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Investigating Risk Factors of the Development of Compulsive Exercise and Eating Disorder Symptoms in College Students

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Investigating Risk Factors of the Development of Compulsive Exercise and Eating Disorder Symptoms in College Students

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy Department of Psychology College of Arts and Sciences University of South Florida

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Keywords: compulsive exercise, exercise identity, disordered eating, peer exercise norms

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Dedication

This dissertation is the product of kindhearted mentorship, supportive friendships, and endless encouragement from numerous individuals. Above all, this project was possible due to the invaluable guidance from my mentor Dr. Diana Rancourt. From the moment I accepted a position as your student, you have championed my ideas, supported my development as a researcher, and have always pushed me to do the things I was quick to talk myself out of. Without your support, I would not have accomplished what I have thus far.

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To my friends and family, thank you for cheering me on while I pursued my dreams. Last, to my husband Spencer, thank you for your unwavering support and love throughout my PhD journey and long beforehand, I would not be where I am today without you.
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Abstract

Compulsive exercise (e.g., high exercise frequency combined with the inability to reduce or stop exercising) is associated with a variety of maladaptive outcomes in college students, such as quality of life impairment, body dissatisfaction, and poor physical health outcomes. Recent research suggests that compulsive exercise is highly prevalent among college students and that engagement in compulsive exercise behaviors may increase over the first year of college. Given that college is an important developmental period for establishing behavioral patterns that affect long-term health, developing effective preventative interventions for compulsive exercise among early college students is paramount. Extant cross-sectional work suggests that exercise identity is associated with compulsive exercise behaviors among college students; however, there are no longitudinal investigations of this relationship. Additionally, some research suggests that perceived social norms are associated with exercise behaviors, yet no studies specifically assess compulsive exercise. This study investigated compulsive exercise, exercise identity, peer exercise norms, and eating disorder symptoms among 334 first year college students (50.8% female at Time 4) at four time-points over a nine-month academic year. Contrary to hypotheses, linear growth of compulsive exercise was not observed; however, initial exercise identity and peer exercise norms emerged as significant predictors of change in compulsive exercise. Further, engagement in compulsive exercise was a significant predictor of change in eating disorder symptoms both within each semester and across the first year of college. Findings have implications for the prevention and treatment of maladaptive exercise and disordered eating behaviors.
Chapter One: Introduction

Eating disorders affect approximately 18 million individuals in the United States at some point in their lives (Hudson et al., 2007) and are associated with significant psychological distress, quality-of-life impairment, and medical concerns (Fitzsimmons-Craft et al., 2019). College is a particularly high risk period for the development of eating disorders (Fitzsimmons-Craft et al., 2019), with approximately 60% of college students at high risk for the development of a clinical or subclinical eating disorder (Fitzsimmons-Craft et al., 2019). In addition, disordered eating behaviors have been shown to increase over the first 9-months of the academic year among first year college students (Delinsky & Wilson, 2008; Striegel-Moore et al., 1989). Eating disorders among college students are associated with declines in academic performance and overall quality of life (Fitzsimmons-Craft et al., 2019), underscoring college as an important context for early prevention efforts related to eating disorder symptoms.

Current eating disorder prevention programs typically produce small to moderate effect sizes (Le et al., 2017), suggesting that existing preventative interventions for eating disorders are lacking. One way to improve existing preventive interventions related to eating disorder symptoms is to identify novel risk factors for disordered eating behaviors that may generate more robust prevention outcomes. Compulsive exercise (e.g., driven and inflexible exercise patterns combined with the inability to reduce or stop exercise behaviors; Taranis & Meyer, 2011) is one previously overlooked risk factor for eating disorders that may bolster prevention outcomes if appropriately targeted. Compulsive exercise has recently been identified as a key unmet challenge in the treatment of eating disorders (Zipfel et al., 2015). Approximately 84% of
individuals with eating disorders engage in compulsive exercise over their lifetime (Taranis & Meyer, 2011) and compulsive exercise is often one of the last eating disorder symptoms to remit during treatment (Meyer et al., 2011). Compulsive exercise is the most frequently reported compensatory behavior (i.e., a deliberate method of expending unwanted calories; Davis et al., 1995) observed among children and adolescents and is thought to be a “gateway behavior” to other future compensatory behaviors (e.g., vomiting or laxative use). However, exercise behavior is rarely targeted in eating disorder preventive interventions or treatments.

Until recently, compulsive exercise was conceptualized only as a compensatory behavior in the context of eating disorders. However, evidence suggests that compulsive exercise may occur independently of other eating disordered behaviors (Lichtenstein et al., 2017). Specifically, compulsive exercise is associated with elevated eating pathology among non-eating disordered samples (Meyer et al., 2011) and is prevalent among college students (Schaumberg et al., 2014). Additionally, compulsive exercise has been shown to increase over the 9-month academic year among college students with athletic-ideal and thin-ideal internalization (Homan, 2010). Further, certain aspects of compulsive exercise have been shown to increase over the first semester of college among first year students (Zhan et al., 2022). This suggests that compulsive exercise may be a unique maladaptive behavior that is prevalent among first year college students.

Yet, this maladaptive behavior is neglected in eating disorder screening and prevention programs. Importantly, compulsive exercise may be an overlooked risk factor in populations in which over-exercise may be perceived positively, such as among athletes, males, and college students more generally. It may even be considered a desirable behavior, especially given pervasive trends of weight stigma (Puhl et al., 2021). Notably, it is not the exercise behavior itself that defines compulsive exercise, but rather the underlying cognitions and motivations
related to exercise behaviors (Goodwin et al., 2016). Despite strong associations between compulsive exercise and eating disorders, it is unknown if compulsive exercise truly is a risk factor for eating disorders or simply a correlate.

Compulsive exercise is associated with a variety of problematic physical (e.g., stress fractures, exercising despite injury; Hausenblas & Downs, 2002) and mental health outcomes (e.g., increased negative mood and social isolation, body dissatisfaction; Homan, 2010; Li et al., 2015). However, currently, little is known about risk factors for compulsive exercise, limiting the understanding of important prevention and intervention targets for this problematic behavior. Examining novel and developmentally salient psychosocial risk factors of compulsive exercise will inform the development of preventative interventions targeted at reducing compulsive exercise. Given associations between compulsive exercise and eating disorders, prevention of compulsive exercise also may produce downstream consequences of preventing eating disorders. Informed by deviance regulation theory (Blanton et al., 2001), this dissertation project investigates how exercise identity and peer exercise norms predict the trajectory of compulsive exercise, as well as examines compulsive exercise as a risk factor for eating disorder symptoms.

**Deviance Regulation Theory**

Deviance regulation theory (DRT; Blanton & Christie, 2003; Blanton et al., 2001) proposes that people self-regulate their behaviors based on perceived social consequences of deviating from behavioral norms. DRT specifically focuses on descriptive peer norms, which reflect an individual’s perception of how other people are behaving (e.g., most of my friends exercise at least three times per week; Kim et al., 2019), and injunctive norms, which reflect social approval or disapproval of a given behavior (Cialdini et al., 2006). DRT suggests that individuals may create meaningful identities by engaging in actions based on reference group
norms (Blanton & Christie, 2003). Within a DRT framework, individuals are thought to self-regulate their behaviors based on social norms in two ways: 1) the desire to “stand out” to achieve a positive identity for being different from that of existing norms and 2) the desire to “fit in” to avoid a negative identity that contrasts social norms in undesirable ways (Blanton & Christie, 2003). For example, if there are low descriptive norms (i.e., few individuals engage in a behavior), but the behavior is positively perceived, an individual may engage in that behavior to positively deviate from the norm. In the case of compulsive exercise, if exercise is perceived positively, individuals may engage in greater levels of exercise to deviate from the norm in a way that will be socially rewarded and contribute to their positive identity.

DRT successfully predicts a variety of adaptive and maladaptive health behavior intentions and motivations (Dvorak et al., 2018; Ferrer et al., 2012; Hall & Blanton, 2009), though no studies to date focus on disordered eating or exercise. Recent research, however, supports investigating maladaptive exercise within a DRT framework. Findings suggested that individuals who are high in both exercise identity and weight bias (i.e., negative attitudes towards individuals with excess weight; Forbush et al., 2013) may be at greatest risk for engaging in maladaptive exercise behaviors (Palermo et al., 2021). In this study, weight bias was conceptualized as a norm-based attitude, given evidence that fitness professionals and frequent exercisers strongly endorse weight bias (Flint et al., 2015; Robertson & Vohora, 2008). There also is ample evidence that disordered eating and exercise behaviors more broadly are influenced by social norms and context, particularly among adolescents and young adults (Clemens et al., 2008; Eisenberg & Neumark-Sztainer, 2010; McArthur & Raedeke, 2009), which will be described in more detail below. Taken together, extant work provides support for using DRT to understand risk factors for disordered eating and exercise behaviors.
Though DRT research primarily focuses on intentions and motivations, DRT-based interventions are associated with behavior change, including increases in physical activity (Crozier & Spink, 2017; Dvorak et al., 2018). Important to the current study, DRT-based interventions targeting physical activity do not measure if the exercise behaviors of participants are adaptive or maladaptive. It is notable that only research on DRT-based interventions measure behaviors as outcomes (Dvorak et al., 2018; Hall & Blanton, 2009; Sargent et al., 2018) while DRT-based interventions hold potential to be particularly effective for college students’ disordered eating and maladaptive exercise behaviors given: 1) that messaging about what is normative can be altered based upon what behavior change is desired and 2) social norms are particularly relevant for behavior regulation among this population (Borsari & Carey, 2001; Forney & Ward, 2013; Haines & Spear, 1996). The current study is novel as it is a non-intervention study using DRT to predict early college students’ actual behaviors.

Identity and Eating Disorders

Identity development is posited to be an important psychosocial task during adolescence and young adulthood (Erikson, 1968). Identity is defined as parts of the self, composed of the meanings that individuals attach to their multiple roles in life (Stryker & Burke, 2000). Additionally, previous research suggests that eating disorders are thought to stem from fundamental disturbances in personal identity development (Stein & Corte, 2008). According to identity theory, there are three main types of identities: social/group identities (who a person is in terms of groups to which they belong), role identities (who a person is in terms of the roles they occupy), and personal identities (who a person is in terms of personal characteristics they claim; Burke, 2013). Identity theory posits that identity functions to self-regulate behavior since individuals are motivated to maintain their identities and will monitor and engage in behaviors
that are consistent with and reinforce identities they value (Reifsteck et al., 2016). One important concept of identity theory relevant to behavior regulation is identity salience, defined as the importance of one identity relative to others (Stryker, 1980). The more salient one's identity, the more likely it is that individuals will engage in identity-consistent behaviors (Stets & Burke, 2000).

Identity salience is what influences the likelihood that a given identity will be invoked in a social interaction (Stryker, 1987). The more salient one's identity in a given situation, the more likely it is that an individual will engage in behaviors associated with that identity (Stets & Burke, 2000). While many studies investigate aspects of identity as predictors and/or risk factors for a variety of behaviors, this literature often disregards how identity salience may influence the behaviors of interest. For example, someone identifying as African American (by simply checking a race/ethnicity box on a survey) may not have a highly salient African American identity (i.e., they do not strongly identify with the values of that cultural community). Yet, researchers may erroneously assume that because this individual self-identified as African American that this is a salient identity. Conceptually, identity salience is an important, but overlooked, psychosocial predictor of behaviors. Specifically, there is limited empirical work that investigates how the salience of certain role identities is related to eating disordered and exercise behaviors.

**Exercise Identity as a Risk Factor of Compulsive Exercise**

One role identity that may be particularly relevant to eating disordered and compulsive exercise behaviors is exercise identity (Karr et al., 2014; Lantz et al., 2004). Individuals with strong exercise identity may be particularly motivated to engage in and maintain exercise behaviors. Indeed, strong exercise identity can foster motivation for exercise behaviors over a 6-
month period (Ntoumanis et al., 2018) and a meta-analysis suggests a positive relationship between exercise identity and physical activity behaviors broadly (Rhodes et al., 2016). These studies, however, do not distinguish between adaptive and maladaptive exercise. Limited work investigating maladaptive exercise outcomes suggests that exercise identity is associated with compulsive exercise (Karr et al., 2014) and disordered eating behaviors (Lantz et al., 2004; Palermo et al., 2021). Currently, the research on compulsive exercise and exercise identity is cross-sectional and it is unknown if exercise identity is a risk factor for compulsive exercise behaviors. Given that identity development is an important psychosocial task during adolescence and young adulthood (Erikson, 1968) investigating exercise identity as a risk factor for compulsive exercise among first year college students will contribute to an improved understanding of how compulsive exercise may develop, as well as establish if exercise identity is a valuable target for compulsive exercise preventive interventions.

Social Norms and Eating Disordered and Exercise Behaviors

Descriptive peer norms influence disordered eating behaviors (Clemens et al., 2008). For example, a prospective study of female adolescents demonstrated that friends’ self-reported dieting behavior predicted participants’ engagement in disordered eating behaviors five years later (Eisenberg & Neumark-Sztainer, 2010). Among female athletes, teammates have been identified as having a negative influence on athletes’ eating attitudes and behaviors through normalizing disordered eating attitudes and behaviors (Arthur-Cameselle & Quatromoni, 2011). Similarly, perceived maladaptive norms related to food, weight, and shape (e.g., beliefs that teammates were engaging in pathological eating behaviors) are linked to increased disordered eating attitudes and behaviors among individual sports team members (Engel et al., 2003). Last, peers’ eating behaviors can contribute to body image and eating disturbances among college
students more generally (Crandall, 1988; Giles et al., 2007; Gravener et al., 2008; Zalta & Keel, 2006). In sum, research suggests that college appears to be a time during which peer norms are influential to young adults’ disordered eating behaviors.

Notably, no extant research examines how peer norms may predict maladaptive exercise specifically. Some research suggests that descriptive norms are associated with (Ball et al., 2010; Emmons et al., 2007; Heinrich et al., 2008; Priebe & Spink, 2011) and influence exercise behaviors more generally (Carpenter & Amaravadi, 2019). This limited work, however, does not distinguish between adaptive and maladaptive exercise behavior. Consistent with DRT, the extent to which peer norms influence exercise behavior may be impacted by the extent to which college students hold exercise as part of their identity. Contrary to theoretical expectations, one study found that perceiving peers as engaging in frequent exercise (i.e., strong peer norms) was associated with increased intention to exercise among individuals with low exercise identity, but not high exercise identity (Yun & Silk, 2011). This study, however, was cross-sectional and only assessed intention to exercise. It is possible that individuals who already hold strong exercise identity may be less influenced by peer exercise norms. As early college students are engaging in developmental tasks related to identity development in the context of new peer norms, they may be more susceptible to being influenced by these new peer norms. Investigating the relationships between exercise identity, peer exercise norms, and exercise behaviors among college students is important to identifying exercise-related eating disorder prevention and intervention targets.

