2015

DEVELOPMENTAL TRAJECTORIES OF EXCESSIVE EXERCISE AND FASTING ACROSS THE MIDDLE SCHOOL YEARS

Heather A. Davis
University of Kentucky, h.davis@uky.edu

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Heather A. Davis, Student

Dr. Gregory T. Smith, Major Professor

Dr. Mark Fillmore, Director of Graduate Studies

DEVELOPMENTAL TRAJECTORIES OF EXCESSIVE EXERCISE AND FASTING ACROSS THE MIDDLE SCHOOL YEARS

THESIS

A thesis submitted in partial fulfillment of
the requirements for the degree of Master of
Science in the College of Arts and Sciences
at the University of Kentucky

By

Heather A. Davis

Advisor: Dr. Gregory T. Smith, Professor of Psychology

Lexington, KY

2015

ABSTRACT OF THESIS

DEVELOPMENTAL TRAJECTORIES OF EXCESSIVE EXERCISE AND FASTING ACROSS THE MIDDLE SCHOOL YEARS

Repeated excessive exercise (EE) fasting behavior, in the absence of binge eating and purging, are important eating disorder behaviors that are not captured by the current diagnostic system. Though they appear to be harmful and distressing for adults, little is known about these behaviors in youth. To begin to understand their development, I studied the course of the behaviors across the three years of middle school (n = 1,195). Both behaviors were present in middle school girls and boys, and youth progressed along different developmental trajectories of engagement in the behaviors. Youth involved in either behavior experienced elevated levels of depression and some forms of high-risk eating and thinness expectancies. Their distress levels did not differ from those of youth engaging in purging behavior or low levels of binge eating. EE and fasting behavior can be identified in the early stages of adolescence, youth differ in their developmental experience of these behaviors, and they are associated with significant distress very early in development.

KEYWORDS: *eating disorder, compensatory behavior, excessive exercise, fasting*

Heather A. Davis

June 12, 2015

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By

Heather A. Davis

Gregory T. Smith, Ph.D.
Director of Thesis

Mark Fillmore, Ph.D.
Director of Graduate Studies

June 12, 2015

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CHAPTER ONE: INTRODUCTION

Background on Excessive Exercise and Fasting

There is growing evidence indicating the presence of nontraditional eating disorder behaviors that, though not represented in the current diagnostic system, are nevertheless harmful. In particular, researchers have investigated the psychological correlates of syndromes characterized by nonpurging compensatory behaviors, specifically, excessive exercise and fasting (Davis, Holland, Keel, 2014; LePage, Crowther, Harrington, Engler, 2008; Mond & Calogero, 2009; Mond, Hay, Rodgers, Owen, Crosby, Mitchell, 2006a; Tobin, Griffing, and Griffing, 1997). Excessive exercise is defined as exercising a great deal as a way to control one's weight or shape, or in response to an episode of excessive food consumption (Cooper & Fairburn, 1987; Mond, Hay, Rodgers, & Owen, 2006b). Fasting is generally defined as not eating for at least 8 waking hours for the purpose of controlling one's weight and/or shape (Cooper & Fairburn, 1987).

It appears that both of these nonpurging compensatory behaviors, even in the absence of objective binge eating and purging, are associated with harm among adults (Davis et al., 2014; Mond et al., 2006a; Tobin et al., 1997). For example, nonpurging compensatory behaviors in the absence of binge eating and purging have been linked to greater body image disturbance (Davis et al, 2014), elevated anxiety (Davis et al., 2014), increased functional impairment (Mond et al., 2006a) and increased likelihood of psychiatric hospitalization (Tobin et al, 1997). However, little is known about the emergence and development of these behaviors during adolescence. To address this need, the current study provides the first exploration of the developmental course of these behaviors in early adolescence.

There has been some research on maladaptive exercise behavior and fasting behavior among adolescents, but this work has typically included adolescents also engaging in binge eating and purging (Crow, Eisenberg, Story, Neumark-Sztainer, 2008; Pisetsky, Chao, Dierker, May, Striegel-Moore, 2008; Stiles-Shields, Goldschmidt, Boepple, Glunz, Le Grange, 2011). Most of these studies have included middle (Crow et al., 2008) and high school-aged (Crow et al., 2008; Pisetsky et al., 2008) children, and one involved a clinical sample of children aged 7 to 18 years (Stiles-Shields et al., 2011). Findings suggest that the two behaviors are both prevalent (Eddy et al., 2008; Machado, Machado, Goncalves, & Hoek, 2007) and potentially problematic (Allen, Crosby, Oddy, Byrne, 2013; Neumark-Sztainer, Wall, Story, Perry, 2003; Pisetsky et al., 2008; Stiles-Shields et al., 2013). Among middle to late adolescents, 37.5% reported dietary restriction and 12.5% reported excessive exercise (Machado et al., 2007). In a clinical sample of youth aged 12 to 19 years with eating disorders other than anorexia nervosa (AN) or bulimia nervosa (BN), about half reported engaging in excessive exercise and a quarter reported fasting (Eddy et al., 2008). The two behaviors have been associated with elevated anxiety and depression (Allen et al., 2013), increased substance abuse (Pietsky et al., 2008), suicidal ideation (Crow et al., 2008), social distress (such as increased teasing by peers; Neumark-Sztainer et al., 2003), and depressive symptomatology (Stiles-Shields et al., 2011). However, it is not yet clear whether excessive exercise and fasting relate to dysfunction in the absence of binge eating and purging.

The current study was designed to advance understanding of adolescent engagement in excessive exercise and fasting in two ways. First, no prior investigation has examined the longitudinal course of nonpurging compensatory behaviors among

adolescents. My primary aim was to test whether excessive exercise and fasting were present in a community sample of middle school-age early adolescents, and whether these behaviors follow different developmental courses for different youth across the middle school years. I focused on the middle school years because this period has been described as a potential turning point in adolescent development; it is associated with significant behavioral and psychological change (Graber & Brooks-Gunn, 1996; Rutter, 1994; Spear, 2000). Eating disorders in particular often develop during adolescence (Bulik, 2002); it may thus be important to understand the developmental emergence of excessive exercise and fasting during these years. Further, pubertal onset is associated with increased risk for eating disorder-related behaviors in girls and with the developmental emergence of heritable risk for eating disorders (Baker, Thornton, Lichtenstein, & Bulik, 2012; Klump et al., 2003). To date, no study has tested whether pubertal onset early in adolescence is associated with different trajectories of the development of excessive exercise and fasting behavior.

Second, little is known about the presence and correlates of nonpurging compensatory behaviors in the absence of other eating disordered behavior in adolescents. Therefore, it is not yet clear whether the two behaviors of excessive exercise or fasting alone are associated with psychological distress in youth. I addressed this need by (a) studying the early adolescent developmental course of excessive exercise and fasting among youth not engaging in either binge eating or purging, and (b) determining whether the emergence of these behaviors, again in the absence of binge eating or purging, is associated with dysfunction. Specifically, I tested whether engaging in nonpurging compensatory behaviors related to depressive symptomatology, as has been

shown in samples that included adolescents who also binge eat or purge, and to two eating disorder-specific risk factors: expectancies for reinforcement from eating (eating helps one manage negative affect) and expectancies for reinforcement from thinness (being thin leads to overgeneralized life improvement). These two expectancies predict subsequent eating disorder behaviors in adolescents (Pearson et al., 2012) and differentiate women with bulimia nervosa, anorexia nervosa, and psychiatric controls (Hohlstein, Smith, & Atlas, 1998).

It is quite possible that different youth proceed along different developmental trajectories in relation to nonpurging compensatory behaviors. At this early stage of research on these behaviors, it is important not to assume that all youth develop in the same way. It is also important to study girls and boys separately. Girls tend to engage in compensatory behaviors more often than boys (Abebe et al., 2012; Allen et al., 2012; Neumark-Sztainer et al, 2006; O'Dea, 2010; Haines, Ziyadeh, Franko, Mond, Austin, 2011; Pisetsky et al., 2008), although this may not be true for nonpurging compensatory behaviors (Anderson & Bulik, 2004; Crow et al., 2008; Goodwin, Haycraft, Meyer, 2012; Pisetsky et al., 2008; Stiles-Shields, 2011, 2013).

The Current Study

With these considerations in mind, I studied n = 1,910 youth at six time points: the fall and spring of 6th, 7th, and 8th grades (the middle school years in the participating school districts). I first identified a subset of this sample that reported no binge eating or purging behavior at all six time points (n = 1,195). I conducted a series of trajectory analyses on this subsample. Trajectory analysis is a statistical method that seeks to identify different subgroups of youth who proceed along different developmental

pathways over time (Nagin, 2005). I studied excessive exercise and fasting separately, and I studied developmental trajectories separately in boys and girls.

