

PILOT STUDY OF MENTAL HEALTH SYMPTOMS IN COLLEGIATE ATHLETES: THE  
INFLUENCE OF RESILIENCE ACROSS A COMPETITIVE SEASON

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## ABSTRACT

Megan Beth Simon: Mental Health Symptoms in Collegiate Athletes: The influence of resilience across a competitive season  
(Under the direction of J.D. DeFreese)

**Objectives:** We explored associations between training load (TL) and mental health symptoms (MHS) throughout a competitive season. Secondly, we examined resilience as an influencer on these associations. **Participants:** 114 student-athletes between 18-23 years old. **Methods:** We measured MHS and resilience at 3 timepoints throughout a competitive season with psychometric questionnaires. We collected TL daily then calculated average acute to chronic workload ratios (ACWR) and total TLs. **Results:** None of our hypothesized variables predicted the change in flourishing mental health or anxiety. Total TL at timepoint 3 had a positive main effect. Those who had greater total TL had greater increases in depression ( $t = 2.14, p = 0.035$ ). Individuals with greater total TL at timepoint 3 and lower average resilience tended to report the greatest increases in depression ( $t = -2.75, p = 0.007$ ). **Conclusion:** Results suggests the importance of evaluation of student-athlete resilience and follow-up evaluation of depression.

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## LIST OF ABBREVIATIONS

ACWR	Acute to Chronic Workload Ratio
CD-RISC-10	Connor-Davidson Resilience Scale-10 Questionnaire
GAD-7	Generalized Anxiety Disorder 7-item Questionnaire
HPA	Hypothalamic Pituitary Axis
MHC-SF	Mental Health Continuum-Short Form Questionnaire
MHS	Mental Health Symptoms
PHQ-9	Patient Health Questionnaire 9-item Questionnaire
RPE	Rate of Perceived Exertion
sRPE	Session Rate of Perceived Exertion
SAM	Sympathetic-Adrenomedullary

## CHAPTER I: INTRODUCTION

Negative mental health symptoms, such as depression and anxiety, are most prevalent in the general population between the ages of 16-34 years old (Gulliver, Griffiths, Mackinnon, Batterham, & Stanimirovic, 2015). Generally, depression and anxiety symptoms include, feeling sad, empty, and hopeless, with diminished interest in almost all activities, and excessive fear or worry, among others (American Psychiatric Association., 2013). While depression and anxiety symptoms are prevalent in society, this does not necessarily indicate that adults are functioning positively and productively. Therefore, it is also essential to evaluate a person's positive mental health, measured as flourishing mental health. Flourishing mental health can be defined as a state of positive mental functional performance and includes symptoms of positive feelings and adaptive functioning in individual life and community life (Keyes, 2002; Lamers, Westerhof, Ernst, Klooster, & Keyes, 2011). In alignment with extant holistic mental health research, we will investigate the multifaceted compilation of the symptoms associated with depression, anxiety, and flourishing mental health (Keyes, 2002; Rice et al., 2016).

Physically active individuals, such as athletes, have been shown to experience lower rates of negative mental health symptoms as compared to less active individuals (Gulliver et al., 2015). It can be posited, therefore, that collegiate student-athletes should experience less negative mental health symptoms than the young adult general population. However, researchers have recently indicated that elite athletes experience a similar prevalence of depression and anxiety symptoms when compared to the general population (Gulliver et al., 2015; *NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016; Radloff,

1991; Yang et al., 2007). In a study conducted by the NCAA (2015), researchers found that approximately 25% of student-athletes felt depressed and approximately 40% of student-athletes felt anxiety (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). Athletes may not be receiving the psychological benefits of exercise in part due to the exposure to stress, such as continual physical training, in competitive sport, which may increase their risk of experiencing negative mental health symptoms.

Generally, athletes must complete specific training cycles with periods of increased training and periods of recovery in order to enhance their performance (Soligard et al., 2016a). Recovery is an essential component to training cycles for athletes to regain vitality and reduce overall fatigue (DeFreese, Raedeke, & Smith, 2013; G Kenttä, 2002). Quantifying and monitoring training is essential to confirm that athletes are adapting to their training and recovering appropriately. Training loads are quantified via multiple components that correspond to the physical work of training (external load) and the perception of training (internal load) (Borg, 1982; Foster et al., 2001; Haddad et al., 2013; Soligard et al., 2016a). Internal training load is an individual's response to training, which can be measured through heart rate variability, volume of oxygen consumption (VO<sub>2</sub>) values, blood variables, or a rating of perceived exertion (RPE) (T. J. Gabbett, Hulin, Blanch, & Whiteley, 2016). Whereas, external training load is the physical work component of training which can be measured via activity duration, distance covered, intensity of activity, number of jumps, etc. (Foster et al., 2001; Hulin, Gabbett, Caputi, Lawson, & Sampson, 2016). Total training load is the product of internal and external training load and is commonly measured via session RPE (sRPE) (T. Gabbett, 2017; T. J. Gabbett et al., 2016; Hulin et al., 2016; Malone et al., 2017). Moreover, researchers have found that specific training load ratios either put athletes at an increased risk of injury or act as a protective

mechanism against injury (T. Gabbett, 2017; Huli et al., 2014). As training load varies throughout a competitive season, measuring training load during the season will help clinicians better understand the amount of internal and external stress an athlete is facing and may then predict the mental health symptoms an athlete is experiencing.

To date, the relationship between training load and mental health symptoms remains unclear. One possible means to predicting adaptive or maladaptive outcomes following this physical stressor may be the intrapersonal characteristic of resilience. Resilience is a complex, dynamic process that involves how one adapts to adversity, with better adaptation reflecting higher resilience (Connor & Davidson, 2003). Due to the relationship between resilience and adversity, resilience may be essential to understanding negative mental health symptoms such as depression or anxiety, and subsequent reactions to stressful situations (Bonanno, 2008; Dray et al., 2017; Infurna & Luthar, 2016). Resilience has the potential to influence positive and negative mental health in many populations, but has been mainly explored in children or those who have experienced extreme trauma in their life (Sarkar & Fletcher, 2014). Resilience has been examined in sport mainly exploring its relationship to performance failure or qualitative interview studies to comprehend thoughts and feelings of athletes who have overcome adversity (Gail & Gonzalez, 2014).

As athletes experience different types of stressors throughout a season (such as academic requirements, numerous competitions, travel, and changing training load), it is important to identify whether resilience scores also vary over time throughout a competitive season. Additionally, previous research effects mental health symptoms may change as a result of injury and may lead to an increase in depressive symptoms specifically (Appaneal, Levine, Perna, & Roh, 2009). As musculoskeletal injury may inhibit an athlete's ability to train at the same load as

her/his teammates and injury may affect mental health symptoms, injured athletes may be a confounding variable and therefore will be controlled for in all analyses. Better understanding the ways in which resilience influences mental health symptoms of depression and anxiety in otherwise healthy athletes may allow for better treatment and management of athletes struggling with these symptoms.

## **Purpose**

The primary purpose of this study is to explore whether collegiate athletes' mental health symptoms of depression, anxiety, and flourishing mental health are associated with training load over the course of a competitive season. A secondary purpose of this study is determining whether resilience act as a moderator of the relationship between training load and mental health symptoms of depression, anxiety, and flourishing mental health.

## **Research Questions and Hypothesis**

Research Question 1: What are the associations between training load and changes in mental health symptoms related to depression, anxiety, and flourishing mental health throughout a competitive season?

- Hypothesis 1: Individuals with a higher training load will tend to report greater increases in depression and anxiety scores as well as decreases flourishing mental health scores over time.
- Independent variables: Total training load and acute to chronic workload ratios at all timepoints (baseline, 6 weeks, and 12 weeks)

- Dependent variables: Mental health symptoms (depression, anxiety, and flourishing mental health symptoms) at all timepoints

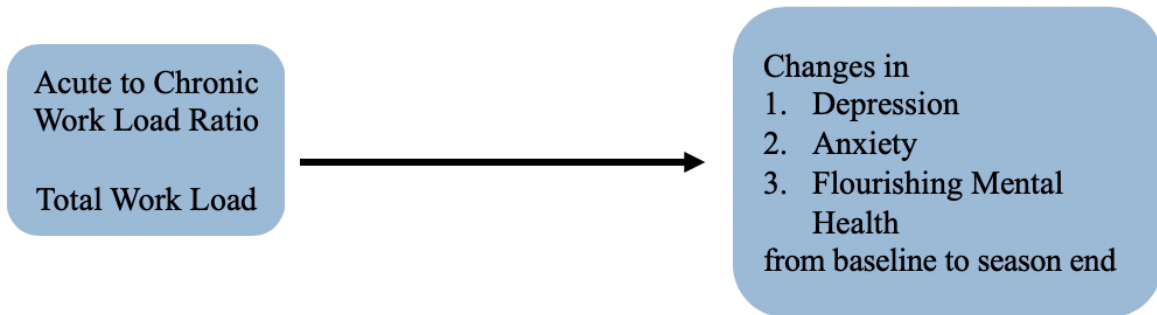


Figure 1. Proposed Relationship Between Workload and Changes in Mental Health Symptoms

Research Question 2: Does resilience act as a moderator of the relationship between training load and changes in mental health symptom scores related to depression, anxiety, and flourishing mental health throughout a competitive season?

- Hypothesis 2: Individuals higher in resilience will tend to report the lowest increases in depression and anxiety scores as well as the lowest decreases in flourishing mental health scores with high training load.
- Independent variables: Total training load and acute to chronic workload ratios at all timepoints (baseline, 6 weeks, and 12 weeks), resilience scores
- Dependent variables: Mental health symptoms (depression, anxiety, and flourishing mental health symptoms) at all timepoints

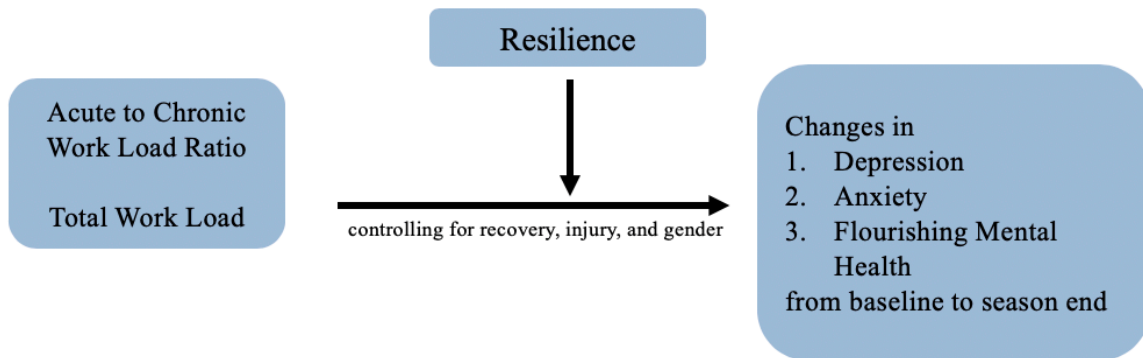


Figure 2. Moderating Effect of Resilience on the Relationship Between Workload and Changes in Mental Health Symptoms

## **CHAPTER II: REVIEW OF LITERATURE**

### **Health and Well-Being in Athletes**

The World Health Organization (WHO) defines health as a state of physical, social and mental well-being (World health organization: Division of mental health and prevention of substance abuse., 1997). This indicates that these distinct factors of well-being are essential to maintaining positive functioning and overall health (Reinboth & Duda, 2006). One manner in which people aim to improve their health is through participation in athletics. Most athletes begin their participation in sport at a young age through deliberate play, a term that describes activities such as street hockey or pick-up basketball (Côté & Abernethy, 2007). This type of participation in sport is aimed at immediate gratification and pure enjoyment of the activity (Côté & Abernethy, 2007). As athletes age and become more elite, participation in athletics shifts towards more deliberate practice, emphasizing the need to achieve a future goal and improve overall performance (Côté & Abernethy, 2007). Research has indicated that many factors influence an athlete's performance in their sport. In a study completed by Gould and colleagues (1999), researchers found that peak performance at the Olympic Games was influenced by a variety of physical, social, and psychological factors, such as high-quality training, coping skills for dealing with social distraction, and mental readiness (Gould, Guinan, Greenleaf, Medberty, & Peterson, 1999).

