behavior throughout the four-year period of eight data collections (decreasing binge eating group). The rate of linear decrease was statistically significant, $t(1) = -6.56$, $p < .001$. A group of 110 girls (11.73%) reported increasing levels of binge eating behavior (increasing binge eating group). The pattern of increase followed a combination of a significant linear trend ($t(1) = 6.92$, $p < .001$) and a significant quadratic trend ($t(1) = -6.51$, $p < .001$). The final group was the smallest group, consisting of 93 girls (9.91%) who consistently endorsed relatively high levels of binge eating behavior throughout the study time (high steady binge eating group). On average, these girls reported objective binge eating episodes between 1-3 times per week, and the slope of the linear trend did not differ from zero.

Purging behavior—As shown in Figure 2, of the 938 girls in the study, 698 (74.41%) reported essentially no purging behavior across the four-year, eight-wave time period (non-purging group). A group of 177 girls (18.87%) comprised a second group characterized by reports of purging behavior on some measurement occasions and not on others. We describe this group as a “dabble” group; the smoothed curve presented in Figure 2 documents a higher average level of purging than was true of the non-purging group. The smallest group consisted of 63 girls (6.72%) and was characterized by a trajectory of purging that increased across the eight waves (increasing purging group). This group may have had some decline in purging behavior from wave 7 to wave 8, but more data points are necessary in order to determine if this is indeed a trend. By the end of 9th grade, these girls purged 1-3 times in the preceding two weeks. The pattern of increase followed a combination of a significant linear trend ($t(1) = 4.28$, $p < .001$) and a significant quadratic trend ($t(1) = -4.01$, $p < .001$).

Prediction of Trajectory Groups Membership from Personal Characteristics

We next conducted a series of analyses to test whether trajectory groups differed from each other on the risk factors we described above at the spring, 5th grade assessment, i.e., at the start of the trajectory period. First, we tested whether the risk factors differentiated those who engaged in the target behavior (binge eating or purging) from those who did not engage in the behavior by conducting one-way analysis of variance (ANOVA). Second, we tested how the different groups of individuals who engaged in the target behavior differed from each other, again using ANOVA contrasts.

Binge eating

Non-binge eating group vs. binge eating groups—Girls who engaged in binge eating behavior over the course of the developmental period had higher 5th grade scores on negative affect, negative urgency, and expectancies for reinforcement from both eating and thinness than girls who did not (Table 3), but were not more likely to have experienced early pubertal onset.

Increasing group vs. non-binge eating group—The increasing group and the non-binge eating group both reported no binge eating behavior at wave 1; we tested whether, nevertheless, the groups differed in risk. Wave 1 contrasts revealed that, of the girls who reported no binge eating at the end of 5th grade, those who were higher on negative affect and negative urgency were likely to go on to binge eat later (Table 3). Also at wave 1, the two groups did not differ in eating expectancies, thinness expectancies, or early pubertal onset. We then compared the two groups six months later (wave 2: fall, 6th grade). Although members of the two groups were still not engaging in binge eating behavior, by wave 2 the group that later began binge eating had become higher in eating expectancies ($t(625) = 2.25$, $p < .02$) and thinness expectancies ($t(625) = 1.89$, $p < .05$), and were still higher in negative affect ($t(625) = 2.80$, $p < .001$) and negative urgency ($t(625) = 2.11$, $p < .02$). In addition, more of the members of the increasing group had experienced pubertal onset by wave 2 ($\chi^2(1) = 3.99$, $p < .05$).

High steady group vs. other binge eating groups—The high steady group appeared to be more distressed: members were significantly higher in negative urgency, negative affect, eating expectancies, and thinness expectancies (Table 3), but not in early pubertal onset.

Increasing group vs. decreasing group—As Figure 1 shows, the trajectories for the increasing group and the decreasing group crossed over at wave 5. We therefore compared these groups at wave 1 (when the decreasing group was higher in binge eating), wave 5, and wave 8 (when the increasing group was higher in binge eating).