To determine if engagement in, or the development of, excessive exercise and fasting behaviors is associated with dysfunction among early adolescents, I compared trajectory groups on measures of depressive symptomatology and eating and thinness expectancies at the start of the longitudinal period. Doing so enabled me to determine whether development of either of the nonpurging compensatory behaviors follows from initial general and eating disorder-specific distress.

I also sought to determine whether engaging in the nonpurging compensatory behaviors was associated with less or similar levels of distress as is experienced by youth engaging in binge eating or purging. I therefore compared initial distress levels between those who engaged in nonpurging compensatory behaviors and those who engaged in binge eating and purging.

CHAPTER TWO: METHODS

Sample

Participants were drawn from a longitudinal sample of 1,910 youth (972 boys, 938 girls), who were assessed at six time points: Fall and spring of each year of middle school, or 6th through 8th grades. The mean age of the participants at the initiation of the study was 11.33 years. Most were European American (60.9%), followed by African American (18.7%); the remainder of the sample identified themselves as Hispanic (8.2%), Asian (2.9%), Middle Eastern (0.4%), or other (8.8%). From this larger group, I selected a subsample comprising all participants who did not report binge eating or purging during any of the six waves. The subsample included 1,195 youth (631 boys, 564 girls) and it did not differ from the larger sample on any demographic variable.

Measures

Demographic and Background Questionnaire. This measure provided the assessment of the demographic information reported above.

Eating Disorder Examination- Questionnaire *(EDE-Q;* Fairburn & Beglin, 1994*).* I used the EDE-Q, which is a self-report version of the Eating Disorders Examination semi-structured interview (Cooper & Fairburn, 1993) to assess excessive exercise and fasting. 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). As is typical in studies of youth, I adapted the EDE-Q 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). I measured excessive exercise with a sequence of two questions. The first was "Over the past two weeks, have you exercised a lot as a way to control your weight or because you ate a lot?" The item was dichotomous. Participants who responded "yes" then completed a second item: "If yes, on how many days of the last 14 have you done this?" There were six response options, ranging from "1-2 days" through "14 days or every day." I combined the two items, such that 0 reflected no excessive exercise, 1 reflected having done so 1-2 days of the last 14, 2 reflected 3-4 days of the last 14, 3 reflected 5-7 days of the last 14, 4 reflected 8-10 days of the last 14, 5 reflected 11-13 days of the last 14, and 5 reflected 14 days or everyday of the last 14 days. To measure fasting behavior, I used the item "Over the past two weeks, have you gone for long periods of time (8 hours or more) without eating in order to control your shape or weight?" Responses were dichotomous.

Center for Epidemiological Studies-Depression Scale (CES-D: Radloff, 1977) was used to measure individual differences in depressive symptomology, as is often done in this age group (e.g., Clarke et al., 2005). The scale has proven reliable (internal consistency estimates ranging from .85 to .90) and valid in numerous studies; it is frequently used with children, adolescents, and adults (Clarke et al., 2005; Radloff, 1977, 1991; Roberts, Lewinsohn, & Seeley, 1991). I used CES-D scores as interval scale indicators of depressive symptomology ($\alpha = .85$ in wave 1 and higher in subsequent waves).

Eating Expectancy Inventory (EEI; Hohlstein et al., 1998). This five-factor measure reflects expectancies for reinforcement from eating. For this study, I used the measure of the expectancy that eating helps one manage negative mood states. This scale

has been shown to differentiate women with BN from women with AN and both psychiatric and normal controls (Hohlstein et al., 1998) and to predict subsequent onset of binge eating (Pearson, Combs, Zapolski, & Smith, 2012; Smith et al., 2007). In the current sample, as in past samples, the scale was internally consistent (Wave 1 $\alpha = .93$ and higher in subsequent waves).

Thinness and Restricting Expectancy Inventory *(*TREI*;* Hohlstein et al., 1998*)*. This measure reflects overgeneralized expectancies about the life benefits of dieting and thinness. Items include such statements as "I would feel like I could do whatever I wanted to if I were thin." The scale has been shown to be unidimensional. It differentiates women with AN and women with BN from both psychiatric and normal controls (Hohlstein et al., 1998) and it predicts eating disorder symptom onset (Hohlstein et al., 1998; MacBrayer, Smith, McCarthy, Demos, & Simmons, 2001; Simmons et al., 2002; Smith et al., 2007). 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).

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). The PDS permits dichotomous classifications: following prior research, I rated scores of 2.5 or greater as reflective of pubertal onset.

Procedure

Data collection. Each wave, the questionnaires were administered in 15 public middle schools during school hours. A passive consent procedure was used. Each family was sent a letter, through the U.S. Mail, introducing the study. Families were asked to return an enclosed, stamped letter or call a phone number if they did not want their child to participate. Out of 1988 students whose families approached by letter, 95.8%, or 1910, of the students participated in the study. A total of 78 students did not participate due to one of the following reasons: Families declined participation for their child, students declined assent, or a variety of other reasons, such as language disabilities that precluded completing the questionnaires.

Data collections took place in the fall and then the spring in the three consecutive years of 6^{th}, 7^{th}, and 8^{th} grades (the three years of middle school in the participating school systems). Questionnaires were administered in school classrooms or cafeterias. It was made clear to the students that their responses to the measures were to be kept confidential and no one outside of the research team would see them. The research team introduced the federal certificate of confidentiality for the project and emphasized that they were legally bound to keep all responses confidential. After each participant signed the assent form, the researchers then passed out packets of questionnaires. Participants who moved out of the study's school districts were contacted and asked to complete the forms by mail and were paid $30 for doing so. The questionnaire administration took 60 minutes or less. This procedure was approved by the University's IRB and by the participating school systems. There was no compensation for participants (except for those who moved out of district).

Data analytic method. The primary analyses for this study were four trajectory analyses. Separately for girls and boys, I examined trajectories of the development of excessive exercise and of fasting behavior across the six waves of the study. I applied finite mixture modeling (Nagin, 2005), using SAS Version 9.1 PROC TRAJ to model trajectories as a function of measurement wave. I used zero inflated poisson (ZIP) modeling because a large number of participant responses were zeros (reflecting non-engagement in fasting or excessive exercise). 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 fits the data and to describe the shape of the trajectory for each group. One can then calculate the probability of each individual belonging to each of the trajectory groups that make up the model; individuals can then be assigned to the group to which the probability of their belonging is the highest.

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).

For each analysis, I proceeded as follows. I first specified two groups and then tested a series of models in which I 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).

Once I had determined trajectory group structure and assigned individuals to groups, I conducted analysis of variance (ANOVA) and planned contrasts to compare the groups on measures of depression, eating expectancies, and thinness expectancies. I report results comparing trajectory groups on these measures at wave 1 (the start of the longitudinal period), to determine if trajectories of change in fasting and excessive exercise had different distress levels at the start of the longitudinal period.

CHAPTER THREE: RESULTS

Participant Attrition Analysis and Treatment of Missing Data

Retention rates did not differ between the 1,195 individuals on whom I conducted the trajectory analyses and the full longitudinal sample of 1,910. Of the full sample, the percentage who participated ranged from 94.56% at wave 1 to 80.10% at wave 6. Analyses comparing those who participated and those who did not on all study variables indicated no significant differences. I therefore assumed data were missing at random, and I used the expectation maximization 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, such as deleting cases with missing data or conducting mean substitutions for missing values (Little & Rubin, 1989). As a result, I was able to make full use of the sample of 1,910 (1,195 for the trajectory analyses and 1,910 for analyses comparing trajectory groups to individuals who reported binge eating or purging).

Possible Effects due to School Membership

In order to determine whether there was significant covariance among the study variables due to participants attending the same school, I calculated intraclass coefficients for each variable (using middle school membership, n = 15, as the nesting variable). Intraclass coefficients ranged from .03 to .00. I therefore concluded that school membership was essentially unrelated to study variables.

Descriptive Statistics

Table 1 presents the frequencies of fasting and excessive exercise by sex over the 2 weeks preceding the assessments. As Table 1 shows, at each wave, over 19% of girls and over 18% of boys reported as least some excessive exercise over the preceding 2 weeks. At each wave, nearly 5% of girls and over 3% of boys reported as least some fasting over the preceding 2 weeks. The bottom of Table 1 presents the means and standard deviations for depression, eating expectancies, and thinness expectancies at wave 1, and the percentage of participants who underwent pubertal onset each wave. Table 2 presents correlations among all study variables at wave 1.

Subgroups of Girls and Boys: Different Developmental Trajectories

We used Nagin's (2005) procedure to determine (a) whether individual differences in girls' (and then boys') trajectories of excessive exercise and fasting could be characterized in terms of subgroups and (b) what the number and shapes of the excessive exercise and fasting trajectory groups were. I separately developed trajectory groups for excessive exercise and fasting.

