Psychopathology and Anxiety Outcomes in Female Anorexic Exercisers and Nonexercisers

A Senior Honors Thesis in Community Health

Megan Kuhnle

Megan.Kuhnle@tufts.edu

Committee Chair: Dr. Jennifer Allen

Thesis Readers: Dr. Elizabeth Austen Lawson

Dr. Kendra Becker

Dr. Madina Agénor

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Abstract

Anorexia nervosa (AN) is a serious eating disorder that causes extreme weight loss and has severe physical and psychological ramifications. It is more prevalent among females than males and 1.2% of females in the United States will be diagnosed with AN at some point in their lifetime. AN is often seen with depression and anxiety as comorbidities and has the highest mortality of any psychological disorder. Excessive exercise is frequently implicated as part of an AN diagnosis therefore understanding the role exercise plays in the psychopathology and anxiety outcomes of AN patients is essential in order to optimize treatment strategies and understand the best way to incorporate exercise as part of recovery. Data were analyzed from four studies conducted in the Neuroendocrine Unit at Massachusetts General Hospital to better understand the relationship between exercise and eating disorder psychopathology and anxiety outcomes among anorexic exercisers and nonexercisers. No significant difference was found in eating disorder psychopathology as measured by the Eating Disorders Examination Questionnaire (EDE-Q) between exercisers and nonexercisers. Among exercisers, the number of hours per week exercised was significantly positively ($p<0.05$) related to an higher eating disorder psychopathology scores (EDE-Q). Exercisers were found to have significantly lower anxiety levels as measured by the Spielberger State-Trait Anxiety Inventory (STAI-Trait) compared to nonexercisers ($p<0.05$). The results of this study indicate that exercise is an important factor to consider when evaluating the mental health of patients with AN and should be further examined to determine appropriate recommendations for exercise regimens during treatment for AN.

Background

Defining anorexia nervosa

Anorexia nervosa (AN) is an eating disorder involving behavioral and psychological traits related to restriction of food intake, resulting in low body weight ("DSM-5" 2013). The Diagnostic Statistical Manual 5 diagnostic criteria include intense fear of gaining weight or becoming fat, and disturbance of body image (Harrington, Jimerson, & Israel, 2015). Patients often deny the seriousness of their low weight while simultaneously expressing fears about weight gain (Fairburn & Brownell, 2005). The DSM-5 criteria were updated in 2013 from the DSM-4, published in 2000, to include a severity of weight loss index (Figure 1) rather than the previous cutoff of 80% of ideal body weight (IBW) (Harrington et al., 2015). Additionally, the new criteria no longer require amenorrhea (cessation of menstruation) as part of the criteria for diagnosis (Harrington et al., 2015).

DSM-5 Severity Index	BMI (kg/m^2)
Mild	≥ 17
Moderate	16-16.99
Severe	15-15.99
Extreme	< 15

Figure 1: DSM-5 Severity Levels with BMI ("DSM-5" 2013)

AN is subdivided into two types: restrictive eating and binge eating/purging. Clinical presentation of restrictive eating includes weight loss due to dieting, fasting, and/or excessive exercise. Binge eating/purging occurs when the patient engages in cycles of

overeating followed by a purge that can include self-induced vomiting, misuse of laxatives, diuretics, or enemas (Harrington et al., 2015). Long term AN can cause myriad physical and mental health issues including bone problems, malnutrition, infertility, and social isolation (Miller & Golden, 2010).

The development of AN has been studied both in terms of patient mental health as well as social causes. A review of several studies suggests that AN is not a "culture-bound syndrome", defined as "a collection of signs and symptoms (excluding notions of cause) which is restricted to a limited number of cultures primarily by reason of certain of their psychosocial features" (Keel & Klump, 2003). AN has existed outside of self-starvation for weight loss purposes in instances such as hunger strikes and spiritual starvation, and is not a result of societal norms. AN has been observed in all Western and non-Western nations (Keel & Klump, 2003).

Epidemiology of eating disorders and anorexia nervosa

95% of patients diagnosed with eating disorders in the United States are female (Harrington et al., 2015) and 12% of adolescent females experience an eating disorder by age 20. It has been suggested that up to 16.7% of female athletes suffer from some type of disordered eating and 42% of females in sports that emphasize aesthetics experience disordered eating (Sundgot-Borgen & Torstveit, 2004; Vardar & Kurt, 2007). Prevalence of AN in the United States is 0.5% of females at any given time, and 1.2% of females will be diagnosed with AN at some point in their lifetime (Stice, Marti, Shaw, & Jaconis, 2009).

Risk factors for anorexia nervosa

The risk factors for AN are complex and range from biological to psychological to social, and combinations of exposure to these different risk factors often culminate with the onset of AN. The major risk factors are described below.

Family environment

While the etiology of eating disorders is not fully understood, it has been suggested that parenting style, stress, family discord, and emphasis on success and external rewards are behaviors that can contribute to feelings of anxiety that place individuals at risk for an eating disorder (Harrington et al., 2015). Children and adolescents who develop eating disorders often use what they eat to establish a sense of control (Harrington et al., 2015). A review of twin studies concluded that AN can be familial due to the shared environment, but the specific factors within the environment remain to be determined (Bulik, Sullivan, Wade, & Kendler, 2000). Attachment insecurity to mothers has been found to be significantly correlated with body dissatisfaction and drive for thinness, but the effects of fathers' parenting styles has yet to be studied (Hoxha, 2015). Maternal data collected about eating disorder patients demonstrated that "maladaptive perfectionism" might have a mediating role between the eating disorder and exercise dependence for both male and female exercisers (Costa, Arcan, Cuzzocrea, Oliva, & Hausenblas, 2016).

Genetics

Genetic susceptibility to both AN and non-anorexic binge eating disorder has been suggested by several studies (Thornton, Mazzeo, & Bulik, 2011). It has been shown that first and second degree relatives of patients with obsessive compulsive disorder (OCD) have an increased risk for AN, and this risk increases with the level of genetic relatedness (Cederlöf et al., 2015). The Australian Twin Registry was used to determine that common genetic factors underlie an eating disorder phenotype contributing to suicidality, and a Swedish study also demonstrated this link (Bulik, Institutet, Kleiman, & Yilmaz, 2016).

Dieting and environmental perfectionism

When examining risk and onset patterns, dieting with the goal of weight loss was the most common onset factor seen in women diagnosed with AN, and women with a history of dieting are more likely to develop eating disorders. Among women with eating disorders including AN, bulimia nervosa, and binge eating disorder, women with AN reported the highest exposure to environmental perfectionism. Environmental perfectionism is defined as being in the presence of others who conform to a high level of perfectionist habits, which suggests the impetus behind their strong adherence to diets. Many children see their parents model perfectionism and adopt it as a learned behavior (Hilbert et al., 2014).

Link between excessive exercise and anorexia nervosa

Excessive physical activity is recognized for its detrimental effects related to the onset

and persistence of AN; it is associated with longer admission durations in inpatient treatment programs, higher chronic outcomes, and drop out from treatment (Lehmann et al., 2018). Excessive exercise is defined as physical activity which ‘‘significantly interferes with important activities, occurs at inappropriate times or in inappropriate settings, or continues despite injury or other medical complications’’ (Mond, Hay, Rodgers, & Owen, 2006). It has also been demonstrated that anorexic patients can become hypermetabolic, easily lose weight, and need higher amounts of calories to gain weight back, issues which are further exacerbated by excessive exercise (Marzola, Nasser, Hashim, Shih, & Kaye, 2013). Anorexic patients who do not engage in exercise typically need a 4,000 calorie excess to gain 1 kilogram of weight, while the caloric need of an anorexic patient engaging in extreme exercise may increase to 12,000 excess calories to gain 1 kilogram (Marzola et al., 2013). High levels of depression are expected among both AN and bulimia nervosa patients who exercise excessively, and anxiety levels are higher among AN patients who exercise excessively (Peñas-Lledó, Vaz Leal, & Waller, 2002).