Important psychological factors that may affect an athlete's performance in sport and day to day life are mental health symptoms and well-being. Mental health is not merely the presence



of well-being, nor the absence of mental illness and, as such, should be evaluated on a continuum (Keyes, 2002). Those with high levels of well-being are classified as maintaining flourishing mental health. Flourishing mental health can be recognized in individuals who function well socially and psychologically while being filled with positive emotion (Keyes, 2002). Those with low well-being and experiencing negative mental health symptoms are classified as having languishing mental health (Keyes, 2002). Languishing mental health is distinguished by feelings of emptiness and stagnation and may be accompanied with symptoms related to depression or anxiety (Keyes, 2002). If ignored, languishing mental health may manifest into maladaptive consequences such as clinical mental health disorders or physical injury. Ivarsson and colleagues (2013) found that anxiety and negative-life-event stress significantly predicted injury in Swedish professional soccer players. Additionally, Devantier and colleagues (2011) found that the best psychological predictors of injury severity were somatic anxiety and coping with adversity in Danish professional soccer players. Coaches and sports medicine clinicians aim to enhance the overall health of their athletes to promote performance in sport and positive functioning in society. To reach this goal, clinicians must optimize the athlete's physical and mental health.

### **Training Load**

In order for athletes to improve their performance, they must modify their frequency, duration, and intensity of their training throughout a training cycle (Halson, 2014; Halson & Jeukendrup, 2004). Athletes often increase these parameters for their training, which is known as overreaching (Halson, 2014; Smith, 2003; Soligard et al., 2016a). While overreaching often results in significant fatigue for the athlete, when given the appropriate recovery period athletes experience a supercompensation effect. This supercompensation effect results in improved

performance as compared to baseline levels (Soligard et al., 2016a). Issues arise when athletes do not adapt to their training loads appropriately and can result in more serious conditions such as overtraining syndrome (Saw, Main, & Gatin, 2016). Overtraining syndrome is a condition where the patient experiences alterations in their physiological functioning and adaptations to training, dysfunction at the immune system level, biochemical changes, and impaired psychological processing due to the inability to recover properly from their training (Halsen & Jeukendrup, 2004). While often used interchangeably, overreaching is different from overtraining (Halsen & Jeukendrup, 2004). Overreaching is considered a normal outcome for elite athletes, allows for the possibility of the supercompensatory effect, and takes a relatively short time to recover from (approximately 2 weeks) (Halsen & Jeukendrup, 2004). Overtraining syndrome often results in mood disturbances, symptoms similar to depression, and requires months to years of recovery time (Halsen & Jeukendrup, 2004; Morgan, W P, Facsm D R, Raglin J S, O'Connor, P J, Ellickson, 1991; Saw et al., 2016). This demonstrates the importance of quantifying and monitoring training through more than a singular method.

### *Physiological Response to Training*

Training load assessment is an essential component to improving performance as it focuses on the clinical features of muscle damage and fatigue in response to training. Participation in sport and training results in acute fatigue and subclinical soft tissue damage (Fry, Morton, & Keast, 1991; Soligard et al., 2016a). Excessive participation in sport or lack of recovery, which can be quantified via training load assessment, can lead to increased soft tissue damage (T. C. Chen, Chen, Lin, Wu, & Nosaka, 2009; Lauritzen, Paulsen, Raastad, Bergersen, & Owe, 2009). Lack of appropriate recovery periods can manifest into clinical measures of

fatigue including decreased range of motion, changes in neuromuscular factors, and increased muscle pain and soreness (Brownstein et al., 2017; Erickson et al., 2016; Frank, Gilsdorf, Goerger, Prentice, & Padua, 2014; Freehill et al., 2014; Nedelec et al., 2014; Reuther, Larsen, Kuhn, Kelly, & Thomas, 2016). All of these factors indicate the importance of monitoring training load to confirm that athletes achieve the appropriate recovery periods during training.

### *Internal Training Load*

Internal training load is the physiological or perceptual response to training (Alexiou & Coutts, 2008; Soligard et al., 2016a). It can be measured through heart rate variability, VO<sub>2</sub> values, endocrine and erythrocyte blood markers, and perceptual responses to training such as mood or perceived exertion (Saw et al., 2016). Internal training load can also be measured as rate of perceived exertion (RPE), as this assessment does not require training, is easy to use, and can be used across different sport scenarios (Alexiou & Coutts, 2008; Soligard et al., 2016a).

Additionally, researchers have found that humans are able to distinguish between sensations of effort and sensations of pain during exercise. In a study conducted by Pollak and colleagues in 2014, researchers injected metabolites that either evoked pain-related or pain-unrelated sensations into skeletal muscle (Pollak et al., 2014). These metabolite injections were meant to mimic the sensations muscles experience during exercise yet, participants did not report perception of effort (Pollak et al., 2014). These results indicate that humans are able to differentiate between sensations of pain and effort during exercise and that RPE is an accurate representation of perceived effort and not other sensations (Pollak et al., 2014).

Measuring internal training load through the RPE scale gives the clinician an assessment of the physiological and psychological response to training (M. J. Chen et al., 2016).

Additionally, researchers have found significant relationships between changes in injuries during training and changes in perceived training intensity in semi-professional rugby league players and women's collegiate basketball players (Anderson, Tripplett-McBride, Foster, Doberstein, & Brice, 2003; T. Gabbett, 2004; T. Gabbett & Domrow, 2007). Monitoring internal training load can also indicate the appropriate stimulus for ideal physiological adaptation to training (Soligard et al., 2016a). Additionally, it has been found that subjective well-being was negatively correlated with internal training load (Saw et al., 2016). As measures of internal training load provide a quantitative assessment of psychological response to training, it is essential to understand how internal load is related to markers of psychological health and flourishing mental health in athletes.

### *External Training Load*

External training load is the physical work component of training or the external stimulus applied to the athlete which can be measured separately from their physiological response (Soligard et al., 2016b). It is critical to measure external training loads specifically as they have been associated with an increase in upper extremity joint pain and lower extremity soft-tissue injury past certain thresholds (T. Gabbett & Ullah, 2012; Lyman, Fleisig, Andrews, & Osinski, 2002). Gabbett and Ullah (2012) found a 2.7 times increase in injury risk when high-velocity running exceeded a 9-minute interval (T. Gabbett & Ullah, 2012). These researchers also found that distance covered at low and moderate speeds offered a protective effect against soft tissue injury (T. Gabbett & Ullah, 2012). Pertaining to monitoring training loads in the upper extremity, researchers found a 52% increased risk of shoulder pain and 35% increased risk of elbow pain when youth baseball players pitched 75-99 pitches per game (Lyman et al., 2002). As joint pain

is thought to be an early predictor of injury, monitoring these pitch counts can help to reduce the risk of injury in youth pitchers (Lyman et al., 2002). In a study by Olsen and colleagues, researchers surveyed adolescent baseball pitchers who had elbow or shoulder surgery and pitchers who did not experience a significant pitching related injury (Olsen, Fleisig, Dun, Loftice, & Andrews, 2006). Results indicated that the surgical group had pitched significantly more months per year, games per year, innings per game, pitches per year, pitches per game, and warm-up pitches prior to a game (Olsen et al., 2006). In additional upper extremity research, Hulin and colleagues (2014) found that elite cricket fast bowlers with an external load training-stress balance of more than 200% had a 3.3 times greater risk for injury compared to those with an external load training-stress of 50-99% (Huli et al., 2014). These studies show that using external training load alone can be helpful for monitoring athlete health and risk of injury. In sum, internal training load is the physiological and perceptual response to training whereas external training load is the physical work component of training.

### *Total Training Load*

External training loads are an important objective measure to combine with internal training loads to indicate total training load. These different portions of training programs provide a universal representation of what the body is experiencing and are likely associated to injury. Total training load can aid in detecting medical conditions, guide the amount of training prescribed to the athlete, and determine if there has been a decline in performance on a particular physical test (Saw et al., 2016).

Previous research has indicated that higher external training loads are associated with higher injury rates but, there has been conflicting evidence on whether or not there is a

relationship between total training load and injury risk (T. J. Gabbett et al., 2016; Soligard et al., 2016b). Gabbett (2017) describes the “Training-Injury Prevention Paradox” model. This model is the construct that athletes who are accustomed to high training loads actually have fewer injuries compared to athletes training at lower workloads. This construct, which can be measured via the acute to chronic work load ratio (ACWR), is based off evidence that it is more likely an inappropriate training program that causes non-contact injuries, not the amount of training completed by the athlete. Gabbett concludes through this work that an appropriately prescribed training program can improve an athletes overall fitness which could actually protect the athlete from injury (T. Gabbett, 2017).