Excessive Exercise Trajectories: Selection of Trajectory Models. For girls and for boys, the BIC and AIC values became progressively less negative from the two-group solution to the three-group solution, but worsened with the four-group solution. For both sexes, the four-group solution included groups with very small samples sizes and did not involve groups with substantively different trajectories from those apparent in the three-group solutions. I therefore adopted three-group solutions for both sexes. For girls, the

three-group solution for excessive exercise had average group membership probabilities from .87 to .96; for boys, the values ranged from .93 to .98.

Fasting Trajectories: Selection of Trajectory Models. For each analysis, for both girls and boys, the three-group solutions produced BIC and AIC values that were less negative, but they included groups with very small samples sizes and did not involve groups with substantively different trajectories from those apparent in the two-group solutions. I therefore adopted two-group trajectory solutions for both sexes. The two-group solution for fasting among girls had average group membership probabilities from .85 to .94. For boys, the two-group solution had average group membership probabilities from .83 to .89. Thus, there was clear, straightforward assignment of individuals to trajectory groups.

Girls' Excessive Exercise Behavior Trajectories. As shown in the bottom panel of Figure 1, of the 564 girls, 364 consistently reported essentially no excessive exercise behavior across the 3-year, six-wave period. Still, the rate of linear increase for this group was statistically significant: $t(563)=3.80$, $p < .001$. It appears that as these girls progressed through middle school, they became a little more likely to engage in exercise behavior to control weight or shape, but did not do so at a high level, as the average value in the spring of 8th grade is not very different from zero. A relatively large number of girls (n = 153) comprised what I refer to as the "decreasing group." They endorsed high levels of excessive exercise behavior in 6th grade, with the behavior appearing to drop to less than one time per week by 8th grade. The rate of linear decrease for this group was statistically significant, $t(152)=-6.75$, $p < .001$. A smaller group of girls (n = 47) made up the "increasing group." Their engagement in excessive exercise increased across the six

measurement waves. The pattern of increase followed a combination of a significant linear trend ($t(46) = 3.07$, $p < .01$), quadratic trend ($t(46) = -3.48$, $p < .001$) and cubic trend, ($t(46) = 3.5$, $p < .001$). At the start of 6th grade, they were engaging in virtually no excessive exercise and were not distinguishable from the asymptomatic trajectory group. However, by the end of 8th grade, the average girl in the increasing excessive exercise trajectory group reported exercising excessively to control weight or shape 3-4 times per week.

Boys' Excessive Exercise Behavior Trajectories. As shown in the bottom panel of Figure 2, of the 631 boys, 415 consistently reported essentially no excessive exercise behavior across the six waves. Similar to the girls' low exercise group, the rate of linear increase for this group was statistically significant, $t(414)=5.50$, $p < .001$. A group of 57 boys reported high levels of engagement in excessive exercise in 6th grade, with a dramatic decrease to essentially no excessive exercise in 8th grade. While the average boy in this group reported excessively exercising 3-4 times over the last 14 days in 6th grade, the average boy reported no excessive exercise by the end of 8th grade. I refer to this group as the decreasing group: the rate of linear decrease was statistically significant, $t(56) = -2.18$, $p < .05$. The final group of 159 boys is characterized by a trajectory of excessive exercise that remained consistently high across all three years of middle school. The reported behavior of this group of boys followed a statistically significant negative quadratic slope, $t(158)=-2.81$, $p < .01$, reflecting a concave trend.

Girls' Fasting Behavior Trajectories. As shown in Figure 1, top panel, 515 of the 564 girls reported little to no fasting behavior at each of the six semi-annual data collections spanning the period from the fall of 6th grade through the spring of 8th grade.

The rate of linear decrease for the little to no fasting trajectory group was statistically significant: $t(514) = -2.62$, $p < .01$. This finding suggests some early engagement in fasting by members of this group that did not continue. A second group of girls (n = 49) exhibited fasting behavior that was consistently high across the six measurement waves. Thus, a small subset of girls, none of whom engaged in binge eating or purging, consistently reported fasting for 8 or more hours to control their shape or weight. The rate of linear increase for the high fasting group was not statistically significant: $t(48) = .32$, $p = 0.75$. This pattern is striking: the high fasting group was already engaging in fasting behavior at the start of middle school, and engagement in this behavior neither increased nor decreased over the developmental period. I found no evidence of a group that initiated fasting behavior during middle school.

Boys' Fasting Behavior Trajectories. As shown in the top panel of Figure 2, of the 631 boys, 527 consistently reported essentially no fasting behavior across the 3-year, six-wave period. The rate of linear decrease for the little to no fasting trajectory group was not statistically significant: $t(526)=-1.74$, $p =.081$. A group of 104 boys exhibited fasting behavior that was consistently high across the six measurement waves. Thus, a substantial minority of boys who do not binge eat or purge consistently reported fasting for 8 or more hours to control their shape or weight. The rate of linear change for the high fasting group was also not statistically significant: $t(103)=-0.53$, $p = 0.60$. Similar to the girls' high fasting trajectory group, this finding indicates that this group of boys was engaging in fasting behavior before the fall of 6th grade, and engagement in the behavior neither increased nor decreased across the middle school years. Again, there was no indication of a group of boys that initiated fasting behavior over the course of the study.

Differences Among the Trajectory Groups on Depression and Eating Disorder-Specific Risk Factors

We report comparisons of the trajectory groups at wave 1. Results of comparisons among excessive exercise groups are presented in Table 3. Results of comparisons among fasting trajectory groups are presented in Table 4.

To examine differences among the excessive exercise groups, one-way ANOVA examined differences across excessive exercise developmental trajectory groups among girls and boys. I also conducted planned contrasts to compare specific groups, as described below.

Girls' Excessive Exercise. At wave 1, the three groups differed significantly on depression ($F(2, 561) = 15.03$, $p < .001$), expectancies that eating helps alleviate negative affect ($F(2, 561) = 8.04$, $p < .001$), and expectancies for overgeneralized life improvement from thinness ($F(2, 561) = 35.75$, $p < .001$). The three groups did not differ on pubertal status at wave 1 ($p > .24$).

Increasing group vs. asymptomatic group. I first contrasted the increasing group and the asymptomatic group at wave 1, to determine if those groups could be distinguished on any measures of dysfunction or on pubertal status, even though neither group reported excessive exercise at the time. Members of the increasing group reported more depressive symptoms ($t(1, 561) = 3.04$, $p < .01$) than the asymptomatic group. The two groups did not differ in either expectancies for reinforcement from eating ($p > .08$) or in expectancies for overgeneralized life improvement from thinness ($p > .30$). Thus, in

the absence of differences in exercise behavior or eating disorder-specific risk factors at the beginning of 6th grade, the group that subsequently began to engage in excessive exercise reported higher levels of depression. Members of the increasing group were not more likely to have gone through puberty than asymptomatic individuals ($p > .54$).

Decreasing group vs. other groups. I next contrasted the decreasing group (the group with elevated excessive exercise in wave 1) to the other two groups (both asymptomatic at wave 1) on the eating and thinness expectancy measures. The decreasing group endorsed significantly stronger expectancies that thinness leads to overgeneralized life improvement $t(1, 561) = 6.55$, $p < .001$) and expectancies that eating helps manage negative affect ($t(1, 561) = 2.14$, $p < .03$). I then contrasted the groups on pubertal status at wave 1. I found that members of the decreasing group were not more likely to have gone through puberty in wave 1 compared to the asymptomatic and increasing groups ($p > .55$).

Boys' Excessive Exercise. At wave 1, the three groups differed significantly on depression ($F(2, 628) = 12.63$, $p < .001$), expectancies that eating helps alleviate negative affect ($F(2, 628) = 7.51$, $p < .001$), and expectancies for overgeneralized life improvement from thinness ($F(2, 628) = 29.22$, $p < .001$). The three groups differed significantly in wave 1 pubertal status ($p < .002$).

Symptomatic groups vs. asymptomatic group. I first compared the combination of the decreasing and consistently symptomatic trajectory groups to the asymptomatic group on each variable. Those two groups were higher in depression symptoms ($t(1, 628) = 3.87$, $p < .001$), expectancies that eating helps alleviate negative affect ($t(1, 628) = 2.02$, p

< .05), and expectancies for overgeneralized life improvement from thinness ($t(1, 628) = 6.18$, $p < .001$). Boys in the symptomatic groups were more likely to have undergone pubertal onset at wave one than were boys in the asymptomatic group ($p < .001$).