History of anxiety and depression

Many patients with AN also have a history of one or more clinically significant anxiety disorders prior to the onset of AN (Higgins & Cahn, 2018). Figure 2: Comorbidities of eating disorders (NIMH 2017) displays the prevalence of lifetime psychological comorbidities for AN showing that 47.9% of patients with AN also present with an anxiety disorder and 42.1% with a mood disorder, which encompasses depression (NIMH 2017).

Lifetime Co-morbidity of Eating Disorders with Other Core Disorders Among U.S. Adults Data from National Comorbidity Survey - Replication (NCS-R)[1]			
	Anorexia Nervosa (%)	Bulimia Nervosa (%)	Binge-Eating Disorder (%)
Any Anxiety Disorder	47.9	80.6	65.1
Any Mood Disorder	42.1	70.7	46.4
Any Impulse Control Disorder	30.8	63.8	43.3
Any Substance Use Disorder	27.0	36.8	23.3
Any Disorder	56.2	94.5	78.9

Figure 2: Comorbidities of eating disorders (NIMH 2017)

It has also been demonstrated that females with OCD have a sixteen fold increase in having a comorbid diagnosis of AN (Cederlöf et al., 2015). The binge-purge subtype of AN has been linked to higher rates of psychiatric comorbidities compared to the restrictive subtype (Bühren et al., 2013). Adolescents with AN have lower rates of these psychiatric comorbidities compared to adults with AN, so it is essential that treatment begin early to avoid more severe psychiatric consequences (Bühren et al., 2013).

History of trauma

Over 50% of patients with AN in a study reported a history of sexual abuse compared to 28% among patients with other eating disorders, and a meta-analysis showed that females who have experienced sexual abuse are 2.34 times more likely to develop an eating disorder (Chen et al., 2010; Hall, Tice, Beresford, Wooley, & Hall, 1989). It is reported that 33% of women will experience sexual abuse at some point during their lives therefore this risk factor is highly important to consider from both a societal lens and a clinical perspective (*The National Intimate Partner and Sexual Violence Survey*

2010-2012 State Report, 2012). Among patients with AN who have experienced sexual abuse, higher levels of depression, anxiety and severe obsessive-compulsive behaviors have been reported (Carter, Bewell, Blackmore, & Woodside, 2006). In addition, no significant difference has been found in recovery success of AN between patients with a history of sexual abuse and those without a history of sexual abuse when using enhanced cognitive-behavioral therapy (Calugi, Franchini, Pivari, Conti, & Ghoch, 2018).

Weight history

Physicians must measure a patient's current body weight and compare it with the patient's weight history to assess the implications of current body weight for the patient, since frequent weight changes and historic low weight can be important risk factors to note related to the onset of AN. Even if the patient's weight is not critically low, it is still essential that weight changes be monitored and taken into account when evaluating the patient's motivations surrounding food and their cognitive processes (Fairburn & Brownell, 2005).

Clinical presentation and diagnosis of anorexia

Physical symptoms at initial presentation

Many patients hide their weight loss and eating behaviors and first present to medical professionals with complications from their eating disorder including oligomenorrhea (irregular menses), amenorrhea, palpitations, cold intolerance, fatigue, and abdominal

pain. Subsequently, signs of malnutrition are commonly found during physical examinations for anorexic patients and patients presenting with an eating disorder are often visibly low-weight (Starr & Kreipe, 2014). Puberty can often be delayed as well as determined by the Tanner stages, a scale with five stages of pubertal development (Miller & Golden, 2010).

Psychological symptoms at initial presentation

In addition to physical signals that the patient is anorexic, the psychiatric presentation often involves phobia of weight gain that can be described as obsessive, or even pathological (Fairburn & Brownell, 2005). Common psychological symptoms include depression, social withdrawal, loss of sexual libido, obsessive rituals, dysphoria (a state of unease or general dissatisfaction), and reduced alertness and ability to concentrate (Fairburn & Brownell, 2005). Intense drive for thinness and body dissatisfaction are principal issues among individuals presenting with AN (Thornton et al., 2011). Many patients also present with issues of clinical perfectionism, which involves self-criticism and has been implicated in several studies as an additional risk factor for eating disorders (Shanmugam & Davies, 2015). Depression is often a comorbid diagnosis with AN, and some studies have demonstrated that up to 63% of patients have this comorbidity (Gowers, 2009). AN patients are high-needs and high-risk population and AN has the highest mortality of any psychological disorder (Higgins & Cahn, 2018). Individuals with AN overestimate their body size more compared to matched healthy controls and have greater body dissatisfaction, defined as one's subjective negative feelings about their weight and body shape (Hagman et al., 2015). Additionally, women

with AN have difficulties with emotional acceptance, defined as adopting a non-judgmental attitude toward their body-related emotions and thoughts, as an emotional regulation strategy and experience worse moods after looking at pictures of thin models (Naumann, Tuschen-Caffier, Voderholzer, Schäfer, & Svaldi, 2016).

Long-term health effects of anorexia

Skeletal system effects

The skeletal system is heavily affected by AN, particularly in cases of low bone mineral density (BMD) that can lead to osteopenia and osteoporosis. Osteopenia is a condition where a patient has reduced BMD and does not make new bone as quickly as it reabsorbs old bone. It is considered a precursor to osteoporosis, a condition where bones become weak and brittle which can pose an increased risk of fracture. It has been found that biomarkers that indicate low BMD are related to decreased bone accrual and increased reabsorption in the vertebrae (Starr & Kreipe, 2014). Decreased bone accrual in adolescents poses additional concerns of not reaching optimal peak bone mass if a patient does not have adequate nutritional intake as a result of an eating disorder (Misra & Klibanski, 2011).

Endocrine system effects

Patients with AN have significantly different levels of several hormones including endogenous insulin-like growth factor 1 (IGF-1), leptin, and androgens, which can predict poorer outcomes for bone microarchitecture (Lawson et al., 2010). They also

have increased levels of ghrelin, a hormone that promotes hunger (Schalla & Stengel, 2018). Women with AN have lower oxytocin levels compared to healthy controls, and it has been found that postprandial (after eating a meal) oxytocin levels in women with AN are associated with increased symptoms of anxiety and depression (Lawson et al., 2013). Novel therapies using oxytocin are in the clinical trial stage (Giel, Zipfel, & Hallschmid, 2018). Additionally, brain-derived neurotrophic factor (BDNF) levels are lower in women with AN, and exercise promotes expression of BDNF via ketone body beta hydroxybutyrate (Brandys, Kas, van Elburg, Campbell, & Adan, 2011; Sleiman et al., 2016).

Changes in brain matter

Patients with AN have larger cerebrospinal fluid (CSF) volumes but lower levels of essential hormones in their CSF, and deficits in both gray and white matter volumes (Lambe, Katzman, Mikulis, Kennedy, & Zipursky, 1997; Nickel et al., 2018). In a study using MRI scans to analyze gray and white matter recovery in a weight-recovered AN group and age-matched controls, the weight-recovered group had significantly lower gray matter and higher CSF volumes than age-matched controls as seen in Figure 3: MRI brain scans of adolescent females (Katzman et al., 1996).