At wave 1, members of the decreasing group endorsed both eating expectancies ($t(326) = 4.42$, $p < .001$) and thinness expectancies ($t(326) = 3.78$, $p < .001$) more strongly than those in the increasing group. There were no differences in negative affect, negative urgency, or wave 1 pubertal status. At wave 5, the two groups did not differ on any of the five risk factors. At wave 8, roughly the opposite pattern as wave 1 was present. The increasing group had become higher in eating expectancies ($t(326) = 2.56$, $p < .01$), thinness expectancies ($t(326) = 1.76$, $p < .05$), and negative affect ($t(326) = 2.72$, $p < .01$). The groups did not differ in negative urgency or pubertal status.

Purging

Non-purging group vs. purging groups—Those who purged (increasing and dabble groups) were significantly higher in negative urgency, negative affect, eating expectancies, thinness expectancies at the end of 5th grade than those who did not (Table 4). They were not more likely to have experienced early pubertal onset.

Increasing group vs. non-purging group—At wave 1, although members of neither the increasing group nor the non-purging group were engaging in purging behavior, members of the increasing group had higher mean scores in negative urgency ($t(759) = 2.16$, $p < .02$) and thinness expectancies ($t(759) = 1.75$, $p < .05$); the groups did not differ in negative affect, eating expectancies, or pubertal onset. Six months later, the same group differences were present and, in addition, the increasing purging group had higher mean scores in eating expectancies ($t(759) = 2.87$, $p < .01$).

Increasing group vs. dabbler group—We next examined how the two purging groups differed from each other. None of the risk factors (negative urgency, negative affect, eating expectancies, thinness expectancies, early pubertal onset) differentiated between those who dabbled in purging and those whose purging behavior increased over this developmental period at any wave.

Covariation between Membership in Binge Eating and Purging Trajectories

There was a high degree of covariation in membership of binge eating and purging trajectory groups (Table 5). 54.8% of the girls did not engage in any binge eating and purging behavior. Of the girls who reported no binge eating, 99% also reported no purging. Of the girls who reported no purging, 73.6% reported no binge eating. Of the girls in the high steady binge eating group, 73.1% were in one of the two trajectory groups positive for purging. All of the girls in the increasing purging group were also binge eating, and 56% were in the high steady binge eating group. One quarter (25.3%) of the girls reported engaging in both binge eating and purging over the course of the study, and only 20.0% reported engaging in just one type of disordered eating behavior.

We conducted two chi-square tests of independence to determine if the covariation helped differentiate between groups that did not differ on the risk factors.

Increasing vs. decreasing binge eating groups—There was a significant difference in group membership by purging (χ^2 (1)= 187.69, $p < .001$) such that those who increased their binge eating behavior were more likely to be in a purging group while those who decreased their binge eating behavior were more likely to be in the non-purging group. Of the 110 girls who made up the increasing binge eating group, almost all of them (102 girls, 93%) also purged: 75 (68%) were in the dabble purge group and 28 (25%) were in the increasing purge group. In contrast, of the 218 girls in the decreasing binge eating group, none of them increased their purging behavior and most did not purge (152 girls, 70%).

Dabble vs. increasing purging groups—These groups did differ as a function of binge eating group membership ($\chi^2 = 27.38$, $p < .001$). Whereas all girls in the increasing purging group engaged in binge eating, those who dabbled with purging engaged in various kinds of binge eating behavior, including decreasing binge eating behavior (37%), increasing binge eating (42%), consistent high binge eating behavior throughout the study (19%), or, in a few cases, no binge eating behavior at all (2%).

Discussion

Adolescent girls vary in the trajectories along which they come to engage in binge eating and purging behavior during the years prior to the peak age of onset. Concerning the development of binge eating from pre-adolescence through mid-adolescence, whereas most girls did not engage in the behavior, some did so at very young ages and then reduced the behavior, others began and increased the behavior during these years, and a small number consistently engaged in high levels of binge eating throughout this developmental period. Concerning purging behavior, though most girls did not purge, a substantial minority purged intermittently, and a small number began purging and were engaging in high levels of the behavior by the end of the first year of high school. These findings, together with others on older adolescents (e.g., Aime et al., 2008; Smith et al., 2007) indicate considerable variability among girls in their engagement and development of bulimic behaviors. One implication of the current findings is that early adolescent risk research using non-trajectory analytic methods, such as regression or structural equation modeling, is perhaps best understood as research into macro trends that collapse across meaningful variability among children.