**Current Study**

Research examining associations among compulsive exercise, eating disorder symptoms, peer norms, and exercise identity primarily is cross-sectional in nature, limiting causal conclusions. The current study is based in deviance regulation theory (Blanto
and contributes to prevention and intervention efforts related to disordered eating and exercise behaviors. The current study had two aims. The first aim was to investigate how peer norms and exercise identity may predict the trajectory of compulsive exercise over a 9-month period – i.e., a standard academic year. Based on extant work, it was hypothesized that compulsive exercise would increase over the 9-month study period (Hypothesis 1). Consistent with identity theory, it was anticipated that stronger initial exercise identity at Time 1 would predict greater increases in compulsive exercise over time (Hypothesis 2a). Further, consistent with DRT, it was hypothesized that peer exercise norms at Time 1 would moderate the association between exercise identity at Time 1 and change in compulsive exercise over time. Specifically, it was anticipated that among individuals with stronger exercise identity, stronger peer exercise norms would be associated with greater increases in compulsive exercise (Hypothesis 2b). The second aim of the study was to examine compulsive exercise as a risk factor for eating disorder symptoms in first year college students. Given evidence that compulsive exercise may exist independent of eating disordered behaviors, it was hypothesized that compulsive exercise would significantly and prospectively predict eating disorder symptoms over the 9-month study period (Hypothesis 3).
Chapter Two: Method

Participants

The current study examined first-year college students (ages 18-20) at a large southeastern university who self-reported being able to engage in physical activity. First year college students were defined as “an individual who is in their first year of college participation”. Individuals were excluded if they were a transfer student, including those who had completed community/junior college classes. Additional exclusion criteria were: (1) inability to speak, read, or write English, and (2) currently in treatment for an eating disorder.

Time 1

At Time 1, 717 individuals indicated interest in being screened for eligibility to participate in the study. Of those, 362 individuals were eligible for the study and 360 individuals completed the Time 1 survey. Twenty-six individuals were removed for failing attention checks, leaving 334 first-year college students (49.1% female, mean age=18.16) for analyses. The sample was primarily Caucasian (39.5%; Multiracial: 21.9%; Hispanic or Latinx: 14.4%; Asian: 14.1%; Black or African American: 5.1%; Arab or Middle Eastern: 3.0%; Other: 1.5%; and Southeast Asian: 0.6%). The sample primarily identified as Heterosexual/Straight (78.4%; Bisexual/Pansexual/Plurisexual: 14.4%; Gay or Lesbian: 2.4%; Asexual: 2.4% and Other: 2.4%). Individuals primarily indicated living on-campus (58.4%; Off-campus with family: 23.1%; Off-Campus with roommates: 17.4% and Other: 1.2%). Individuals at Time 1 had an average self-reported BMI of 23.64 (SD=4.77) and 37.1% of participants considered themselves to be an athlete.
Time 2

Of the 334 individuals eligible to complete Time 2, 280 individuals responded to the Qualtrics survey. Twenty individuals were removed for failing attention checks, one individual was removed for not having Time 1 data, 11 were removed for missing data past name and email, and three were removed for completing the survey twice, leaving 245 individuals (51.0% female, mean age at Time 1=18.15) available for analyses (73% retention rate). The sample was primarily Caucasian (38.0%; Multiracial: 22.0%; Hispanic or Latinx: 15.1%; Asian: 14.7%; Black or African American: 5.3%; Arab or Middle Eastern: 3.3%; Other: 1.2%; and Southeast Asian: 0.4%). The sample primarily identified as Heterosexual/Straight (78.8%; Bisexual/Pansexual/Plurisexual: 14.7%; Gay or Lesbian: 2.0%; Asexual: 2.4% and Other: 2.0%). Individuals primarily indicated living on-campus (58.0%; Off-campus with family: 26.1%; Off-Campus with roommates: 14.7% and Other: 1.2%). Individuals at Time 2 had an average self-reported BMI of 23.70 (SD=4.66) and 33.9% of participants considered themselves to be an athlete.

Time 3

Of the 334 individuals eligible to complete Time 3, 261 individuals responded to the Qualtrics survey. Ten individuals were removed for failing attention checks, four individuals were removed for not having Time 1 data, 11 were removed for missing data past name and email, and three were removed for completing the survey twice, leaving 234 individuals (53.0% female, mean age at Time 1=18.16) available for analyses (69% retention rate). The sample was primarily Caucasian (37.2%; Multiracial: 23.1%; Hispanic or Latinx: 15.4%; Asian: 15.0%; Black or African American: 5.1%; Arab or Middle Eastern: 2.6%; Other: 0.9%; and Southeast Asian: 0.9%). The sample primarily identified as Heterosexual/Straight (78.6%;
Bisexual/Pansexual/Plurisexual: 14.5%; Gay or Lesbian: 2.6%; Asexual: 2.6% and Other: 1.7%). Individuals primarily indicated living on-campus (58.1%; Off-campus with family: 23.9%; Off-Campus with roommates: 16.7% and Other: 1.3%). Individuals at Time 3 had an average self-reported BMI of 23.70 (SD=4.56) and 35.0% of participants considered themselves to be an athlete.

**Time 4**

Of the 334 individuals eligible to complete Time 4, 271 individuals responded to the Qualtrics survey. Eleven individuals were removed for failing attention checks, three individuals were removed for not having Time 1 data, three were removed for missing data past name and email, and four were removed for completing the survey twice, leaving 250 individuals (50.8% female, mean age at Time 1=18.16) available for analyses (74% retention rate). The sample was primarily Caucasian (36.8%; Multiracial: 22.8%; Hispanic or Latinx: 15.2%; Asian: 15.6%; Black or African American: 5.2%; Arab or Middle Eastern: 2.4%; Other: 1.2%; and Southeast Asian: 0.8%). The sample primarily identified as Heterosexual/Straight (78.0%; Bisexual/Pansexual/Plurisexual: 14.4%; Gay or Lesbian: 3.2%; Asexual: 2.8% and Other: 1.6%). Individuals primarily indicated living on-campus (58.8%; Off-campus with family: 25.6%; Off-Campus with roommates: 14.4% and Other: 1.2%). Individuals at Time 4 had an average self-reported BMI of 23.85 (SD=4.49) and 34.4% of participants considered themselves to be an athlete.

**Procedure**

Recruitment was conducted campus-wide via flyers and email announcements sent to undergraduate listservs. Recruitment for the study began August 23rd, 2021 (the first week of the semester) and continued through September 20th, 2021 (the last day students were eligible to
Surveys were estimated to take 25 minutes to complete at each time point. Participants received $5.00 for the Time 1 survey, $5.00 for the Time 2 survey, $5.00 for the Time 3 survey, and $15.00 for the Time 4 survey, for a total of $30.00. All compensation was distributed as an electronic Amazon gift card. All compensation was distributed within 10 business days of survey completion.

In order to facilitate study retention, multiple strategies were employed that have been used with recent success with college students (Hanna et al., 2014). First, participants were asked to provide multiple sources of contact information (e.g., email, cell phone number). Second, participants received both email and text message reminders about the completion of the study surveys. Participants received up to three reminders on each platform before they were considered missing for that time point. Students who missed or failed attention checks at Time 2/Time 3 were still considered eligible to complete the Time 3/Time 4 survey. Third, participants received email newsletters in October, December, and March with information about stress-reduction techniques and mental health resources available on campus. Surveys were completed via an online survey system (Qualtrics) at four time points over a 9-month period during the 2021-2022 academic year: Time 1(August 23rd - September 19th), Time 2 (November 8th- 22nd), Time 3 (January 24th- February 7th) and Time 4 (April 11th- 25th).

At Time 1, interested individuals completed a brief eligibility questionnaire (i.e., age, year in school, eating disorder treatment status, ability to engage in physical activity). Eligible individuals were then redirected to the study consent form and survey (measures listed below). Demographics were collected only at Time 1. Regardless of study eligibility, all individuals received mental health resources after Time 1 and all participants received mental health resources at each following assessment. Attention checks were included in all surveys, with the
items being added to the end of different questionnaires for each data collection. Based on the recommendations of Meade and Craig (2012), three bogus items were incorporated into the surveys, and individuals who incorrectly responded to two or more bogus items were removed from the analytic sample. The probability of being screened out when using a random response using this method is very close to 1.0 (Meade & Craig, 2012). Individuals who failed the attention check protocol at Time 1 were screened out of the study entirely and not eligible to participate in later time points.

**Materials**

**Demographic Information.** Participants reported year in school; age; sex; gender identity; living situation (at home, on-campus, off-campus), race; height and weight; ethnicity; and if they identify as an athlete (yes/no).

**Screening Measure for Eating Disorder Risk.** Individuals completed the SCOFF (Hill et al., 2010), a well-validated screening tool for eating disorders as part of the eligibility screening. The SCOFF is a five-item questionnaire with a threshold of two or more positive answers suggesting high risk for an eating disorder, with a sensitivity of 85% and a specificity of 90% (Ammann et al., 2018). The SCOFF been used with male and female college students (Ammann et al., 2018; Eisenberg et al., 2011). The SCOFF demonstrated low reliability in the current sample for all study time points: Cronbach’s α Time 1 = .61; Cronbach’s α Time 2= .58; Cronbach’s α Time 3 = .52; Cronbach’s α Time 4 = .55.

**Disordered Eating Symptoms.** Individuals completed the Eating Disorder Diagnostic Scale for DSM-5 (EDDS; Stice, n.d.). The EDDS is a brief (22-item) self-report measure designed to generate likely DSM-5 diagnoses of anorexia nervosa, bulimia nervosa, and binge eating disorder. This scale has shown good convergent validity with extant eating pathology
scales and interview diagnoses (Becker et al., 2017; Sysko et al., 2015). For this study, a raw symptom count was generated with higher scores indicating more eating pathology. Likely diagnoses were generated to describe the current sample. The symptom count score demonstrated acceptable reliability in the current sample for all study time points: Cronbach’s α Time 1 = .80; Cronbach’s α Time 2= .78; Cronbach’s α Time 3= .79; Cronbach’s α Time 4= .79.

**Exercise Identity.** The nine-item Exercise Identity Scale (EIS; Anderson & Cychosz, 1994) was used to capture exercise identity, with higher scores indicating stronger exercise identity. Items are rated on a seven-point Likert scale from 1 = *strongly disagree* to 7 = *strongly agree*. The EIS is positively correlated with exercise behavior, suggesting criterion validity (Anderson & Cychosz, 1994; Cardinal & Cardinal, 1997) and demonstrated excellent reliability in the present sample for all study time points: Cronbach’s α Time 1 = .92; Cronbach’s α Time 2= .94; Cronbach’s α Time 3= .93; Cronbach’s α Time 4= .94.

**Compulsive Exercise.** The 24-item Compulsive Exercise Test (CET; Taranis et al., 2011) was used to capture compulsive exercise. Items are rated on a 6-point scale with responses ranging from *never true* to *always true*. The current study used the global score from the CET to reflect compulsive exercise, with higher scores indicating a greater level of compulsive exercise. The CET has been used with community populations (Taranis & Meyer, 2011; Taranis et al., 2011), is sensitive to change in compulsive exercise over time (Goodwin et al., 2014a, 2014b), and has demonstrated acceptable internal consistency, with Cronbach’s α’s ranging from .83 to .92 (Taranis et al., 2011; Young et al., 2017). A global score of 15 or higher indicates clinically significant levels of compulsive exercise. The global score demonstrated good reliability in the present sample for all study time points: Cronbach’s α Time 1 = .82; Cronbach’s α Time 2= .87; Cronbach’s α Time 3= .87; Cronbach’s α Time 4= .89.
**Peer Exercise Norms.** The 6-item Peer Norms Physical Activity scale (Ling et al., 2014) was used to capture perceived peer exercise norms among close friends. Three components of peer exercise norms are measured via this scale: prevalence of exercise, perceived importance of physical activity, and perceived acceptance of physical activity. Items are rated on a 4-point scale with responses ranging from 0-3 (response options vary with question, see Appendix G) with higher sum scores indicating stronger perceived peer exercise norms. The measure demonstrated good to acceptable reliability in the present sample for all study time points: Cronbach’s $\alpha$ Time 1 = .75; Cronbach’s $\alpha$ Time 2 = .77; Cronbach’s $\alpha$ Time 3 = .81; Cronbach’s $\alpha$ Time 4 = .76.

**International Physical Activity Questionnaire-Short Form.** (IPAQ-Short; Craig et al., 2003), The IPAQ-Short was used to assess self-reported physical activity levels. The IPAQ-Short consists of seven questions assessing physical activity over the past week and captures moderate and vigorous physical activity. IPAQ scores are an appropriate proxy for accelerometer data when assessing moderate physical activity in college students (Hsu et al., 2020). Results for the IPAQ can be presented as a continuous total variable (MET minutes per week; Craig et al., 2003). MET minutes represent the amount of energy expended carrying out physical activity, so each category (vigorous, moderate, walking) will have a different MET value. Walking receives 3.3 METS, moderate receives 4 METS, and vigorous receives 8 METS. To calculate a total MET score for each category, the MET value for a given category is multiplied by the minutes the activity was carried out and then multiplied by the number of days that activity was completed. To calculate physical activity scores for a month, the weekly MET minutes for the week a participant indicates is their typical week was multiplied by 4 to obtain MET minutes per month.

The IPAQ-Short also included an additional question of “Is this level of physical activity reported similar to your physical activity over the past 4 weeks (yes or no)?” If the individual
reported no, then they received three additional questions: 1. *Of the past 4 weeks, how many weeks have you exercised in a similar pattern to what you reported above? (1, 2, 3, or 4 weeks)*

2. *What does a typical exercise week look like for you? (Modified IPAQ-S questions see Appendix H)*

3. *Of the past 4 weeks, how many weeks have been “typical” exercise weeks for you? (1, 2, 3, or 4 weeks).* The participants’ response to “is this level of physical activity reported similar to your physical activity over the past 4 weeks?” would determine if the original MET minutes per week was multiplied by 4, or if there was a need to include responses from the Modified IPAQ-S when calculating MET minutes per month.

**Data Analytic Plan**

Descriptive statistics were generated using SPSS 26 and hypothesis testing was conducted in R Statistical Programming Language (Team, 2013) using the lavaan (Rosseel et al., 2017), lcsm (Wiedemann et al., 2022), and lme4 packages (Bates et al., 2014). All outcome variables were within the acceptable range for skewness and kurtosis (i.e., no items exceeded skewness of an absolute value ≥ 2 and/or kurtosis of an absolute value of ≥ 7; West et al., 1995) except for eating disorder symptom counts at Time 3 and Time 4 (Kurtosis Time 3= 2.02, Kurtosis Time 4=2.12). The eating disorder symptom count variable commonly is zero-inflated and prone to positive skew, therefore, the skewness was not corrected (Coxe et al., 2009). Homogeneity of variances, independence of errors, and correlations between study variables were investigated. Chi-square, independent samples t-tests, and Mann-Whitney U tests were used to conduct attrition analyses. Repeated measures analysis of variance was used to examine raw mean differences in scores of variables of interest across the study period. A Friedman test was used to examine median differences in eating disorder symptom counts across the study period.
For hypotheses 1-2b, both structural equation modeling (SEM) and multilevel modeling (MLM) frameworks were used to test hypotheses. Specifically, latent growth curve models were estimated in both SEM and MLM were used to test hypotheses 1-2b. Given the research questions, SEM and MLM models will produce mathematically equivalent outcomes. However, SEM relies on global fit measures that can be affected by sample size (Kenny et al., 2015; Reise et al., 1993); therefore, hypotheses were also investigated using an MLM framework to ensure sample size did not unwarrantedly affect findings. Bivariate latent difference score (LDS) and random intercept cross-lagged panel models (RI-CLPM) were used to test hypothesis 3. Both LDS and RI-CLPM are estimated within an SEM framework; however, the dual change model in bivariate LDS models requires significant change in both outcome variables in order to be estimated. RI-CLPM can be estimated even without significant change among outcome variables.

All predictor variables were mean centered prior to analyses. Given results from attrition analyses (described below), all models employed maximum likelihood estimation with robust standard errors and used full information maximum likelihood (FIML) with SEM and restricted maximum likelihood (REML) with MLM. FIML has desirable statistical properties (e.g., low estimator bias) even with mild departures from multivariate normality and when data are assumed to be missing at random (Collins et al., 2001; Schafer & Graham, 2002). REML also has demonstrated low estimator bias (Browne & Draper, 2000).