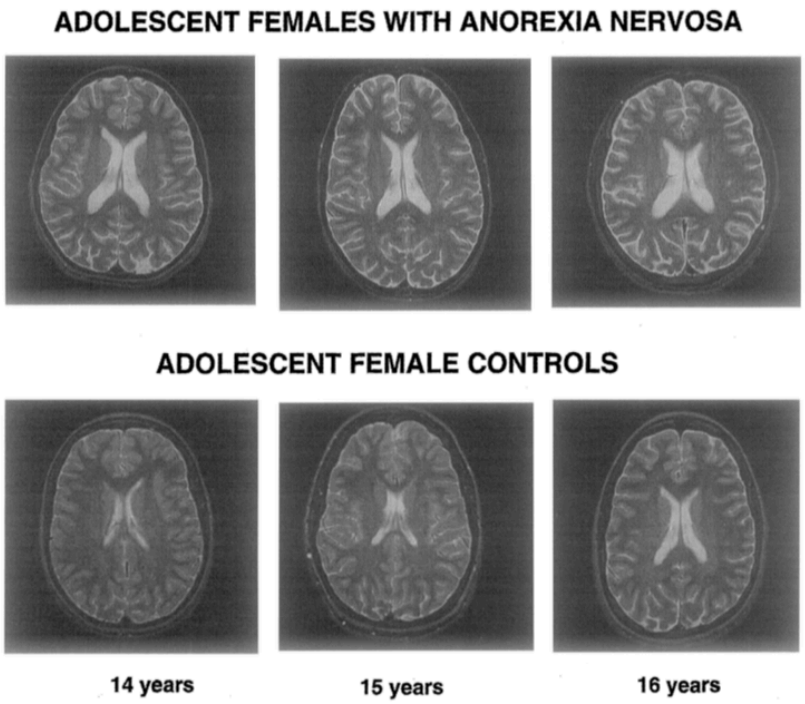

Figure 3: MRI brain scans of adolescent females (Katzman et al., 1996)

A low-weight group in the same study had higher CSF volumes and smaller gray and white matter volumes compared to the weight-recovered group (Lambe et al., 1997). A meta-analysis concluded that acute adolescent patients display significantly worse reductions in gray matter compared to acute adult patients (-8.4 vs. -3.1%). The adults displayed full long-term recovery from this deficit but data for adolescent recovery is sparse (Seitz, Herpertz-Dahlmann, & Konrad, 2016). AN patients also typically have enlarged ventricles and sulcals that show up on CT scans which have been suggested to be an effect on malnutrition (Dolan, Mitchell, & Wakeling, 1988). Sulcal width was reversed returned to the size of the sulcals of healthy controls following refeeding and (Dolan et al., 1988). In addition to its association with greater ventricular size, lower weight has been associated with worse performance on flexibility, inhibition, and memory tasks (Kingston, Andrewes, Tress, Desmond, & Szmukler, 2009).

Implications of changes in brain matter

Body Image Distortion

The presence of white matter pathology in patients with AN may help explain some symptoms including body image distortion and impairments in energy balance and reward pathways (Via et al., 2014). Individuals diagnosed with AN perceive themselves with a distorted body image, but this distortion does not extend to how they perceive the shape of others (Sachdev, Mondraty, Wen, & Gulliford, 2008). AN individuals lack activation in the attentional system and insula when processing self-images, and damaged pathways for emotional and perceptual processing may underlie the distortion perceived when looking at self-images (Sachdev et al., 2008). Patients with AN who have decreased grey matter volume typically experience the deficit in regions including the superior temporal gyrus, middle temporal gyrus, pulvinar, and superior frontal gyrus (Kohmura et al., 2017). Decreased grey matter volume in the superior frontal gyrus is associated with body dissatisfaction which may stem from impaired visuospatial perception and can be involved in the onset of AN (Kohmura et al., 2017).

Permanence of changes

It has been found that gray matter reductions are most reversible when a patient first begins AN treatment, as opposed to after weight recovery has taken place (Mainz, Schulte-Rüther, Fink, Herpertz-Dahlmann, & Konrad, 2012). While some of the brain matter changes are due to starvation mechanisms, changes in specific regions including the hippocampus are related to hormone dysfunction caused by the illness. Additionally,

long-term deficits in essential hormones can leave “biological scars” that make patients more susceptible to mood and anxiety disorders (Mainz et al., 2012).

Changes in reward pathways

It has been found that females with AN have significantly increased brain activation in the orbitofrontal cortex compared to female healthy weight controls, and obese females have reduced activation in this region compared to healthy weight controls (Frank et al., 2012). This data suggests that females with AN are more sensitive in dopamine-related pathways compared to healthy controls and OB counterparts who are less sensitive, and that AN females can find pleasure in restricting their food intake (Frank et al., 2012).

Screening for anorexia

There are a variety of ways to screen for eating disorders so that preventive psychological treatment, including cognitive behavioral therapy (CBT), can be started before disordered eating behaviors turn into full-fledged eating disorders. Systematic reviews have determined that the most reliable way to screen for eating disorders is through a structured or semi-structured interview conducted by a physician or a trained interviewer (Mond, Hay, Rodgers, Owen, & Beumont, 2004). The American Academy of Pediatrics recommends that all preteens and teens be routinely screened at their annual physicals or at evaluations taking place prior to participation in sports (McBride, 2011). AN diagnosis is complex, particularly with the increase in subclinical eating disorders, and female physicians are slightly more likely to make a correct AN diagnosis than male

physicians, suggesting that they may be more aware of patients' eating psychopathology due to higher eating disorder prevalence among females (Higgins & Cahn, 2018). The most commonly used screening tools and athlete-specific tools are described below.

Selection of screening tools

Of the four tools reviewed for this thesis, the Eating Disorders Examination (EDE-Q) was selected due to its prevalence in clinical practices today, including in the parent studies for this study, and its comparison to the Sick, Control, One, Fat, Food Questionnaire (SCOFF). The other two tools described below, the Female Athlete Screening Tool (FAST) and Low Energy Availability in Females Questionnaire (LEAF-Q), were chosen for review due to their specific aims of creating a tool to screen for eating disorders in the female athlete population. The FAST and the LEAF-Q have not been widely used in clinical settings to date. The parent studies used to create the dataset for this study used the EDE-Q to evaluate patients.

EDE-Q

The EDE-Q is a widely used self-administered questionnaire to identify AN, bulimia nervosa, and binge-purge disorders in clinical settings. It was developed at Stanford University's Department of Psychiatry and Behavioral Sciences and has 83% sensitivity and 96% specificity. The EDE-Q poses a series of 33 questions about behaviors and feelings eating habits in public and in private, satisfaction with shape, and weight concerns to gather information and provide ratings on four subscales about specific aspects of a patient's eating disorder. The subscales are restraint, eating concern,

weight concern, and shape concern (Mond et al., 2004). There is a 6-point Likert scale for most of the questions, and the remaining questions ask how many days over the last 28 days a particular behavior or activity has occurred. The restraint, eating concern, and weight concern subscales each have 5 corresponding questions, and the shape concern subscale has 10 corresponding questions. The EDE-Q subscales are calculated then averaged to come up with the global score. The global score can range from 1 to 6, with 1 indicating no disordered eating behaviors and 6 indicating severe disordered eating behaviors. There is also an interview version where a trained clinician administers the questions to the patient, the EDE-I (Luce, Crowther, & Pole, 2008). The EDE-Q has demonstrated strong concurrent validity with other self-report scales including the Compulsive Exercise Test and has been validated among athlete populations in addition to nonathletes (Pope, Gao, Bolter, & Pritchard, 2015; Young et al., 2017).

SCOFF

The SCOFF questionnaire has been shown to be an effective method of determining if a case of AN or bulimia nervosa is likely with a 100% sensitivity for AN and bulimia nervosa and a specificity of 87.5% for both eating disorders (Morgan, Reid, & Lacey, 1999). It was developed in the United Kingdom as a tool to be used by physicians to screen for eating disorders in patients who potentially have an eating disorder or are in the process of developing one. It poses a selection of five questions related to each of the title concepts that the patient self-administers and answers. Questions include "Would you say that food dominates your life?" and "Do you think you are too fat, even though others say you are too thin?" (Morgan et al., 1999).