Decreasing group vs. high group. I next compared the decreasing group to the consistently symptomatic group to see if those groups, though both engaging in excessive exercise at wave 1, could be differentiated on my symptom and risk variables. The consistently symptomatic group reported greater expectancies for reinforcement from eating ($t(1, 628) = 62.23$, $p < .05$), but the two groups did not differ in depression ($p > .16$), or expectancies for reinforcement from thinness ($p > .31$). Finally, the decreasing and high groups did not differ in pubertal status at wave 1 ($p > .78$).

Girls' Fasting. The high fasting group reported higher wave 1 depression symptom scores ($t(1, 562) = 5.26$, $p < .001$), stronger wave 1 endorsement of the expectancy that thinness leads to overgeneralized life improvement ($t(1, 562) = 4.70$, $p < .001$), stronger wave 1 endorsement of the expectancy that eating helps manage negative affect ($t(1,562) = 3.22$, $p < .001$), and were more likely to have undergone pubertal onset at wave 1 ($\chi^2 (1) = 6.54$, $p < .02$).

Boys' Fasting. The high fasting group reported higher wave 1 depression symptom scores ($t(1, 629) = 3.26$, $p < .001$) and stronger wave 1 endorsement of the expectancy that thinness leads to overgeneralized life improvement ($t(1, 629) = 2.79$, $p < .005$). They did not differ from the non-fasting group in expectancies that eating helps alleviate negative mood ($p > .25$), nor were they more likely to have undergone pubertal onset ($p > .27$).

Covariation between Excessive Exercise and Fasting Trajectory Group Membership

For both sexes, I conducted chi-square analyses to determine the degree to which membership in a symptomatic group for one behavior covaried with membership in a symptomatic group for the other behavior. I did so because the two behaviors are often described as two types of nonpurging compensatory behavior.

Girls' excessive exercise and fasting. As shown in the top half of table 5, membership in the two types of trajectory groups covaried: χ^2 (2) = 50.82, $p < .001$, phi coefficient = .29. As the table shows, 63% of girls were in consistently asymptomatic groups for both behaviors. Among the girls in the non-fasting trajectory group, 94% were in either the asymptomatic or decreasing excessive exercise group. Of the 49 members of the high fasting group, 13 were also in the increasing exercise group, while 36 were in the asymptomatic or decreasing excessive exercise groups. This suggests that engagement in fasting behavior may not appreciably heighten risk for engagement in excessive exercise behavior.

Boys' excessive exercise and fasting. The bottom half of table 5 presents the co-variation of trajectory group membership for the two behaviors for boys. There was again covariation between the two: χ^2 (2) = 16.16, $p < .001$, phi coefficient = .16. As the table shows, 58% of boys were in consistently asymptomatic groups for both behaviors. Among the boys in the non-fasting trajectory group, 64.7% were in either the asymptomatic or decreasing excessive exercise group. Of the 104 boys in the high fasting group, 41 were in the high excessive exercise group, while 63 were in the asymptomatic or decreasing excessive exercise groups. Similar to the girls' results, this suggests that

engagement in fasting behavior may not greatly increase risk for excessive exercise engagement.

Comparisons with binge eating and purging groups

Girls and boys who reported binge eating or purging in at least one wave formed the binge eating and purging subsample. This subsample consisted of 341 boys and 374 girls. Participants who reported binge eating at least once the previous two weeks in three or more waves were defined as a "high binge eating" group, while participants who reported binge eating in less than three waves were defined as a "low binge eating" group. All participants who reported purging in at least one wave were considered part of the purging group, because the total number of girls (n=4) and boys (n=9) who reported purging in three or more waves was small. I tested whether the derived trajectory groups differed from these binge eating and purging groups along the same dimensions used to compare the trajectory groups to each other. I again made the comparisons at wave 1.

Excessive Exercise

Excessive exercise compared to binge eating. For girls, I compared the two symptomatic groups (the decreasing and increasing groups) to the binge eating groups. At wave 1, girls in the decreasing and increasing excessive exercise trajectory groups did not differ from girls in the low binge eating group on depression ($p > .81$), or thinness expectancies ($p > .81$). Girls in the low binge eating group endorsed stronger expectancies for reinforcement from eating ($t(1, 845) = 3.19$, $p < .001$). Girls in the high binge eating group endorsed stronger expectancies for reinforcement from eating and from thinness ($t(1, 845) = 6.54$, $p < .001$, $t(1, 845) = 3.39$, $p < .001$, respectively).

For boys, I compared the consistently high excessive exercise group with the two binge eating groups. At wave 1, boys in the low binge eating group did not differ from the consistently high excessive exercise group in depression ($p > .99$), expectancies for reinforcement from eating ($p > .054$), or expectancies for reinforcement from thinness ($p > .72$). Boys in the high binge eating group did not differ from the consistently high excessive exercise trajectory group in expectancies for reinforcement from thinness ($p > .11$). They did endorse stronger expectancies for reinforcement from eating ($t(1, 896) = 6.05$, $p < .001$), had more depression symptoms ($t(1, 896) = 3.09$, $p < .01$), and reported a higher rate of fasting ($t(1, 896) = 3.00$, $p < .01$).

Excessive exercise compared to purging. At wave 1, girls in the increasing and decreasing excessive exercise groups did not differ significantly from girls in the purging group on depression ($p > .43$) or expectancies for reinforcement for thinness ($p > .43$). Girls who exhibited purging reported greater fasting behavior ($t(1, 777) = 2.00$, $p < .05$) and greater expectancies for reinforcement from eating than girls in the increasing and decreasing excessive exercise groups ($t(1, 777) = 3.21$, $p < .001$).

For boys, the consistently high excessive exercise group did not differ from the purging group on depression ($p > .91$), expectancies for reinforcement from eating ($p > .11$), or expectancies for reinforcement from thinness ($p > .64$). Boys who purged reported greater fasting behavior ($t(1, 826) = 2.05$, $p < .05$) than boys in the consistently high excessive exercise trajectory group.

Fasting

Fasting compared to binge eating. At wave 1, girls in the high fasting trajectory group reported more depression symptoms ($t(1, 846) = 2.15$, $p < .05$) and greater expectancies for reinforcement from thinness ($t(1, 846) = 2.27$, $p < .05$) compared to girls who endorsed low levels of binge eating. Those two groups did not differ on eating expectancies. However, when comparing the girls in the high fasting trajectory group to the girls who endorsed high levels of binge eating, the only significant difference was in eating expectancies. That is, girls who engaged in high levels of binge eating endorsed significantly higher expectancies that eating will help manage negative affect than girls in the high fasting trajectory group ($t(1, 846) = 4.24$, $p < .001$).

At wave 1, boys in the high fasting trajectory group did not differ from boys who exhibited low levels of binge eating on depression or thinness expectancies. Boys who exhibited high levels of binge eating endorsed more depression symptoms ($t(1, 897) = 3.04$, $p < .01$) and greater expectancies for reinforcement from thinness ($t(1, 897) = 2.64$, $p < .01$) than boys in the high fasting trajectory group. Boys engaging in both low levels and high levels of binge eating held stronger expectancies for reinforcement from eating than did boys in the high fasting group ($t(1, 897) = 2.82$, $p < .005$, $t(1, 897) = 6.47$, $p < .001$, respectively).

Fasting compared to purging. At wave 1, girls in the high fasting trajectory group did not differ significantly from girls in the purging group on depression ($p > .08$), expectancies for reinforcement from eating, expectancies for reinforcement from thinness ($p > .06$), or excessive exercise ($p > .11$). Boys in the high fasting trajectory group did not

differ from boys in the purging group on depression ($p > .75$), expectancies for reinforcement from thinness ($p > .21$), or excessive exercise ($p > .27$). Boys who engaged in purging behavior endorsed greater expectancies for reinforcement from eating ($t(1, 827) = 2.56$, $p < .01$) than boys in the high fasting trajectory group.

CHAPTER FOUR: DISCUSSION

Overall Results of the Study

Recurrent excessive exercise and fasting in the absence of binge eating and purging appear to be harmful and distressing to adults, but prior to this study very little was known about the behaviors in youth. The current study is the first to identify developmental trajectories for excessive exercise and fasting behaviors in middle-school aged girls and boys and the first to investigate dysfunction associated with these behaviors in the absence of the classic eating disorder symptoms of binge eating and purging. I found that (a) different trajectories of excessive exercise and fasting patterns occur in girls and boys as they develop through middle school, (b) the trajectory groups differed with respect to depression, eating expectancies, and thinness expectancies at the start of the trajectory period, and (c) the level of distress associated with excessive exercise and fasting was often comparable to that of youth engaging in binge eating and purging behavior.

With respect to excessive exercise, I identified three different groups with different patterns of change across middle school for both sexes. For girls, I identified two groups that were asymptomatic at the start of middle school: the larger group remained asymptomatic throughout middle school, but the smaller group reported increasing engagement in excessive exercise across those years. Interestingly, although the two groups could not be distinguished with respect to the target behavior of excessive exercise, the "increasing" group endorsed more depressive symptoms at wave 1 than did the asymptomatic group. A third group reported decreasing engagement in excessive

exercise over the middle school years. That group also reported more depressive symptomatology than the asymptomatic group at wave 1.