Data from the IPAQ-Short were of poor quality. At Time 1, many individuals supplied abnormally high hours per day of exercise (e.g., 20 hours). Given the data, participants might have been providing the number of hours per week they exercise. At Time 2, the questionnaire was modified to clarify the items that were asking about hours per day. Despite this
modification, participants continued to report unreasonably high hour totals for daily physical activity. Data were deemed to be unreliable reports of physical activity and these data are not reported in this document.

For hypotheses 1-2b, model fit of the latent growth curves (SEM) were evaluated using the following global fit indices: the Satorra-Bentler scaled chi-square statistic ($S-B\chi^2$), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). The factor loadings of the intercept were fixed to 1, and given that measurement waves were equally spaced in time, the factor loadings of the linear slopes were fixed to 0, 1, 2, and 3. First, an unconditional latent growth curve of compulsive exercise was estimated and evaluated for model fit using the aforementioned fit indices. For hypotheses 2a and 2b Time 1 exercise identity, Time 1 peer exercise norms, and the interaction between Time 1 exercise identity and peer exercise norms were added as predictors of the latent slope and intercept.

To test hypotheses 1-2b using an MLM framework, first a linear growth curve model of compulsive exercise with a fixed slope was estimated. Next, the model was estimated with a random slope. Best model fit was determined using $X^2$ likelihood ratio testing. Time was coded as 0, 1, 2, 3 for each time point. Similar to the SEM models, for the conditional MLM growth curve models, fixed effects of Time 1 exercise identity and Time 1 peer exercise norms, their interaction, and an exercise identity*peer exercise norms*time term were added to the model. The interaction between exercise identity and time was used to test hypothesis 2a. The three-way interaction between exercise identity, peer exercise norms, and time was used to test hypothesis 2b.

For hypothesis 3, a model building approach was used to develop the bivariate latent difference score model. First, four different unconditional univariate models were estimated for
both compulsive exercise and eating disorder symptoms: 1. Constant change only - i.e., there is constant change over time, (e.g., compulsive exercise increases by an average of X units per time point), which is mathematically equivalent to a linear latent growth curve model; 2. Proportional change - i.e., change is influenced by the score of the same latent variable at the previous time point (e.g., compulsive exercise at Time 1 predicts change in compulsive exercise at Time 2, and the change is influenced by the status of compulsive exercise behaviors at the previous time point); 3. Dual change (both constant and proportional change, e.g., there is change over time and that change is dependent on previous compulsive exercise behaviors); and 4. No change.

Once the best univariate model fit for each construct was determined using the Satorra-Bentler scaled method for Chi-square difference testing, then both univariate models were included in the bivariate LDS model. Four possible bivariate LDS models were examined: 1) no coupling – i.e., changes in compulsive exercise and eating disorder symptoms are independent; 2) compulsive exercise leads to subsequent changes in eating disorder symptoms; 3) eating disorder symptoms lead to subsequent changes in compulsive exercise; and 4) a reciprocal model in which compulsive exercise and eating disorder symptoms longitudinally predict each other.

Model fit was evaluated using the same metrics as described above.

Hypothesis 3 was also investigated using a random intercept cross-lagged panel model framework. Three separate models (unconstrained, autoregressive paths constrained, and cross-lagged effects constrained) were estimated to ensure the most parsimonious model was used to test hypotheses. Autoregressive paths represent the within-person stability of a variable over time, similar to the proportional change model of the LDS. Cross-lagged effects represent to what extent a previous deviation (from a person-specific mean) in one variable is associated with a subsequent deviation in the other variable. The within-time correlations represent the extent to
which deviations from the person-specific mean in one variable are accompanied by deviations from the person-specific mean in the other variable. This is similar to the reciprocal model of the bivariate LDS. Random intercepts represent stable between-person differences of a variable. Correlations between random intercepts reflect to what extent stable differences between individuals in the two variables are correlated. To investigate hypothesis 3, the cross-lagged loadings from compulsive exercise and eating disorder symptoms were examined.

Post-hoc exploratory analyses included three path models to investigate if the interaction between exercise identity and peer exercise norms at Time 1 predicted compulsive exercise at Times 2 and 4 and if the interaction between exercise identity and peer exercise norms at Time 3 predicted compulsive exercise at Time 4. Significant interactions were probed at +/- 1 SD of the moderator. If the interaction was not significant, then exercise identity and peer exercise norms were explored as individual predictors of compulsive exercise. Three additional path models were used to investigate if compulsive exercise at Time 1 predicted eating disorder symptoms at Times 2 and 4 and if compulsive exercise at Time 3 predicted eating disorder symptoms at Time 4. All path models utilized MLR to quantify standardized path estimates.

Missing Data Analyses

Data missingness was investigated in three ways. First, Little’s Missing Completely at Random test demonstrated data were missing at random at each time point, $\chi^2(6) = 6.22, p=.339$ (Time 1), $\chi^2(13) = 11.34, p=.582$ (Time 2), $\chi^2(4) = 4.39, p=.356$ (Time 3), $\chi^2(1) =.82, p=.365$ (Time 4). Second, data from individuals who only completed Time 1 (n=43) were compared to data from individuals who completed Time 1 and any additional time point(s) (n=291). Results from the Chi-square, independent samples t-tests, and Mann-Whitney U tests indicated suggest that participants who only completed Time 1 did not differ on any study variables compared to
those who completed Time 1 and any additional time point(s) (Table 1). Third, data from individuals who completed the survey at all four time points (n=212) were compared to data from individuals who had any missing time points (n=121). Results from the Chi-square, independent samples t-tests, and Mann-Whitney U tests indicated that participants who had data at all four time points did not differ on any study variables from those who had any missing time points (Table 2). Given these findings, missing data were classified as missing at random and all models employed maximum likelihood estimation with robust standard errors and used full information maximum likelihood (FIML) or restricted maximum likelihood (REML).

**Power Analyses, Sample Size Considerations, and Type I Error Considerations**

The number of participants needed for the study was determined based on rules of thumb for SEM, which suggest minimum sample sizes of 100 or 200 (Boomsma, 1983, 1985), 5-10 observations per estimated parameter (Bentler & Chou, 1987; Bollen, 1989), or 10 cases per variable (Nunnally, 1967) to adequately power proposed analyses. Based on these metrics, the required sample size for the present study could range from 90 to 140, suggesting that the actual sample size of 334 was sufficient to detect the hypothesized effects. Additionally, the required sample size to detect a medium effect with four time points and a power of .80 using an MLM framework is 300 (Zhang & Wang, 2009), thus, the current sample size of 334 was deemed adequate to detect hypothesized effects using an MLM framework.
Table 1: Comparison of Study Variables Across Individuals Who Only Completed Time 1 and Those Who Completed Time 1 and Any Additional Time Point (N=334)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time 1 Only (n = 43)</th>
<th>Time 1 and additional (n = 291)</th>
<th>X²(df)/t</th>
<th>p</th>
<th>Cramer’s V/ d/r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>58.14% man/male</td>
<td>63.01% man/male</td>
<td>2.44(3)</td>
<td>.486</td>
<td>.09</td>
</tr>
<tr>
<td>Gender Minority</td>
<td>95.34% non-gender</td>
<td>98.28% non-gender minority</td>
<td>1.57(1)</td>
<td>.210</td>
<td>.07</td>
</tr>
<tr>
<td>Race/Ethnic Background</td>
<td>55.81% White</td>
<td>37.11% White</td>
<td>7.25(7)</td>
<td>.403</td>
<td>.15</td>
</tr>
<tr>
<td>Sexual Orientation</td>
<td>74.42% Heterosexual/</td>
<td>Heterosexual/Straight</td>
<td>7.41(4)</td>
<td>.116</td>
<td>.12</td>
</tr>
<tr>
<td>Athlete Status</td>
<td>55.81% non-Athlete</td>
<td>63.92% non-Athlete</td>
<td>1.05(1)</td>
<td>.305</td>
<td>.06</td>
</tr>
<tr>
<td>Living Situation</td>
<td>65.12% living on-</td>
<td>57.39% living on-campus</td>
<td>2.72(3)</td>
<td>.436</td>
<td>.09</td>
</tr>
<tr>
<td>Age</td>
<td>18.09 (.29)</td>
<td>18.16 (.44)</td>
<td>1.04</td>
<td>.300</td>
<td>.17</td>
</tr>
<tr>
<td>Peer Norms for Physical Activity</td>
<td>9.87(3.97)</td>
<td>9.56(3.99)</td>
<td>-.49</td>
<td>.629</td>
<td>.08</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>24.36(5.85)</td>
<td>23.54(4.60)</td>
<td>-1.05</td>
<td>.296</td>
<td>.14</td>
</tr>
<tr>
<td>Compulsive Exercise</td>
<td>11.41(3.14)</td>
<td>11.15(2.86)</td>
<td>-.54</td>
<td>.593</td>
<td>.09</td>
</tr>
<tr>
<td>Exercise Identity</td>
<td>4.31(1.66)</td>
<td>4.20(1.44)</td>
<td>-.48</td>
<td>.635</td>
<td>.07</td>
</tr>
<tr>
<td>Eating Disorder Risk</td>
<td>1.07(1.42)</td>
<td>.89(1.16)</td>
<td>-.92</td>
<td>.360</td>
<td>.14</td>
</tr>
<tr>
<td>EDDS Raw Symptom Count</td>
<td>15.72(12.99)</td>
<td>15.58(12.36)</td>
<td>-.06</td>
<td>.949</td>
<td>.003</td>
</tr>
</tbody>
</table>

Note. Effect size interpretations: Cramer’s V: small=0.1, medium=0.3, large=0.5; Cohen’s d: small=0.2, medium=0.5, large <.8; Pearson’s r: small= ± 0.1, medium= ± 0.3, large=± 0.5


<table>
<thead>
<tr>
<th>Variable</th>
<th>All 4 Time points (n = 212)</th>
<th>Any Missing Time points (n = 122)</th>
<th>$X^2(df)/t$</th>
<th>$p$</th>
<th>Cramer’s V/ $d/r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>46.22% man/male</td>
<td>53.28% man/male</td>
<td>3.46(3)</td>
<td>.326</td>
<td>.33</td>
</tr>
<tr>
<td>Gender Minority</td>
<td>97.64% non-gender minority</td>
<td>98.36% non-gender minority</td>
<td>.20(1)</td>
<td>.659</td>
<td>.02</td>
</tr>
<tr>
<td>Race/Ethnic Background</td>
<td>34.91% White</td>
<td>47.54% White</td>
<td>9.95(7)</td>
<td>.192</td>
<td>.17</td>
</tr>
<tr>
<td>Sexual Orientation</td>
<td>77.36% Heterosexual/Straight</td>
<td>80.33% Heterosexual/Straight</td>
<td>3.29 (4)</td>
<td>.527</td>
<td>.10</td>
</tr>
<tr>
<td>Athlete Status</td>
<td>65.09% non-Athlete</td>
<td>59.02% non-Athlete</td>
<td>1.23(1)</td>
<td>.268</td>
<td>.06</td>
</tr>
<tr>
<td>Living Situation</td>
<td>56.60% living on-campus</td>
<td>61.48% living on-campus</td>
<td>5.97(3)</td>
<td>.113</td>
<td>.13</td>
</tr>
<tr>
<td>Age</td>
<td>18.17 (0.44)</td>
<td>18.13 (0.41)</td>
<td>.80</td>
<td>.423</td>
<td>.09</td>
</tr>
<tr>
<td>Peer Norms for Physical Activity</td>
<td>9.63(3.85)</td>
<td>9.54(4.21)</td>
<td>.20</td>
<td>.845</td>
<td>.02</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>23.64(4.53)</td>
<td>23.64(5.19)</td>
<td>.01</td>
<td>.992</td>
<td>.001</td>
</tr>
<tr>
<td>Compulsive Exercise</td>
<td>11.29(2.88)</td>
<td>11.00(2.93)</td>
<td>.895</td>
<td>.371</td>
<td>.10</td>
</tr>
<tr>
<td>Exercise Identity</td>
<td>4.21(1.40)</td>
<td>4.22(1.57)</td>
<td>-.07</td>
<td>.942</td>
<td>.008</td>
</tr>
<tr>
<td>Eating Disorder Risk</td>
<td>.97(1.23)</td>
<td>.82(1.14)</td>
<td>1.08</td>
<td>.280</td>
<td>.12</td>
</tr>
<tr>
<td>EDDS Raw Symptom Count</td>
<td>16.26(12.63)</td>
<td>14.44(12.03)</td>
<td>.19</td>
<td>.190</td>
<td>.01</td>
</tr>
</tbody>
</table>

**Note.** Effect size interpretations: Cramer’s $V$: small=0.1, medium=0.3, large=0.5; Cohen’s $d$: small=0.2, medium=0.5, large <.8; Pearson’s $r$: small=± 0.1, medium=± 0.3, large=± 0.5
Chapter Three: Results

Sample Characteristics at Time 1

At Time 1, 9.94% of the sample reported clinically significant levels of compulsive exercise. Participants reported an average compulsive exercise global score of 11.02 (SD= 2.95; Table 3). Further, 7.52% of individuals met criteria for a full or subthreshold eating disorder diagnosis and 23.65% of individuals met criteria for being at risk of the development of an eating disorder based on their responses on the SCOFF. The mean exercise identity score was 4.21 and the mean score for the influence of peer norms on physical activity was 9.60 (Table 3).

Sample Characteristics at Time 2

At Time 2, 14.80% of the sample reported clinically significant levels of compulsive exercise. Participants reported an average compulsive exercise global score of 11.28 (SD= 3.22; Table 5). Further, 8.92% of individuals met criteria for a full or subthreshold eating disorder diagnosis and 24.52% of individuals met criteria for being at risk of the development of an eating disorder based on their responses on the SCOFF. The mean exercise identity score was 4.13 and the mean score for the influence of peer norms on physical activity was 10.02 (Table 5).

Sample Characteristics at Time 3

At Time 3, 12.01% of the sample reported clinically significant levels of compulsive exercise. Participants reported an average compulsive exercise global score of 11.15 (SD= 3.26; Table 6). Further, 9.96% of individuals met criteria for a full or subthreshold eating disorder diagnosis and 26.61% of individuals met criteria for being at risk of the development of an eating
disorder based on their responses on the SCOFF. The mean exercise identity score was 4.07 and the mean score for the influence of peer norms on physical activity was 9.48 (Table 6).

Sample Characteristics at Time 4

At Time 4, 12.96% of the sample reported clinically significant levels of compulsive exercise. Participants reported an average compulsive exercise global score of 11.25 (SD= 3.24; Table 7). Further, 13.17% of individuals met criteria for a full or subthreshold eating disorder diagnosis and 21.29% of individuals met criteria for being at risk of the development of an eating disorder based on their responses on the SCOFF. The mean exercise identity score was 3.96 and the mean score for the influence of peer norms on physical activity was 9.71 (Table 7).