Comparison of EDE-Q and SCOFF screening instruments

A comparative validity study of the EDE-Q and the SCOFF questionnaire concluded that both measures are valid detective tools but the EDE-Q performed better than the SCOFF across all ages and weight. The EDE-Q is much more commonly used in the clinical setting, particularly in the United States. Eating disorders with extreme weight-control behaviors are often diagnosed in early adulthood, compared to binge eating disorders which tend to be more prominent for people of a middle age which is why it is important for instruments to be reliable for all ages (Mond et al., 2008).

FAST

The FAST (Female Athlete Screening Tool) is a questionnaire that is used to detect abnormal eating psychopathology in female athletes. The tool has high internal consistency (Cronbach's alpha = 0.87) and is strongly correlated to the EDE-Q in terms of reliability. There are 33 questions that are self-administered by the patient related to restrictive food intake, training, and weight management. Questions on the FAST ask specifically about exercise, training, relationships with food, and associating thinness with winning (McNulty, Adams, Anderson, & Affenito, 2001). The FAST has been used in several clinical studies including an evaluation of female ultramarathoners and their risk for developing the Female Athlete Triad (Folscher, Grant, Fletcher, & van Rensberg, 2015).

LEAF-Q

A newer tool used for screening for eating disorders among athletes is the LEAF-Q, which aims to identify a combination of limited caloric intake and excessive exercise. The LEAF-Q has 25 questions about reproductive function, bone health, and physiological symptoms related to energy deficiency in addition to physical examinations looking at changes in blood pressure when moving from a supine position to a standing position. This tool aims to identify females at risk for the Female Athlete Triad, a combination of three conditions: disordered eating, amenorrhea, and osteoporosis, seen in Figure 4: The Female Athlete Triad (Nattiv et al., 2014). The LEAF-Q can identify both subclinical eating disorders and eating disorders diagnosable per the DSM-5, and has 78% sensitivity and 90% specificity (Melin et al., 2014).

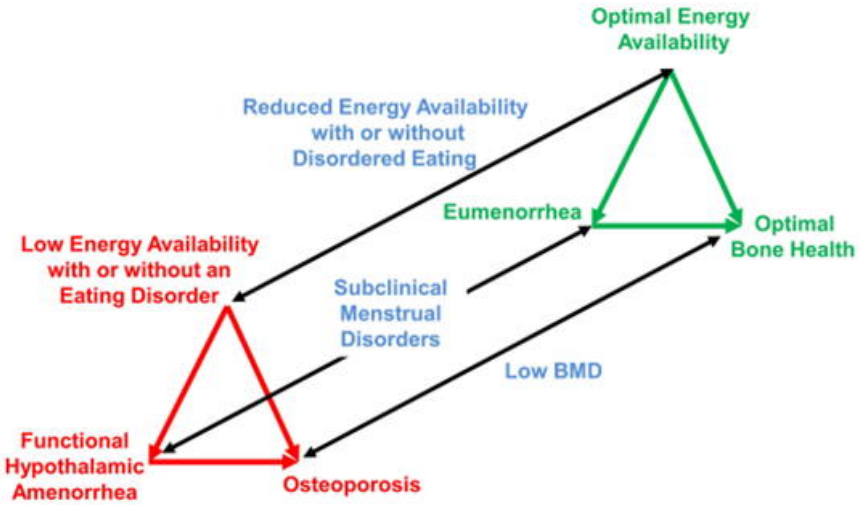

Figure 4: The Female Athlete Triad (Nattiv et al., 2014)

STAI-Trait

Anxiety is a transitory condition that can be both a trait and a state a person is in. Two versions of this self-report scale are used in clinical research, the state version asks

respondents how they are feeling “right now, at this moment,” while the trait version asks respondents how they “generally feel” (Oei, Evans, & Crook, 1990). For this study we selected the STAI-Trait, which asks how participants to score how they “generally feel.” The STAI-Trait exam has 20 questions scored on a four point Likert scale. Questions include “I feel satisfied with myself,” “I am a steady person,” and “I wish I could be as happy as others seem to be.” The STAI-Trait has high internal consistency with a Cronbach’s alpha of 0.781 in the general population (Vitasari, Wahab, Herawan, Othman, & Sinnadurai, 2011). Higher STAI-Trait scores indicate higher anxiety levels. The theoretical range of scores is 20 to 80 with 20 indicating very low levels of anxiety and 80 indicating very high levels of anxiety. A score of 41 has been suggested as a threshold to determine whether someone can be considered “anxious.”

Paffenbarger Physical Activity Questionnaire

The Paffenbarger Physical Activity Questionnaire, also referred to as the as the Harvard Alumni Questionnaire, asks respondents the number of city blocks they walk per day and how many flights of stairs they climb in addition to the number of hours of vigorous, moderate, and light activity they complete per week. The vigorous activity question of the Paffenbarger regarding intensity of activity (vigorous activity [gardening, strenuous sports, jogging, chopping wood, heavy carpentry, bicycling on hills, etc.] hours per weekday and hours per weekend day) has been significantly associated with objectively measured physical activity and health and fitness measures, and is an adequate tool to profile habitual physical activity (Simpson et al., 2011). The Paffenbarger has eight

questions total and some of the questions have follow-up questions contingent on the answer to the initial question.

Treatment strategies for AN

Treatment goals

The American Psychiatric Association (APA) guidelines specify that the first goal of AN treatment is weight restoration: “The goals of nutritional rehabilitation for seriously underweight patients are to restore weight, normalize eating patterns, achieve normal perceptions of hunger and satiety, and correct biological and psychological sequelae of malnutrition” (Yager et al., 2010). After weight gain is achieved to ensure that the patient is not in immediate danger of cachexia, treatment can begin to focus on repairing the patient’s relationship with food. Once these goals are met individuals are able to direct their treatment regimen toward improving psychological health, including psychopathology and anxiety. Recovery times vary by individual depending on the severity of the condition and success of the chosen treatment strategy (Marzola et al., 2013).

Family-based treatment

Family-based treatment has been shown by some studies to be the most effective for treating anorexic children and adolescents, its forerunner being the “Maudsley approach.” Family-based treatment, including the Maudsley approach, allows parents to help restore their child’s weight to a healthy level, allow their child to retake control

over their eating when they have reached a healthy weight and the treatment team decides it is appropriate, and support normal growth and development. This growth and development may include addressing mental health including anxiety, mood disturbances, and any obsessive or compulsive traits (Starr & Kreipe, 2014). This type of therapy is most useful in the short term for individuals with AN who reside at home with both parents in the household in order to promote weight gain and reframe the relationship with food, while long-term solutions may include further psychological treatment and follow-up visits with the treatment team. Family-based approaches are tailored to meet the need of each individual patient and family (Fisher, Hetrick, & Rushford, 2010).

Treatment programs

In addition to family treatment strategies, there are both inpatient and outpatient treatment options for patients. Preliminary findings have suggested that outpatient programs that are less restrictive in terms of patient autonomy over food choices and overall independence create better outcomes for recovery (Madden, 2015). Programs that start patients at 30-40 calories per kilogram per day and increase that amount to 70-100 calories per kilogram per day can help patients gain 1-1.5 kilograms per week during weight restoration (Marzola et al., 2013). Treatment can present many challenges including mental health complications and comorbid gastrointestinal (GI) symptoms. The GI symptoms can be a preexisting condition, arise as a result of AN, or come about as a side effect of refeeding and further complicate weight recovery as the patient returns to a less restrictive diet (Mascolo, Geer, Feuerstein, & Mehler, 2017). In

addition to general GI symptoms, preliminary findings have suggested an association between celiac disease and AN diagnosis (Mårild et al., 2017).