While there is not much current research on the associations between training load and mental health symptoms, there have been some mental health changes observed in a condition known as over training syndrome (Aurélio, Peluso, Helena, & Guerra De Andrade, 2005). Overtraining syndrome is a condition where the patient experiences alterations in their physiological functioning and adaptations to training, dysfunction at the immune system level, biochemical changes, and impaired psychological processing due to the inability to recover properly from their training (Halsen & Jeukendrup, 2004). With overtraining syndrome, patients often experience associated mood disturbances, emotional lability, and depressive symptoms as well (Aurélio et al., 2005). In a seminal study examining over-trained swimmers, Morgan and colleagues (1987) found that these athletes experienced a significant increase in negative mood states during training (Morgan, Facsm, Raglin, O’Connor, & Ellickson, 1987). Interestingly, with a gradual tapering of training load prior to championship competition, athletes began to experience more positive mood states indicating that training load may directly influence mood states in athletes (Morgan et al., 1987). An improved well-being has been associated with acute

reductions in training load (Saw et al., 2016). These studies show that these mood, depressive symptoms, and subjective measures are responsive to training load. (Saw et al., 2016)

### *Acute to Chronic Workload*

The acute to chronic workload ratio (ACWR) is an outcome that models the relationship between the subjects current fatigue against their current fitness (Murray, Gabbett, Townshend, & Blanch, 2017). The overarching goal of acute to chronic workload ratio is to predict performance or injury through the comparison to acute to chronic loads (Murray et al., 2017). Additionally, acute to chronic workload ratio has been utilized to predict injury, as high acute to chronic workload ratio ranges have been associated with an increased injury risk (T. Gabbett & Ullah, 2012). When studying elite cricket athletes, researchers found if the players acute to chronic workload ratio was less than or equal to 0.99 the likelihood of injury over the next week was approximately 4% (Huli et al., 2014). When the work load in the current week was 1.5 times greater than what the athlete was prepared for (i.e., ACWR greater or equal to 1.5) the risk for injury was increased by 2-4 times for the next week (Huli et al., 2014). In research on elite rugby athletes, Hulin and colleagues (2016) found that players who had acute to chronic workload ratios greater or equal to 1.6, increased risk of match injury by 3.4-5.8 times as compared to those with lower acute to chronic workload ratios (Hulin et al., 2016). Furthermore, the appropriate training load can provide a protective mechanism against injury (T. Gabbett, 2017; Malone et al., 2017; Windt & Gabbett, 2017). Malone and colleagues (2016) found that professional soccer players who exerted acute to chronic workload ratios between 1.0 and 1.25 were at a lower risk of injury compared to the reference group whose acute to chronic workload ratio was 0.85 (Malone et al., 2017). High acute to chronic workload ratios are associated to an

increased risk for physical injury, but moderate acute to chronic workloads are associated to decreased risk for injury. Previous research has shown that when athletes are injured, they experience increases in negative mental health symptoms (Appaneal et al., 2009; Rice et al., 2016).

### **Mental Health Symptoms**

Mental health symptoms are largely encompassing of both positive and negative states. These negative states include depressive symptoms, hyperactivity, obsessive-compulsive symptoms, or symptoms related to anxiety. Whereas positive states may include positive relationships, self-acceptance, and personal growth (American Psychiatric Association., 2013; Keyes, 2002). Mental health symptoms refer to the multifaceted compilation of the symptoms associated with depression, anxiety, and flourishing mental health (American Psychiatric Association., 2013; Junge & Feddermann-Demont, 2015; Keyes, 2002; Rice et al., 2016). While the majority of the general population will never be clinically diagnosed with negative mental health disorders, this does not mean that the large majority of the population is without mental health symptoms that affect their normal day to day functioning (Keyes, 2002). An individual experiencing mental health symptoms may not necessarily be clinically diagnosed with depression or an anxiety disorder, but rather he or she may simply display some of the symptoms associated with these disorders (e.g., feeling distraught, hopeless, or diminished interest all of which are associated with depression. Symptoms associated with anxiety include insomnia, fatigue, thoughts of immediate danger, or escape behaviors (American Psychiatric Association., 2013). These symptoms can have significant negative effects on an individual, so it is imperative for clinicians to recognize the relationship between training load and mental health symptoms.



## *Depression*

The prevalence of depression symptoms in collegiate athletes has been reported to be approximately 25%, but this number may be lower than expected as it has been determined that depression is under recognized in athletic settings (Appaneal et al., 2009; *NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016; Trojian, 2016). Yet, in a recent study completed by the NCAA (2015), researchers stated that about 30% of student-athletes report that they have felt significantly overwhelmed (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). Additionally, approximately 33% of student-athletes struggled to find energy which they attributed to the physical demands of athletic participation and 25% reported exhaustion from the mental demands of their sport (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). Predictors of depression in collegiate student-athletes include low self-esteem, decreased social connectedness, sleep, and gender (Trojian, 2016). Researchers have also found that injured athletes have significantly higher symptoms of depression as compared to uninjured athletes (Appaneal et al., 2009; Gulliver et al., 2015). Given the prevalence of depression in athletes and the implications of injury on depression levels in athletes, it is essential that clinicians are able to recognize the signs and symptoms of depressive disorders (Trojian, 2016).

While categories of depression can range from the experience of depressive symptoms to Major Depressive Disorder, the common symptoms of these disorders include sadness, irritable mood, and a feeling of emptiness among many other potential symptoms (American Psychiatric Association., 2013). Additional symptoms patients with depression may face include loneliness, hopelessness, and anxiety (Kroenke, Spitzer, & Williams, 2001). The most serious repercussion of unrecognized depression symptoms is suicidal ideation. With these debilitating symptoms,

screening for depressive symptoms prior to and throughout athletic participation should be utilized so that the overall health of the athlete is being monitored continuously (Trojian, 2016).

Previous research related to depression in athletes has typically focused on prevalence, risk factors, and the relationship between depression and injury. As previously stated the prevalence of depression in collegiate athletes is around 25% (Armstrong, 2007; *NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016; Yang et al., 2007). This prevalence is comparable to that of the general population (Appaneal et al., 2009; Gulliver et al., 2015; Radloff, 1991; Yang et al., 2007). Risk factors that have been previously researched in athletes include, low levels of social connectedness, low self-esteem, gender, collegiate class, and performance failure (Armstrong, 2007; Hammond, Gialloredo, Kubas, & Davis, 2013; Yang et al., 2007). In a study by Armstrong and colleagues (2007), researchers found a negative relationship between self-esteem and depression in collegiate athletes (Armstrong, 2007). This study also found a significant negative relationship between athlete social connectedness and depression (Armstrong, 2007). Yang and colleagues (2007) found that female student-athletes were at 1.3 times greater risk of experiencing depression symptoms as compared to male student-athletes (Yang et al., 2007). These researchers also found that collegiate freshman were 3 times more likely to experience symptoms of depression as compared to any other collegiate class (Yang et al., 2007). Additionally, in a study involving elite swimmers, Hammond and colleagues found a positive correlation between depression symptoms (scored on the DSM-IV) and performances slower than their personal best times (Hammond et al., 2013).

Other existing research involving athletes and depression has indicated that athletes recovering from injury experience increased depressive symptoms (Appaneal et al., 2009; Rice et al., 2016; Yang et al., 2007). Appaneal and colleagues (2009) examined postinjury depression in

competitive athletes utilizing the Center for Epidemiological Studies Depression (CES-D) Scale and the semistructured interview guide for the Hamilton Rating Scale for Depression (SIGH-D) (Appaneal et al., 2009). Analyses via a repeated measures design showed a significant main effect for time indicating that depression symptoms decreased over time after the initial injury incident. Additional analyses showed a significant interaction for injury group and time showing that the injured group experienced increased depression symptoms as compared to the uninjured group (Appaneal et al., 2009).

Finally, there is a plethora of research related to depression in athletes and its relationship with concussion. This research has indicated that athletes who experience concussions or their related syndromes often will experience depression throughout their recovery or later in life (Kerr, Evenson, et al., 2014; Kontos, Covassin, Elbin, & Parker, 2012). Kerr and colleagues found that former collegiate athletes who reported 3 or more concussions in total were 2.4 times more likely to experience moderate to severe depression as compared to former collegiate athletes who reported zero concussions (Kerr, Evenson, et al., 2014). Additionally, a study conducted by Kontos and colleagues demonstrated that concussed athletes displayed significantly higher levels of depression on the Beck Depression Inventory-II from baseline to 2 days, 7 days, and 14 days postconcussion (Kontos et al., 2012). This research also indicated that collegiate athletes experienced increased depressive symptoms at 14 days postconcussion as compared to high school athletes (Kontos et al., 2012). While the relationships between athletic injury is important to understand, often the majority of an athletic team will remain healthy and continue with their specific training cycles. The current research will aim to better understand how mental health symptoms, including those related to depression, change during these training cycles which has not been explored yet.

There is limited research related to depression and athlete's training load. Most existing research in this realm is related to overtraining syndrome. As previously defined, overtraining syndrome is a condition where athletes experiences alterations in their physiological functioning, dysfunction at the immune system level, biochemical changes, and impaired psychological processing due to the inability to recover properly from their training (Aurélio et al., 2005; Halson, 2014). This often presents with frequent infections and depression in athletes with this condition and requires significant rest to allow full recovery (Budgett, 1998). While it is important to understand the implications of overtraining syndrome and its relationship to depression symptoms, most athletes will respond to their training appropriately and not be diagnosed with overtraining syndrome. Yet, they may still experience depressive symptoms. An aim of the current research is to better understand the relationship between training load and depressive symptoms.

### *Anxiety*

Generalized Anxiety Disorder is prevalent in approximately 6% of the general population but more of the population experiences symptoms related to anxiety (Spitzer, Kroenke, Williams, & Löwe, 2006). While anxiety disorders are often measured concurrently with depression disorders, it is important to note that in a study by Spitzer and colleagues (2006), more than half of patients with high anxiety scores did not have high depression scores. These researchers also found value in assessing depression and anxiety as two separate dimensions through factor analysis (Spitzer et al., 2006). Additionally, 6% of elite French athletes experienced clinical anxiety within a 6-month period (Schaal et al., 2011). In a study of elite Australian athletes, approximately 7% examined experienced anxiety symptoms (Gulliver et al., 2015). Most

strikingly, a study conducted by the NCAA reported that on average 40% of student-athletes stated they felt anxiety (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). This prevalence of anxiety symptoms is relatively similar to the general population, yet much greater for collegiate student-athletes. Research by Gulliver and colleagues (2015) also found that the presence of injury predicted anxiety symptoms. In a recent study of elite Swiss soccer players, researchers found the average anxiety scores to be similar to the general population for both males and females (Junge & Feddermann-Demont, 2015). As these levels of clinical anxiety in athletes are comparable to its prevalence in the general population, it is very important to recognize the signs and symptoms of anxiety.

Anxiety disorders tend to have many overlapping qualities as they differ based on the types of situations or objects that induce fear, avoidance behavior, or anxiety (American Psychiatric Association., 2013). Key symptoms of anxiety include physical symptoms of increased heart rate, restlessness, difficulty concentrating or mind going blank, being easily fatigued, irritability, sleep disturbance, sweating or muscle tension (American Psychiatric Association., 2013). Cognitively, those with anxiety symptoms face persistent and excessive worry about various domains and fear about what could happen (American Psychiatric Association., 2013).

There is a broad scope of anxiety disorders, yet the majority of research related to anxiety in athletes is related to state anxiety, more specifically performance or competitive anxiety. In the context of athletics, performance anxiety is defined as interpreting competitive situations as threatening and responding to such situations with feelings of apprehension and tension (Patel, Omar, & Terry, 2010). Research has shown that athletes who strive for perfection tended to report less competitive anxiety and greater self-confidence (Hamidi & Besharat, 2010). In

contrast, athletes with negative reactions to imperfection showed a positive correlation to competitive anxiety and a negative correlation to self-confidence (Hamidi & Besharat, 2010). Additional anxiety research shows associations between anxiety disorders and eating disorders in athletes (Hausenblas & Mack, 1999; Vardar, Vardar, & Kurt, 2007). In research conducted by Vardar and colleagues (2007) researchers found that disordered eating athletes experience significantly increased state anxiety as compared to a normal eating habits group (Vardar et al., 2007). While competitive anxiety is an important construct to understand in the context of athletics, limited research exists related to collegiate athletes and symptoms related to non-competition-specific anxiety.