Variables of Interest Over Time

The raw means of the three variables of interest (compulsive exercise, exercise identity, peer exercise norms) were explored using repeated-measures ANOVAs. As all three variables violated the assumption of sphericity, Greenhouse-Geisser estimates were interpreted. No significant differences in the mean compulsive exercise scores were observed across the four time points (F (2.80, 435.10) =.76, p=.509, ηp²=.005; Table 8, Figure 1). No overall mean differences were observed for exercise identity (F (2.67, 429.94) =2.57, p=.061, ηp²=.016; Table 8; Figure 2). Peer exercise norms significantly differed across the four time points (F (2.84, 457.52) =2.80, p=.043, ηp²=.017; Table 8; Figure 3). A post hoc pairwise comparison using the Bonferroni correction indicated no significant pairwise comparisons. A Friedman test indicated that there were no significant differences in median scores of eating disorder symptoms across the four time points χ²(3) =6.90, p=.075; Table 8, Figure 4.
Figure 1. Raw Means of Compulsive Exercise at Study Time Points

Figure 2. Raw Means of Exercise Identity at Study Time Points
Figure 3. Raw Means of Peer Exercise Norms at Study Time Points

Figure 4. Raw Eating Disorder Symptom Counts at Study Time Points
Aim 1: Investigate How Peer Norms and Exercise Identity Predict the Trajectory of Compulsive Exercise Over the 9-Month Period

Results from the unconditional latent growth curve model (LGCM) demonstrated good fit [S-B$\chi^2(5) = 11.76, p=.038$; RMSEA= .06; CFI= .99; (Table 9)]. Hypothesis 1 was not supported. On average, no significant linear trajectory of compulsive exercise behaviors was observed over time ($B_{slope} = .12, p=.404$). Additionally, the variance estimate of the slope was not significant ($B = 1.00, p=.290$) indicating that there were no significant differences in intraindividual trajectories of compulsive exercise.

Hypothesis 1 also was tested using MLM. The unconditional growth model with random slope was determined to fit better than the fixed sloped model (Table 10) based on $X^2$ likelihood ratio testing ($\chi^2=9.08, p=.011$). Similar to the results of the LCGM, time was not a significant predictor of compulsive exercise ($b=.04, p=.437$; Figure 5, Table 11), suggesting that compulsive exercise did not significantly change over the study period.

Results from the conditional latent growth curve model demonstrated acceptable model fit [S-B$\chi^2(7) = 14.05, p=.050$; RMSEA= .06; CFI= .99; (Table 9)]. Hypothesis 2a was not supported. Exercise identity at Time 1 did not significantly predict the slope of compulsive exercise ($B = .13, p = .290$). Results from MLM analyses replicated these findings. The interaction between exercise identity at Time 1 and time was not significant ($b=.04, p=.267$; Model 2, Table 11), suggesting that exercise identity at Time 1 did not predict the trajectory of compulsive exercise over time.
Results from the conditional latent growth curve model with FIML demonstrated excellent fit \[ S-B\chi^2(11) = 17.95, p=.083; \text{RMSEA= } .04; \text{CFI=.99;} \text{ (Table 9)}. \] Hypothesis 2b was not supported, as the interaction between Time 1 exercise identity and Time 1 peer exercise norms did not significantly predict the slope of compulsive exercise \( (B = .004, p = .972). \) Results from MLM analyses similarly indicated that the interaction between peer exercise norms, exercise identity, and time was not a significant predictor of compulsive exercise over time \( (b=.001, p = .948; \text{Model 3, Table 11}). \) Findings also indicated that stronger exercise identity at

![Figure 5. Aim 1 Latent Growth Curve Model](image)

*Figure 5. Aim 1 Latent Growth Curve Model*

*Note: *\(p < .05; **p < .001\)*

Time 1 was significantly associated with more compulsive exercise at Time 1 \( (B = .61, p < .001), \) and that greater peer exercise norms at Time 1 were significantly associated with *less* compulsive exercise at Time 1 \( (B = -.12, p = .047). \)

**Aim 1: Summary of Findings.** Hypotheses 1-2b were not supported. Compulsive exercise did not significantly linearly increase over the study period. Stronger exercise identity at Time 1 was not a significant predictor of increases in compulsive exercise over the study period.
Further, peer exercise norms did not moderate the relationship between exercise identity and compulsive exercise.

Aim 2: Examine Compulsive Exercise as a Risk Factor for Eating Disorder Symptoms in College Students

Univariate Models. A univariate LDS model estimating change in compulsive exercise over the 9-month study period suggested that the dual change model demonstrated the best model fit \( S-B\chi^2(3) = 6.15, p = .081; \text{RMSEA} = .05; \text{CFI} = .99; \) (Table 12). The dual change model demonstrates that change in compulsive exercise was influenced by both time and the previous compulsive exercise score. More specifically, the constant change component implies that with each time point, compulsive exercise scores increased by an average of 15.35. However, the proportional change estimate of -1.35 reflects a competing force, which reduced scores by 135.0% of the previous time points true score at every time point. The combination of these two forces yields the observed scores. At earlier time points, the compulsive exercise scores were lower, so the constant change component dominated, leading to an estimate of growth. However, as the scores became larger over time, the influence of the proportional change component strengthened and eventually negated any observed growth. Last, the correlation between the intercept and constant change component was positive (.10), suggesting that participants who reported more compulsive exercise at Time 1 experienced more growth in compulsive exercise over the study. In sum, growth in compulsive exercise over the 9-month study period was characterized by a constant amount of growth and decreasing proportional change that attenuated the observed growth over time.

The univariate LDS model examining change in eating disorder symptoms over the 9-month study period suggested that the no change model demonstrated the best model fit \( S- \)
\[ B\chi^2(11) = 24.02, \text{ } p=.013; \text{ } \text{RMSEA}=.08; \text{ } \text{CFI}=.96; \text{ } \text{(Table 12)} \]. This suggests that there was no significant change in eating disorder symptoms over the study period.

These univariate models were used to estimate four bivariate models to examine the coupling patterns of compulsive exercise and eating disorder symptoms.

**LDS Models: No Coupling.** The no coupling model demonstrated good model fit: \[ S-B\chi^2(27) = 54.28, \text{ } p=.001; \text{ } \text{RMSEA}=.06; \text{ } \text{CFI}=.97; \text{ } \text{(Table 13)} \].

**LDS Models: Compulsive Exercise Predicting Change in Eating Disorder Symptoms (Univariate Coupling).** The univariate coupling model predicting that change in compulsive exercise predicts change in eating disorder symptoms also demonstrated good model fit: \[ S-B\chi^2(26) = 53.98, \text{ } p=.001; \text{ } \text{RMSEA}=.07; \text{ } \text{CFI}=.97; \text{ } \text{(Table 13)} \].

**LDS Models: Eating Disorder Symptoms Predicting Change in Compulsive Exercise (Univariate Coupling).** Given that the no-change model fit eating disorder symptoms best, it was not possible to determine if change in eating disorder symptoms predicted change in compulsive exercise behaviors, therefore, this model was not estimated.

**LDS Models: Dual Change Model.** This model was not estimated since only compulsive exercise behaviors demonstrated significant change over time.

**Comparison of Models.** The no coupling model was compared to the univariate coupling model in which change in compulsive exercise predicted change in eating disorder symptoms. Satorra-Bentler scaled chi-squared testing indicated that the no coupling model demonstrated the best fit to the data \( \Delta\chi^2=0.7, \text{ } p=1.00; \text{ } \text{Table 13} \). The lack of meaningful coupling coefficients suggests that change in compulsive exercise did not predict change in eating disorder symptoms or vice versa over the 9-month study period.
LDS Models: Summary of Findings

Findings from the LDS models did not support hypothesis 3. Change in compulsive exercise behaviors did not predict change in eating disorder symptoms over the study period.

Random-Intercepts Cross-Lagged Panel Modeling

Given that two out of the four possible LDS models were unable to be estimated due to a lack of significant change in eating disorder symptoms, hypothesis 3 was also investigated using a random-intercepts cross-lagged panel modeling framework.

Cross-Lagged Panel Models: Autoregressions and Cross-Lags Unconstrained. The model where both the autoregressions (previous time point observations predicting next time point) and cross-lags (one variable at previous time point predicting different variable at next time point) were unconstrained (allowed to vary across time) demonstrated excellent model fit $S-B\chi^2(10) = 14.56, p=.149$; RMSEA= .04; CFI= .99; (Table 14).

Cross-Lagged Panel Models: Autoregressions Constrained. The model with the autoregressions constrained demonstrated acceptable model fit $S-B\chi^2(14) = 30.77, p=.006$; RMSEA= .07; CFI= .98; (Table 14).

Cross-Lagged Panel Models: Cross-Lags Constrained. The model with the cross-lagged paths constrained demonstrated good model fit $S-B\chi^2(14) = 30.24, p=.007$; RMSEA=.06; CFI= .99; (Table 14).

Model Comparison and Interpretation. Satorra-Bentler scaled Chi-squared testing indicated that the fully unconstrained model fit the data best ($\Delta\chi^2_{\text{autoregressions constrained}}=22.48, p<.001$; $\Delta\chi^2_{\text{cross-lagged constrained}}=136.66, p<.001$; Table 14) and this unconstrained model was used to examine the relationship between compulsive exercise behaviors and eating disorder symptoms over the 9-month study period. At the within-person level, the autoregressive paths for
compulsive exercise and eating disorder symptoms were not consistently significant. Greater compulsive exercise and eating disorder symptoms at Time 3 were associated with greater subsequent compulsive exercise and eating disorder symptoms at Time 4, but not at other time points. Additionally, none of the cross-lagged regression paths between compulsive exercise and eating disorder symptoms were statistically significant, providing further evidence that these behaviors did not influence each other over time. See Figure 6.

![Figure 6: Results of Random Intercept Cross-Lagged Panel Models](image)

*Note. *p<.01, **p<.001*

**Summary of RI-CLPM Findings**

Hypothesis 3 was not supported. The cross-lagged pathways between compulsive exercise and eating disorder symptoms were not significant, indicating that these behaviors did not influence each other over time. However, the autoregressive paths for both compulsive exercise and eating disorder symptoms between Times 3 and 4 were significant, suggesting that the Time 3 score predicted the Time 4 score for both variables.

**Post-Hoc Analyses**

Given a modest cubic trend to the data where both compulsive exercise and peer exercise norms demonstrated increases from Time 1 to Time 2 and from Time 3 to Time 4, post-hoc analyses included investigating relationships between variables of interest within these two timeframes, in addition to the relationship between variables of interest at Time 1 with the variables of interest at Time 4. To test whether the interaction between exercise identity and peer
exercise norms at Time 1 predicted compulsive exercise at Time 2 a prospective path model was conducted controlling for compulsive exercise at Time 1. Results suggested that the interaction between exercise identity and peer exercise norms at Time 1 did not predict compulsive exercise at Time 2 ($B = -.07$, SE $= .03$, $p = .193$; Table 15). Given that the interaction was not significant, exercise identity and peer norms at Time 1 were investigated as independent predictors of compulsive exercise at Time 2. Partially consistent with hypotheses, greater exercise identity at Time 1 was associated with increases in compulsive exercise at Time 2 ($B = .17$, SE $= .15$, $p = .010$; Table 15). Peer exercise norms at Time 1 was not a significant predictor of compulsive exercise at Time 2 ($B = -.08$, SE $= .05$, $p = .173$; Table 15).

The interaction between exercise identity and peer exercise norms at Time 1 also was examined as a predictor of compulsive exercise at Time 4, controlling for compulsive exercise at Time 1. Results suggested that the interaction between exercise identity and peer exercise norms at Time 1 did not predict compulsive exercise at Time 4 ($B = -.02$, SE $= .03$, $p = .738$; Table 15). Exercise identity and peer norms at Time 1 then were investigated as independent predictors of compulsive exercise at Time 4. Partially consistent with hypotheses, results suggested that exercise identity at Time 1 significantly predicted change in compulsive exercise behaviors at Time 4 ($B = .21$, SE $= .12$, $p < .001$; Table 15). Greater exercise identity at Time 1 was associated with increases in compulsive exercise at Time 4. Peer exercise norms at Time 1 were not a significant predictor of compulsive exercise at Time 4 ($B = .03$, SE $= .04$, $p = .473$; Table 15).

Last, the interaction between exercise identity and peer exercise norms at Time 3 was examined as a predictor of compulsive exercise at Time 4, controlling for compulsive exercise at Time 3. Results suggested that the interaction between exercise identity and peer exercise norms at Time 3 did not predict compulsive exercise at Time 4 ($B = -.07$, SE $= .02$, $p = .106$; Table 15).
Exercise identity and peer norms at Time 1 then were investigated as independent predictors of compulsive exercise at Time 4. Partially consistent with expectations, results suggested that both exercise identity ($B = .12$, SE $= .12$, $p < .030$; Table 15) and peer exercise norms ($B = -.10$, SE $= .04$, $p = .033$, $f^2 = 1.74$; Table 15) at Time 3 significantly predicted change in compulsive exercise behaviors at Time 4. Greater exercise identity and lower peer exercise norms were associated with more compulsive exercise at Time 4.

Three additional prospective path models were conducted to replicate these analyses for eating disorder symptoms, controlling for eating disorder symptoms at Time 1. Consistent with expectations, results suggested that compulsive exercise at Time 1 significantly predicted increases in eating disorder symptoms at Time 2 ($B = .16$, SE $= .28$, $p = .009$; Table 16) and Time 4 ($B = .14$, SE $= .26$, $p = .017$; Table 16). Further, controlling for eating disorder symptoms at Time 3, compulsive exercise at Time 3 significantly predicted increases in eating disorder symptoms at Time 4 ($B = .09$, SE $= .18$, $p = .035$; Table 16).
Table 3: Descriptive Statistics and Correlations for All Time 1 Variables (N=334)

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SCOFF</td>
<td>.23**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Exercise Identity</td>
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<td>.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Peer Norms for Exercise</td>
<td>-.005</td>
<td>-.07</td>
<td>.32**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. EDDS Raw Symptom Count</td>
<td>.34**</td>
<td>.66**</td>
<td>.04</td>
<td>-.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Compulsive Exercise</td>
<td>.26**</td>
<td>.37**</td>
<td>.49**</td>
<td>.07</td>
<td>.48**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Sex (1=female)</td>
<td>-.05</td>
<td>.15**</td>
<td>-.13*</td>
<td>-.13</td>
<td>.21**</td>
<td>-.005</td>
<td></td>
</tr>
</tbody>
</table>

Sample Mean: 23.64 0.91 4.21 9.60 15.60 11.19 49.1%
Sample SD: 4.77 1.20 1.47 3.98 12.43 2.89 Female

Note. SD=Standard deviation. BMI=Body Mass Index. *p < .05; **p < .01

Table 4: Eating Disorder Diagnosis Per Time Point

<table>
<thead>
<tr>
<th>Eating Disorder Diagnosis</th>
<th>Time 1 (n= 319)</th>
<th>Time 2 (n= 213)</th>
<th>Time 3 (n=231)</th>
<th>Time 4 (n=243)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anorexia Nervosa</td>
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<td>2</td>
<td>1</td>
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<tr>
<td>2. Bulimia Nervosa</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>3. Binge Eating Disorder</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4. Atypical Anorexia</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>5. Low Frequency Bulimia Nervosa</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
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<tr>
<td>6. Low Frequency Binge Eating Disorder</td>
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<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7. Purging Disorder</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>8. Night Eating Syndrome</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Total: 24 (7.52%) 19 (8.92%) 23 (9.96%) 32 (13.17%)
Table 5: Descriptive Statistics and Correlations for All Time 2 Variables (N=245)