Perhaps the most striking findings of the study were that, for both binge eating and purging, risk factors measured in 5th grade could differentiate between sets of girls when behavior could not. Among 5th grade girls not engaging in binge eating behavior, those who later began to binge eat were higher on negative affect and negative urgency. Girls who have high levels of subjective distress, and who are disposed to act rashly when distressed, are more likely than other girls to develop binge eating behavior in early adolescence. Among 5th grade girls not engaging in purging behavior, those who later began to purge had higher levels of negative urgency and expectancies for reinforcement from thinness. In elementary school, girls who, over the course of early adolescence began to purge, were more likely than other girls to act rashly when distressed and to expect thinness to provide overgeneralized life improvement. These two sets of findings are consistent with current theoretical and empirical accounts of the risk process (Culbert et al., 2015; Pearson et al., 2015b).

The trajectory group of girls who developed binge eating behavior (the increasing group) began to engage in the behavior in the fall of 7th grade. Interestingly, although they did not differ from non-binge eating girls in eating or thinness expectancies in spring of 5th grade, they did by fall of 6th grade: they came to endorse both types of expectancies more strongly than girls in the non-binge eating trajectory group. Thus, there was a pattern in which girls in the increasing group were elevated in the transdiagnostic risk factors in the spring of 5th grade and then in the eating disorder-specific risk factors six months later. This pattern is consistent with the acquired preparedness model of risk (Combs & Smith, 2009; Pearson et al., 2012, 2015a), which holds that elevations in negative urgency bias the learning process to lead to increases in high risk expectancies, and then to engagement in bulimic behaviors.

There was considerable and interesting covariation in membership in binge eating and purging trajectory groups. All of the girls in the increasing purging group were also binge eating, and more than half were in the group characterized by steadily high levels of binge

eating. During these early adolescent years, we found no evidence of a group engaging in consistent purging behavior who were not also binge eating. One possibility for this strong covariation is the finding that the girls in the increasing purging group endorsed eating expectancies in 6th grade, before they began purging. Thus, perhaps holding beliefs and expectancies about both thinness and eating contributed to engagement in both behaviors.

At a more fine-grained level of analysis, whereas established risk factors did not differentiate between girls in the increasing purging and dabbling in purging groups, binge eating behavior did. Whereas every girl in the increasing purging group was binge eating, girls who dabbled in purging varied among themselves a great deal with respect to binge eating. It appears to be the case that binge eating behavior, more than established personality and learning-based risk factors, increases the likelihood of purging behavior becoming extensive.

In a parallel way, knowledge of purging behavior helped differentiate between girls who decreased vs. increased their binge eating behavior during early adolescence. None of the girls who reduced their binge eating increased their purging, and most did not purge at all. By contrast, almost all of the girls in the increasing binge eating group also purged. This study does not permit causal inferences, but the findings are consistent with the possibility that engagement in purging behavior facilitates binge eating, or, put differently, a failure to develop purging behavior reduces the tendency to binge eat. This possibility is consistent with risk models that emphasize the pursuit of thinness (see review by Culbert et al., 2015).

Our findings suggest important intervention strategies. First, given the covariation between behaviors, it is important to regularly assess for both binge eating and purging behaviors because it seems that as a girl increases one behavior, she is likely to increase the other, even if she has never engaged in that behavior before. This could perhaps be due to the reinforcing quality of the behaviors (Pearson et al., 2015b). Second, our findings suggest that interventions that focus both on transdiagnostic risk factors (like negative urgency and negative affect) and eating disorder-specific risk factors are likely to be important. In fact, girls who are high on negative urgency and negative affect in 5th grade but do not yet engage in eating disorder behaviors, are likely to benefit from emotion regulation and distress tolerance skills such as those taught in dialectical behavior therapy (Linehan, 1993) to reduce risk for future bulimic behaviors. Similar interventions, with an eating disorder focus, such as Integrative Cognitive Affective Therapy for Bulimia Nervosa (ICAT-BN: Wonderlich, Peterson, Mitchell, Crow, Smith, & Klein, 2014) may be beneficial for the girls already engaging in behaviors.