As 10% of the average college student population presents with anxiety, there should be more research conducted to understand anxiety in collegiate student-athletes (Eisenberg, Gollust, Golberstein, & Hefner, 2007). Current research has indicated that the occurrence of anxiety in college students may be related to personality traits such as perfectionism, academic support available, and academic workload (Hunt & Eisenberg, 2010). College student-athletes face these same stressors with the additional need to balance significant time for training in their schedules. The NCAA GOALS Study (2015) reported that Division I athletes spent an average of 34 hours per week on athletics and 39 hours per week on academics (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). With these large time commitments dedicated to sport that must be balanced with the expectations of the average college student, approximately 30% of student-athletes have reported feeling intractably overwhelmed (*NCAA GOALS Study of the Student-Athlete Experience: Initial Summary of Findings*, 2016). The current research will examine these associations in hopes of determining the relationship between training load and clinical anxiety symptoms.

### *Flourishing Mental Health*

While depression and anxiety symptoms do have a prevalence in society, this does not necessarily indicate that adults free of mental illness are functioning positively and productively. Therefore, it is essential to evaluate a person's positive mental health by determining if they have flourishing mental health. Flourishing mental health can be defined as a state of positive mental functional performance and positive feelings (Keyes, 2002). Those with flourishing mental health experience, as examples, positive relationships, purpose in life, independent functioning, self-acceptance, self-esteem, personal growth, and comfort in one's environment, and positive emotions (Keyes, 2002).

Previous research related to flourishing mental health in athletes has focused on adaptive types of motivation and the effect of career-ending injuries (Blanchard, Amiot, Perreault, Vallerand, & Provencher, 2009; Kleiber & Brock, 1992; Reinboth & Duda, 2004). In research on high school aged basketball players, Blanchard and colleagues (2009) found that self-determined motivation predicted positive emotions and satisfaction each of which are essential components of flourishing mental health (Blanchard et al., 2009). Reinboth and colleagues (2006) found that athlete autonomy, or the feeling that one is the initiator of one's own actions and the experience of making one's own choices, was the strongest predictor of flourishing mental health in terms of the athletes motivation (Reinboth & Duda, 2006). In a separate study Reinboth and Duda (2004) found that athlete's self-esteem, an essential component of flourishing mental health, was positively predicted by motivational situations that focused on task mastery and learning and also by perceived ability (Reinboth & Duda, 2004). In a study conducted by Kleiber and Brock (1992) researchers found that athletes who suffered career-ending injuries experienced lower

psychological well-being than those who did not in the 5 to 10 years following their retirement from sport (Kleiber & Brock, 1992).

While the relationships between flourishing mental health with adaptive types of motivation and career-ending injuries are important to understand, they are only a small scope of the potential stressors student-athletes may face that effect their flourishing mental health. Student-athletes who have the ability to function positively and productively will translate this functioning to their life inside and outside of their respective sports. As sports medicine clinicians aim to provide their athletes with positive health related quality of life, it is essential that clinicians gain a deeper understanding of the relationship between flourishing mental health and training load.

## **Resilience**

Resilience broadly is defined as the ability to thrive in the face of adversity or stress (Campbell-Sills & Stein, 2007; Luthar, Cicchetti, & Becker, 2000). The concept of resilience encompasses the effects of protective and promotive factors to aid in adaptation which will vary situationally and across one's lifespan (Fletcher & Sarkar, 2013). An individual may react positively to stressors at one point in their life, demonstrating high resilience but, this does not guarantee that they will react the same way to stressors at other points of their life (Fletcher & Sarkar, 2013). Resilience can be broken up into two factors including hardiness, which is considered the dispositional or static component of resilience, and persistence, which is considered the situational or malleable component of resilience (Campbell-Sills & Stein, 2007). Further, hardiness involves personal toughness and the ability to utilize positivity when faced with problems (Campbell-Sills & Stein, 2007). In contrast, persistence refers to belief in one's



ability to achieve goals despite impediments, giving one's best effort no matter what, working to attain goals despite difficulty, and not giving up in the moment of adversity/stressor (Fletcher & Sarkar, 2013).

Within this dual process, an individual possesses a particular level of hardiness that aids in management of stressors throughout their lifetime, but their level of persistence may vary throughout their life resulting in changes in their ability to thrive when faced with stressors (Fletcher & Sarkar, 2013). To support that resilience is a dynamic process, it is key to note that resilience has been found to be modifiable in patients. Dray et al. (2017) concluded from a meta-analytical review that resilience-focused interventions (i.e., training students to utilize the characteristics of resilient people when faced with adversity) were effective in reducing depressive symptoms, and general psychological distress (Dray et al., 2017). This suggests that resilience is dynamic process that one is able to learn and utilize when faced with adversities. Moreover, resilience-focused interventions may provide short-term reduction in depressive and anxiety symptoms in young people (Dray et al., 2017). Resilience is a concept involving dispositional and situational components. The current research aims to explore resilience specifically as this dynamic process and its influence on mental health symptoms.

### *Challenge versus Threat Appraisal*

When faced with stressors, those who are more resilient tend to appraise the stressor differently than those who are less resilient (Blascovich, 2008). Those who have lower resilience scores may appraise adversity as a threat (Seery, 2011). Those who have higher levels of resilience will appraise adversity as a challenge (Seery, 2011). The most successful athletes

thrive by utilizing a challenge appraisal approach. Determining if an athlete appraises a stressor as a challenge or a threat may help the athlete to act more resiliently.

### *Resilience and Autonomic Flexibility*

Once an individual appraises a stressor as a challenge, there is a specific physiological framework of autonomic flexibility observed in people with high resilience and those with low resilience. Autonomic flexibility involves the capacity of the parasympathetic nervous system to adapt to changes in circumstance by modifying arousal, respiration, heart rate, and attention (Kok & Fredrickson, 2010). When a stressor is experienced, the sympathetic nervous system is activated resulting in sympathetic-adrenomedullary (SAM) activation in all individuals (Blascovich, 2008). Those with low resilience interpret the stressor as a threat, then experience greater hypothalamic pituitary axis (HPA) activation. HPA activation increases release of the stress hormone cortisol, resulting in inefficient use of internal resources and maladaptive consequences (Seery, 2011).

Those with high resilience experience greater sympathetic-adrenomedullary (SAM) activation, causing a release in epinephrine and vasoconstriction (Blascovich, 2008). This decreases systemic vascular resistance, enhances left ventricular contractility, and increases heart rate (Blascovich, 2008). Those processes lead to enhanced cardiac output and provide energy via increased blood flow to the muscles and brain (Blascovich, 2008). Those with high resilience will have increased activation of the vagal nerve resulting in an increase in parasympathetic activity and a faster, more efficient return to their baseline heart rate (Kok & Fredrickson, 2010). This more adaptive recovery has been associated to better emotional regulation, adaptive coping, and increased psychosocial well-being (Kok & Fredrickson, 2010). The predicted outcomes from

these cognitive responses include prolonged psychosocial health, cognitive performance, and cardiovascular health (Kok & Fredrickson, 2010). As those with high resilience have faster physiological recovery to stressors, it is important to understand how resilient athletes recover from the stressor of training. With positive outcomes such as these, it is clear that having higher levels of resilience is beneficial to overall health and mental well-being, especially in our at-risk population of student-athletes.

Previous research has indicated that athletes experience a similar prevalence of mental health symptoms to that of the general population (Gulliver et al., 2015; Junge & Feddermann-Demont, 2015; Schaal et al., 2011). Training load is a consistent stressor athletes face that is distinct from the general population's experiences, which motivates the current research to examine the associations between mental health symptoms and training load. When exposed to stressors, those with high resilience display faster and more efficient physiological recovery (Blascovich, 2008). The current research will also explore if resilience influences the association between training load and mental health. Gaining a deeper understanding of these associations will improve screening and management strategies of athletes experiencing negative mental health symptoms related to depression and anxiety.

### **Measures of Mental Health, Resilience, and Training Load**

The following measures have been chosen to operationally define symptoms related to depression, anxiety, flourishing mental health and resilience. The Patient Health Questionnaire will assess depression symptoms. Anxiety symptoms will be measured through the Generalized Anxiety Disorder 7-item questionnaire. Flourishing mental health will be evaluated utilizing the Mental Health Continuum-Short Form and the Connor-Davidson Resilience Scale-10 will assess

resilience. Finally, training load will be assessed daily utilizing a session-RPE method. Details of these measures are elaborated on below including how subjects will be asked to respond and their respective validities.

### *Depression*

The Patient Health Questionnaire (PHQ-9) has been utilized in mental health assessment of the general population, but its use in athletes has been documented mainly as the relationship between depression and concussion (Kerr, Defreese, & Marshall, 2014; Trojian, 2016). The PHQ-9 is a diagnostic tool that can be utilized in mental health assessment but it is not the only piece required for a clinical diagnosis of depression. The PHQ-9 assesses depressive symptoms that can accumulate to display minor to major depressive symptoms that have occurred over the previous two weeks. The questionnaire includes items such as, “Over the last 2 weeks, how often have you been bothered by any of the following? Little interest or pleasure in doing things” or “Feeling tired or having little energy”. This psychometric also assesses the severity and frequency of each symptom using a 4-point Likert Scale, ranging from 0 (not at all) to 3 (nearly every day) (Kroenke et al., 2001; Li et al., 2017). Based on their scores, patients are categorized by their depressive symptoms. A score of 0-4 is considered minimal, 5-9 mild, 10-14 moderate, and greater or equal to 15 is severe (Kroenke et al., 2001; Li et al., 2017). Through a systematic review of depression screening tools, the PHQ-9 was found to have a sensitivity ranging from 28% to 95% and a specificity ranging from 61% to 98% (El-Den, Chen, Gan, Wong, & O’Reilly, 2018). Additionally the PHQ-9 was found to have decent internal reliability and test-retest reliability when assessed in those 18 years old and up (Cronbach alpha values range from 0.56 to 0.94) (El-Den et al., 2018; Kroenke et al., 2001). Additionally, researchers have previously demonstrated acceptable internal consistency reliability of the PHQ-9 in athletic populations,

demonstrating that this short questionnaire would be effective to utilize in an efficient clinical environment (El-Den et al., 2018; Kroenke et al., 2001).