Mental health and AN in athletes

Expectations of athletes

Elite athletes with AN often experience additional risk factors compared to the general AN population which must be considered when studying their AN and treating it appropriately. While some studies have shown that participation in athletics protects against development of eating disorders (DiBartolo & Shaffer, 2002; Levine & Smolak, 2016), others have concluded that such participation places individuals at risk for developing eating disorders (Holm-Denoma, Scaringi, Gordon, Van Orden, & Joiner Jr., 2009; Sundgot-Borgen & Torstveit, 2004). Several traits have been implicated that are related to what constitutes a "good athlete" and are also commonly seen in individuals with AN. These characteristics include mental toughness and self-control, commitment to training and exercise programs, perfectionism, excessive compliance and willingness to obey, selflessness, and continuing with tasks or exercise despite pain or discomfort (Forsberg & Lock, 2006).

Self-esteem and stress

In elite athletes, low self-esteem has been associated with several behaviors and attitudes related to disordered eating (Engel et al., 2003; Tylka, Russell, & Neal, 2015). It has been well documented that "competitive thinness," social comparison of weight

and performance, is highly prevalent among athletic populations, demonstrating the far-reaching debilitating effects of this comparative and competitive mentality (Plateau, 2014). Athletes have reported that their teammates and opponents are one of the main sources of stress and pressure related to body image and weight (Filaire, Rouveix, Pannafieux, & Ferrand, 2007). In addition to teammates, verbal abuse from coaches related to shape or performance can contribute to the onset of eating disorders (Stirling & Kerr, 2009).

Athlete eating psychopathology

Eating psychopathology in individuals with AN goes beyond a normal level of concern related to weight and shape, reaching a point where weight and shape are the primary if not sole criterion for judging self-worth (Fairburn & Brownell, 2005). Elevated levels of eating psychopathology related to insecure attachment styles with parents including anxious and avoidant styles have been demonstrated among athletes (Shanmugam, Jowett, & Meyer, 2012). Insecure attachment styles are associated with externalizing behavior and secondary coping processes to manage stress and deal with change in the general population (Fearon, Lapsley, Bakersman-Kranenburg, van Ijzendoorn, & Roisman, 2010).

Anxiety and self-confidence

Athletes striving for perfection experience a positive correlation with anxiety and a negative correlation with their self-confidence (Hamidi & Besharat, 2010). Additionally, athletes who experience negative reactions to imperfection have heightened anxiety

levels (Stoeber, Otto, Pescheck, Becker, & Stoll, 2007). It has been shown that youth athletes have higher anxiety levels when there is a high level of parental pressure to succeed in their sport (Schwebel, Smith, & Smoll, 2016).

Treatment obstacles for athletes

Specific recovery obstacles for athletes have been identified as negative emotions and cognitions related to weight gain, pressure to return to their sports, and hurtful eating pattern modeling from teammates and coaches. Athletes have reported that the most helpful components of their treatment process have been supportive relationships, positive cognitive and emotional shifts, and decreased concerns related to athletic performance (Arthur-Cameselle et al., 2018). Dancers, cross country runners, and swimmers are particularly susceptible to athletics-related eating disorder issues, including the Female Athlete Triad. Low energy availability caused by insufficient caloric intake to maintain body weight given an individual's athletic load can cause menstrual function to become irregular or cease and can cause impaired skeletal health (Nattiv et al., 2011).

Exercise as a recovery tool

While regular exercise is usually implicated as a negative or obsessive part of life for AN individuals, exercise and physical therapy can be used to restore body image confidence in patients. Excessive exercise is never recommended as part of treatment, but a focus on the mind-body connection, particularly breathing patterns, can help patients restore a sense of self and refocus on exercise in a non-compulsive way (Kolnes, 2017). In order

to improve psychopathology among AN patients who exercise, patients need to experience reductions in exercise dependence and use of exercise for negative affect regulation (Bratland-Sanda, Sundgot-Borgen, Rosenvinge, & Hoffart, 2010). Negative affect regulation is sometimes achieved through self-harm, and excessive exercise can be viewed as self-injurious (Bratland-Sanda et al., 2010). Compulsive exercise is moderately associated with poorer quality of life among patients with eating disorders (Young et al., 2018).

Limitations of previous research

Most previous research has been conducted among professional female athletes as opposed to athletes who are not elite and people who exercise frequently but may lack the connotation of being an "athlete" if exercise is done alone. There has also been little research on the most beneficial role of exercise as part of treatment programs and recovery for the AN population as a whole. Assessing anxiety levels surrounding patients' ability and drive to exercise is also important so that treatment can be tailored accordingly for some patients. There is a plethora of research on eating disorders and also on exercise, but the intersection of these topics with respect to psychopathology and anxiety has yet to be fully explored. Athletes with disordered eating have been shown to have worse psychopathology outcomes compared to healthy controls, but there has yet to be a comparative study of the psychopathology of the effect of exercise on the AN population (van Niekerk & Card, 2018). A number of questions regarding

differences in anorexic exercisers vs. anorexic nonexercisers remain unanswered, specifically the psychopathology and anxiety levels in these two populations. The purpose of this research is to help address this knowledge gap and provide direction for future clinical research studies and new or adjusted public health interventions.

Thesis aims

The aims of this thesis are:

1. To assess if there is a significant difference in the eating psychopathology of anorexic exercisers compared to anorexic nonexercisers as measured by the EDE-Q

   Hypothesis: Anorexic exercisers will have better eating psychopathology (lower EDE-Q scores) outcomes than anorexic nonexercisers.
2. To assess whether anorexic exercisers have significantly higher EDE-Q scores as number of hours of exercise per week increase.

   Hypothesis: Anorexic exercisers will report higher EDE-Q scores as the number of hours of exercise per week increase.
3. To investigate whether anorexic exercisers are more anxious compared to anorexic nonexercisers as measured by the STAI-Trait exam.

   Hypothesis: Anorexic exercisers will report lower scores on the STAI-Trait exam than nonexercisers, indicating lower levels of anxiety.

Methods

Study Design and Datasets

This thesis is a secondary analysis of data gathered from previous studies of females with AN cited below. The thesis was conducted in partnership with the Neuroendocrine Unit at Massachusetts General Hospital (MGH). Data are from four clinical research studies conducted at the Neuroendocrine Unit investigating AN that examined different variables and treatments. All studies were conducted at the Neuroendocrine facilities at MGH including the Translational and Clinical Research Center at the Boston campus and the Martinos Center for Biomedical Imaging at the Charlestown campus.

The studies comprising the data set are 842: Neurobiology of Appetite Regulation in Anorexia Nervosa (n=36) that examined leptin, ghrelin, and peptide YY in fasting and postprandial time periods, 914: Hormonal Factors in the Treatment of Anorexia Nervosa (n=118) that investigated testosterone treatment, 831: Physiology and Role of Appetite Regulating and Stress Hormones in the Etiology of Anorexia Nervosa (n=164) that analyzed saliva samples and genetics, and 730: Determinants of Endocrine Function Across the Weight Spectrum (n=320) that examined various hormones in populations of varying body weight and eating disorder status. Inclusion criteria for all of these studies included an AN diagnosis. The data from these studies were collected at Massachusetts General Hospital between the years of 2005 and 2018. Data files of results were obtained with permission from each of the four studies, and all patient identifiers were removed before merging the files using JMP (a statistical software) with the variables of interest for this study. None of the four parent studies examined exercise status related

to psychopathology or anxiety in their analysis. The combined dataset was exported from JMP format to SAS format and analyzed in SPSS 25 at the Tufts Data Lab.