Early pubertal onset was not associated with differences in the developmental trajectories of girls' subsequent binge eating and purging behavior. Pubertal onset has a clear role in relation to the genetics of eating disorder symptom expression (e.g., Culbert, Burt, McGue, Iacono, & Klump, 2009; Klump et al., 2003) and is associated with symptom onset (Baker et al., 2012). The current study addressed a different question, which was whether pubertal onset that occurred early was associated with subsequent trajectory group membership. Current models for the role of puberty in eating disorder risk emphasize biological aspects

of the pubertal process, such as increases in ovarian hormones (Klump, Keel, Sisk, & Burt, 2010); the timing of puberty may be less important than its biological impact.

The findings of this study should be viewed in the context of the study's limitations. First, we did not model variability among girls who are members of the same trajectory group. Second, though there were relatively low attrition rates, we cannot know whether the results would have differed with even higher retention. Third, all risk and bulimic symptom reporting was done by questionnaire and was not supplemented by interview data. Fourth, girls were asked to report engagement in the behaviors over the two weeks preceding the assessment. This procedure is standard when using the EDE-Q in youth; our use of it facilitates comparison of the current results with those of other studies. Nonetheless, it may well lead to underestimates of engagement in the behaviors. Fifth, we did not assess the context of the eating disorder behavior. Sixth, increased adiposity has been linked to loss of control eating in children (Matherne, Tanofsky-Kraff, Altschul, Shank, Schvey et al., 2015), and we did not include a measure of body mass index (BMI). We opted not to for the current study for three primary reasons: (a) it generally has not been investigated in prior adolescent trajectory research (e.g., Aime et al., 2008); (b) it has not altered the predictive effects of the risk factors (e.g., Combs et al., 2010); and (c) it tends not to be associated with bulimic behaviors in adults. Nevertheless, we cannot know whether findings would have differed had we had access to BMI. Seventh, we measured purging by assessing self-induced vomiting, due to the very low base rates of other purging behaviors in our young sample. We cannot know if other forms of purging develop along different trajectories.

In sum, the present findings provide clear support for different developmental trajectories of bulimic behaviors in girls as they transition from late elementary school through middle school and into high school. Membership in trajectory groups was predictable from personality and psychosocial learning characteristics of the girls when they were in 5th grade, and engagement in each behavior (binge eating or purging) helped explain engagement in the other. These findings can help inform researchers and clinicians about the different ways in which binge eating and purging may develop in girls early in life, which may inform theories of etiology as well as intervention efforts.

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This study suggests that (a) pre-adolescent girls vary considerably in their eating disorder behaviors, such that they can be grouped into different developmental trajectories of bulimic behaviors from elementary school through high school and (b) these groups can be distinguished by specific personality and learning risk factors.

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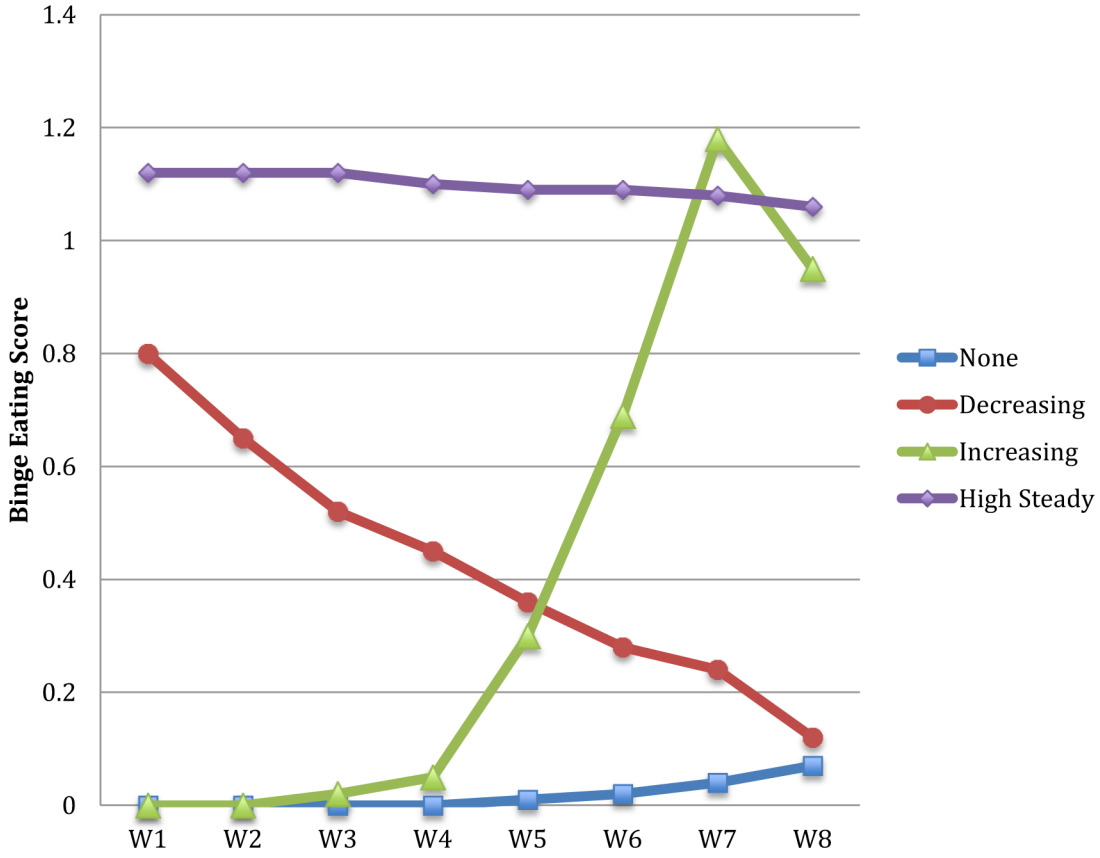