### *Anxiety*

Anxiety is typically measured through the Generalized Anxiety Disorder 7-item (GAD-7) assessment, although the GAD-7 cannot diagnosis clinical anxiety independently. The GAD-7 consists of 7 items rated on a Likert scale of 0-3 where 0 is analogous to “Not at all” and 3 is “Nearly every day” (Spitzer et al., 2006). The questionnaire includes items such as, “Over the last 2 weeks, how often have you been bothered by the following problems? Being so restless that it's hard to sit still” or “Not being able to stop or control worrying”. Scores on the GAD-7 can help to classify the level of anxiety faced by the patient, where 5 points indicates mild anxiety, 10 points indicates moderate anxiety, and 15 points indicates severe anxiety (Spitzer et al., 2006). The GAD-7 was found to have good convergent validity when assessed with the Beck Anxiety Inventory ( $r=0.72$ ) and the anxiety subscale of the Symptom Checklist-90 ( $r=0.74$ ) (Spitzer et al., 2006). Additionally, the GAD-7 demonstrated strong construct validity and high criterion validity for identifying cases of GAD in subjects 18 years old and up (Spitzer et al., 2006). Additionally, researchers have previously demonstrated acceptable internal consistency reliability of the GAD-7 in athletic populations (Fraser et al., 2016). These results indicate that the GAD-7 is a valid and efficient screening tool for generalized anxiety disorder which could be utilized in a sports medicine environment (Keyes, 2002).

### *Flourishing Mental Health*

The Mental Health Continuum Short Form (MHC-SF) is a 14-item questionnaire utilized to assess flourishing mental health (Keyes, 2002). Items on the MHC-SF include “Please answer

the following questions are about how you have been feeling during the past month. Place a check mark in the box that best represents how often you have experienced or felt the following: That you had warm and trusting relationships with others” or “That your life has a sense of direction and meaning to it”. Responses are rated on a scale from 0 (reflecting “none of the time”) and 5 (reflecting “all of the time) (Keyes, 2002; Petrillo, Capone, Caso, & Keyes, 2015). These scores are summed across all questions with a maximum score possible of 70 with high scores reflecting flourishing mental health and low scores indicating languishing mental health. Assessment of the MHC-SF in subjects 18 years old and up revealed subscales had good internal reliability ( $\alpha = 0.89$ ) and moderate test-retest reliability suggesting that MCH-SF is stable over time and sensitive to change (Lamers et al., 2011). Finally, the MHC-SF has good convergent validity suggesting that it can be utilized as a valid measurement of flourishing mental health (Lamers et al., 2011).

### *Resilience*

There are multiple scales that can be utilized to measure resilience scores as a dynamic process. One such scale is the Connor-Davidson Resilience Scale-10 or CD-RISC-10. The content of this scale was developed off various constructs related to resilience developed by previous researchers (Connor & Davidson, 2003). Content of this scale includes items such as, “Able to adapt to change” and “Can handle unpleasant feelings” and is rated on a scale of 1 (not true at all) to 5 (true nearly all of the time) (Campbell-Sills & Stein, 2007). A maximum score of 50 reflects someone who portrays highly resilient qualities. This version of the scale was evaluated by Ehrich (2017) and colleagues and Campbell-Sills and Stein (2007) who found good psychometric functioning once again based off factor analyses (salient loadings on their latent

constructs, ranging from .39 to .80, all  $ps < .001$ ) (Campbell-Sills & Stein, 2007; Ehrich, Mornane, & Povern, 2017). Additionally, the CD-RISC-10 focuses on the hardiness and persistence factors of resilience and eliminates extraneous concepts that are not necessary in the evaluation of an individual's resilience (Campbell-Sills & Stein, 2007). Results of analyses from Campbell-Sills and Stein (2007) suggest that CD-RISC-10 measures characteristics that differentiate individuals who are thriving after adversity from those who are not (Gonzalez, Moore, Newton, & Galli, 2016). Furthermore, Gonzalez and colleagues (2016) found initial psychometric evidence for the use of the CD-RISC-10 in athletes through a sample of competitive American distance runners (Gonzalez et al., 2016).

### *Training*

Measuring training via training load can be broken up into three different categories, internal training load, external training load, and total training load. Internal training load can be measured via rate of perceived exertion (RPE). RPE was designed to reflect the intensity of activity on a scale from 6-20, where 6 would correlate with “nothing at all” and 20 would relate to “very, very hard” (Borg, 1982). The range from 6-20 was expected to predict changes in heart rate ranging from a resting 60 to a maximal 200 beats per minute (Borg, 1982). RPE is now typically measured on a 0 to 10 point scale where 0 would indicate “rest” and 10 would indicate “maximal effort”. The 0 to 10 RPE scale reflects only the intensity of an exercise and not the generalized fatigue and stress perceived before the beginning of training (Foster et al., 2001; Haddad et al., 2013).

RPE has been correlated with physiological measures of exercise such as oxygen consumption, blood lactate concentration, heart rate, and respiratory rate (Borg, 1982; Brown,

Chitwood, Beason, & Mclemore, 1996b; M. J. Chen et al., 2016; Coutts, Rampinini, Marcora, Castagna, & Impellizzeri, 2009; Stoudemire et al., 1996). Maximal oxygen consumption during exercise, known as  $VO_{2max}$ , has been shown to be an extremely valid measure of fitness (Brown et al., 1996b; Brown, Chitwood, Beason, & Mclemore, 1996a). In addition,  $\%VO_{2max}$  is highly correlated with heart rate (Hall, Macdonald, Maddison, & O'Hare, 1998). In a meta-analysis examining the correlation between RPE and  $\%VO_{2max}$ , researchers found a moderate to strong correlation (mean  $r$  with Fischer's  $z$  transformation = 0.64) between the two variables (M. J. Chen et al., 2016; Wilmore et al., 1985). This indicates that RPE can reflect oxygen consumption during physical work. Another physiological change that has been found with exercise is blood lactate levels (Stoudemire et al., 1996). Blood lactate concentration is an objective measure of exercise intensity at a local level (Stoudemire et al., 1996). Researchers have found a moderate correlation between RPE and blood lactate concentration (M. J. Chen et al., 2016; Kolkhorst, Mittelstadt, & Dolgener, 1996; Ljunggren, Ceci, & Karlsson, 1987). Heart rate is an additional physiological indicator of physical work. Initially formatted to match changes in heart rate, the RPE scale was found to have a moderate to strong correlation with heart rate (mean  $r_1$  = 0.58 and mean  $r_2$  = 0.62) (Borg, 1982; M. J. Chen et al., 2016; Ljunggren et al., 1987; Mackinnon, 1999). Respiration rate, or breathes per minute, has been considered the most effective physiological measure of oxygen consumption due to different amounts of oxygen being inspired at various testing environments (M. J. Chen et al., 2016). Respiration rate has the strongest correlations of measures of oxygen consumption at mean  $r_1$  = 0.67 and mean  $r_2$  = 0.72 indicating a strong correlation (M. J. Chen et al., 2016). These correlations to physiological responses to conditioning suggests that RPE can be utilized as a valid marker for monitoring internal training load (Alexiou & Coutts, 2008).



External Training Load is typically measured by quantifying the load from training and competition (Soligard et al., 2016b). This quantification can occur in many ways such as the hours of training, distance run, weight lifted, number/intensity of sprints, jumps, pitches thrown or collisions (T. J. Gabbett et al., 2016; Soligard et al., 2016b). Measuring external training load gives the clinician an objective understanding of the total work completed by the athlete (Soligard et al., 2016b). In this study, external training load will be measured through minutes of training.

Total training load is the product of internal training load and external training load, which is often measured as session RPE (sRPE) (Soligard et al., 2016b). Total training load can also be quantified via total training load and the acute to chronic work load ratio (ACWR). Total training load is the sum of training load over a specific duration of time. For the acute to chronic workload ratio, the acute or rolling 7-day work load accounts for current fatigue measures whereas the rolling 28-day workload measures the current fitness aspect of this model (Banister & Calvert, 1980; Huli et al., 2014).

### *Injury/Illness*

Injury or illness will be defined as an event in which activity limitation is required for at least one day (Anderson et al., 2003). Researchers have examined the effect of injury and depression in female and male athletes at 1 week, 1 month, and 3 months post injury (Appaneal et al., 2009). Their results indicated significant effects of groups (i.e., injured vs. control) and time (injury) (Appaneal et al., 2009). As injuries have been found to be related to depression in athletes, it is essential to track incidence of injury and illness throughout the current study (Appaneal et al., 2009; Gulliver et al., 2015).

## **Research Gap**

Keyes (2002) proposed that mental health fluctuates on a continuum from flourishing mental health, involving positive emotion and productive relationships, to languishing mental health, involving symptoms that are associated with depression and anxiety (Keyes, 2002). Current research has indicated a near equivalent prevalence of negative mental health symptoms in athletes as compared to the general population (Gulliver et al., 2015; Junge & Feddermann-Demont, 2015; Rice et al., 2016; Yang et al., 2007). But, the existing research related to the potential causes of mental health symptoms in the athletic population is lacking. There has yet to be research connecting the relationships between the mental health continuum, training load stressors, and resilience in an athletic population. The current study will emphasize monitoring training load before an athlete experiences injury and is at increased risk for negative mental health symptoms. Further conceptual understanding of these relationships is essential for a variety of clinical reasons. Understanding these relationships may help sports medicine clinicians predict when their athletes are at increased risk for negative mental health symptoms and allow them to refer to sports psychologists at more opportune times. Once the relationships between mental health symptoms, training load, and resilience are better understood through the context of this study, future research could aim to understand what specific aspects of a college student-athletes life increases negative mental health symptoms most significantly.

## **Clinical Significance**

While the large majority of the population will never be clinically diagnosed with a mental health disorder such as depression or anxiety, this does not indicate that many people are without mental health symptoms that pose daily challenges (Keyes, 2002). Despite the many

external stressors that elite athletes face, symptoms of depression and anxiety often are under-recognized in the sporting population (Trojian, 2016). One constant stressor athletes face is that of training. Training loads are known to vary throughout an athletic season, typically with a bolus of training during pre-season and tapering during regular season play. While current research demonstrates that high acute to chronic workload ratios have been associated with an increased injury risk, there is little existing research on the associations between training load, mental health symptoms, and resilience.

Although there is current research on resilience in the general population, such as those dealing with long term diseases, children who have experienced trauma, and the military, there are few current studies that examine resilience in elite athletes (Bonanno, 2008; Dray et al., 2017; Infurna & Luthar, 2016). More resilient athletes should appraise training load stressors as a challenge as opposed to a threat, which will enhance the probability in a more adaptive psychophysiological response (Blascovich, 2008). Coaches may benefit from this research by gaining a deeper understanding of how their athletes respond to the stress of training and the potential negative effect that training loads have on their athletes' overall physical and mental health. Sports medicine professionals will benefit from the current research as they will gain perspective on athletes' mental health throughout a competitive season. The current research will provide a deeper understanding of athletes' mental health and will aid in patient-centered, compressive care by clinicians.

## CHAPTER III: METHODS

### Participants

A total of 160 NCAA Division I athletes were recruited (age 18-23 years old) as a convenience sample from the University of North Carolina at Chapel Hill Varsity Volleyball, Field Hockey, Women's Soccer, Men's Soccer and Men's Lacrosse teams during their Fall 2018 training. Rosters of each team contained the following number of athletes: volleyball  $n=15$ ; field hockey  $n=28$ ; women's soccer  $n=30$ ; men's soccer  $n=36$ ; and men's lacrosse  $n=51$ . Participants were selected to represent a targeted group of male and female athletes competing in both contact and non-contact sports. Participants were informed of the requirements for full participation in the study through their sports medicine staff. Each participant signed an informed consent approved by the university's Institutional Review Board.