Measures

Eating Disorders Examination Questionnaire (EDE-Q)

A copy of the EDE-Q can be found in Appendix C1. All study participants completed the EDE-Q at their first baseline visit or main study visit.

Spielberger State-Trait Anxiety Inventory (STAI-Trait)

A copy of the STAI-Trait can be found in Appendix C2. Of the 102 participants, 52 had STAI-Trait data. This questionnaire was completed at the patient's first baseline visit or main study visit depending on the structure of the study.

Paffenbarger Physical Activity Questionnaire/Case Report Form Exercise Question

Number of hours of exercise per week was obtained from the Paffenbarger questionnaire for two of the parent studies (730 and 914). Numbers of hours exercised was asked in the main visit CRF for the other two studies (831 and 842). This information was gathered at the first baseline visit or the main study visit depending on the study protocol. A copy of the Paffenbarger can be found in Appendix C3. The Paffenbarger was administered as a written questionnaire and the CRF question was administered verbally to participants.

Data analysis

Data analysis was conducted using IBM SPSS 25® (Corp., 2017). Files were converted from .jmp to .sas to .sav format. Patients were excluded if they lacked complete records of relevant variables and AN status. Participant status as an exerciser or nonexerciser was categorized based on the number of hours exercised per week, "exercisers" exercised for five or more hours per week while "nonexercisers" exercised for fewer than five hours per week (Peñas-Lledó et al., 2002). SPSS output can be found in Appendix B. Exercise data was gathered from Paffenbarger questionnaires and statements in CRFs about the number of hours per week participants exercised and equated in the dataset.

Normality tests were conducted to examine distributions for the EDE-Q, STAI-Trait, and hours of exercise per week (Paffenbarger/CRF) data. One-way ANOVAs were run to adjust for age and BMI. Age and BMI were controlled for in ANOVAs using the EDE-Q due to previous findings of correlation with EDE-Q scores (Rø, Reas, & Rosenvinge, 2012).

Human subjects statement

The thesis author was added to the protocols for the four studies used in this analysis, and the Partners Institutional Review Board (IRB) approved the amendments to the studies that allowed the author to access the protocols and data from the studies for the purposes of secondary analysis. The dataset was completely de-identified before analysis and the author completed Collaborative Institutional Training Initiative (CITI) trainings for Social and Behavioral Research, Good Clinical Practice, Responsible Conduct

of Research, and Biomedical Research Investigators and Key Personnel. Due to previous IRB approval from Partners, this thesis was exempted from review by the Tufts IRB.

Results

Characteristics of study participants

The final sample for this study was comprised of 102 participants with EDE-Q and exercise data and 52 with STAI-Trait data. Participants self-identified as female and the mean age of study participants was 25.7 (SD: 8.03. range: 14-53), and the mean BMI was 18.01 (SD: 1.84, range: 14.1-22.7). 92.2% of the sample identified as White, 3.9% as Asian, 0.9% as Black, 0.9% as Hispanic, and 2.0% as more than one race. 59 participants were classified as exercisers, reporting 5 or more hours of weekly exercise and 43 were classified as nonexercisers. Table 1 in Appendix A provides this information in table format.

Participant selection

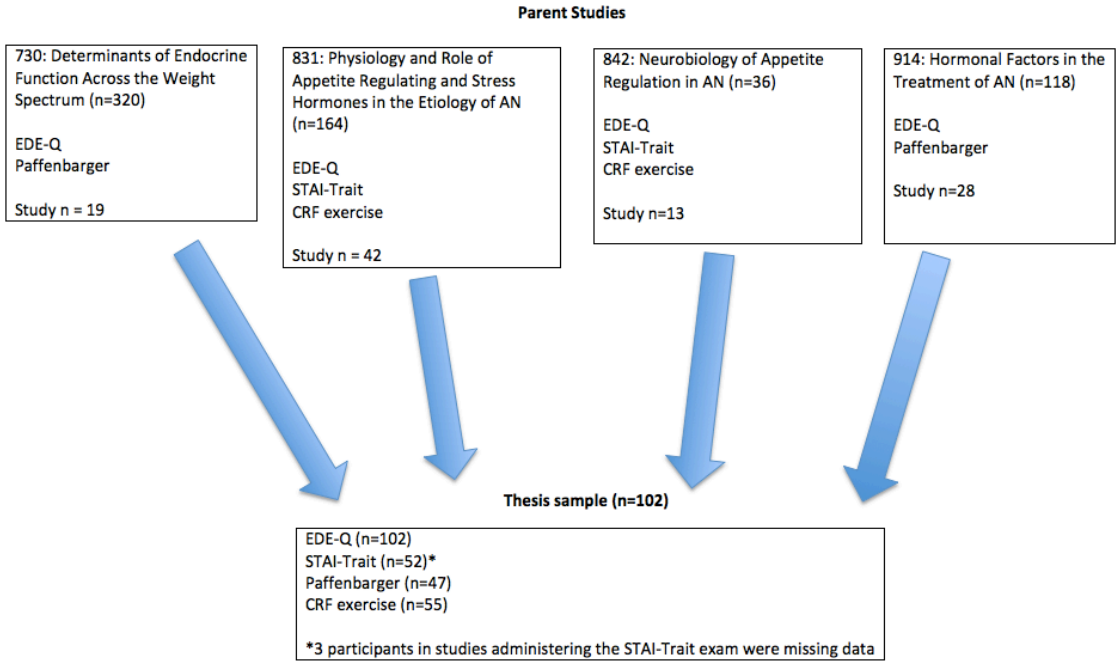

Figure 5: Flowchart of participant selection for study sample

EDE-Q scores between groups

The mean EDE-Q global score for nonexercisers was 3.54 (SD 1.46, range: 0.44-5.49) and 3.26 (SD 1.44, range: 0.09-5.38) for exercisers. The one-way ANOVA conducted for EDE-Q global scores between exercisers and nonexercisers was not significant ($F=0.895$, $p=0.346$).

EDE-Q Global Score among exercisers

Among patients with AN who exercised, there was a significant ($p<0.05$) difference in EDE-Q global scores, which increased as the number of hours exercised per week (examined as a continuous variable) increased as determined by one-way ANOVA ($F = 3.305$, $p =0.004$). Hours of exercise per week ranged from 5 to 30 and n=59. This

indicates that there is a positive relationship among anorexic exercisers between the number of hours exercised per week and EDE-Q global scores.

STAI-Trait scores between groups

The mean STAI-Trait score among nonexercisers was 55.48 (SD 2.545, range: 50.49-60.47) and for exercisers the mean was 50.18 (SD 2.087, range: 46.09-54.27). The effect size was 0.439 and the one-way ANOVA conducted for STAI-Trait scores between exercisers and nonexercisers was significant (F=3.199, p=0.002).

Discussion

Purpose of study

This study was conducted to better understand the effects of exercise on anxiety for the population with AN and provide direction for future clinical research and inform public health recommendations. These findings support the hypotheses that female anorexic exercisers have lower anxiety levels compared to their nonexerciser counterparts at diagnosis and that psychopathology scores are positively associated with the number of hours of exercise per week among exercisers. There was no significant difference found between the two groups for psychopathology scores. Exercisers had lower levels of anxiety, although increased exercise was associated with the severity of an individual's psychopathology as measured by the EDE-Q. The fact that exercisers and nonexercisers do not report any difference in EDE-Q global scores suggests that psychopathology is not related to exerciser status, and that exercisers and nonexercisers perceive their

eating disorders with similar severity. Excessive exercise may be detrimental in terms of the severity of AN psychopathology among afflicted individuals and should be further investigated in order to understand the links between exercise, AN psychopathology, and anxiety and the role of exercise in AN recovery.