Figure 1. Binge Eating Trajectory Groups

Note: These lines represent the smoothed curves for each group's change over time. On the *x*-axis, each wave represents 6 months of development, except between W7 and W8, which represents 12 months of development. Waves 1-7 refer to biannual data collections, which occurred in every 6 months beginning in the spring of 5th grade (W1) through the spring of 8th grade (W7). W8 refers to the fall of 9th grade, the last data collection, which took place one year after W7. Scores of 1 represent 1-2 binge eating episodes in the past 2 weeks from assessment and scores of 2 represent 2-3 binge eating episodes in the past 2 weeks from assessment. None-binge eating, *n* = 517; Decreasing binge eating, *n* =218; Increasing binge eating, *n* = 110; High Steady binge eating, *n* = 93.

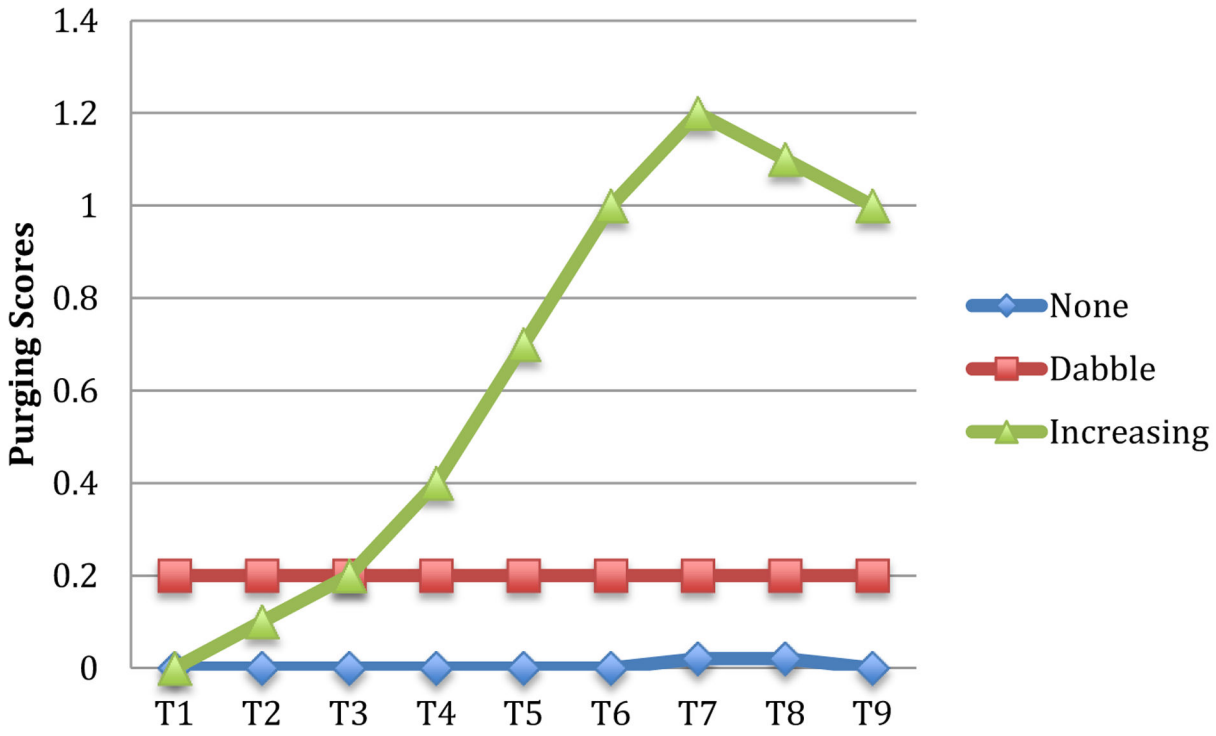

Figure 2. Purging Trajectory Groups

Note:These lines represent the smoothed curves for each group's change over time. On the *x*-axis, each wave represents 6 months of development, except between W7 and W8, which represents 12 months of development. Waves 1-7 refer to biannual data collections, which occurred in every 6 months beginning in the spring of 5th grade (W1) through the spring of 8th grade (W7). W8 refers to the fall of 9th grade, the last data collection, which took place one year after W7. Scores of 1 represent 1-2 purge episodes in the past 2 weeks from assessment and scores of 2 represent 2-3 purge episodes in the past 2 weeks from assessment. None-Purging, *n* = 698; Dabble Purging, *n* =177; Increasing Purging, *n* = 63.

