THE EFFECTIVENESS OF THE FEMALE ATHLETE TRIAD COMPONENTS IN IDENTIFYING COLLEGIATE ATHLETES AT POTENTIAL RISK OF LONG-TERM HEALTH CONSEQUENCES

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Over the last thirty years, especially after the passage of Title IX legislation in 1972, the opportunity for females to participate in athletics increased dramatically.[1] Participation in athletics is a positive experience for females providing improved physical fitness, enhanced self-esteem, and better physical and mental health for most individuals.[2,3,4] However, for some, the desire for athletic success combined with the pressure to reach a desired body weight can become overpowering to a female athlete and cause serious health implications.[5] Research on the effects of excessive exercise on female athletes increased to investigate three distinct, yet interrelated disorders frequently affecting female athletes involved in sports emphasizing a lean physique: disordered eating, amenorrhea, and osteoporosis now known as the female athlete triad. [1,2,5,6,7,8,9] The American College of Sports Medicine (ACSM) published a position statement in 1997 stating that the female athlete triad is a serious syndrome consisting of: disordered eating, amenorrhea, and osteoporosis.[5] A new position stand was published in 2007 stating the female athlete triad "refers to interrelationships among energy availability, menstrual function, and bone mineral density, which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and osteoporosis."[10] It is generally accepted the development of the female athlete triad follows a typical pattern.[2,6] The

female athlete believes that a lower body weight enhance performance; therefore, she restricts her diet.[2,3,5,6,11-13] This energy restriction predisposes the female athlete to menstrual dysfunction and consequent decreased bone mineral density. [2,3,5,6,11-13] In addition, literature suggests disordered eating is associated with menstrual dysfunction,[1,6,12,14-17] menstrual dysfunction is associated with low bone mineral density,[1,6,18-22] and disordered eating is associated independently with low bone mineral density.[1,6,23-25]

Disordered eating and clinical eating disorders are terms frequently used interchangeably.[26] However, each demonstrates distinct differences.[26] Disordered eating is a broad term used to describe a spectrum of abnormal and harmful eating behaviors used in an attempt to lose weight.[26,27] Clinical eating disorders refers to anorexia nervosa, bulimia, nervosa and eating disorder not otherwise specified (EDNOS).[26] These are clinically diagnosable conditions found in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR).[28] Any individual must meet the strict criteria of anorexia nervosa, bulimia nervosa, and EDNOS according to the DSM-IV-TR in order to be clinically diagnosed with an eating disorder.[26] Disordered eating is more prevalent than clinical eating disorders in female athletes.[6,8,29-32] One prevalence study indicated, only 5% of the female athletes had been diagnosed with a clinical eating disorder and over 50% were using disordered eating practices.[29] Disordered eating alone is harmful to the female athlete.[2,6] Literature suggests even minor disordered eating behaviors can lead to menstrual irregularities in female athletes.[2,6,7,8,27,29,33,34]

The existing literature proposes menstrual dysfunction is interrelated with disordered eating due to the body, continued functioning in an energy deficient state.[2,6,7,8,27,29,33,34] When the body has a low amount of energy due to lack of dietary intake, it naturally ceases menstruation in order to conserve energy.[1,2,8,33,34,35] The ACSM's position stand on the female athlete triad refers to menstrual dysfunction as a spectrum ranging from eumenorrhea to amenorrhea.[10] However, this updated statement mainly refers to the end of the spectrum, amenorrhea, as the main diagnosis component of the female athlete triad.[7,10] Prevalence studies show oligomenorrhea, or abnormal menses, is more common in female athletes rather than amenorrhea.[7,30,33] Regardless of which menstrual dysfunction an athlete suffers from, even slight menstrual irregularities pose serious health consequences, specifically decreased bone mineral density, which cause an increased risk of stress fractures and premature osteoporosis.[2,6,10,7,35]

The ACSM refers to a spectrum of bone mineral density ranging from optimal bone health to osteoporosis.[10] However, osteoporosis is used as the final diagnosis for the female athlete triad.[1,7,10] Literature suggests the more menstrual cycles missed, bone mineral density begins to decline.[10] Any amount of bone loss is detrimental to a female athlete.[7] This decrease in bone mineral density may not be reversible and increases the risk for stress fractures.[7] Prevalence studies indicate that osteoporosis is not as common in female athletes as is osteopenia or an athlete being at risk for low bone health.[2,6,7,36,37] One study reported 17% of the participants in their study were classified as having osteopenia and only 2% classified as having osteoporosis.[7]