Implications for clinicians

In order to evaluate the effect of exercise on patients with AN, it is important to examine exercise behaviors in different time frames related to the diagnosis to understand if exercise behaviors have changed and potentially contributed to the onset of AN. Clinicians need to understand how the patient uses exercise as an emotional regulation strategy when considering treatments for AN, and how exercise will be incorporated as part of the patient's recovery process to maximize treatment outcomes. As this study found, EDE-Q scores are positively associated with the number of hours of exercise per week among exercisers so setting a weekly hour limit for patients who exercise during recovery may be helpful. Additionally, allowing patients to maintain an agreed upon level of weekly exercise while simultaneously teaching them new emotional regulation strategies may help to set them up for a healthier relationship with exercise long-term (Cook, 2018). The new coping mechanisms can improve recovery times and success rates for treatment (Harrington et al., 2015).

Implications for coaches of female athletes

In order to identify early signs of disordered eating behavior among female athletes, coaches need to receive training to help them recognize symptoms of disordered eating

and engage with the athlete appropriately, provide support as the athlete seeks treatment, and understand how best to reintegrate the individual into sports, if she returns to her sport. Organizations including the Young Adult Abuse Prevention Program and the National Eating Disorders Association (NEDA) have recommendations on how to best coach female athletes, including de-emphasizing weight as a performance factor and promoting positive body image (NEDA, n.d.; Young Adult Abuse Prevention Program, n.d.). Many of these organizations have also created a toolkit for early identification of eating disorders including not participating in team meals and exercising excessively outside of regular sports practice. Most research to date has been anecdotal but trials are underway to evaluate the effectiveness of eating disorder education and prevention programs for athletes. Nationwide adoption of such programs and recommendations may prevent the development of full-fledged eating disorders and provide coaches with resources to best serve their athletes. This study points to the need for coaches to understand anxiety surrounding exercise and create a positive athletic environment.

Implications for families

Involvement of parents is crucial in the treatment and recovery processes, particularly if the patient lives at home or has remained on a parent's health insurance policy (Rosling, Salonen Ros, & Swenne, 2016). Creating a supportive environment for the patient to receive treatment and return to more normal eating and exercise habits with positive role modeling is essential. Athletes will require additional support as they take a break from their sport then reintroduce it into their lives as recovery progresses. Support can

be given to a patient recovering both in person if the patient is living in a family environment and at a distance digitally, financially, and emotionally. Patients who enrolled in digital family-based treatment were successful in gaining weight to increase their BMI and in reducing their EDE-Q global scores (Anderson, Byrne, Crosby, & Le Grange, 2017). This study suggests that AN patients need emotional regulation strategies distinct from exercise and families can assist with this by deemphasizing value placed on exercise and providing support when AN patients are trying new strategies to find what works best for them.

Implications for public health practice

Implications for public health practice include making recommendations on how exercise is used in AN recovery programs in terms of quantity, particularly compared to the amount of exercise patients were doing prior to seeking treatment. It is easiest to control the amount of exercise done in the inpatient environment, but recommendations and limits can also be set for patients participating in outpatient treatment settings. Tracking exercise presents challenges because exercise logs and motion tracking devices such as FitBits to monitor exercise habits have been shown to increase eating disorder symptoms (Simpson & Mazzeo, 2017). Patients who exercise for a particularly high number of hours per week may need special attention and more resources for emotional regulation strategies such as distress tolerance, reality acceptance, and mindfulness (Aldao, Nolen-hoeksema, & Schweizer, 2014).

The role of social media should also be considered, as it has been demonstrated that the number of social media sites visited daily is a significant predictor of body dissatisfaction among collegiate women (Bennett et al., 2019). Public health campaigns could focus on body positivity, and mindfulness about eating could also be promoted through public health. Social media campaigns and focus groups can help achieve the dissemination of these concepts. Anxiety assessments such as the STAI-Trait and treatments need to become more widely available, and access to mental health resources including therapists needs to increase. This study has shown that exercise is an important factor to consider due to its association with psychopathology and anxiety outcomes, and should be incorporated into recommendations.

Implications for patients

For the individual patient, several studies have suggested that meditation and mindfulness programs can help athletes reduce anxiety levels, improve mental attitude, and increase mindfulness scores. These programs may also be helpful in order to reframe the relationship patients who exercise have with physical activity (Baltzell & Akhtar, 2014; Heckman, 2018). Athletes also report feeling more equipped to handle emotional reactions to situations presented to them after completing mindfulness programs. Mindfulness can also increase sports performance, and is more impactful if frames a way that encourage patients to improve their mental health related to exercise as opposed to helping them perform at a high level. Exercising with the explicit goal of burning calories or as compensation for perceived overeating is not a healthy perspective, and changing this mindset is an essential part of recovery (Heckman, 2018).

Patients need to understand that exercise can have many positive effects in their lives from lower anxiety levels to mood regulation, but also need to establish as healthy a relationship as possible with their bodies and exercise.

Implications for research

This study is a start in examining the relationship between exercise and anxiety in patients with AN but there is a need for further exploration of this topic. In clinical research, a study controlling for other variables such as food intake could examine mental health outcomes in groups exercising five or more hours per week and fewer than five hours per week. Exercise could also be examined as a continuous variable to allow study participants more flexibility with their exercise habits and not make patients feel compelled to exercise. The type of exercise (cardio, weightlifting, team sports, etc.) may also be important in evaluating what is detrimental and beneficial for patients in recovery. It would also be prudent to investigate the differences between team sports and individual exercise, and if being on a team creates more pressure in terms of weight and shape.

Developing or improving an interview-style questionnaire that can be used to identify excessive and compulsive exercise habits among patients with AN is crucial for collecting more data on this topic to better understand and treat this condition. The Compulsive Exercise Test (CET) is currently used, but is a self-reported measure of exercise (Meyer et al., 2016). The CET should be refined and used consistently in the clinical setting to assess exercise habits among patients with a diagnosis of AN.

Limitations of this thesis

This thesis has several limitations that must be acknowledged. Due both to the nature of the clinical visits, which don't always allow for completion of all questionnaires due to time constraints, and because each study examined different variables, not all of the participants from the parent studies had data available for each measure examined in this analysis, notably 50 participants did not have STAI-Trait data. This study utilized a complete case method for EDE-Q and exercise data and an incomplete case method for STAI-Trait analysis. Participants selected for this analysis needed to have complete and correct data, which greatly reduced the study sample size limiting the power to detect differences between the exerciser and nonexerciser populations.

Another limitation was that exercise levels were reported using two different measures. 730 and 914 used the Paffenbarger questionnaire, where self-reported hours of vigorous exercise per week are used to determine the number of hours exercised per week. In 831 and 842 exercise data was gathered with a question on the case report form (CRF) where study participants were asked how many hours per week they exercised. Both questions were phrased similarly and had the same response metrics (hours per week). However, the Paffenbarger is more reputed and widely used than the CRF exercise question.

The interpretation of the EDE-Q and STAI-Trait measures is limited as they are self-reported questionnaires. An interview questionnaire with a trained clinician would likely

produce more accurate answers than a self-report questionnaire despite the potential for interviewer bias due to the cognitive burden placed on the respondent for a self-report questionnaire and control over the order of questions imposed by the interviewer (Bowling, 2005).