<table>
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<tr>
<th>Variable</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
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<td>1. BMI</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SCOFF</td>
<td>.26**</td>
<td>--</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3. Exercise Identity</td>
<td>-.18**</td>
<td>-.09</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Peer Norms for Exercise</td>
<td>-.05</td>
<td>-.19*</td>
<td>.41**</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. EDDS Raw Symptom Count</td>
<td>.36**</td>
<td>.67**</td>
<td>-.02</td>
<td>.01</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Compulsive Exercise</td>
<td>.12</td>
<td>.35**</td>
<td>.51**</td>
<td>.25**</td>
<td>.41**</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7. Sex (1=female)</td>
<td>.01</td>
<td>.20**</td>
<td>-.21**</td>
<td>-.11</td>
<td>.25**</td>
<td>.08</td>
<td>--</td>
</tr>
<tr>
<td>Sample Mean</td>
<td>23.69</td>
<td>0.92</td>
<td>4.13</td>
<td>10.02</td>
<td>15.34</td>
<td>11.34</td>
<td>51.0%</td>
</tr>
<tr>
<td>Sample SD</td>
<td>4.66</td>
<td>1.16</td>
<td>1.51</td>
<td>4.69</td>
<td>12.77</td>
<td>3.19</td>
<td>Female</td>
</tr>
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</table>

Note. SD=Standard deviation. BMI=Body Mass Index. *p < .05; **p < .01

Table 6: Descriptive Statistics and Correlations for All Time 3 Variables (N=250)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>1. BMI</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SCOFF</td>
<td>.29**</td>
<td>--</td>
<td></td>
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</tr>
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<td>3. Exercise Identity</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Peer Norms for Exercise</td>
<td>.03</td>
<td>.05</td>
<td>.43**</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5. EDDS Raw Symptom Count</td>
<td>.32**</td>
<td>.73**</td>
<td>.11</td>
<td>-.01</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Compulsive Exercise</td>
<td>.21**</td>
<td>.48**</td>
<td>.59**</td>
<td>.28**</td>
<td>.49**</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7. Sex (1=female)</td>
<td>.01</td>
<td>.19**</td>
<td>-.06</td>
<td>-.08</td>
<td>.21**</td>
<td>.08</td>
<td>--</td>
</tr>
<tr>
<td>Sample Mean</td>
<td>23.70</td>
<td>0.90</td>
<td>4.07</td>
<td>9.47</td>
<td>15.19</td>
<td>11.22</td>
<td>53.0%</td>
</tr>
<tr>
<td>Sample SD</td>
<td>4.56</td>
<td>1.10</td>
<td>1.50</td>
<td>4.32</td>
<td>13.54</td>
<td>3.21</td>
<td>Female</td>
</tr>
</tbody>
</table>

Note. SD=Standard deviation. BMI=Body Mass Index. *p < .05; **p < .01
Table 7: Descriptive Statistics and Correlations for All Time 4 Variables (N=223)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BMI</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SCOFF</td>
<td>.20**</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Exercise Identity</td>
<td>.05</td>
<td>.10</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Peer Norms for Exercise</td>
<td>.04</td>
<td>-.02</td>
<td>.42**</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. EDDS Raw Symptom Count</td>
<td>.34**</td>
<td>.72**</td>
<td>.15*</td>
<td>.01</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Compulsive Exercise</td>
<td>.22**</td>
<td>.37**</td>
<td>.61**</td>
<td>.29**</td>
<td>.52**</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7. Sex (1=female)</td>
<td>.07</td>
<td>.23**</td>
<td>-.07</td>
<td>-.02</td>
<td>.25**</td>
<td>.08</td>
<td>--</td>
</tr>
</tbody>
</table>

| Sample Mean                       | 23.84| 0.76| 3.96| 9.71| 14.83| 11.25| 50.8%|
| Sample SD                         | 4.47 | 1.05| 1.57| 4.02| 13.08| 3.24 | Female|

Note. SD=Standard deviation. BMI=Body Mass Index. *p < .05; **p < .01

Table 8: Differences of Raw Means of Main Study Variables Across Time for Repeated Measures Analysis of Variance/Friedman Test

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F/Friedman Test (X²)</th>
<th>p</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsive Exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.81</td>
<td>7.02</td>
<td>2.50</td>
<td>0.76</td>
<td>.509</td>
<td>.005</td>
</tr>
<tr>
<td>Within Groups</td>
<td>435.10</td>
<td>1431.28</td>
<td>3.29</td>
<td>0.76</td>
<td>.509</td>
<td>.005</td>
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<tr>
<td>Between Groups</td>
<td>2.67</td>
<td>3.44</td>
<td>1.29</td>
<td>2.57</td>
<td>.061</td>
<td>.016</td>
</tr>
<tr>
<td>Within Groups</td>
<td>429.94</td>
<td>215.83</td>
<td>.50</td>
<td>2.57</td>
<td>.061</td>
<td>.016</td>
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<tr>
<td>Peer Exercise Norms</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.84</td>
<td>67.73</td>
<td>23.83</td>
<td>2.80</td>
<td>.043</td>
<td>.017</td>
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<tr>
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<td>3894.778</td>
<td>8.51</td>
<td>2.80</td>
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<td>.017</td>
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<td>Disordered Eating Symptoms</td>
<td>3</td>
<td>6.90</td>
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<td></td>
<td>.075</td>
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</tr>
</tbody>
</table>

Note: Abbreviations: SS=Sum of Squares, MS= Mean Square, ηp²= partial eta squared effect size: small=0.01, medium=0.06, large=0.14
### Table 9: Fit Statistics for Aim 1 Latent Growth Curve Models

<table>
<thead>
<tr>
<th>Model</th>
<th>$S-BX^2$</th>
<th>df</th>
<th>$B$</th>
<th>$p$</th>
<th>RMSEA</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconditional Model of Compulsive Exercise</td>
<td>11.76</td>
<td>5</td>
<td>4.66*</td>
<td>.038</td>
<td>.06</td>
<td>.99</td>
</tr>
<tr>
<td>Conditional Model with Exercise Identity</td>
<td>14.05</td>
<td>7</td>
<td>4.58*</td>
<td>.050</td>
<td>.06</td>
<td>.99</td>
</tr>
<tr>
<td>Conditional Model with Exercise Identity X Peer Norms</td>
<td>17.95</td>
<td>11</td>
<td>3.11*</td>
<td>.083</td>
<td>.04</td>
<td>.99</td>
</tr>
</tbody>
</table>

Note: Abbreviations: $S-BX^2$, Satorra-Bentler scaled chi-square statistic; RMSEA, root mean square error of approximation; CFI, comparative fit index, *$p < .001$

### Table 10: Unconditional Multilevel Growth Models of Compulsive Exercise

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept $\beta$</th>
<th>Intercept Variance</th>
<th>Slope $\beta$</th>
<th>Slope Variance</th>
<th>Intercept-Slope Correlation</th>
<th>AIC</th>
<th>$\chi^2$</th>
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<tbody>
<tr>
<td>Fixed Slope Unconditional Growth Model</td>
<td>11.24**</td>
<td>6.52</td>
<td>.04</td>
<td>-.38</td>
<td></td>
<td>4635.45</td>
<td></td>
</tr>
<tr>
<td>Random Slope Unconditional Growth Model</td>
<td>11.24**</td>
<td>5.78</td>
<td>.04</td>
<td>.09</td>
<td>-.27</td>
<td>4630.45</td>
<td>9.08*</td>
</tr>
</tbody>
</table>

Note: Abbreviations AIC= Akaike Information Criteria; $\chi^2$= likelihood ratio test comparing fit of nested models, *$p<.01$, **$p < .001$
Table 11: Conditional Multilevel Growth Models of Compulsive Exercise, Exercise Identity, and Peer Exercise Norms

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>11.24(.16)**</td>
<td>11.25(.14)**</td>
<td>11.23(.14)**</td>
</tr>
<tr>
<td>Time</td>
<td>.04(.05)</td>
<td>.04(.05)</td>
<td>.04(.05)</td>
</tr>
<tr>
<td>Exercise Identity</td>
<td>.96(.10)**</td>
<td></td>
<td>1.02(.10)**</td>
</tr>
<tr>
<td>Peer Exercise Norms</td>
<td>-.08(.04)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2-Way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time*Exercise Identity</td>
<td>.04(.03)</td>
<td></td>
<td>.02(.04)</td>
</tr>
<tr>
<td>Exercise Identity*Peer Norms</td>
<td>.004(.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time*Peer Exercise Norms</td>
<td>.02(.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3-Way Interactions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time<em>Exercise Identity</em>Peer Norms</td>
<td>.001(.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>2.88</td>
<td>2.88</td>
<td>2.89</td>
</tr>
<tr>
<td>$\tau_{00}$</td>
<td>5.78</td>
<td>3.97</td>
<td>3.82</td>
</tr>
<tr>
<td>$\tau_{11}$</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>$\rho_{01}$</td>
<td>.32</td>
<td>.30</td>
<td>.33</td>
</tr>
<tr>
<td>ICC</td>
<td>.70</td>
<td>.62</td>
<td>.62</td>
</tr>
</tbody>
</table>

Note: Parameters are listed as $b$(Standard Error), ICC= Intra-class Correlation, *$p<.05$, **$p < .001$
Table 12: Univariate Change Patterns of Compulsive Exercise and Eating Disorder Symptoms

<table>
<thead>
<tr>
<th></th>
<th>No Change</th>
<th>Constant</th>
<th>Proportional</th>
<th>Dual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsive Exercise</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMSEA</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
</tr>
<tr>
<td>CFI</td>
<td>.95</td>
<td>.96</td>
<td>.95</td>
<td>.97</td>
</tr>
<tr>
<td>AIC</td>
<td>4634.02</td>
<td>4653.29</td>
<td>4634.24</td>
<td>4628.39</td>
</tr>
<tr>
<td>S-BX²</td>
<td>33.01***</td>
<td>26.76***</td>
<td>31.26***</td>
<td>21.39***</td>
</tr>
<tr>
<td>df</td>
<td>11</td>
<td>8</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Δχ² (Δdf)</td>
<td>11.61(4)*</td>
<td>8.41(1)**</td>
<td>9.87(3)**</td>
<td></td>
</tr>
<tr>
<td><strong>Eating Disorder Symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMSEA</td>
<td>.08</td>
<td>.08</td>
<td>.09</td>
<td>.06</td>
</tr>
<tr>
<td>CFI</td>
<td>.96</td>
<td>.97</td>
<td>.96</td>
<td>.99</td>
</tr>
<tr>
<td>AIC</td>
<td>7492.08</td>
<td>7487.20</td>
<td>7493.83</td>
<td>7478.18</td>
</tr>
<tr>
<td>S-BX²</td>
<td>24.02*</td>
<td>18.43*</td>
<td>26.27**</td>
<td>17.03*</td>
</tr>
<tr>
<td>df</td>
<td>11</td>
<td>8</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Δχ² (Δdf)</td>
<td>8.15(4)</td>
<td>2.15(1)</td>
<td>8.35(3)*</td>
<td></td>
</tr>
</tbody>
</table>

Note. Bolded columns represent the model that fit the data best. Abbreviations: RMSEA, root mean square error of approximation; CFI, comparative fit index. AIC, Akaike information criteria; S-BX², Satorra-Bentler scaled chi-square statistic, Δχ² (Δdf)= likelihood ratio test comparing fit of nested models. *p < .05; **p < .01; ***p<.001
**Table 13:** Dynamic Coupling Coefficients Between Compulsive Exercise and Eating Disorder Symptoms

<table>
<thead>
<tr>
<th></th>
<th>No Coupling</th>
<th>Compulsive Exercise Change Predicts Eating Disorder Symptom Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSEA</td>
<td>.06</td>
<td>.07</td>
</tr>
<tr>
<td>CFI</td>
<td>.97</td>
<td>.97</td>
</tr>
<tr>
<td>AIC</td>
<td>11982.82</td>
<td>11990.12</td>
</tr>
<tr>
<td>S-BX²</td>
<td>62.66***</td>
<td>60.64***</td>
</tr>
<tr>
<td>df</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>Δχ² (Δdf)</td>
<td>1.97 (1)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Bolded columns represent the model that fit the data best. Abbreviations: RMSEA, root mean square error of approximation; CFI, comparative fit index. AIC, Akaike information criteria; S-BX², Satorra-Bentler scaled chi-square statistic. *p < .05; **p < .01; ***p<.001

**Table 14:** Random Intercepts Cross-Lagged Panel Models for Compulsive Exercise and Eating Disorder Symptoms

<table>
<thead>
<tr>
<th></th>
<th>Unconstrained</th>
<th>Autoregressions Constrained</th>
<th>Cross-Lags Constrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSEA</td>
<td>.04</td>
<td>.07</td>
<td>.06</td>
</tr>
<tr>
<td>CFI</td>
<td>.99</td>
<td>.98</td>
<td>.99</td>
</tr>
<tr>
<td>AIC</td>
<td>11968.40</td>
<td>11980.64</td>
<td>11974.406</td>
</tr>
<tr>
<td>S-BX²</td>
<td>14.56</td>
<td>30.77**</td>
<td>30.24**</td>
</tr>
<tr>
<td>df</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Δχ² (Δdf)</td>
<td>22.48(4) ***</td>
<td>136.66***</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Bolded columns represent the model that fit the data best. Abbreviations: RMSEA, root mean square error of approximation; CFI, comparative fit index. AIC, Akaike information criteria; S-BX², Satorra-Bentler scaled chi-square statistic, Δχ² (Δdf)= likelihood ratio test comparing fit of nested models. *p < .01; **p < .001
Table 15: Results from Path Models of Proposed Risk Factors Predicting Compulsive Exercise Behaviors

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$b$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 2 Compulsive Exercise (n=330)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.95</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1 Exercise Identity X Time 1 Peer Exercise Norms</td>
<td>-.04</td>
<td>.03</td>
<td>-.07</td>
<td>.193</td>
</tr>
<tr>
<td><strong>Time 1 Compulsive Exercise</strong></td>
<td>.68</td>
<td>.07</td>
<td>.61</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 2 Compulsive Exercise (n=330)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.65</td>
<td>.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1 Exercise Identity</td>
<td>.38</td>
<td>.15</td>
<td>.17</td>
<td>.010</td>
</tr>
<tr>
<td><strong>Time 1 Compulsive Exercise</strong></td>
<td>.61</td>
<td>.09</td>
<td>.54</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 1 Peer Exercise Norms</td>
<td>-.06</td>
<td>.05</td>
<td>-.08</td>
<td>.173</td>
</tr>
<tr>
<td>Time 4 Compulsive Exercise (n=330)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.28</td>
<td>.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1 Exercise Identity X Time 1 Peer Exercise Norms</td>
<td>-.01</td>
<td>.03</td>
<td>-.02</td>
<td>.738</td>
</tr>
<tr>
<td><strong>Time 1 Compulsive Exercise</strong></td>
<td>.72</td>
<td>.06</td>
<td>.65</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 4 Compulsive Exercise (n=330)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.24</td>
<td>.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1 Exercise Identity</td>
<td>.47</td>
<td>.12</td>
<td>.21</td>
<td>&lt;.001</td>
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<tr>
<td><strong>Time 1 Compulsive Exercise</strong></td>
<td>.62</td>
<td>.06</td>
<td>.55</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 1 Peer Exercise Norms</td>
<td>.03</td>
<td>.04</td>
<td>.03</td>
<td>.473</td>
</tr>
<tr>
<td>Time 4 Compulsive Exercise (n=230)</td>
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<td></td>
<td></td>
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<tr>
<td>Intercept</td>
<td>2.60</td>
<td>.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 3 Exercise Identity X Time 3 Peer Exercise Norms</td>
<td>-.03</td>
<td>.02</td>
<td>-.07</td>
<td>.106</td>
</tr>
<tr>
<td><strong>Time 3 Compulsive Exercise</strong></td>
<td>.78</td>
<td>.04</td>
<td>.77</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 4 Compulsive Exercise (n=230)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.51</td>
<td>.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time 3 Compulsive Exercise</strong></td>
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<td>.74</td>
<td>&lt;.001</td>
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<tr>
<td>Time 3 Peer Exercise Norms</td>
<td>-.08</td>
<td>.04</td>
<td>-.10</td>
<td>.033</td>
</tr>
</tbody>
</table>