By timepoint 3, we experienced a 28.8% attrition rate, resulting in an  $n$  of 114. Participants were on average  $19.9 \pm 1.3$  years old with 55.8% being male. For ethnicity, 7.8% of subjects reported to be Hispanic or Latino with the race distribution as follows: American Indian/Alaskan Native 0.7%, Asian 1.3%, Black or African American 3.9%, White 83.9%, more than one race 7.1%, unknown/other 1.9%, and with 1.3% not reporting their race. Of all subjects 21.2% were freshman, 25.6% were sophomores, 23.1% were juniors, and 30.1% were senior level student-athletes.

### *Power Analysis*

A power analysis for between-factors repeated measures analysis of variance (ANOVA) using G\*power software indicated a sample size of 78 participants. Data was analyzed as between-factors as this study examined the influence of training load and resilience on mental health symptoms. The type of power analysis utilized was a priori, as there was no pilot study data to conduct the power analysis. Extant literature involving repeated measures on post injury depression in athletes was utilized to determine effect size, which was set at 0.16 (Appaneal et al., 2009). The alpha value was allowed to remain at .05. Resilience will be incorporated into this model as a predictor but, it will solely act as a secondary moderator. Data was collected at 3 timepoints across a competitive season, at pre-season screening (+1 week) as well as at approximately 6 weeks (range of 5-7 weeks) into the season, and 12 weeks (range of 11-13 weeks) into the season. It is an assumption of repeated measures analyses of variance that observations at each timepoint are not correlated. Due to the potential attrition associated with longitudinal designs, we recruited 160 participants, approximately 2x more than the required power analysis.

### *Inclusion Criteria*

Inclusion criteria required that subjects are Division I collegiate athletes between the ages of 18-23 years old.

### Exclusion Criteria

Subjects were excluded from participation if they are uncomfortable completing regular questionnaires related to mental health symptoms ( $n=0$ ).

### Research Design

This study followed a longitudinal repeated measures design. Athletes were examined for resilience, depression, anxiety and flourishing mental health symptoms at a baseline testing session during their preseason screening with sports medicine staff. Athletes then completed follow up assessments at approximately 6 and 12 weeks post-baseline reassessing depression, anxiety, flourishing mental health symptoms and resilience. Throughout their competitive season, session RPE was tracked after official team training sessions to monitor training load.

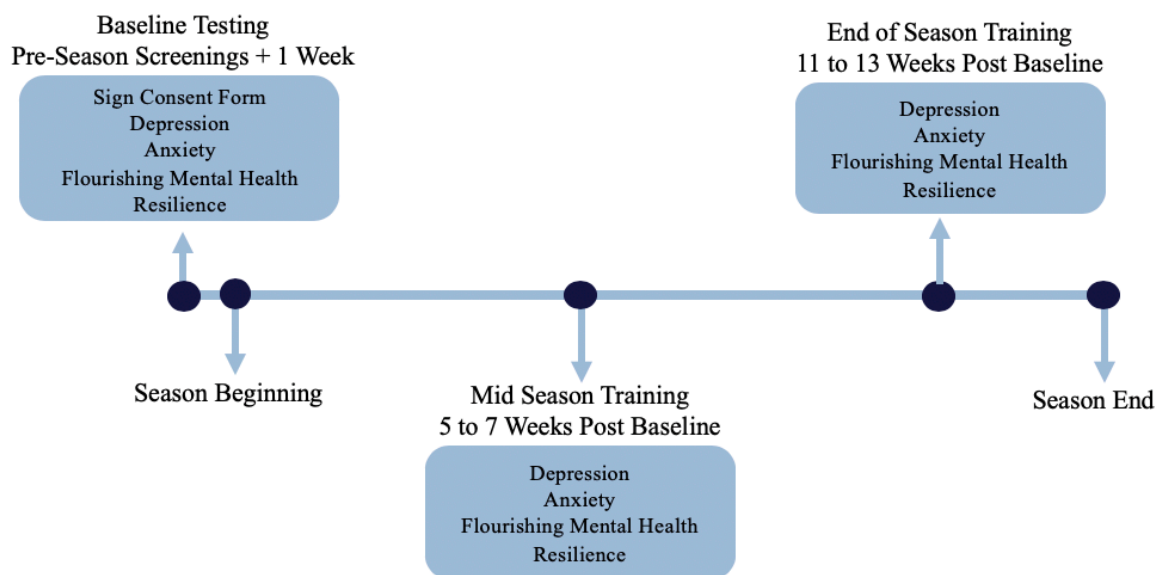


Figure 3. Procedural Timeline

## **Procedures**

During the athlete's pre-season screening with sports medicine clinicians, athletes reported to the central athletic training facility on campus to complete a baseline psychometric assessment. Participants signed a consent form indicating that they were comfortable completing questionnaires related to mental health symptoms. Via pen and paper, athletes completed the PHQ-9 to assess symptoms related to depression, the GAD-7 to assess anxiety symptoms, and the MHC-SF to assess flourishing mental health. Athletes also completed the CD-RISC-10 to assess resilience. They repeated this process at approximately 6 (within 5-7 weeks) and 12 (within 11-13 weeks) weeks after baseline testing for the PHQ-9, GAD-7, MHC-SF, and CD-RISC-10 via email follow-up. Throughout their training, RPE and training duration was recorded after official team training as previously stated through pen and paper tracking by athletic training staff or via online questionnaire. On days where no training was completed, training duration was documented as zero minutes with the associated RPE value. These values were important in calculating the total training load and acute to chronic workload ratio.

## **Psychometric Questionnaires**

A variety of psychometric questionnaires were used to assess the mental health symptoms of the participants. The PHQ-9 was utilized to monitor symptoms related to depression. This questionnaire was found to have excellent internal consistency and test-retest reliability in previous research involving college aged students (Cronbach  $\alpha = .89$ ), which demonstrates its effectiveness (El-Den et al., 2018; Kroenke et al., 2001). Additionally, when validated specifically in university students, the PHQ-9 displayed good internal consistency (Cronbach  $\alpha = .85$ ) (Adewuya, Ola, & Afolabi, 2006).

Symptoms related to anxiety were measured through the GAD-7 questionnaire which previous research has shown strong construct validity and high criterion validity (Spitzer et al., 2006). Research shows excellent internal consistency of the GAD-7 (Cronbach  $\alpha = .92$ ) (Spitzer et al., 2006). Furthermore, when assessed in Portuguese college students the GAD-7 demonstrated good convergent validity (Bártolo, Monteiro, & Pereira, 2017). This is the only comprehensive validation of the GAD-7 in collegiate students to our knowledge. Additionally, previous research has demonstrated acceptable internal consistency reliability of the PHQ-9 and GAD-7 in athletic populations (Fraser et al., 2016).

The MHC-SF, utilized to measure flourishing mental health, has good convergent validity suggesting that it can be utilized as a valid measurement (Lamers et al., 2011). Although the MHC-SF has not been validated in college students specifically, it has demonstrated high internal reliability (Cronbach  $\alpha = .89$ ) in patients 18 years old and up (Lamers et al., 2011).

Finally, resilience was measured through the CD-RISC-10. Campbell-Sills and Stein (2007) found good psychometric functioning of this scale based off factor analyses (salient loadings on their latent constructs, ranging from .39 to .80, all  $p < .001$ ) (Campbell-Sills & Stein, 2007). The CD-RISC-10 has also been validated in competitive sport demonstrating excellent internal reliability (Cronbach  $\alpha = .87$ ) (Gonzalez et al., 2016). Although these instruments have been validated in various populations (including college students and in competitive sport), these measures are not sufficient to diagnose these disorders clinically.

## **Training Load**

Total training load was measured in this study through session RPE. Athletic training staff tracked the athletes external training load via training session duration in minutes and



associated internal training load via RPE value using manual tracking via pen and paper. Athletes received detailed descriptions of the RPE scale and were instructed to report training RPE within 15 minutes of the cessation of their training session. Due to limited athletic training staff, one team completed session duration and associated RPE value tracking through an online workload questionnaire which was completed on the student-athlete's personal phone, computer, or tablet. RPEs were collected only after official team practices and competition and did not include additional official team training that occurs in the weight room. This was due to the inability of athletic training staff to be at all weight training sessions. Further, there were situations where it was not clinically or socially appropriate to probe student-athletes for their RPE value. All training load information was filtered to create data points at which the psychometric questionnaires are distributed. Cumulative sums of training load were utilized to assess total training load at 12 weeks. Weekly averages were utilized to calculate the athlete's acute to chronic workload ratio. Acute to chronic workload ratio is calculated through dividing the acute workload, training load for 1-week, by the chronic workload, training load from 4-weeks ( $ACWR = \frac{1 \text{ Week Training}}{4 \text{ Weeks Training}}$ ) (Huli et al., 2014; Stares et al., 2018). For example, if an athlete's average workload for 1 week's training is 428.6 arbitrary units and their average workload for 4 weeks' training is 422.3 arbitrary units, their acute to chronic workload ratio would be 1.0.

### **Injury Follow-Up**

As injuries have been found to be related to depression in athletes, it was essential to track incidence of injury and illness throughout the current study (Appaneal et al., 2009; Gulliver et al., 2015). This was completed by a follow-up injury survey that was administered to all

participants via email. The survey obtained self-reported injury and time loss during Fall 2018 training. Injury was defined as an incident that removed the subject from practice or competition. This information was utilized in statistical analyses to control for any potentially confounding variables.

### **Statistical Analysis**

All data was analyzed utilizing SAS statistical software. Filtering of daily session RPE occurred by calculating weekly average session RPE for all participants. The athlete's acute to chronic workload ratio was calculated to match follow up assessments at approximately 6 and 12 weeks post-baseline questionnaires. A general linear model was utilized to determine if training load predicted variance in all mental health outcomes. Finally, a general linear model was conducted to determine if resilience influenced the changes in mental health symptoms due to training load at all timepoints. As gender, injury, and recovery all may be confounding variables, they were controlled for in all analyses. Data were eliminated from the data set list wise. Even with attrition and missingness, we still had a sample size greater than that was required via our power analysis. Therefore, no computations for missingness were completed.