When compared to binge eating and purging girls, neither the increasing nor decreasing excessive exercise groups differed from low level binge eaters or purgers in depression or expectancies for reinforcement from thinness, although they were lower than high level binge eaters on these variables. The finding of comparable distress to that of low level binge eaters and purgers at the start of the longitudinal trajectory period highlights the potential harm associated with excessive exercise in middle school girls.

For boys at the start of 6th grade, I identified groups that were consistently asymptomatic, that decreased their excessive exercise over time, and that consistently engaged in the behavior throughout middle school. Boys in both the decreasing and consistently high excessive exercise groups reported more depression and stronger expectancies for reinforcement from thinness than did the asymptomatic group at wave 1. Both groups were similar in their depression and expectancy levels to boys reporting low levels of binge eating and boys reporting fasting, but lower than boys reporting high levels of binge eating. Importantly, the level of comparable distress to low levels of binge eating was apparent at the start of the trajectory period.

With respect to both girls' and boys' fasting behavior, the striking finding of this study was that a subset of youth were engaging in fasting behavior from the beginning of this study's longitudinal period. That is, from the beginning of the first year of middle school (6th grade) through the end of middle school (8th grade), substantial groups of girls and boys reported engaging in this behavior. Strikingly, the rates of fasting in these

subgroups neither increased nor decreased across the middle school years. I did not find the middle school years to be an important developmental period for this behavior; rather, I found the behavior to be present prior to the start of middle school and stable throughout that period.

For both sexes, membership in the fasting group was associated with higher levels of depressive symptomatology and stronger endorsement of expectancies for overgeneralized life improvement from thinness in the first year of middle school. Girls in the fasting group reported greater depression symptoms and expectancies for reinforcement from thinness than girls who exhibited low levels of binge eating, and endorsed similar levels of depression and thinness expectancies to girls who reported a high frequency of binge eating in 6th grade. Girls in the fasting group did not differ from girls who reported purging on these variables. Boys in the fasting group did not differ in depression or expectancies for reinforcement from thinness from boys who engaged in low-levels of binge eating or boys who reported purging. Boys who endorsed high levels of binge eating reported more depression and higher endorsement of both kinds of expectancies. Clearly, engagement in fasting behavior at this young age is associated with significant distress, in many ways comparable to that associated with the classic eating disorder symptoms of binge eating and purging.

Implications

There are a number of clinical implications to be drawn from these findings. Most fundamentally, both girls and boys are engaging in two nonpurging compensatory behaviors during the middle school years. There is harm associated with engagement of

these behaviors at the start of middle school, and, for some youth, before the behaviors even begin. In addition to the harm associated with the behaviors themselves, youth engagement in the behaviors is associated with both general and eating disorder-specific distress at levels comparable to that of many youth engaging in binge eating or purging behavior.

The finding that children this young are engaging in these behaviors suggests that intervention in the middle school years may be clinically necessary. Excessive exercise and fasting deserve the attention of eating disorder clinicians. One specific finding of clinical relevance is that asymptomatic girls who later develop excessive exercise behaviors report more depressive symptoms than do girls who remain asymptomatic across middle school. This finding suggests that depressive symptomology may be a risk factor for future engagement in excessive exercise behavior.

Although excessive exercise and fasting covaried significantly for both girls and boys, the phi coefficients measuring the magnitude of association were relatively modest (.29 for girls and .16 for boys). The two behaviors serve the similar purpose of weight and shape management and often do co-occur, but there are also many youth who engage in one behavior but not the other. The reasons for choice of excessive exercise and fasting merit further inquiry. Decisions about whether to combine the two behaviors into a common, nonpurging compensatory behavior syndrome should be made with their modest level of covariation in mind.

One possibility is that nonpurging compensatory behaviors in early adolescence set the stage for purging behavior by late adolescence or early adulthood. It is certainly

possible that many youth who reported fasting or exercising excessively during middle school turn later to purging behavior. The findings of this study cannot address that possibility. It is perhaps noteworthy, though, that a substantial number of youth engaged in excessive exercise or fasting behavior over the three year period of middle school without initiating purging behavior. Future, longer-term research on this topic is clearly necessary.

Limitations

The findings of this study should be considered in light of its limitations. First, all risk and behavioral symptom data were self-reported by questionnaire. Although the measures used demonstrated excellent psychometric properties in this and previous studies of adolescents, face-to-face interviews provide the opportunity for clarification of terms, which may be particularly useful in a sample of youth. Second, I did not include a measure of body mass index (BMI). The inclusion of BMI as a measure in this study may have clarified whether any of the participants were suffering from an established eating disorder (such as AN). Prior research has found that the lifetime prevalence of AN in adolescents is quite low (0.3%; Hoek, 2006). Therefore, it is unlikely that many girls and boys in the symptomatic trajectory groups were currently or historically underweight. Additionally, a recent study of compensatory behaviors in youth found that BMI of participants reporting excessive exercise and/or fasting did not differ from participants reporting no compensatory behaviors (Stiles-Shields et al., 2013). Nevertheless, I cannot know whether the inclusion of BMI would have altered the findings in the current study. Finally, fasting was measured dichotomously. I cannot know if different patterns of fasting behavior would have been apparent had it been measured on an interval scale.

Conclusions and Future directions

The findings of the current study indicate the presence of the nonpurging compensatory behaviors of excessive exercise and fasting among early adolescent girls and boys. There appear to be different groups of youth who proceed along different trajectories of engagement in these behaviors during the middle school years. When present by themselves (i.e., without binge eating and purging behavior), both behaviors are associated with both general (depressive symptoms) and eating disorder-specific dysfunction (eating and thinness expectancies) at the start of middle school. Research to further understand the development of these behaviors in youth can better inform clinical prevention and intervention efforts.

REFERENCES

Abebe, D. S., Lien, L., & von Soest, T. (2012). The development of bulimic symptoms from adolescence to young adulthood in females and males: A population‐based longitudinal cohort study. *International Journal of Eating Disorders*, *45*(6), 737-745.

Allen, K. L., Crosby, R. D., Oddy, W. H., & Byrne, S. M. (2013). Eating disorder symptom trajectories in adolescence: effects of time, participant sex, and early adolescent depressive symptoms. *Journal of Eating Disorders*, *1*(1), 32.

Allen, K. L., Byrne, S. M., Oddy, W. H., & Crosby, R. D. (2013). Early Onset Binge Eating and Purging Eating Disorders: Course and Outcome in a Population-Based Study of Adolescents. *Journal of Abnormal Child Psychology*, *41*(7), 1083-1096.

Anderson, C. B., & Bulik, C. M. (2004). Gender differences in compensatory behaviors, weight and shape salience, and drive for thinness. *Eating Behaviors*, *5*(1), 1-11.

Bulik, C. M. (2002). Eating disorders in adolescents and young adults. *Child and Adolescent Psychiatric Clinics of North America*, *11*(2), 201-218.

Carter, J. C., Stewart, D. A., & Fairburn, C. G. (2001). Eating disorder examination questionnaire: norms for young adolescent girls. *Behaviour Research and Therapy*, *39*(5), 625-632.

Clarke, G., Debar, L., Lynch, F., Powell, J., Gale, J., O'Connor, E., ... & Hertert, S. (2005). A randomized effectiveness trial of brief cognitive-behavioral therapy for

depressed adolescents receiving antidepressant medication. *Journal of the American Academy of Child & Adolescent Psychiatry*, *44*(9), 888-898.

Cooper, M. J., & Fairburn, C. G. (1993). Demographic and clinical correlates of selective information-processing in patients with bulimia nervosa. *International Journal of Eating Disorders,* 13, 109–116.

Cooper, Z., & Fairburn, C. (1987). The eating disorder examination: A semi‐structured interview for the assessment of the specific psychopathology of eating disorders. *International Journal of Eating Disorders*, *6*(1), 1-8.

Crow, S., Eisenberg, M. E., Story, M., & Neumark‐Sztainer, D. (2008). Suicidal behavior in adolescents: relationship to weight status, weight control behaviors, and body dissatisfaction. *International Journal of Eating Disorders*, *41*(1), 82-87.

Davis, H. A., Holland, L. A., & Keel, P. K. (2014). A preliminary examination of a nonpurging compensatory eating disorder. *International Journal of Eating Disorders*, *47(*3), 239-43.

Eddy, K. T., Celio Doyle, A., Rienecke Hoste, R., Herzog, D. B., & Le Grange, D. (2008). Eating disorder not otherwise specified in adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(2), 156-164.