*Note.* Bolded indicates significant p-value for predictor. Abbreviations: SE=Standard Error.
Table 16: Results from Path Models of Proposed Risk Factors Predicting Eating Disorder Symptoms

<table>
<thead>
<tr>
<th>Predictor</th>
<th>b</th>
<th>SE</th>
<th>β</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 2 Eating Disorder Symptoms (n=332)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.58</td>
<td>2.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1 Eating Disorder Symptoms</td>
<td>0.65</td>
<td>0.07</td>
<td>0.62</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 1 Compulsive Exercise</td>
<td>0.73</td>
<td>0.28</td>
<td>0.16</td>
<td>0.009</td>
</tr>
<tr>
<td>Time 4 Eating Disorder Symptoms (n=332)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Intercept</td>
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<td>2.40</td>
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</tr>
<tr>
<td>Time 1 Eating Disorder Symptoms</td>
<td>0.67</td>
<td>0.06</td>
<td>0.64</td>
<td>&lt;.001</td>
</tr>
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<td>Time 1 Compulsive Exercise</td>
<td>0.61</td>
<td>0.26</td>
<td>0.14</td>
<td>0.017</td>
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<tr>
<td>Time 4 Eating Disorder Symptoms (n=232)</td>
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<td></td>
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<tr>
<td>Intercept</td>
<td>-1.22</td>
<td>1.62</td>
<td></td>
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</tr>
<tr>
<td>Time 3 Eating Disorder Symptoms</td>
<td>0.78</td>
<td>0.05</td>
<td>0.80</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time 3 Compulsive Exercise</td>
<td>0.38</td>
<td>0.18</td>
<td>0.09</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Note. Bolded indicates significant p-value for predictor. Abbreviations: SE=Standard Error.
Chapter Four: Discussion

The current study addresses important gaps in the compulsive exercise literature by longitudinally investigating the relationship between exercise identity, peer exercise norms, eating disorder symptoms, and compulsive exercise. While linear growth of compulsive exercise was not observed, exercise identity emerged as a significant predictor of change in compulsive exercise both within each semester and across the first year of college. Further, peer exercise norms emerged as a significant predictor of change in compulsive exercise over the spring semester. Similarly, while there was no evidence of a longitudinal dynamic process between compulsive exercise and eating disorder symptoms, compulsive exercise was a significant predictor of change in eating disorder symptoms both within each semester and across the first year of college. Results from this study extended both prior cross-sectional (Karr et al., 2014) and longitudinal (Chapa et al., 2020; Homan, 2010; Zhan et al., 2022) findings related to compulsive exercise and eating disorder symptoms.

Compulsive Exercise Change Over Time

Hypothesis 1 posited that compulsive exercise would increase over the 9-month study period. Results from both MLM and SEM analyses indicated that compulsive exercise did not demonstrate significant linear growth over time. Further, post-hoc analyses indicated that there were no overall mean differences in compulsive exercise across the four time points. Previous research has found that compulsive exercise increases over the academic year among female undergraduates (Homan, 2010). Research conducted with a diverse sample of first year college students who were demographically similar to the current sample, however, reported similar
findings to the present study. Specifically, findings indicated that the majority of the subscales of the compulsive exercise test (CET) did not change over the first semester of college (Zhan et al., 2022). However, the Avoidance and Rule-Driven Exercise subscale demonstrated a modest effect of time (initial increase and later leveled off). Future research may benefit from considering CET subscales as independent outcome variables.

Although the present findings are somewhat aligned with recent research, there are several important discrepancies between the participants and research methodology that would benefit from further investigation. For example, compulsive exercise may be more salient to female than male early college students. The sample in the present student was approximately 50% male college students, while the findings from Homan (2010) are from exclusively female undergraduates. Investigating whether gender may moderate the trajectory of compulsive exercise over the first year of college would provide insight into whether this may explain differences between the current findings and the findings from Homan (2010). Alternatively, it may be that only certain subscales of the CET are relevant to the first year of college. The current study used the global score for the CET, which combines all the subscales, whereas Zhan and colleagues (2022) considered each subscale individually. Future research may benefit from examining each subscale of the CET to see if certain aspects of compulsive exercise demonstrate growth over the first year of college to inform preventative intervention targets.

Importantly, although not statistically significant, findings demonstrated a modest cubic trend to the data. In the current study, compulsive exercise increased from Time 1 to Time 2, decreased from Time 2 to Time 3, and then increased again from Time 3 to Time 4 (see Figure 1). Overall, Time 2 had the highest percentage of individuals with clinically significant compulsive exercise. It is possible that this spike in compulsive exercise at the end of the first
The first semester of college was related to individuals initially adapting to the stressors of the first year of college. This pattern mirrors the findings from Zhan et al. (2022) where the Avoidance and Rule-Driven Exercise subscale demonstrated an initial increase in maladaptive exercise, after which the level was maintained. The Avoidance and Rule Driven Subscale assesses exercise behaviors driven by avoidance of negative affect (e.g., “I feel extremely guilty if I miss an exercise session”). Therefore, the findings from Zahn et al. (2022) may indicate that college students are engaging in compulsive exercise primarily to avoid experiencing negative emotions. If individuals are engaging in compulsive exercise to cope with initial stressors of the first year of college and/or to avoid feeling negative emotions, preventative interventions may consider including an emotion regulation component. Further, the spike in compulsive exercise at Time 2 could also be related to the myth of the “Freshmen 15” – the idea that students will gain 15 pounds in their first year of college. While there is evidence that, on average, first year college students do not experience substantial weight gain (Fedewa et al., 2014; Vadeboncoeur et al., 2015), first year students may engage in exercise behaviors motivated by concerns about the Freshmen 15 as they approach the end of their first semester of college. If this pattern of increased behaviors over the first semester of college is replicated in future research, it may be that one key intervention point for compulsive exercise is the early weeks of the first year of college. Research also may benefit from qualitatively assessing motivations for engaging in compulsive exercise behaviors. For example, if individuals are engaging in compulsive exercise due to concerns about the “Freshmen 15”, preventative interventions could focus on providing psychoeducation about realistic weight gain trajectories across the first year of college. This style of intervention may mitigate concerns about weight gain, and therefore reduce engagement in maladaptive exercise behaviors.
It is also important to note that winter break occurred between Times 2 and 3 and many students may have returned home for several weeks during this time. The decrease in engagement in compulsive exercise from Time 2 to Time 3 may indicate that the break between semesters somehow interrupts the trajectory of compulsive exercise and that each semester should be considered individually. There are several possibilities as to why the winter break may impact behaviors. First, students going home may no longer have access to facilities where they were engaging in compulsive exercise (e.g., the university gym). Related to this, it may not be as easy for students to engage in compulsive exercise behaviors without other individuals taking note (e.g., parents, siblings, etc.). Additionally, it may be that since students are not experiencing the stress of the college environment, they may not feel the need to engage in maladaptive coping behaviors such as compulsive exercise. Intolerance of uncertainty – a facet of anxiety – is hypothesized to facilitate increased compulsive or “safety” behaviors (Boswell et al., 2013) and compulsive exercise can function as a “safety” behavior. Indeed, Scharmer et al. (2020) found that intolerance of uncertainty was the strongest predictor of compulsive exercise among college students. It may be that compulsive exercise is used as a coping mechanism during more stressful times of the semester (e.g., midterms or finals weeks). Last, the change in context could have implications for exercise behaviors. For example, if an individual’s family does not normally exercise or if individuals are engaging in fewer social comparisons since they are no longer around peers, they may not feel as compelled to engage in maladaptive exercise behaviors while at home.

If future studies demonstrate that compulsive exercise increases within each semester but decreases between semesters, it may be important to consider semesters as independent risk periods. For example, first-year students may benefit from receiving interventions for
compulsive exercise at the beginning of each semester, not just the first semester of their first year. Future research should investigate if compulsive exercise appears to increase across semesters and decrease between semesters among a sample of students in all years of college. This will help determine if there is something unique about the first year of college (e.g., the stress of adapting to a new environment/experiences) that specifically motivates this pattern of engagement in compulsive exercise behaviors. Additionally, it will be important to understand these patterns among non-first year students who live off-campus, those who return home for winter break for shorter periods of time, and among students who live at home and commute to college. In the current sample, the majority of participants reported living on campus at all time points. If different living situations are associated with different patterns of engagement in compulsive exercise over the academic year, it may be that there is something specific to living on campus (e.g., proximity to a gym, less separation from a stressful environment, etc.) that is conducive to increasing risk for engagement in compulsive exercise.

The lack of overall linear growth in compulsive exercise in the current sample may indicate that the first year of college is not relevant to the development of compulsive exercise. It is possible that incoming first-year students who already are engaging in compulsive exercise maintain the same level of this behavior over the first year of college. Eating disorders most commonly develop during adolescence (Anderson & Nicolay, 2016; Swanson et al., 2011) and compulsive exercise behaviors may follow this same developmental pattern. Indeed, there is evidence to suggest that compulsive exercise is present in non-eating-disordered adolescent samples (Goodwin et al., 2014a). Since research indicates that compulsive exercise is observed in non-eating disorder populations among both college students and adolescents (Goodwin et al., 2014a; Zhan et al., 2022), identifying a clear risk period for compulsive exercise will be
imperative to inform when preventative interventions will be most impactful. For example, adult exercise behaviors and attitudes are often established in adolescence (Patton et al., 2016). If these findings hold true for compulsive exercise, this is a clear sign that preventive interventions should be implemented in high school.

Results from the RI-CLPM indicated that the only change in behaviors that were significantly predictive of each other were compulsive exercise from Time 3 to Time 4 and eating disorder symptoms from Time 3 to Time 4. This may indicate that there is something about the spring semester that makes both eating disordered and compulsive exercise behaviors more salient. One possibility for this potential increased salience could be spring break. Spring break has been established as a significant motivator for physical activity among college students (Piazza-Gardner & Barry, 2014). Further, qualitative research indicates that spring break may exacerbate body image concerns and influence dieting behaviors among college students (Seward et al., 2018). These findings merit replication and highlight the potential utility of repeating preventive interventions targeting maladaptive exercise and eating disorders at the beginning of the spring semester.

In sum, findings from the current study suggest that compulsive exercise does not demonstrate significant linear growth over the first year of college. Further, results indicate that winter break may impact engagement in health risk behaviors and that disordered eating and compulsive exercise behaviors may be more salient in the spring semester. Future research would benefit from investigating more nuanced research questions related to compulsive exercise among first-year college students by examining specific subscales of the CET, collecting additional data points over each semester, and following students over multiple years of college. In addition, future research should work to understand the key risk period for
compulsive exercise (e.g., adolescence vs. emerging adulthood) and motivations for engagement in compulsive exercise to inform when and which preventative interventions would be most effective. Last, given the trend of the data to have an increase in behaviors during the spring semester, future research should investigate if preventative interventions administered at the beginning of each semester more effective than a one-time intervention at the beginning of the fall semester.

**Exercise Identity as Risk Factor for Development of Compulsive Exercise**

Hypothesis 2a posited that stronger initial exercise identity at Time 1 would predict greater increases in compulsive exercise over time. Hypothesis 2a was not supported since there was no evidence of a linear trajectory of compulsive exercise over the study period. Although this was the first study to longitudinally investigate the relationship between exercise identity and compulsive exercise, these results were somewhat unexpected. Previous research has demonstrated that strong exercise identity can foster motivation for exercise behaviors over a 6-month period (Ntoumanis et al., 2018). However, Ntoumanis et al. (2018) did not specifically examine compulsive exercise, which may explain the differences in findings.

Given a signal of a cubic trajectory, post-hoc path analyses investigated hypotheses within each semester and from the beginning to the end of the 9-month study period. Results indicated that exercise identity at Time 1 predicted change in compulsive exercise at Times 2 (end of fall semester) and 4. Further exercise identity at Time 3 (beginning of spring semester) predicted change in compulsive exercise at Time 4. These findings suggest that higher exercise identity predicts increases in compulsive exercise within a given semester and from the beginning to the end of the first year of college. This study extends existing cross-sectional work suggesting that compulsive exercise and exercise identity are associated (Karr et al., 2014;
Palermo & Rancourt, 2021). Since this study is the first to establish that exercise identity and compulsive exercise are significantly associated over time, results merit replication.

Stronger exercise identity at the beginning of the first year of college predicted increases in engagement in compulsive exercise at the end of the academic year. Assessing exercise identity at the beginning of the first year of college could be an effective non-face valid screener for identifying individuals engaging in maladaptive exercise. However, before exercise identity is used as a screening tool, it will be important to determine what score range of exercise identity is associated with clinical/sub-clinical levels of compulsive exercise.

Interestingly, exercise identity did not demonstrate significant mean differences over time. This may indicate that the first-year college environment may not affect exercise identity development. Since emerging adulthood covers the 18-25 age range (Arnett, 2000) it may be that identity changes and/or development occur after the first year of college once the individual has had time to adapt to new peer groups and a new environment. Future research should investigate if exercise identity demonstrates change over the collegiate experience to determine if this is something that forms before, during, or even after college. Previous research indicates that exercise identity can increase in female adults ages 18-52 (mean age= 27.3, SD= 9.0) when given a physical activity intervention (Cardinal & Cardinal, 1997), indicating that identity change is not solely unique to individuals in the emerging adulthood period. Future research should work to continue to establish if exercise identity is a risk factor for compulsive exercise or if these constructs have a dual change relationship. Personal identity formation and eating disordered behaviors demonstrate a bidirectional relationship (Verschueren et al., 2018), and this pattern may replicate for exercise identity and compulsive exercise behaviors.
This is the first study to longitudinally establish a relationship between exercise identity and compulsive exercise. Findings merit replication among exercisers and over a longer time period. Exercise identity may hold potential to be used as a screening tool to identify individuals at risk of or currently engaging in clinically significant levels of compulsive exercise. Future research will benefit from continuing to understand the longitudinal relationship between exercise identity and compulsive exercise.

Peer Exercise Norms as a Moderator of the Relationship Between Exercise Identity and Compulsive Exercise

Hypothesis 2b posited that peer exercise norms would moderate the relationship between exercise identity and the trajectory of compulsive exercise behaviors. There was no evidence of an interaction between exercise identity and peer norms in any of the models. Results from post-hoc path analyses, however, suggest that peer exercise norms at Time 3 independently significantly predicted change in compulsive exercise behaviors at Time 4. Importantly, this finding was in the opposite direction as expected based on previous research investigating peer norms and disordered eating behaviors (Eisenberg & Neumark-Sztainer, 2010; Gravener et al., 2008). There are several reasons that may explain the findings from the current study.

First, the study sample was comprised of individuals who engaged in a range of exercise frequency from no exercise to a high frequency of exercise. It may be that peer exercise norms are not as salient to non-exercisers and having a mixed sample may have attenuated results. Importantly, peer exercise norms and compulsive exercise were significantly and positively correlated at all time points except Time 1, indicating that these norms at Time 1 may have been less salient/meaningful to behavior. This result in some ways is unsurprising. Time 1 was collected during the first few weeks of one’s college experience and peer exercise norms may not
have been established. Currently, it is unknown how long it takes to internalize peer norms within the college environment. It is possible that peer exercise norms may not feel particularly salient until later in the first year of college or even in later years of college as peer groups change. Future research should aim to understand when peer norms, specifically peer exercise norms become salient among college students.