## CHAPTER IV: RESULTS

### Descriptive Statistics

160 student-athletes were recruited to participate in the current study. By timepoint 3, we experienced a 28.8% attrition rate, resulting in an  $n$  of 114. 155 subjects completed timepoint 1, 135 subjects completed timepoint 2, and 114 subjects completed timepoint 3. Means and standard deviations among psychometrics and acute to chronic workload ratios can be found in Table 1. It is important to note that on average across all timepoints, participants did not report symptoms high enough that would warrant referral to team psychologists, as PHQ-9 scores from 5-9, 10-14, and greater than 15 indicate mild, moderate, and severe levels of depression symptoms respectively (Kroenke et al., 2001). Research indicates that cut-off scores for detection of major depressive disorder and referral is a score greater than 8 on a PHQ-9 (Manea, Gilbody, & McMillian, 2012). In this study average depressive symptom scores were 1.5, 3.0, and 2.5 at the three timepoints respectively. For GAD-7 assessments of anxiety, scores of 5 points, 10 points, and 15 points indicate mild, moderate, and severe anxiety respectively (Spitzer et al., 2006). Sum scores of greater or equal to 10 points are cause for referral to the appropriate mental health care provider for those with anxiety symptoms (Löwe et al., 2008). In this study average anxiety symptom scores were 3.2, 3.9, 3.6, at the three timepoints respectively.

### *Univariate Correlations*

Upon statistical analysis, it was observed that the change in PHQ-9, GAD-7, and MHC-SF, did not have a significant association to the average resilience or acute to chronic workload

ratio at timepoint 3 (approximately 12 weeks). Resilience and workload were also not associated with the changes in each dependent variable across the study period ( $p$ -values  $> 0.05$ ). However, they were associated with aggregate scores of mental health symptoms at certain timepoints in the expected directions. Specifically, higher baseline, 6 weeks, and 12 weeks resilience were associated with higher flourishing mental health at each timepoint ( $0.001 < p$ -values  $< 0.0014$ ). Further, higher baseline, 6 weeks, and 12 weeks resilience were associated with lower anxiety symptoms at each timepoint, excluding baseline resilience on flourishing mental health at 6 weeks and 12 weeks ( $0.001 < p$ -values  $< 0.049$ ). Finally, higher baseline, 6 weeks, and 12 weeks resilience was associated with lower depressive symptoms at each timepoint, excluding baseline resilience on flourishing mental health at 12 weeks ( $0.001 < p$ -values  $< 0.002$ ).

Females reported lower resilience ( $r = -0.214, p = 0.024$ ) and lower acute to chronic workload ratio at timepoint 3 ( $r = -0.270, p = 0.004$ ). Gender was not associated with total training load at timepoint 3. Recovery, a potential confounding variable to changes in mental health symptoms, was investigated for significant associations amongst study variables. We found that at all timepoints recovery was associated with each dependent variable at all timepoints, excluding recovery at 6 and 12 weeks on flourishing mental health and resilience at baseline, recovery at 12 weeks on flourishing mental health at 6 weeks, and recovery at 6 weeks on flourishing mental health, resilience, and anxiety at 12 weeks ( $0.001 < p$ -values  $< 0.044$ ). For acute to chronic workload ratio, scores for 6 weeks were significant and trending toward significantly correlated to baseline depressive and anxiety symptoms, respectively ( $p$ -values = 0.003, 0.054).

## Depression

To answer Hypothesis 1, we tested both acute to chronic workload ratio and total training load at timepoint 3 as predictors of depression across the study period. Total training load at timepoint 3 was the only significant main effect. Total training load at timepoint 3 had a positive main effect, in that those who had greater total training load had greater increases in depressive symptoms ( $t\text{-score} = 2.14$ ,  $p\text{-value} = 0.035$ ). To control for any potentially confounding variables average recovery, gender, and injury were added to the model. Gender was the only significant predictor in changes in depression across the study period ( $t\text{-scores} = -2.52$ ,  $p\text{-value} = 0.013$ ), and recovery was dropped from the final model. Males experienced greater increases in depressive symptoms than females.

To answer Hypothesis 2, average resilience over the study period as well as the interaction between both training load measures (acute to chronic workload ratio and total training load) were added to the model. Total training load at timepoint 3, gender, and the interaction between average resilience and total training load all significantly predicted changes in depression across the season (see Table 3,  $t\text{-scores} = 3.00$ ,  $-2.66$ , and  $-2.75$  respectively,  $p\text{-values} = 0.004$ ,  $0.009$ , and  $0.007$  respectively). This model accounted for almost 17% of the variance in changes in depressive symptoms. The only significant interaction effect was between resilience and total training load at timepoint 3. As seen in Figure 4, individuals with greater total training load at timepoint 3 and lower average resilience tended to report the greatest increases in depressive symptoms across the study period. More specifically, those high in resilience were able to buffer against the potential negative effects of high training load.

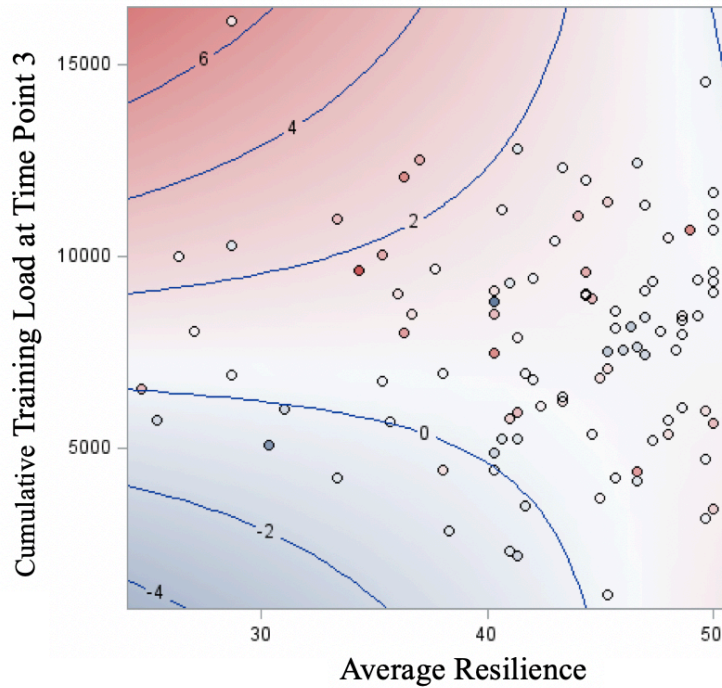


Figure 4. Contour Fit Plot of the Moderating Effect of Resilience on the Relationship between Total Training Load and Changes in Depressive Symptoms

### Anxiety

We tested both acute to chronic workload ratio and total training load at timepoint 3 as predictors of anxiety across the study period to answer the first hypothesis. Neither workload variable showed a significant effect,  $F(2,102) = 0.23$ ,  $p\text{-value} = 0.7973$ . To answer Hypothesis 2 average resilience, as well as the interaction between both training load measures were added to the model. None of our hypothesized variables predicted the change in anxiety (see Table 3,  $t\text{-scores} = 0.85, 0.33, 0.66, -0.44$ , and  $-0.71$  respectively,  $p\text{-values} = 0.40, 0.74, 0.51, 0.66$ , and  $0.48$  respectively). This model accounted for less than 2% of the variance in changes in anxiety symptoms. No variables predicted any variance in anxiety symptom changes across the competitive season.

## Flourishing Mental Health

To answer Hypothesis 1, we tested both acute to chronic workload ratio and total training load at timepoint 3 as predictors of flourishing mental health across the study period. Total training load at timepoint 3 was the only significant effect and it had a negative effect meaning, as there were increases in total training load, changes in flourishing mental health symptoms went from increases, to no change, to decreases ( $t$ -scores = -2.29,  $p$ -value = 0.024). To control for any potentially confounding variables average recovery, gender, and injury were added to the model, none were significant,  $p$ -value > 0.05, and therefore were dropped from the final model.

To answer Hypothesis 2 average resilience as well as the interaction between both training load measures were added to the model. Total training load, acute to chronic workload ratio, gender, resilience, and the interactions between workload variables and resilience trended toward significantly predicting the variance in flourishing mental health symptom changes. This model accounted for almost 7% of the variance in changes in flourishing mental health symptom changes. None of our hypothesized variables predicted the change in flourishing mental health (see Table 3,  $t$ -scores = -0.14, -0.79, 0.27, 0.72, and 0.34 respectively,  $p$ -values = 0.89, 0.43, 0.79, 0.47, and 0.56 respectively).

**Table 1.** Descriptive Statistics (Mean  $\pm$  SD)

(n = 114)

	Timepoint 1	Timepoint 2	Timepoint 3
PHQ-9	1.54 $\pm$ 2.42	3.04 $\pm$ 3.44	2.46 $\pm$ 3.24
GAD-7	3.21 $\pm$ 3.77	3.86 $\pm$ 3.96	3.60 $\pm$ 4.39
MHC-SF	57.32 $\pm$ 11.04	57.95 $\pm$ 10.08	58.64 $\pm$ 11.46
CD-RISC-10	42.58 $\pm$ 7.84	42.49 $\pm$ 6.95	42.25 $\pm$ 8.49
ACWR		1.20 $\pm$ 0.32	1.06 $\pm$ 0.33
Total Training Load		8897 $\pm$ 3787	7716 $\pm$ 2815

*Note.* PHQ = Depression, GAD = Anxiety, MHC = Flourishing Mental Health Symptoms.  
Timepoint 1 = Baseline, Timepoint 2 = Approx. 6 Weeks, Timepoint 3 = Approx. 12 Weeks.

**Table 2.** Mental Health Symptoms Correlations to Predictors

(n = 114)

	PHQ			GAD			MHC		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
<b>CD-RISC-10</b>	-0.37***	-0.40***	-0.33**	-0.33**	-0.35**	-0.27**	0.47***	0.51***	0.52***
<b>ACWR</b>	-0.04	-0.04	-0.04	0.11	0.02	0.04	0.09	-0.0005	0.08
<b>Total Training Load</b>	0.09	0.09	0.24	0.13	0.11	0.10	0.15	0.01	-0.07

Note. PHQ = Depression, GAD = Anxiety, MHC = Flourishing Mental Health Symptoms.  
Time 1 = Baseline, Time 2 = Approx. 6 Weeks, Time 3 = Approx. 12 Weeks.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

**Table 3.** Full Model Estimates and Standard Errors.

(n = 114)

	PHQ		GAD		MHC	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
<b>Intercept</b>	-13.16 <sup>+</sup>	7.56	-7.57	10.58	15.34	37.61
<b>CD-RISC-10</b>	0.34 <sup>+</sup>	0.19	0.22	0.26	-0.13	0.92
<b>ACWR</b>	1.35	6.37	2.99	9.00	-25.14	31.98
<b>Total Training Load</b>	0.002**	0.0006	0.0006	0.0009	0.0008	0.003
<b>CD-RISC-10 *ACWR</b>	-0.06	0.15	-0.94	0.22	0.55	0.76
<b>CD-RISC-10*Total Training Load</b>	-0.00004**	0.00001	-0.00001	0.000002	-0.00004	0.00007
<b>Gender</b>	-1.47**	0.55				

Note. PHQ = Depression, GAD = Anxiety, MHC = Flourishing Mental Health Symptoms.

<sup>+</sup> $p < .10$ , \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .



## CHAPTER V: DISCUSSION

### Study Overview

The present study was conducted to investigate whether collegiate student-athletes' mental health symptoms of depression, anxiety, and flourishing mental health were associated with training load over the course of a competitive season. Additionally, this study was conducted to determine whether resilience influences the seasonal relationships among training load and mental health symptoms of depression, anxiety, and flourishing mental health. We found some support for our hypotheses regarding depression and total training load at 12 weeks, and the influence of resilience on total training load on depression at 12 weeks. We also observed that resilience and total training load were associated with aggregate scores of mental health symptoms at certain timepoints. Finally, we observed that recovery was associated with aggregate scores of mental health symptoms at most timepoints. The significant and nonsignificant results both have theoretical and clinical implications, discussed below.

Present study hypotheses regarding the associations among training load and mental health symptoms were not supported regarding flourishing mental health and anxiety with the exception of partial support for hypotheses regarding depression. A significant association was found between depression symptoms and total training load at 12 weeks. More specifically, results showed no significant changes in mental health symptoms related to flourishing mental health, anxiety, or depression across the study period. There are many potential rationales for the lack of significant changes in mental health symptoms. As the current study was observational in nature, it is important to note that training load was not controlled. With the inability to compare

to a training load control group in this study, it can be difficult to determine associations between mental health symptoms and training load. Additionally, mental health symptoms were evaluated at 3 timepoints: baseline, approximately 6 weeks, and approximately 12 weeks. This captures subjects at a very specific moment in time that may or may not account for the variability in mental health symptoms that occur throughout one's life. Research has indicated that major negative life events, including injury, career retirement, or performance failure may increase elite athlete's risk of mental health symptoms (Rice et al., 2016). Our evaluation of mental health symptoms at such specific timepoints may not encapsulate the changes in mental health that an individual might experience due to these life events. Additionally, participants may have reported symptoms consistent to what they believe to be social norms due to the negative stigma surrounding mental health. It is also important to consider that there possibly is no relationship between training load and mental health symptoms or that the relationship is too individualized to be captured in the scope of this study. Future research efforts may benefit from tackling these potential explanations for the largely null findings herein.

### **Nonsignificant Findings**

With respect to the current study, the lack of change in flourishing mental health may be related to the nature of the questions on the MHC-SF. Questions are related to contributions to society, feeling as if one belongs to a community or social group, or whether one has warm and trusting relationships with others, all of which may be related to an individual's athletic team involvement. Athletic team involvement promotes friendship and peer interactions along with providing social support and acceptance promoting social well-being (Merkel, 2013). As athletic team involvement promotes social well-being, the participants' variability in consistent (or

inconsistent) involvement in team activities may have resulted in no change in their flourishing mental health.

Also, high level athletes will often strive for perfectionism, and their advanced experiences in sport may have improved their time management skills allowing them to balance many stressors and resulting in unchanging levels of anxiety (Hamidi & Besharat, 2010; Merkel, 2013). Thus, differences in individual exposure and response to stress may attenuate any potential anxiety changes to detect in the current sample. Additionally, the lack of change in anxiety symptoms may be due to the participants high level of experience with the stressful nature of sport and competitive environment (Hamidi & Besharat, 2010). In sum, as there was no overall change in mental health symptoms over the course of the study period, there was limited variability to predict and; accordingly, there was limited capacity to assess how resilience influenced the change in mental health symptoms in the current sample.

The lack of variability in mental health symptoms across the study period also merits discussion. This result may be a consequence of both protective and promotive of factors of mental health symptoms in sport. Collegiate athletes are placed under intense mental and physical demands which is unique to their experience as a student-athlete and may increase their risk of experiencing mental health symptoms (Hughes & Leavey, 2012). However, it has been clearly established that physical activity, a daily requirement for student-athletes, is a beneficial intervention in those that experience depression and anxiety (Callaghan, 2004; Fox, 2000; J.S., 1990). Additionally, research has shown that school sport participation was a significant predictor of lower depression symptoms, lower perceived stress, and higher self-rated mental health in young adulthood (Jewett et al., 2014). These protective effects may explain the limited variability in mental health symptoms across the study period.

While there was no significant relationship between training load and mental health symptoms overall, correlational relationships by timepoint unearth some potentially illustrative findings. Notably, depression symptoms were associated to total training load at timepoint 3. Existing research has established a relationship between total training load and an increased injury rate (Drew & Finch, 2016; Rogalski, Dawson, Heasman, & Gabbett, 2013; Windt & Gabbett, 2017), but this is the first study to establish a relationship between total training load and depression symptoms. This may be due to the cumulative stressors of life as a student-athlete. This includes many factors such as total training load, end of semester exams, post-season travel, conflict with coaches or teammates, and social stressors. This finding is significant to consider when student-athletes are experiencing continuous high training loads, they are not only at increased risk for physical injury, but they may also experience a negative impact on their mental health. Additionally, this finding is alternative to many previous findings suggesting that physical activity is beneficial to mental health symptoms. This finding suggests that there may be a threshold for physical activity that is beneficial for mental health, before it becomes detrimental to one's mental health.

At certain seasonal timepoints, the specific stressors of collegiate sport may mitigate the preventative effects of sport participation for collegiate athletes. Accordingly, perhaps collegiate sport is best characterized as a balance between the benefits of structured physical activity and the stress from intensive sport participation (Kimball & Freysinger, 2003). The individual nature of trade-off could explain study findings and is important for clinicians to consider when working with individual athletes at key times of in-season training and psychological stress. Athletic trainers should monitor specific cases of the student-athletes they care for over the

course of a competitive season while recognizing that individual athletes will respond to stressors differently.

## **Resilience**

An athlete's resilience will affect how they respond to the various stressors they face. Extant literature supports our finding that resilience significantly influenced the relationship between total training load and depressive symptoms. Higher resilience should be related to lower depressive symptoms as resilience has been positively associated with emotional flexibility (i.e., the ability to adapt emotional responses to changing emotional circumstances), which should aid student-athletes with the emotionally taxing environment of competitive training (Vaughn, Thompson, & Gotlib, 2011). We expect resilient athletes to maintain psychological functioning despite increases in training load, whereas athletes lower in resilience may experience decreases in psychological functioning, such as increases in depressive symptoms, with the stressor of increased training load. This was evident in our results wherein individuals with greater total training load at timepoint 3 and lower average resilience tended to report the greatest increases in depressive symptoms across the study period. More specifically, those high in resilience were able to buffer against the potential negative effects of high training load.

## **Clinical Significance**

Despite a majority of null findings found on the associations among mental health symptoms and training load and the influence of resilience on these variables across the study period, clinical significance can be gleaned from the present investigation. Generally, with

mental health research, we do not expect to see a normal distribution of data. Instead, we would expect to see skewed data points, as we did in the current study. This is a positive finding in that we are not recognizing clinical levels of mental health disorders in the majority of the population across a season. Rather, these results confirm that clinically relevant (i.e., in suspected need of sport psychology/counseling referral) levels of mental health symptoms are not common in the student-athlete population sampled. However, this does indicate that there are some specific student-athletes, at certain seasonal time points, that require close monitoring with regard to their mental health. Accordingly, the prevalence of mental health symptoms in our study population has implications for athletic trainers working with collegiate student-athletes.

The current standard of care for athletic trainers regarding the mental health of the student-athletes they treat is a pre-season evaluation of the student-athlete's depressive symptoms often through a PHQ-9 assessment. Athletic trainers will often utilize a PHQ-9 to screen for depressive symptoms with any student-athlete reporting suicidal ideation being immediately flagged. Athletic trainers use this information to refer to the appropriate health care provider, in most cases a team psychologist. Results from the current investigation illustrate that this current standard of care may not be sufficient. Follow-up evaluation of student-athlete's mental health as the semester's workload progresses is essential as significant, positive associations were between depressive symptoms and total training load at 12 weeks. Based on study findings, the addition of a second formal mental health assessment (with a focus on depressive symptoms) at approximately 11-13 weeks into training would seem an appropriate positive change to current clinical practice.

Additionally, evaluation of an athlete's resilience at pre-season screenings may be beneficial to athletic trainers given the influence of resilience on depression symptoms and total

training load. As resilience did not change over the course of the study period, a simple pre-season screening of resilience through a survey such as the CD-RISC-10 may be sufficient for the athletic trainer. This may allow the clinician to determine specific student-athletes whose mental health and training load should be monitored more closely throughout the course of the season with emphasis on the end of the season. This is particularly illustrated through our findings that individuals with greater cumulative workload at timepoint 3 and lower average resilience tended to report the greatest increases in depressive symptoms across the study period. For example, athletic trainers may be able to utilize the findings of a student-athlete with low level resilience as a rationale to monitor that student-athlete's mental health symptoms and training more closely throughout the season, as they may be at an increased risk of experiencing increased depression symptoms. Additionally, such monitoring could aid athletic trainers or other sport medicine personnel in identifying specific athletes for which monitoring may be most beneficial. This may be particularly useful in circumstances where personnel and/or financial resources are currently insufficient to support multi-time point seasonal monitoring for all student-athletes.

## **Limitations**

The current study had some limitations similar to those of other observational designs. First, there were some missing data with respect to training load. RPEs were collected only after official team practices and competition and did not include additional official team training that occurs in the weight room. This was due to the inability of athletic training staff to be at all weight training sessions. Furthermore, in the realm of athletics, there are situations where it is not clinically or socially appropriate to probe student-athletes for their RPE value (i.e., after a

difficult loss or tough discussion with a coach about their performance). Despite this missingness, we felt confident that the training load data collected was still representative of their overall season. Also, follow-up evaluation of self-reported injury was conducted after completion of the competitive season resulting in a limited response rate and limiting the ability to control for injury. Finally, a limitation in the statistical significance found in the current study may have been due to the fact that general linear models were utilized for analyses. As there was no linear change in the participants mental health symptoms across the study period, mixed linear models analysis may have been more appropriate. Mixed linear models would allow for us to recognize that individuals start at different points and change differently as well, which may be more appropriate for analyses related to mental health research, but it is outside of the scope of the present study.

### **Future Research**

Future research should consider utilizing alternative external training load metrics (i.e., distance traveled, average velocity traveled, etc.) for more additional objective data to compliment the subjective data of RPE values. Additional research should also explore gender differences in mental health symptom changes, as male subjects experienced greater increases in mental health symptom changes than females. Finally, researchers should consider examining seasonal differences as athletes may respond to various stressors in-season versus out-of-season differently.



## **Conclusions**

Overall, these findings contribute to already established findings that mental health symptoms are prevalent and associated to one another in the student-athlete population. We assessed mental health symptoms at three specific timepoints while observing training load variables across a competitive season. Total training load at 12 weeks was associated with changes in depression symptoms in that, those with greater total training load at 12 weeks had greater increases in their depressive symptoms. In addition, resilience had a significant influence on the relationship between total training load and depression symptoms. Individuals with greater total training load at 12 weeks and lower average resilience tended to report the greatest increases in depressive symptoms across the study period. Those high in resilience were able to buffer against the potential negative effects of high training load. Despite the limitations, the current study suggests addition of evaluation of student-athlete resilience at pre-season screenings and the importance of follow-up evaluation of depression symptoms. These findings may be essential to provide comprehensive health care to collegiate student-athletes throughout a competitive season.

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