Goodwin, H., Haycraft, E., & Meyer, C. (2012). The relationship between compulsive exercise and emotion regulation in adolescents. *British Journal of Health Psychology*, *17*(4), 699-710.

Graber, J. A., & Brooks-Gunn, J. (1996). Transitions and turning points: Navigating the passage from childhood through adolescence. *Developmental Psychology*, *32*(4), 768.

Haines, J., Ziyadeh, N. J., Franko, D. L., McDonald, J., Mond, J. M., & Austin, S. B. (2011). Screening high school students for eating disorders: Validity of brief behavioral and attitudinal measures. *Journal of School Health*, *81*(9), 530-535.

Hohlstein, L. A., Smith, G. T., & Atlas, J. G. (1998). An application of expectancy theory to eating disorders: Development and validation of measures of eating and dieting expectancies. *Psychological Assessment*, *10*(1), 49.

Keel, P. K., Baxter, M. G., Heatherton, T. F., & Joiner Jr, T. E. (2007). A 20-year longitudinal study of body weight, dieting, and eating disorder symptoms. *Journal of Abnormal Psychology*, *116*(2), 422.

LePage, M. L., Crowther, J. H., Harrington, E. F., & Engler, P. (2008). Psychological correlates of fasting and vigorous exercise as compensatory strategies in undergraduate women. *Eating Behaviors*, *9*(4), 423-429.

Little, R. J., & Rubin, D. B. (1989). The analysis of social science data with missing values. *Sociological Methods & Research*, *18*(2-3), 292-326.

Luce, K. H., & Crowther, J. H. (1999). The reliability of the eating disorder examination—Self‐report questionnaire version (EDE‐Q). *International Journal of Eating Disorders*, *25*(3), 349-351.

MacBrayer, E. K., Smith, G. T., McCarthy, D. M., Demos, S., & Simmons, J. (2001). The role of family of origin food‐related experiences in bulimic symptomatology. *International Journal of Eating Disorders*, *30*(2), 149-160.

Machado, P. P., Machado, B. C., Gonçalves, S., & Hoek, H. W. (2007). The prevalence of eating disorders not otherwise specified. *International Journal of Eating Disorders*, *40*(3), 212-217.

Mond, J. M., & Calogero, R. M. (2009). Excessive exercise in eating disorder patients and in healthy women. *Australasian Psychiatry*, *43*(3), 227-234.

Mond, J. M., Hay, P. J., Rodgers, B., & Owen, C. (2006b). An update on the definition of "excessive exercise" in eating disorders research. *International Journal of Eating Disorders*, *39*(2), 147-153.

Mond, J. M., Hay, P. J., Rodgers, B., Owen, C., & Beumont, P. J. V. (2004). Validity of the Eating Disorder Examination Questionnaire (EDE-Q) in screening for eating disorders in community samples. *Behaviour Research and Therapy*, *42*(5), 551-567.

Mond, J., Hay, P., Rodgers, B., Owen, C., Crosby, R., & Mitchell, J. (2006a). Use of extreme weight control behaviors with and without binge eating in a community sample: Implications for the classification of bulimic‐type eating disorders. *International Journal of Eating Disorders*, *39*(4), 294-302.

Nagin, D. S. (2005). Group-based modeling of development. Cambridge, MA: Harvard University Press.

Neumark-Sztainer, D., Wall, M. M., Story, M., & Perry, C. L. (2003). Correlates of unhealthy weight-control behaviors among adolescents: implications for prevention programs. *Health Psychology*, *22*(1), 88.

Neumark-Sztainer D, Wall M, Eisenberg M.E., Story M, Hannan PJ. (2006) Overweight status and weight control behaviors in adolescents: Longitudinal and secular trends from 1999 to 2004. *Preventative Medicine*, 43, 52–59.

O'Dea, J. (2011). Studies of obesity, body image and related health issues among Australian adolescents: how can programs in schools interact with and complement each other?. *The Journal of Student Wellbeing*, *4*(2), 3-16.

Pearson, C. M., Combs, J. L., Zapolski, T. C., & Smith, G. T. (2012). A longitudinal transactional risk model for early eating disorder onset. *Journal of Abnormal Psychology*, *121*(3), 707.

Pisetsky, E. M., May Chao, Y., Dierker, L. C., May, A. M., & Striegel‐Moore, R. H. (2008). Disordered eating and substance use in high‐school students: Results from the Youth Risk Behavior Surveillance System. *International Journal of Eating Disorders*, *41*(5), 464-470.

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385-401.

Radloff, L. S. (1991). The use of the Center for Epidemiologic Studies Depression Scale in adolescents and young adults. *Journal of Youth and Adolescence*, *20*(2), 149-166

Roberts, R. E., Lewinsohn, P. M., & Seeley, J. R. (1991). Screening for adolescent depression: a comparison of depression scales. *Journal of the American Academy of Child & Adolescent Psychiatry*, *30*(1), 58-66.

Rutter, M. (1994). Beyond longitudinal data: Causes, consequences, changes and continuity. *Journal of Consulting and Clinical Psychology,* 62, 928–940.

Simmons, J. R., Smith, G. T., & Hill, K. K. (2002). Validation of eating and dieting expectancy measures in two adolescent samples. *International Journal of Eating Disorders*, *31*(4), 461-473.

Smith, G. T., Simmons, J. R., Flory, K., Annus, A. M., & Hill, K. K. (2007). Thinness and eating expectancies predict subsequent binge-eating and purging behavior among adolescent girls. *Journal of Abnormal Psychology*, *116*(1), 188.

Spear, L. P. (2000). The adolescent brain and age related behavioral manifestations. *Neuroscience and Behavioral Reviews,* 24, 417–463.

Stiles-Shields, E. C., Goldschmidt, A. B., Boepple, L., Glunz, C., & Le Grange, D. (2011). Driven exercise among treatment-seeking youth with eating disorders. *Eating Behaviors*, *12*(4), 328-331.

Stiles‐Shields, E.C, Labuschagne, Z., Goldschmidt, A. B., Doyle, A. C., & Grange, D. L. (2012). The use of multiple methods of compensatory behaviors as an indicator of eating disorder severity in treatment‐seeking youth. *International Journal of Eating Disorders*, *45*(5), 704-710.

Tobin, D. L., Griffing, A., & Griffing, S. (1997). An examination of subtype criteria for bulimia nervosa. *International Journal of Eating Disorders*, *22*(2), 179-18.

Table 1: Descriptive Statistics: Fasting, Excessive Exercise, and study variables.

Sex	Frequencies of Fasting in last 14 days	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Girls (n=564)		39	35	29	28	29	22
Boys (n=631)		36	42	30	24	30	21

	Number of days Excessive Exercise in last 14 days	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Girls	None	452	440	454	446	438	431
	1-2	41	48	61	70	95	103
	3-4	21	27	22	20	19	10
	5-7	22	22	13	10	3	7
	8-10	9	6	5	7	5	3
	11-13	3	6	4	3	2	2
	>14	16	15	5	8	2	8
Boys	None	497	485	514	518	498	497
	1-2	54	60	54	64	87	85
	3-4	34	30	23	22	26	34
	5-7	24	27	19	9	6	6
	8-10	5	12	10	5	6	1
	11-13	1	4	2	5	3	2
	>14	16	13	9	8	5	6

	Factor and Wave	M	SD
Girls	Depression Symptoms-1	31.98	7.51
	Eating Expectancies-1	1.65	1.00
	Thinness Expectancies-1	2.47	1.58
Boys	Depression Symptoms-1	32.25	7.97
	Eating Expectancies-1	1.73	1.05
	Thinness Expectancies-1	2.35	1.47

Table 1 (cont.): Descriptive Statistics: Fasting, Excessive Exercise, and study variables.