Statement of the Problem

The female athlete triad is a series of disorders posing serious health consequences on the female athlete. Each component of the triad involves a spectrum of severity; however, the current female athlete triad components focus only on the extreme end points of the disorders.[1,2,7] When a female athlete develops the full-blown triad, many of the effects are irreversible and are potentially fatal.[2,7] Few female athletes develop the full-blown female athlete triad according to the strict criteria of the components.[2,6,7] Many suffer from disordered eating and menstrual dysfunction which lead to increase risk of injury and potential irreversible bone density loss.[2,6,7,33] This is significant for the female athlete, from a health and performance perspective. Any occurrence of the components, no matter the severity, is compromising and poses serious life-long health consequences that are potentially irreversible.[2]

The female athlete triad should provide early identification of female athletes at risk of the components to enhance the health advantages gained through participating in athletics.[7] However, the current components of the female athlete triad require strict criteria for female athletes to be identified and be considered at risk.[7] As the current components stand, many female athletes with disordered eating and menstrual dysfunction would not be considered as having the female athlete triad and would be overlooked for intervention.[7] The current female athlete triad components do not properly identify all female athletes who are at risk for health decrements.[7] A new model needs to be developed that includes a more encompassing approach to the female athlete triad.[7]

Purpose of the Study

The purpose of the study is to examine the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for potential future health decrements.

Hypothesis

This research study will be performed to determine if the current components of the female athlete triad are effective in identifying female athletes at risk for potential future health decrements. This research study will utilize a purposive sample with a descriptive no control design. Participants will be assessed using the Female Athlete Screening Tool and the Student Athlete Questionnaire.

Null Hypothesis: There is no difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements.

Alternative Hypothesis: There is a difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements.

Definition of Terms

The terms utilized in this research study are identified and defined below.

Amenorrhea: the absence of menstrual cycles lasting more than three months.[10]

Anorexia Nervosa: a clinical eating disorder characterized by extreme body image distortion and self-starvation. One must meet the diagnostic criteria described in the DSM-IV-TR.[26]

Bone mineral density (BMD): the relative weight of bone substance compared with a reference standard. The heft of the skeleton. BMD is reduced in osteoporosis, and the reduction in skeletal mass predisposes patients to fractures.[38]

Bulimia Nervosa: a clinical eating disorder characterized by repeated cycles of bingeing and purging (at least twice a week for a period of at least three months). One must meet the diagnostic criteria described in the DSM-IV-TR.[26]

Clinical Eating Disorders: anorexia nervosa, bulimia nervosa, and eating disorder not otherwise specified—recognized in the American Psychological Association Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR).[26]

Disordered Eating: the spectrum of abnormal and harmful eating behaviors that are used in a misguided attempt to lose weight or maintain a lower-than-normal body weight.[26]

Eating Disorder Not Otherwise Specified (EDNOS): a clinical eating disorder used to describe a condition that meets some but not all of the criteria for anorexia nervosa and bulimia nervosa. One must meet the diagnostic criteria described in the DSM-IV-TR.[26]

Energy Availability: the amount of dietary energy remaining for all other physiological functions after energy has been expended in exercise training.[2,10]

Eumenorrhea: normal menses cycles—specifically menstrual cycles at intervals near the median interval for young adult women. In young adult women menstrual cycles recur at a median of 28 days that varies with a standard deviation of 7 days.[10]

Female Athlete Triad: refers to relationships among energy availability, menstrual function, and bone mineral density which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and osteoporosis.[10]

Menstrual Dysfunction: spectrum of menstrual irregularities ranging from eumenorrhea to amenorrhea.[2]

Oligomenorrhea: irregular menses—specifically menstrual cycles at intervals longer than 35 days between menstrual cycles, fewer than 6 menstrual cycles in 6 months, and/or fewer than 12 menstrual cycles in 12 months.[10]

Osteopenia: any decrease in the amount of bone tissue, regardless of the cause, increasing the risk of fracture.[38]