Table 1

Frequencies of Binge Eating and Purging Behavior across Waves

Behavior	Number of episodes in last 14 days	Frequencies							
		Wave1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	Wave 8
Binge Eating	None	806 (85.9%)	846 (90.2%)	852 (90.8%)	861 (91.8%)	839 (89.4%)	796 (84.9%)	780 (83.2%)	794 (84.6%)
	1 - 2	24 (2.6%)	32 (3.4%)	27 (2.9%)	34 (3.6%)	44 (4.7%)	80 (8.5%)	86 (9.2%)	95 (10.1%)
	3 - 4	75 (8.0%)	30 (3.2%)	32 (3.4%)	28 (3.0%)	31 (3.3%)	38 (4.1%)	32 (3.4%)	24 (2.6%)
	5 - 7	23 (2.5%)	18 (1.9%)	11 (1.2%)	8 (0.9%)	11 (1.2%)	9 (1.0%)	13 (1.4%)	13 (1.4%)
	8 - 10	7 (0.7%)	4 (0.4%)	4 (0.4%)	5 (0.5%)	1 (0.1%)	6 (0.6%)	8 (0.9%)	2 (0.2%)
	11 - 13	2 (0.2%)	4 (0.4%)	5 (0.5%)	0	3 (0.3%)	6 (0.6%)	6 (0.6%)	2 (0.2%)
	14 or more	1 (0.1%)	4 (0.4%)	7 (0.7%)	2 (0.2%)	9 (1.0%)	3 (0.3%)	13 (1.4%)	8 (0.9%)
Purging	None	898 (95.7%)	906 (96.6%)	915 (97.5%)	915 (97.5%)	906 (96.6%)	837 (89.2%)	829 (88.4%)	875 (93.3%)
	1 - 2	29 (3.1%)	21 (2.2%)	13 (1.4%)	16 (1.6%)	24 (2.6%	81 (8.6%)	68 (7.2%)	45 (4.8%)
	3 - 4	6 (0.6%)	6 (0.6%)	7 (0.7%)	3 (0.3%)	2 (0.2%)	10 (1.1%)	14 (1.5%)	8 (0.9%)
	5 - 7	5 (0.5%)	0	2 (0.2%)	1 (0.1%)	1 (0.1%)	2 (0.2%)	5 (0.5%)	1 (0.1%)
	8 - 10	0	3 (0.3%)	1 (0.1%)	1 (0.1%)	0	4 (0.4%)	8 (0.9%)	0
	11 - 13	0	0	0	0	0	1 (0.1%)	1 (0.1%)	3 (0.3%)
	14 or more	0	2 (0.2%)	0	3 (0.3%)	5 (0.5%)	3 (0.3%)	13 (1.4%)	6 (0.6%)