Sex	Percentage of Participants who had undergone pubertal onset by Wave 1					
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Girls	28.2	38.8	45.6	60.8	64.0	75.9
Boys	30.1	38.2	48.0	59.1	65.5	75.9

Table 2: Correlations among study variables: Fasting (F) and Excessive Exercise (E) Depression (D), Eating Expectancies (EE), Thinness Expectancies (TE)

	F-1	E-1	D-1	EE-1	TE-1	P-1
F-1	-	.15**	.15**	.03	.17**	.08
E-1	.26**	-	.10*	.11*	.25**	.07
D-1	.19**	.13*	-	.17**	.19**	.09
EE-1	.14**	.03	.26**	-	.40**	.11*
TE-1	.27**	.25**	.19**	.32**	-	.08
P-1	.12*	.05	.14**	.02	.06	-

$N = 1{,}195$; * $p \leq .01$, ** $p \leq .001$

Shaded region represents correlations among variables for boys

Table 3: Excessive Exercise Wave 1 Contrasts

Fasting (F) and Excessive Exercise (E) Depression (D), Eating Expectancies (EE), Thinness Expectancies (TE)

				t-tests			
	Excessive Exercise Trajectory Group Means (SD)			Contrast 1 (Increasing vs. Asymptomatic)	Contrast 2 (Decreasing vs. Asymptomatic / Increasing)	Contrast 3 (Decreasing vs. Asymptomatic)	Contrast 4 (Decreasing vs. Increasing)
Girls	None	Decreasing	Increasing	*t(d)*	*t(d)*	*t(d)*	*t(d)*
D-1	30.72 (6.63)	34.28 (8.12)	34.18 (9.49)	3.04[b] (0.25)	2.23[a] (0.19)	5.04* (0.43)	0.087 (0.01)
EE-1	1.53 (0.91)	1.90 (1.13)	1.80 (1.07)	1.73 (0.15)	2.14[a] (0.18)	3.87* (0.33)	0.63 (0.05)
TE-1	2.12 (1.42)	3.33 (1.69)	2.36 (1.34)	1.03 (0.09)	6.55* (0.55)	8.44* (0.71)	3.92* (0.33)
	Excessive Exercise Trajectory Group Means (SD)			Contrast 1 (Decreasing/ High vs. Asymptomatic)	Contrast 2 (Decreasing vs. High)		Contrast 3 (Decreasing vs. Asymptomatic)
Boys	None	Decreasing	High	*t(d)*	*t(d)*		*t(d)*
D-1	31.17 (7.52)	33.09 (6.94)	34.78 (8.85)	3.87* (0.31)	1.40 (0.11)		1.74 (0.14)
EE-1	1.64 (0.98)	1.66 (0.90)	2.01 (1.21)	2.02[a] (0.16)	2.23[a] (0.18)		0.09 (0.01)
TE-1	2.05 (1.30)	2.67 (1.47)	3.03 (1.64)	6.18* (0.49)	1.54 (0.12)		3.09[b] (0.25)

[a] indicates t-test significance ≤ .05 level, [b] indicates t-test significance ≤. 01 level, * indicates t-test significance ≤. 001 level

Table 4: Fasting Trajectory Group Wave 1 Comparisons

Fasting (F) and Excessive Exercise (E) Depression (D), Eating Expectancies (EE), Thinness Expectancies (TE)

	Fasting Trajectory Group Means (SD)		t- tests	
Study Variable	None	High	*t*	*d*
Girls				
D-1	31.47 (6.88)	37.24 (11.01)	5.26**	0.44
EE-1	1.61 (0.95)	2.09 (1.40)	3.22**	0.27
TE-1	2.37 (1.52)	3.46 (1.87)	4.70**	0.40
Boys				
D-1	31.80 (7.49)	34.56 (9.78)	3.26**	0.26
EE-1	1.72 (1.03)	1.85 (1.12)	1.15	0.09
TE-1	2.28 (1.41)	2.72 (1.69)	2.79*	0.22

*indicates t-test significance ≤. 01 level

** indicates t-test significance ≤. 001 level

Table 5.

Covariation between membership in fasting and excessive exercise trajectories

Girls	Non-fasting	High fasting	Total
Non-excessive exercise	354 (62.8%)	10 (1.8%)	364
Decreasing excessive exercise	127 (22.5%)	26 (4.6%)	153
Increasing excessive exercise	34 (6.0%)	13 (2.3%)	47
Total			564
Boys	Non-fasting	High fasting	Total
Non-excessive exercise	364 (57.6%)	51 (8.1%)	415
Decreasing excessive exercise	45 (7.1%)	12 (1.9%)	57
Consistently high excessive exercise	118 (18.7%)	41 (6.5%)	159
Total			631

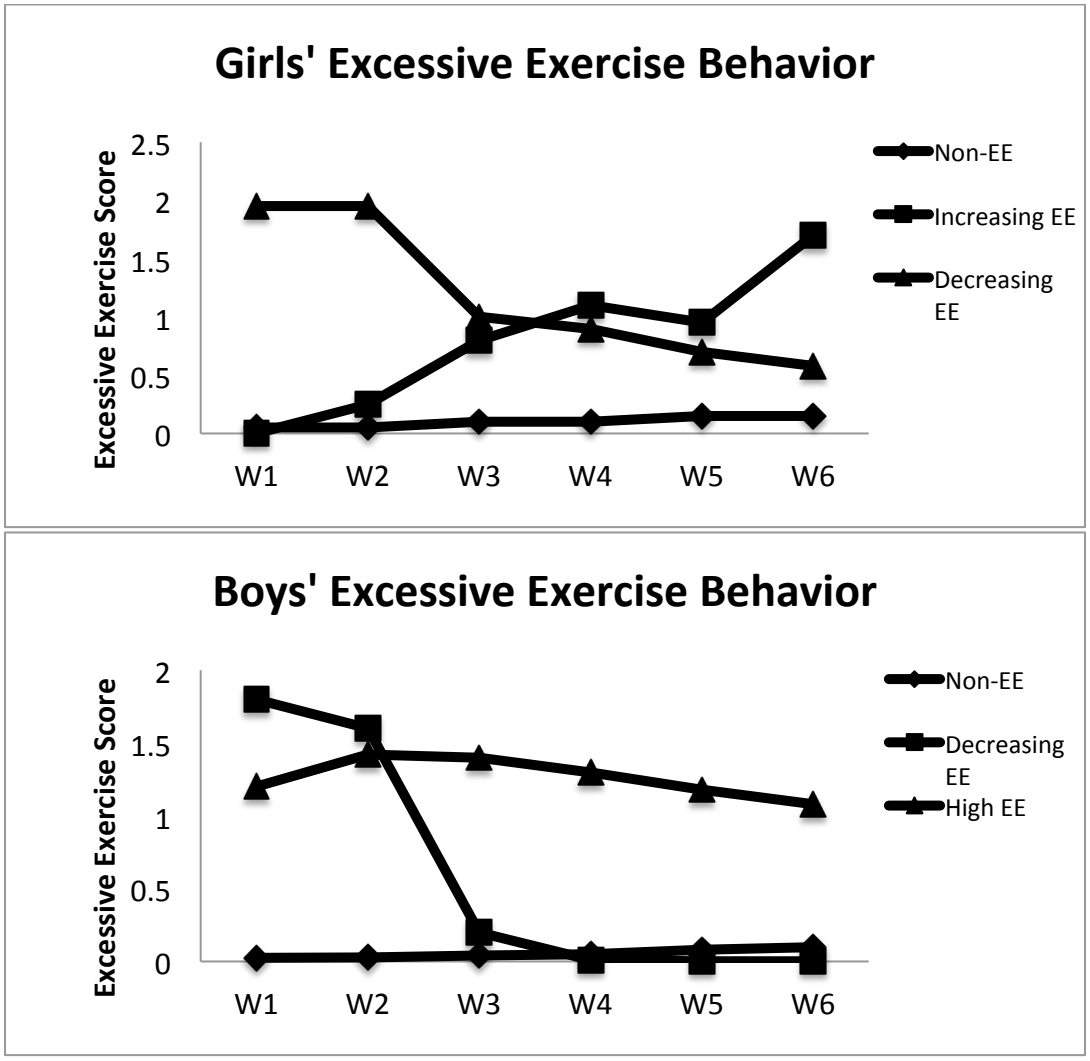

Figure 1. Results of trajectory analyses on reported excessive exercise behavior, among girls and boys, biannually from 6th through 8th grades. The top panels present trajectories of excessive exercise behavior among girls, and the bottom panels present trajectories of excessive exercise behavior among boys. W1 – W6: wave 1 through wave 6. The Y axis reflects mean number of occasions in the preceding two weeks.