Conclusions

Exercise is a heavily implicated negative factor for AN and other eating disorders, but these findings demonstrate that five hours or more of exercise each week is associated with reduced anxiety levels among individuals with AN. However, psychopathology scores increased as the number of hours of exercise per week increased, so it would be important to consider both of these findings in making a recommendation about the ideal range of exercise hours on a weekly basis. Finding an amount that would benefit the patients without causing detriment to their psychopathology is necessary and individuals will respond differently to distinct levels of exercise depending on their previous habits. The questions of starting an exercise program while in recovery and how changing an exercise regimen during the recovery process might affect psychopathology and anxiety remain to be addressed. While there are existing evidence-based treatments, there is still much research that remains to be conducted on the link between exercise and anorexia. These findings provide direction for future investigation into the effect of exercise on patients with AN. Relationships with exercise are complex and multi-faceted, and understanding more of how exercise is related to

AN will help inform treatment decisions and protocols for patients to achieve optimal recovery goals.

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Appendix A: Tables

Table 1: Characteristics of study participants

Characteristics of study participants (N = 102)	
Characteristic	**N %**
Age (mean = 25.7, SD: 8.03)	
14-19	15 (14.7)
20-29	66 (64.7)
30-39	14 (13.7)
40-49	5 (4.9)
50-58	2 (2)
BMI (mean = 18.01, SD: 1.84)	
14-15.9	6 (5.9)
16-17.9	43 (42.2)
18-19.9	50 (49)
20+	3 (2.9)
Race/ethnicity	
White	94 (92.2)
Asian	4 (3.9)
Black	1 (.9)
Hispanic	1 (.9)
More than one race	2 (2)

Appendix B: SPSS Output

Table 2: EDEQ Global Scores for study participants (n=102) between exercisers and nonexercisers

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Nonexercisers	43	3.538	1.464	.223	3.088	3.989	.44	5.49
Exercisers	59	3.263	1.443	.188	2.887	3.639	.09	5.38
Total	102	3.379	1.451	.144	3.094	3.664	.09	5.49

Table 3: One-way ANOVA for EDE-Q Global Scores between exercisers and nonexercisers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.887	1	1.887	.895	.346
Within Groups	210.758	100	2.108		
Total	212.645	101			

Table 4: One-way ANOVA for EDE-Q scores among exercisers compared to number of hours of exercise per week

	Sum of squares	df	Mean square	F	Sig.
Between groups	1548.316	51	30.359	3.305	.004
Within groups	165.339	18	9.185		
Total	1713.655				

Table 5: STAI-Trait scores for study participants (n=52) between exercisers and nonexercisers

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Nonexercisers	25	55.48	12.725	2.545	50.49	60.47	28	71
Exercisers	27	50.18	10.847	2.087	46.09	54.27	35	77
Total	52	52.68	12.064	1.673	49.4	55.96	28	77

Table 6: One-way ANOVA for STAI-Trait between exercisers and nonexercisers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.874	25	.395	3.199	.002
Within Groups	3.333	27	.123		
Total	13.208	52			

Appendix C: Study questionnaires

1. Eating Disorders Examination-Questionnaire (EDE-Q)

EATING QUESTIONNAIRE

Instructions: The following questions are concerned with the past four weeks (28 days) only. Please read each question carefully. Please answer all the questions. Thank you.

Questions 1 to 12: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days) only.

	On how many of the past 28 days …..	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
1	Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
2	Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?	0	1	2	3	4	5	6
3	Have you tried to exclude from your diet any foods that you like in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
4	Have you tried to follow definite rules regarding your eating (for example, a calorie limit) in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
5	Have you had a definite desire to have an empty stomach with the aim of influencing your shape or weight?	0	1	2	3	4	5	6
6	Have you had a definite desire to have a totally flat stomach?	0	1	2	3	4	5	6
7	Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
8	Has thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
9	Have you had a definite fear of losing control over eating?	0	1	2	3	4	5	6
10	Have you had a definite fear that you might gain weight?	0	1	2	3	4	5	6
11	Have you felt fat?	0	1	2	3	4	5	6
12	Have you had a strong desire to lose weight?	0	1	2	3	4	5	6

Questions 13-18: Please fill in the appropriate number in the boxes on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past four weeks (28 days) .....

13 Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?	.....
14 ..... On how many of these times did you have a sense of having lost control over your eating (at the time that you were eating)?	.....
15 Over the past 28 days, on how many **DAYS** have such episodes of overeating occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?	.....
16 Over the past 28 days, how many times have you made yourself sick (vomit) as a means of controlling your shape or weight?	.....
17 Over the past 28 days, how many times have you taken laxatives as a means of controlling your shape or weight?	.....
18 Over the past 28 days, how many times have you exercised in a "driven" or "compulsive" way as a means of controlling your weight, shape or amount of fat, or to burn off calories?	.....

Questions 19 to 21: Please circle the appropriate number. Please note that for these questions the term "binge eating" means eating what others would regard as an unusually large amount of food for the circumstances, accompanied by a sense of having lost control over eating.

19 Over the past 28 days, on how many days have you eaten in secret (ie, furtively)? ..... Do not count episodes of binge eating	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
	0	1	2	3	4	5	6
20 On what proportion of the times that you have eaten have you felt guilty (felt that you've done wrong) because of its effect on your shape or weight? ..... Do not count episodes of binge eating	None of the times	A few of the times	Less than half	Half of the times	More than half	Most of the time	Every time
	0	1	2	3	4	5	6
21 Over the past 28 days, how concerned have you been about other people seeing you eat? ..... Do not count episodes of binge eating	Not at all		Slightly		Moderately		Markedly
	0	1	2	3	4	5	6

Questions 22 to 28: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days).

	Over the past 28 days …..	**Not at all**		**Slightly**		**Moderate -ly**		**Markedly**
22	Has your weight influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
23	Has your shape influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
24	How much would it have upset you if you had been asked to weigh yourself once a week (no more, or less, often) for the next four weeks?	0	1	2	3	4	5	6
25	How dissatisfied have you been with your weight?	0	1	2	3	4	5	6
26	How dissatisfied have you been with your shape?	0	1	2	3	4	5	6
27	How uncomfortable have you felt seeing your body (for example, seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower)?	0	1	2	3	4	5	6
28	How uncomfortable have you felt about others seeing your shape or figure (for example, in communal changing rooms, when swimming, or wearing tight clothes)?	0	1	2	3	4	5	6

What is your weight at present? (Please give your best estimate.) ……

What is your height? (Please give your best estimate.) ……

If female: Over the past three-to-four months have you missed any menstrual periods? ……

If so, how many? ……

Have you been taking the "pill"? ……

THANK YOU

2. Spielberger State-Trait Anxiety Inventory (STAI-Trait)

Trait Anxiety Form

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that doesn't really matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

3. Paffenbarger Questionnaire

Paffenbarger Questionnaire: Physical Activity and Social data

Name: **Date:** **SPID/Visit:**

1. How many flights of stairs do you climb each day? (1 flight = 10 steps)

2. How many city block or their equivalents do you walk each day? (12 blocks = 1 mile)

3. At least once a week, do you engage in any regular activities such as brisk walking, jogging, bicycling, etc., long enough to break a sweat?

YES No

If yes, how many times per week?

If yes, name the type of activity:

On a usual weekday and weekend day during the past week, how much time did you spead on the following activities? (the total hours for each day should add up to 24 hrs)

	Weekday (hrs/day)	Weekend (hrs/day)	Entire Week (total hrs)
4. Sleeping			
5. Vigorous activity (gardening, strenuous sports, jogging, chopping wood, heavy carpentry, bicycling on hills, etc.)			
6. Moderate activity (housework, light sports, walking, yardwork, lawn mowing, painting, repairing, light carpentry, bicycling, etc.)			
7. Light acitivity (sitting, office work, eating, driving a car, personal care, etc.)			
TOTAL	0	0	0

8. Do you currently smoke?

NO Yes

If yes, check all that apply: how many per day?

cigarettes
cigarillos
cigars
pipe

How long have you smoked? _____