Table 2

Correlations among study risk variables in waves 1

	Puberty	Negative Urgency - 1	Negative Affect - 1	Eating Expectancies -1	Thinness Expectancies -1
Puberty	-	-	-	-	-
Negative Urgency - 1	.06	-	-	-	-
Negative Affect - 1	-.04	.39**	-	-	-
Eating Expectancies - 1	-.01	.08*	.20**	-	-
Thinness Expectancies - 1	.04	.14**	.18**	.32**	-

Note: Each number following the variable represents the wave in which the data was collected (i.e., Negative Urgency – 1 = Negative Urgency, wave 1). Correlations with puberty are point-biserial correlations, and others are pearson correlations.

* $p < .01$

** $p < .001$.

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Table 3

Binge Eating: Wave 1 Contrasts

	Binge Eating Trajectory Group Means (SD) or Percentages				t-tests or Chi-Square		
Risk Factor	**None**	**Decreasing**	**Increasing**	**High, Steady**	**Contrast 1 (None vs. others): df = 936**	**Contrast 2 (None vs. Increasing): df = 625**	**Contrast 3 (Increasing vs. Decreasing and High): df = 489**
NU-1	2.08 (0.66)	2.40 (0.64)	2.31 (0.71)	2.43 (0.68)	t=6.44**	t=3.31**	t=1.41
NA-1	1.96 (0.66)	2.35 (0.82)	2.27 (0.77)	2.21 (0.85)	t=6.26**	t=4.17**	t=0.13
EE-1	1.98 (1.13)	2.84 (1.56)	2.09 (1.19)	2.74 (1.55)	t=6.39**	t=0.78	t=4.70**
TE-1	2.86 (1.55)	3.55 (1.67)	2.83 (1.51)	3.76 (1.67)	t=4.62**	t=0.218	t=4.44**
Pubertal Onset	22.7%	24.6%	23.2%	29.4%	χ^2 =0.68	χ^2 =0.01	χ^2 =0.84

Note. NU, negative urgency; NA, negative affect; EE, eating expectancies; TE, thinness expectancies; each number following the variable represents the wave in which the data was collected (i.e., NU-1 = Negative Urgency, wave 1);

** p<.001. For pubertal onset, the percentage positive at wave 1 in each group is reported. All contrasts are t-tests with the exception of those with pubertal onset, which are chi square tests of independence.

Table 4

Purging: Wave 1 None vs. Others Contrast

	Purging Trajectory Groups Means (SD) or Percentages			t-test or chi square
Risk Variable	**None**	**Dabble**	**Increasing**	***t* or χ^2**
NU-1	2.15 (0.66)	2.42 (0.67)	2.37 (0.79)	t = -3.53*
NA-1	2.04 (0.71)	2.41 (0.84)	2.11 (0.76)	t = -3.23*
EE-1	2.18 (1.28)	2.43 (1.48)	2.43 (1.42)	t = -2.06*
TE-1	3.00 (1.59)	3.27 (1.70)	3.44 (1.63)	t = -2.31*
Pubertal Onset	22.5%	28.1%	29.5%	χ^2 =2.98

Note. NU, negative urgency; NA, negative affect; EE, eating expectancies; TE, thinness expectancies; each number following the variable represents the wave in which the data was collected (i.e., NU-1 = Negative Urgency, wave 1); all *t* contrasts had df = 936, χ^2 df = 1;

*p< .05. For pubertal onset, the percentage positive at wave 1 in each group is reported. All contrasts are *t*-tests with the exception of those with pubertal onset, which are chi square tests of independence.

Table 5

Cross-Classification between Binge Eating Trajectory Groups and Purging Trajectory Groups: Frequencies of Membership

	No Purging	Dabble Purging	Increasing Purging	Total
No Binge Eating	514 (54.8%)	3 (0.3%)	0 (0%)	517
Decreasing Binge Eating	152 (16.2%)	66 (7.0%)	0 (0%)	218
Increasing Binge Eating	7 (0.7%)	75 (8.0%)	28 (3.0%)	110
High, Steady Binge Eating	25 (2.7%)	33 (3.5%)	35 (3.7%)	93
Total	698	177	63	938

Note. The percentages reported are percentages of the full sample of 938.

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