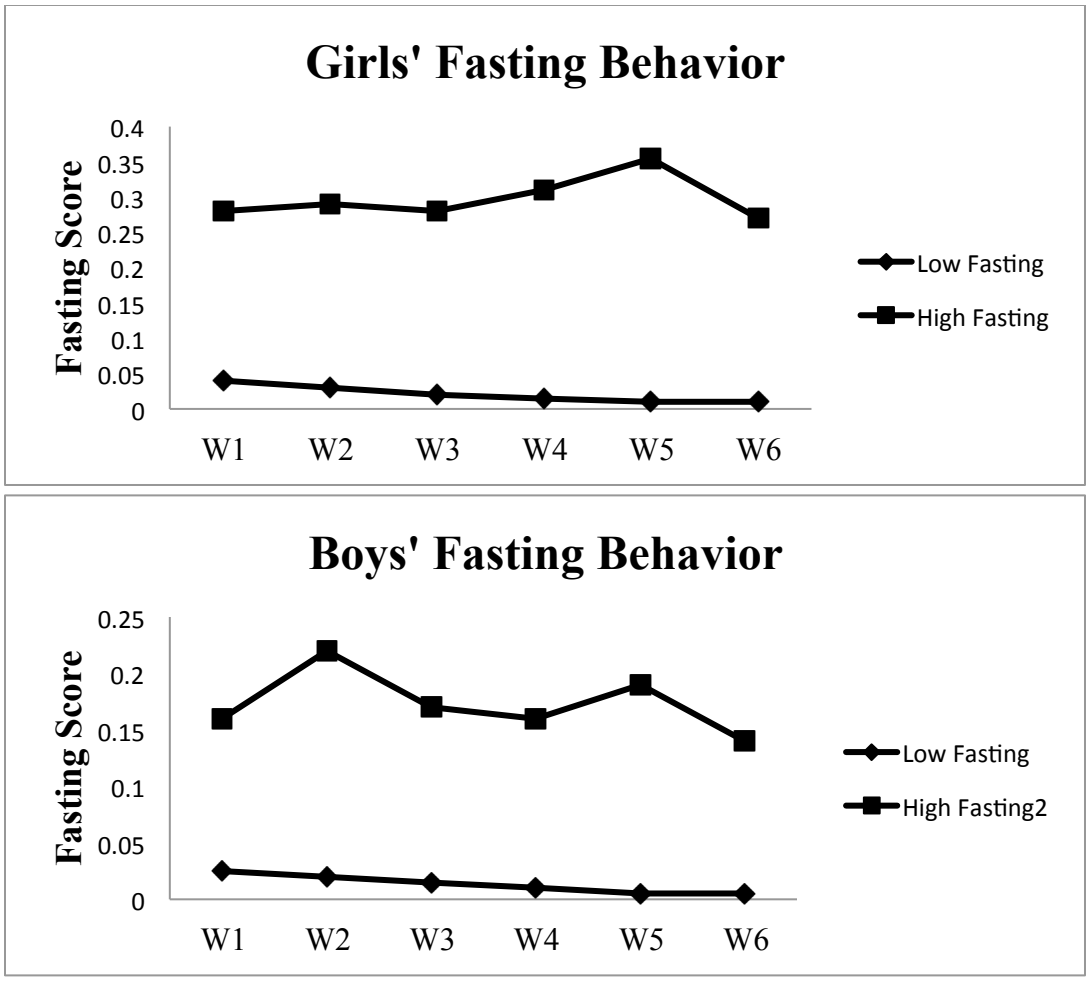

Figure 2. Results of trajectory analyses on reported fasting behavior among girls and boys, semiannually from 6th through 8th grades. The top panel presents trajectories of fasting behavior among girls, and the bottom panel presents trajectories of fasting behavior among boys. W1 – W6: wave 1 through wave 6. The Y axis reflects mean number of occasions in the preceding two weeks.

VITA

HEATHER A. DAVIS
Department of Psychology
University of Kentucky

EDUCATION

August 2013-Present	**University of Kentucky** American Psychological Association Accredited Program Clinical Psychology Doctoral Program Current GPA: 4.00/4.00
August 2008-April 2012	**Florida State University** B.S. in Psychology with Honors, Minor in Child Development Honors Thesis: *Examination of a nonpurging compensatory eating disorder* Chair: Pamela K. Keel, Ph.D. GPA: 3.64

PROFESSIONAL POSITIONS

August 2014- Present	**Jesse G. Harris Psychological Services Center** Student Therapist
August 2014- May 2015	**University of Kentucky Counseling Center** Practicum Therapist
August 2013- Present	**Department of Psychology University of Kentucky** Research Assistant
May 2012- June 2013	**Eating Behaviors Research Clinic Florida State University** Project Coordinator
May 2012- June 2013	**Eating Behaviors Research Clinic Florida State University** Undergraduate Research Assistant

HONORS AND AWARDS

Lyman T. Johnson Fellow, University of Kentucky
Best Poster Award, Undergraduate Research Day, Florida State University
Mark A. Berkley Undergraduate Research Endowment, Florida State University
Mentored Research and Creative Activity Award, Florida State University
Honors in the Major Program in Psychology, Florida State University
Dean's List, Florida State University
Freshmen University Scholarship, Florida State University

Florida Bright Futures Academic Scholarship, Florida State University
Psi Chi Honor Society Florida State University
Order of Omega Honor Society, Florida State University

PUBLICATIONS

Davis, H. A., Riley, E. N., & Smith, G. T. (2015). Transactions between personality and psychosocial learning: Advances in the acquired preparedness model of risk. In P. M. Monti, Suzanne M. Colby, and T. A. O'Leary (Eds.), *Adolescents, Alcohol, and Substance Abuse: Reaching Teens through Brief Interventions (2nd Edition).* New York: Guilford Press.

Davis, H. A., Guller, L., Riley, E. N. & Smith, G. T. (2015). A Positive Feedback Loop of Smoking Risk. In N. Columbus (Ed.) *Nicotine Dependence, Smoking Cessation and Secondhand Smoke: Exposure, Chemical Components and Health Consequences.*

Riley, E. N., **Davis, H. A.** & Smith, G. T. (2015). Personality Change and Problem Behavior: A Positive Feedback Loop of Increasing Risk in Early Adolescence. In N. Columbus (Ed.), *Advances in Psychology Research.*

Riley, E. N., Combs, H., **Davis, H. A.**, & Smith, G. T. (2015) Theory as evidence: Criterion validity in neuropsychological testing. In Bowden, S. C. (Ed.), Evidence-Based Neuropsychological Practice: National Academy of Neuropsychology. NY: Oxford University press.

Pearson, C. M., Riley, E. N., **Davis, H. A.,** & Smith, G. T. (2014). Research Review: Two pathways toward impulsive action: an integrative risk model for bulimic behavior in youth. *Journal of Child Psychology and Psychiatry*, *55*(8), 852-864.

Riley, E. N., Combs, J. L., **Davis, H. A.,** & Smith, G. T. (2014) Impulsive behaviors that distract from distress: Non-suicidal self-injury. In M. Olmstead (Ed.), *Psychology of Impulsivity: New Research*

Davis, H. A., Holland, L. A., Keel, P. K. (2014). A preliminary examination of a nonpurging compensatory eating disorder. *International Journal of Eating Disorders, 47*(3), 239-243

Smith, A. R**.**, Fink, E. L., Anestis, M. D., Ribeiro, J., Gordon, K. H., **Davis, H.**, Keel, P. K., Bardone-Cone, A. M., Peterson, C. M., Klein, M. H., Crow, S., Mitchell, J. E., Crosby, R. D., Wonderlich, S. A., le Grange, D., & Joiner, T. E. (2013). Exercise caution: Over-exercise is associated with suicidality in bulimia nervosa. *Psychiatry Research, 26,* 246-255

PRESENTATIONS

Davis, H. A., Smith, G. T. "The role of pubertal onset in the risk process for binge eating behavior." Paper presented at the University of Kentucky Children at Risk Research Conference. Lexington, KY, April 2015.

Davis, H. A., Smith, G. T. "The role of pubertal onset in the risk process for binge eating behavior." In K. Van Eck (Chair), *How inhibitory control deficits, food reward processing, and negative affect link to binge-eating and weight gain in youth.* Symposium conducted at the meeting of the Society for Research in Child Development. Philadelphia, PA, March 2015.

Davis, H. A., Guller, L., Smith, G. T. "Developmental trajectories of fasting behavior and excessive exercise." Poster presented at the Eating Disorders Research Society meeting. San Diego, CA, October 2014.

Davis, H. A., Guller, L., Smith, G. T. "Developmental trajectories of fasting behavior and excessive exercise." Poster presented at the University of Kentucky Children at Risk Research Conference. Lexington, KY, April 2014.

Davis, H. A., Holland, L. A., Keel, P. K. "A preliminary examination of a nonpurging compensatory eating disorder." Poster presented at the Eating Disorders Research Society meeting. Bethesda, MD, September 2013.

Pearson, C. M., Riley, E., **Davis, H. A.,** Smith, G.T. "Two pathways toward impulsive action: An integrative risk model for bulimic behavior in youth." Poster presented at the Eating Disorders Research Society meeting. Bethesda, MD, September 2013.

Davis, H. A., & Keel, P. K. "Examination of a Nonpurging Compensatory Eating Disorder." Paper orally presented at the Florida State University Psychology Howard Baker Talk Symposium. Tallahassee, FL, April 2012.

Davis, H. A., & Keel, P. K. "Examination of a Nonpurging Compensatory Eating Disorder." Poster presented at the Florida State University Psychology Undergraduate Research Day. Tallahassee, FL, April 2012.

Davis, H. A., & Keel, P. K. "Examination of a Nonpurging Compensatory Eating Disorder: Preliminary findings." Poster presented at the Florida State University Undergraduate Research & Creative Activity Award Symposium. Tallahassee, FL, October 2011.