One notable trend in the data is that the trajectories of peer exercise norms and compulsive exercise mirror one another (Figures 1 and 3). This may indicate that peer exercise norms and engagement in compulsive exercise follow similar trajectories (as one increases, so does the other). However, based on post-hoc analyses, higher peer norms at Time 3 predicted engagement in less compulsive exercise behaviors at Time 4. This was the only time point at which peer exercise norms were a significant predictor of change in compulsive exercise behaviors. Further, findings from the latent growth curve model suggest that higher peer norms at Time 1 were associated with less compulsive exercise at Time 1. Taken together, results indicate that peer exercise norms may be protective against compulsive exercise.

Peer norms are typically risk factors for engagement in these behaviors among college students (e.g., disordered eating: Clemens et al., 2008, binge drinking: Borsari & Carey, 2001, and risky sexual behaviors: McAlaney & Jenkins, 2017). However, one important difference between previous research and the current study is that the current study did not specifically assess peer norms of maladaptive exercise behaviors – the measure asked about exercise more generally. It may be that the peer exercise norms reported in the current study were describing adaptive exercise behaviors and consequently may have been associated with lower engagement in compulsive exercise behaviors. Currently, there are few validated measures to assess peer exercise norms, and none that currently assess both adaptive (e.g., exercise for enjoyment) and
maladaptive (e.g., exercise to compensate for weight/shape concern) norms. A psychometrically valid measure assessing peer norms related to maladaptive exercise is needed to be able to study this construct. If greater peer exercise norms related to adaptive exercise are protective against engagement in compulsive exercise, preventative interventions should aim to deliver peer-norm-based interventions focused on adaptive exercise. Norm-based interventions are successful at decreasing health risk behaviors of college students, such as alcohol use (e.g., Dvorak et al., 2016). It may be that delivering information about why peers are engaging in adaptive exercise behaviors and peer perceptions around maladaptive exercise (e.g., it is negatively perceived) could be effective at decreasing compulsive exercise behaviors in early college students.

This was the first study to investigate the relationship between peer exercise norms and compulsive exercise, and these findings merit replication. Further, if future research continues to assess general peer exercise norms in the context of maladaptive exercise, exploration of how peer exercise norms are defined (adaptive versus maladaptive) is warranted. Future research should replicate findings in a sample of more senior college students who identify as regular exercisers. Finally, it would be useful to longitudinally investigate how maladaptive peer exercise norms affect engagement in maladaptive exercise behaviors among individuals who identify as non-exercisers compared to those who identify as exercisers.

**Compulsive Exercise as a Risk Factor for Eating Disorder Symptoms**

Hypothesis 3 proposed that compulsive exercise would significantly and prospectively predict eating disorder symptoms. Results from both the LDS and RI-CLPM analyses indicated that neither compulsive exercise nor eating disorder symptoms prospectively predicted the other. Similar to the compulsive exercise findings, this may support the idea that the first year of college is not as much of a risk period for eating disorder symptom development as previously
conceptualized (Berg et al., 2009; Delinsky & Wilson, 2008; Howard et al., 2020). Given findings from the current study are counter to prior investigations, this merits replication.

Interestingly, the univariate model that best fit the compulsive exercise data was the dual change model. This model suggests that adequate modeling of growth of compulsive exercise required both constant (constant change over time) and proportional (compulsive exercise change is influenced by the score of compulsive exercise at the previous time point) change parameters. This was a noteworthy result given that the latent growth curve model indicated no significant change over time. These models, however, answer different questions. The latent growth curve model only examines the outcome as a function of time and assumes that the process is inherently linear. A latent growth curve model is mathematically equivalent to the constant change model estimated as part of the LDS model building approach. However, the dual change model views change as a dynamic process, where a score at a given time is viewed as the combination of two competing information sources (the constant change and the proportional change). The mathematical equivalent for a dual change model is a nonlinear three-parameter exponential latent growth curve model (Serang et al., 2019). The latent growth curve model can provide information about overall growth and this can be more difficult to extract from an LDS model (Serang et al., 2019). Therefore, interpretation of overall compulsive exercise growth is best based on the latent growth curve model rather than the dual change model.

Ultimately, results from both the LCGM and the LDS model are aligned. The LCGM model indicated that there was no significant overall linear growth in compulsive exercise over time. Similarly, the LDS dual change model indicated that over time, the constant change parameter was attenuated by the negative proportional change value, suggesting no significant growth over time. It is common for the dual change score model to fit best compared to either the
constant or proportional change model because it is the most flexible in that it is equivalent to modeling exponential change (Jacobucci et al., 2019; Serang et al., 2019). In the case of the current data, although the dual change score model fit the data best, it did not indicate significant growth over time supporting the results from MLM and SEM analyses.

In the current study, compulsive exercise and eating disorder symptoms demonstrated a no change relationship. This supports the idea that compulsive exercise may occur independently of other eating disordered behaviors (Lichtenstein et al., 2017). Findings are partially aligned with previous research. For example, in a broad sample of individuals diagnosed with an eating disorder, the only eating disorder symptom that demonstrated a dual change relationship with driven exercise was cognitive restraint; the majority of eating disorder symptoms (e.g., body dissatisfaction, binge eating, and purging) had a no change relationship with driven exercise (Chapa et al., 2020). Although this study used a clinical sample, it may provide some insight into which eating disorder symptoms are more applicable to engagement in compulsive exercise among non-eating-disordered samples (e.g., cognitive restraint). Results from the current study suggest that future research should continue to conceptualize compulsive exercise as an independent health-risk behavior and investigate which specific components of disordered eating are associated with compulsive exercise.

Previous research suggests that compulsive exercise is strongly associated with eating disorder cognitions (e.g., drive for thinness, dietary restraint), but less strongly related to eating disorder behaviors (Taranis & Meyer, 2011). The present study used a measure that captured weight and shape overvaluation as part of self-reported eating disorder diagnostic criteria. In contrast, Chapa et al. (2020) used a measure that separates behavioral versus cognitive symptoms of eating disorders. General cognitions related to disordered eating, such as cognitive restraint or
negative attitudes towards obesity, may be more closely related to maladaptive exercise behaviors (Meyer et al., 2011). Future research should investigate the relationship between compulsive exercise and both eating disordered behaviors and cognitions using a measure that distinguishes these disordered eating facets, such as the Eating Pathology Symptoms Inventory (EPSI; Forbush et al., 2013). If it appears that compulsive exercise and eating disorder cognitions but not behaviors are closely linked, it will be important to understand if compulsive exercise and eating disorder cognitions demonstrate a dual change relationship. Alternatively, it may be that one prospectively predicts the other among a broad sample of individuals engaging in compulsive exercise.

Last, compulsive exercise and the eating disorder symptom count were significantly correlated at each time point. Additionally, post-hoc findings indicated that compulsive exercise at Time 1 significantly predicted Times 2 and 4 eating disorder symptoms and Time 3 compulsive exercise significantly predicted Time 4 eating disorder symptoms. This finding provides some support for the idea that compulsive exercise may exist independent of other eating disorder symptoms and may be a risk factor for engagement in disordered eating behaviors. Given that these patterns replicated over both the first year of college and within each semester, preventative interventions for eating disorder symptoms may consider incorporating a compulsive exercise component.

In sum, future research should assess compulsive exercise behaviors with both eating disorder behaviors and cognitions to understand what may be driving and/or maintaining compulsive exercise behaviors and vice versa. Further, future research should replicate findings related to the non-linear trajectories of compulsive exercise and eating disorder symptoms over the first year of college given that results were contrary to previous findings.
Strengths and Limitations

The proposed study has several notable strengths including the longitudinal design and the administration of surveys from an online platform to facilitate access and retention of participants. Additionally, this study is one of only a few studies to longitudinally investigate maladaptive exercise among college students (e.g., Homan, 2010; Zhan et al., 2022). Further, the current study is the only one to assess compulsive exercise among both male and female first year college students across the entirety of the first academic year. Additionally, the sample remained gender balanced at all four time points (almost 50/50 split between male and female participants). This gender balance is a strength given many studies of disordered eating behaviors solely focus on female samples. Further, the level of diversity within the sample represents a study strength since many prior studies examining these constructs represent almost entirely Caucasian populations (e.g., Homan, 2010; Patterson & Goodson, 2018). The overall retention rate from Time 1 to Time 4 was 74% and this is well-aligned with recent research with college students using similar study designs (e.g., Stein & Corte 2008; Stutts & Blomquist, 2018). This retention rate, combined with the ability to use FMIL/REML, facilitated the study being well-powered to test hypotheses using both SEM and MLM frameworks. Last, the study used rigorous statistical approaches to test hypotheses allowing for meaningful conclusions to be drawn.

Despite these strengths, a number of limitations should be noted. First, although longitudinal statistical models are best estimated with several time points, feasibility of completion and funding constraints were important points of consideration when designing the study. It was decided that four time points over a 9-month period would allow for the potential to observe behavioral change, sufficient data for the proposed analyses, and completion of the study in a one-year period and within budget limitations. Previous research has observed change across
similar time periods in disordered eating (over nine months) and exercise behaviors (over seven months) among undergraduates with only two time points (Crandall, 1988; Delinsky & Wilson, 2008; Homan, 2010; Striegel-Moore et al., 1989). Additional data points may provide more information about the true trajectory of compulsive exercise, especially related to within-semester patterns. For example, if there were three time points within each semester, it may provide additional information about when engagement in compulsive exercise behaviors increases and whether these increases may be linked to college events or milestones (e.g., right at the start of the semester, over finals week). Further insight is needed into how the semester break may impact compulsive exercise behaviors among first-year college students and at what points during the academic year preventive interventions may be most effective.

Second, data for the current study were collected over the 2021-2022 academic year. There is evidence that compulsive exercise behaviors (Palermo & Rancourt, 2022) and eating disorder symptoms (Tavolacci et al., 2021) increased among college students at the height of the COVID-19 pandemic. These data were collected, however, when the university at which the study was conducted was functioning similarly to pre-COVID-19 with limited restrictions. It is unlikely that COVID-19 would have substantially influenced the present findings.

Third, focusing only on first-year college students may have been both strength (by focusing on an at-risk population) and a limitation of the current study. For example, the impact of psychosocial risk factors, such as exercise identity and peer exercise norms, may not be as salient to behaviors during the first year of college. Risk factors may still be developing and may impact compulsive exercise and eating disorder behaviors later during college. Future research should investigate these constructs using a cohort study design where individuals are followed over multiple years of college. Given that other disordered eating behaviors are known to
develop in adolescence (Anderson & Nicolay, 2016), it would be important to follow a high school sample over the first few years of college to better understand the development and trajectories of these behaviors and risk factors.

Fourth, while the current study represented a relatively diverse sample of individuals, the analyses did not control for or investigate differences in compulsive exercise by racial/ethnic status. There is some evidence that engagement in compulsive exercise may vary by racial/ethnic status. For example, among women, those who identified as Latina, Native American, and White reported comparable levels of excessive exercise, while Black and Asian women reported less engagement in maladaptive exercise behaviors (Bruening & Perez, 2019). Among men, however, there is no evidence of racial/ethnic differences in compulsive exercise (Kelly et al., 2015). It may be that exercise is a more socially normative behavior among certain female racial/ethnic groups. Alternatively, it could be that internalization of appearance norms underlies the differences in compulsive exercise of ethnic/racially diverse women. There are few studies investigating racial/ethnic differences in compulsive exercise of men or women and the empirical literature would benefit from work investigating whether and how compulsive exercise may differ across sociodemographic factors.

Fifth, currently compulsive exercise behaviors are primarily conceptualized as cognitions and motivations related to exercise behavior (Goodwin et al., 2016). However, having data on individuals’ engagement in physical activity behaviors would have provided further understanding into how the self-reported physical activity is aligned with the endorsement of compulsive exercise behaviors. While the current study collected physical activity behaviors using a modified version of the IPAQ, these data were uninterpretable, limiting the ability to investigate if self-reported physical activity levels are associated with compulsive exercise. This
may indicate that the IPAQ-S does not translate well to an online format, however, many recent studies have appeared to use the IPAQ-S with an online survey with no reported issues (e.g., Booker et al., 2021; Daniels et al., 2021). Given that the IPAQ data was unusable, the percentage of participants engaging in regular exercise is unknown. The current study did not restrict participation to individuals who engaged in regular exercise; participants needed to be physically able to participate in exercise, but there were no requirements related to regular engagement. It is possible a subset of study participants felt the survey questions were not applicable. Previous studies investigating compulsive exercise among college students have also used broad samples without restrictions related to engagement in exercise (Homan, 2010; Zhan et al., 2022) and have found changes in compulsive exercise over similar timeframes. Future research should investigate differences between a sample of individuals at all levels of physical activity engagement and those who regularly engage in physical activity. Further, investigating whether compulsive exercise is associated with objectively measured exercise behaviors, such as by pairing fitness tracker and ecological momentary assessment data, would provide additional understanding of how exercise behaviors are related to compulsive exercise cognitions.

Sixth, the current study had two limitations related to measurement. First, there is only one published measure that assesses peer exercise norms. This measure does not distinguish adaptive versus maladaptive peer exercise norms, nor has it undergone rigorous psychometric testing. Second, the current study used a measure of self-reported diagnostic eating disorder symptoms that is best conceptualized as a symptom count. Given that it may be that compulsive exercise and eating disorder cognitions are more closely related (Taranis & Meyer, 2011), future research should include measures that capture both eating disordered cognitions and behaviors.
Last, although all aspects of identity theory (i.e., personal, social, role) may play a role in compulsive exercise, no research has investigated less defined personal (e.g., having attributes that are important to who they are) or specific social identities (e.g., gender, ethnic, sexual identities) as risk factors for maladaptive exercise behaviors. Although individuals with eating disorders have less clearly defined/stable identities than community controls (Vartanian, 2009; Verschueren et al., 2017), the role of identity specifically related to compulsive exercise behaviors is less understood. Future research would benefit from investigating if having a less salient personal identity or certain social identities are linked with maladaptive exercise behaviors.

**Clinical Implications**

Findings from the current study have important clinical implications. First, from a prevention-focused lens, exercise identity may be an effective non-face-valid screening tool to identify individuals at risk of engaging in compulsive exercise. If research determines that exercise identity can be used as a screening tool, universities may be able to identify students who could benefit from a brief preventive intervention targeting exercise motivations. Alternatively, if preventative interventions for compulsive exercise are created, universities could then administer this intervention to students who score above a certain threshold on exercise identity.

Additionally, the current study identified that greater peer exercise norms at the beginning of the second semester were associated with decreases in compulsive exercise at the end of the second semester of the first year of college. If these results are replicated with methods that distinguish between adaptive and maladaptive peer exercise norms, peer exercise norms may be an effective preventative intervention target. Currently, an existing group therapy
treatment protocol for compulsive exercise includes psychoeducation about norms concerning ‘healthy exercise’ (Dittmer et al. 2018). This treatment protocol could be adapted into a preventative intervention format by offering psychoeducation around healthy peer exercise norms (e.g., why peers engage in exercise, peer attitudes towards exercise). Previous psychoeducational interventions focusing on reducing disordered eating pathology have demonstrated success among college students (Zhou et al., 2020). Therefore, future research should examine if providing psychoeducation about norms for engaging in adaptive exercise is effective at reducing maladaptive exercise and increasing adaptive exercise. Last, given the trend of the data to have an increase in behaviors during the spring semester, preventative interventions may be more effective if delivered at the beginning of each semester rather than solely at the beginning of the fall semester.

Findings from the current study also provide information relevant to the treatment of compulsive exercise. Results suggest that higher exercise identity may be predictive of increases in compulsive exercise from the beginning to the end of the first year of college, as well as within each semester. Treatment protocols targeting compulsive exercise may benefit from incorporating an identity reconstruction component. Current CBT- based interventions demonstrated an increase in quality-of-life outcomes for multiple sclerosis patients when incorporating an identity redefinition component (Graziano et al., 2014). Similarly, Stein et al. (2013) have found that developing a positive personal identity during eating disorder treatment is effective for reducing eating disorder symptoms. The limited current research provides support for the idea that including an identity-based intervention could improve treatment outcomes. One way that interventions may be able to incorporate an identity change component is by adopting a
CBT values-based approach. For example, individuals could create an identity hierarchy and identify steps to maintain a more balanced identity framework.

Alternatively, it may be that working to reduce compulsive exercise behaviors will subsequently lead to changes in exercise identity, as increases in physical activity are related to increases in exercise identity (Cardinal & Cardinal, 1997). It might be that identity is similar to the “thoughts” component of cognitive behavior therapy (Beck, 1979). For example, CBT relies on the assumption that changing behaviors will change thoughts and emotions, thus, changes in maladaptive exercise behaviors may lead to changes in exercise identity. Future research should examine how a reduction in compulsive exercise behaviors modifies exercise identity.

Last, evidence from the current study and previous research indicates that compulsive exercise behaviors can exist independent of an eating disorder diagnosis (Meyer et al., 2011). Compulsive exercise is associated with a variety of negative outcomes (e.g., body dissatisfaction, increased negative mood and social isolation; Homan, 2010; Li et al., 2015), yet individuals with compulsive exercise may have difficulty obtaining a diagnosis or seeking treatment if they do not engage in other eating disordered behaviors. Future research should determine how to categorize and provide a diagnosis for an individual with compulsive exercise behaviors. It may be that compulsive exercise, when not co-occurring with other eating disorder symptoms, may be best categorized as Other Specified Feeding or Eating Disorder. In sum, results from the current study have important clinical implications related to the assessment of at-risk individuals, the timing and content of preventative interventions, components to incorporate into treatment protocols for compulsive exercise, and future diagnostic considerations.
Conclusions

This study contributed to the existing literature on compulsive exercise and eating disorder symptoms among first year students in several ways. First, it provides an improved understanding of potential predictors of compulsive exercise behaviors. Findings suggest that high exercise identity predicts increases in compulsive exercise both over the course of an academic year and within each semester. Further, higher peer exercise norms at the beginning of the spring semester are predictive of lower engagement in compulsive exercise at the end of the spring semester. Second, findings indicate that compulsive exercise behaviors may be a risk factor for eating disorder symptoms. Third, the current study yields a substantial account of the developmental trajectory of eating disorder symptoms and compulsive exercise among first-year college students. Contrary to prior research, the first year of college did not represent a time for significant change in compulsive exercise behaviors or eating disorder symptoms in the present sample. Findings have important implications for potential preventative interventions, treatment protocols (e.g., including an exercise identity component), and next steps for the examination of compulsive exercise behaviors, eating disorder symptoms, and related psychosocial variables.
References


https://doi.org/10.1016/j.eatbeh.2009.03.003

https://doi.org/10.1037/1089-2680.7.2.115

https://doi.org/10.1177/0146167201277007


https://doi.org/10.1037/pha0000159


https://doi.org/10.1080/07448481.2010.546461


[https://doi.org/10.1080/1750984X.2017.1354229](https://doi.org/10.1080/1750984X.2017.1354229)


Stice, E. (n.d.). *Measures created or modified by Eric Stice, PhD.* Oregon Research Institute
http://www.ori.org/sticemeasures/


Appendices
Appendix A: IRB Approval Letter

EXEMPT DETERMINATION

August 2, 2021

Madeline Palermo

Dear Madeline Palermo:

On 7/30/2021, the IRB reviewed and approved the following protocol:

<table>
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<th>Application Type:</th>
<th>Initial Study</th>
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<tr>
<td>IRB ID:</td>
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</tr>
<tr>
<td>Review Type:</td>
<td>Exempt 2</td>
</tr>
<tr>
<td>Title:</td>
<td>Identity and Exercise Behaviors in Early College Students</td>
</tr>
<tr>
<td>Funding:</td>
<td>Psi Chi</td>
</tr>
<tr>
<td>Protocol:</td>
<td>HRP-503a - 7.30.docx</td>
</tr>
</tbody>
</table>

The IRB determined that this protocol meets the criteria for exemption from IRB review.

In conducting this protocol, you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Please note, as per USF policy, once the exempt determination is made, the application is closed in BullsIRB. This does not limit your ability to conduct the research. Any proposed or anticipated change to the study design that was previously declared exempt from IRB oversight must be submitted to the IRB as a new study prior to initiation of the change. However, administrative changes, including changes in research personnel, do not warrant a modification or new application.

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit a new request to the IRB for a determination.

As a reminder, please contact USF IT at secops-help@usf.edu to set up your Box.com study folder before storing data on the cloud. You will need to include the name of the Principal Investigator (folder owner), study title, data to be stored, and a list of IRB-
Appendix B: Demographic Survey

1. Please indicate your age: ____
2. Please indicate your gender:
   a. Woman/Female
   b. Man/Male
   c. Other Please specify: ____________
3. Are you transgender or another gender minority
   a. Yes
   b. No
4. Please indicate your height: _____ feet _____ inches
5. Please indicate your weight: _______ pounds
6. What is your current living situation?
   a. On-Campus
   b. Off-Campus with family
   c. Off-Campus with roommates
   d. Other Please specify: ____________
7. Please indicate your race/ethnic background:
   a. Black or African American
   b. White
   c. Native Hawaiian or other Pacific Islander
   d. Asian
   e. American Indian or Alaska Native
   f. Arab or Middle Eastern
   g. Southeast Asian
   h. Hispanic or Latinx
   i. Other Please specify: ____________
8. Please indicate your sexual orientation:
   a. Heterosexual/ Straight
   b. Gay or Lesbian
   c. Bisexual/Pansexual/Plurisexual
   d. Asexual
   e. Other Please specify: ____________
9. Do you consider yourself to be an athlete? You do not have to be participating currently in a varsity sport
   a. Yes
   b. No
10. Before college would you have considered yourself to be an athlete?
    a. Yes
    b. No
11. For how many years have you attended college?
    a. One
    b. Two
    c. Three
    d. Four
e. Five
f. Six or more

12. Please indicate your current relationship status:
   a. Single
   b. Dating
   c. Married
   d. Divorced
   e. Widowed
   f. Separated
Appendix C: Screener for Eating Disorders

1. Do you make yourself sick because you feel uncomfortably full?
   a. Yes
   b. No

2. Do you worry you have lost control over how much you eat?
   a. Yes
   b. No

3. Have you recently lost more than one stone (14 pounds) in a 3-month period?
   a. Yes
   b. No

4. Do you believe yourself to be fat when others say you are too thin?
   a. Yes
   b. No

5. Would you say that food dominates your life?
   a. Yes
   b. No
Appendix D: Eating Disorder Diagnostic Scale for DSM-5

Please carefully complete all questions, choosing NO or 0 for questions that do not apply.

Over the past month… Not at all Slightly Moderately Extremely

1. Have you felt fat? 0 1 2 3 4 5 6
2. Have you had a definite fear that you might gain weight or become fat? 0 1 2 3 4 5 6
3. Has your weight or shape influenced how you judge yourself as a person? 0 1 2 3 4 5 6
4. During the past month have there been times when you have eaten what other people would regard as an unusually large amount of food (e.g., a pint of ice cream) given the circumstances? YES NO
5. During the times when you ate an unusually large amount of food, did you experience a loss of control (e.g., felt you couldn't stop eating or control what or how much you were eating?) YES NO
6. How many times per month on average over the month have you eaten an unusually large amount of food and experienced a loss of control? 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16+

During episodes of overeating with a loss of control, did you…
7. Eat much more rapidly than normal? YES NO
8. Eat until you felt uncomfortably full? YES NO
9. Eat large amounts of food when you didn't feel physically hungry? YES NO
10. Eat alone because you were embarrassed by how much you were eating? YES NO
11. Feel disgusted with yourself, depressed, or very guilty after overeating? YES NO
12. If you have episodes of uncontrollable overeating, does it make you very upset? YES NO

In order to prevent weight gain or counteract the effects of eating, how many times per month on average over the past month have you:
13. Made yourself vomit? ........... 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16+

14. Used laxatives or diuretics? .... 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16+

15. Fasted (skipped at least 2 meals in a row)? ....
16. Engaged in more intense exercise specifically to counteract the effects of overeating ............

17. How many times per month on average over the past month have you eaten after awakening from sleep or eaten an unusually large amount of food after your evening meal and felt distressed by the night eating? ................

18. How much do eating or body image problems impact your relationships with friends and family, work performance, and school performance? ........... 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16+

19. How much do you weigh? If uncertain, please give your best estimate. lbs. -or- kg.

20. How tall are you? ft. in. -or- cm.

21. What is your highest weight at your current height? lbs. -or- kg

22. What is your sex? MALE FEMALE

23. What is your age? ___
Appendix E: Exercise Identity Scale

Instructions: The following questions concern your personal beliefs about exercise. Please indicate the degree to which you agree or disagree with each statement when thinking about your exercise participation.

<table>
<thead>
<tr>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Somewhat Disagree (3)</th>
<th>Neither Agree nor Disagree (4)</th>
<th>Somewhat Agree (5)</th>
<th>Agree (6)</th>
<th>Strongly Agree (7)</th>
</tr>
</thead>
</table>
1. I consider myself an exerciser.  
2. When I describe myself to others, I usually include my involvement in exercise.  
3. I have numerous goals related to exercising.  
4. Physical exercise is a central factor to my self-concept.  
5. I need to exercise to feel good about myself.  
6. Others see me as someone who exercises regularly.  
7. For me, being an exerciser means more than just exercising.  
8. I would feel a real loss if I were forced to give up exercising.  
9. Exercising is something I think about often.
Appendix F: Compulsive Exercise Test

Instructions: Please read each statement, and select the number from 0 (never True of you) to 5 (Always true of you).

<table>
<thead>
<tr>
<th>Never True (0)</th>
<th>Rarely True (1)</th>
<th>Sometimes True (2)</th>
<th>Often True (3)</th>
<th>Usually True (4)</th>
<th>Always True (5)</th>
</tr>
</thead>
</table>

1. I feel happier and/or more positive after I exercise
2. I exercise to improve my appearance
3. I like my days to be organized and structured of which exercise is just one part
4. I feel less anxious after I exercise
5. I find exercise a chore
6. If I feel I have eaten too much, I will do more exercise
7. My weekly pattern of exercise is repetitive
8. I do not exercise to be slim
9. If I cannot exercise, I feel low or depressed
10. I feel extremely guilty if I miss an exercise session
11. I usually continue to exercise despite injury unless I am very ill or too injured
12. I enjoy exercising
13. I exercise to burn calories and lose weight
14. I feel less stressed and/or tense after I exercise
15. If I miss an exercise session, I will try and make up for it when I next exercise
16. If I cannot exercise, I feel agitated and/or irritable
17. Exercise improves my mood
18. If I cannot exercise, I worry that I will gain weight
19. I follow a set routine for my exercise sessions (e.g., walk or run the same route, particular exercises, same amount of time, and so on)
20. If I cannot exercise, I feel angry and/or frustrated
21. I do not enjoy exercising
22. I feel like I’ve let myself down if I miss an exercise session
23. If I cannot exercise, I feel anxious
24. I feel less depressed or low after I exercise
Appendix G: Peer Norms Physical Activity Scale

<table>
<thead>
<tr>
<th>None (0)</th>
<th>A Few/Some (1)</th>
<th>Most (2)</th>
<th>All (3)</th>
</tr>
</thead>
</table>

1. How many of your close friends do you think exercise most days of the week?
2. How many of your close friends would you say are physically active?

<table>
<thead>
<tr>
<th>Not at all important (0)</th>
<th>Somewhat Important (1.5)</th>
<th>Very Important (3)</th>
</tr>
</thead>
</table>

3. How important do you think it is to your close friends to exercise most days of the week?
4. How important do you think it is to your close friends to be physically active?

<table>
<thead>
<tr>
<th>Disagree a lot (0)</th>
<th>Disagree Some (1)</th>
<th>Agree Some (2)</th>
<th>Agree a lot (3)</th>
</tr>
</thead>
</table>

5. My friends encourage me to be physically active.
6. My friends would disapprove if they saw me just sitting around.
Appendix H: International Physical Activity Questionnaire-Short (Used at Time 1)

Instructions: We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   
   _____ days per week

   No vigorous physical activities  
   
   Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

   _____ hours per day

   _____ minutes per day

   Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ days per week

   No moderate physical activities  
   
   Skip to question 5
4. How much time did you usually spend doing moderate physical activities on one of those days?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

____ days per week

☐ No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a weekday?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure
Appendix I: Modified International Physical Activity Questionnaire-Short questions to assess a typical week (Used at Time 1)

1. During a typical week, on how many days do you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   _____ days per week

   No vigorous physical activities  **Skip to question 3**

2. How much time do you usually spend doing vigorous physical activities on one of those days?
   _____ hours per day

   _____ minutes per day

   [ ] Don’t know/Not sure

Think about all the moderate activities that you do in a typical week. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During a typical week, on how many days do you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
   _____ days per week

   [ ] No moderate physical activities  **Skip to question 5**

4. How much time do you usually spend doing moderate physical activities on one of those days?
   _____ hours per day

   _____ minutes per day

   [ ] Don’t know/Not sure

Think about the time you spend walking during a typical week. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.
5. During a typical week, on how many days do you walk for at least 10 minutes at a time?

_____ days per week

☐ No walking           Skip to question 7

6. How much time do you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

☐ Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during a typical week. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During a typical week, how much time do you spend sitting on a weekday?

_____ hours per day

_____ minutes per day

☐ Don’t know/Not sure
Appendix J: International Physical Activity Questionnaire-Short (Used at Times 2, 3, and 4)

Instructions: We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   
   _____ days per week

   No vigorous physical activities   Skip to question 3

2. On a given day, how much time did you usually spend doing vigorous physical activities?
   
   _____ hours per day

   _____ minutes per day

   [ ] Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
   
   _____ days per week
4. **On a given day**, how much time did you usually spend doing **moderate** physical activities?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. **During the last 7 days**, on how many days did you walk for at least 10 minutes at a time?

____ days per week

☐ No walking ⏯️ **Skip to question 7**

6. **On a given day**, how much time did you usually spend **walking** on one of those days?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. **During the last 7 days**, how much time did you spend **sitting** on a **weekday**?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure
Appendix K: Modified International Physical Activity Questionnaire-Short questions to assess a typical week (Used at Times 2, 3, and 4)

1. During a typical week, on how many days do you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   
   ______ days per week
   No vigorous physical activities  Skip to question 3

2. On a given day, how much time do you usually spend doing vigorous physical activities?
   
   ______ hours per day
   ______ minutes per day

   [ ] Don’t know/Not sure

Think about all the moderate activities that you do in a typical week. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During a typical week, on how many days do you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
   
   ______ days per week

   [ ] No moderate physical activities  Skip to question 5

4. On a given day, how much time do you usually spend doing moderate physical activities?
   
   ______ hours per day
   ______ minutes per day

   [ ] Don’t know/Not sure
Think about the time you spend walking during a typical week. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During a typical week, on how many days do you walk for at least 10 minutes at a time?
   _____ days per week
   [ ] No walking    Skip to question 7

6. On a given day, how much time do you usually spend walking?
   _____ hours per day
   _____ minutes per day
   [ ] Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during a typical week. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During a typical week, how much time do you spend sitting on a weekday?
   _____ hours per day
   _____ minutes per day
   [ ] Don’t know/Not sure