Osteoporosis: a skeletal disorder characterized by loss of bone mass predisposing a person to an increased risk of fracture.[10]

Primary Amenorrhea: the absence of menstruation by the age of 15 years old in a female with secondary sex characteristics.[10]

Secondary Amenorrhea: the absence of menstruation that occurs after menarche missing three or more consecutive menstrual cycles.[2]

Subclinical Disordered Eating: a disorder that involves considerable eating pathology and body weight concerns but no significant psychopathology or one that fails to meet the DSM-IV-TR diagnostic criteria for a clinical eating disorder.[26]

Limitations

The potential limitations of this study include the following:

1. Participant may not have an adequate understanding of disordered eating.
2. Participant may not have adequate knowledge of a healthy diet.

3. Participants may not be aware of healthy training regimens.

Delimitations

The potential delimitations of this research study include the following:

1. The participant population in this research study is mainly Caucasian females ages 18-25 which do not represent other populations.
2. The participant population in this research study is from a Division I midwestern university cross country, track and field team which does not represent the general population of female athletes among various sports.
3. The participant population are division I student athletes and results cannot be generalized to elite or recreational athletes.
4. This research study will utilize a purposive sample with a descriptive no control design. Results cannot be generalized to the general female athlete population, because there was no random sampling.

Assumptions of the Research Study

The assumptions of this research study include the following:

1. The instruments utilized in this study, Female Athlete Screening Tool and Student Athlete Questionnaire, are valid and reliable in measuring the desired variables.
2. The research participants will answer all questions on the Female Athlete Screening Tool and the Student Athlete Questionnaire honestly and accurately.
3. Participants meet the inclusion criteria.
4. Participants will not complete questionnaires for another participant.

Summary

Females participating competively in athletics increased dramatically over the last thirty years.[1] Female participation in sports can be beneficial to an individual; however, the desire to be successful can be overpowering to a female athlete causing serious health implications.[5] The female athlete triad is a series of interrelated disorders—clinical eating disorders, amenorrhea, and osteoporosis.[10] Each of these components of the triad has a spectrum of seriousness and a female athlete having one or more of the components of the triad can pose serious health consequences that potentially are irreversible.[2]

The number of female athletes meeting the strict criteria of the current female athlete triad components is relatively low.[2,6,7] Many female athletes suffer from milder forms of the components—disordered eating and menstrual dysfunction which may manifest into increased amount of injuries and an irreversible decrease in bone mineral density.[6,7,33] These female athletes would be overlooked by the current criteria of the female athlete triad; however, suffer potentially irreversible health consequences as well.[7] Therefore, researchers are questioning the effectiveness in the current female athlete triad components in identifying female athletes at risk for health decrements.[7]

CHAPTER II

REVIEW OF LITERATURE

History of the Female Athlete Triad

The passing of Title IX legislation in 1972 brought an increase of females participating in athletics at a competitive level.[1,2] Due to this, research on the effects of excessive exercise on females' health has increased dramatically.[6-9] In 1992, the term "female athlete triad" was first developed in order to explain the negative health consequences commonly being seen in female athletes at the time.[1,2,5-8] This led to the development of the American College of Sports Medicine's (ACSM) position statement of the female athlete triad in 1997 stating the female athlete triad has three components: disordered eating, amenorrhea, and osteoporosis.[5] This position statement summarized all three components as being interrelated and may result in serious health implications for female athletes.[5] After the position statement was released, research was conducted and published regarding the prevalence of the triad. It was brought to the ACSM's attention a new position statement was needed. The American College of Sports Medicine released a new position statement on the female athlete triad referring, "to the interrelationships among energy availability, menstrual function, and bone mineral density, which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and osteoporosis."[10]

The Female Athlete Triad

Each of the components is serious when developed individually; however, when in combination with each other the effects may potentially be fatal.[7] Development of the female athlete triad has a negative effect on performance, increased risk for injury, increased risk of chronic disease, and the risk of developing psychological disorders.[1,10,39] Acute effects of the triad include increased risk for fracture and increase in soft tissue injuries, decreased performance in the sport, anxiety, dehydration, and anemia.[10,39] Chronic effects of the triad pose more serious consequences such as heart disease, gastrointestinal issues, infertility, and even death.[1,10,34,39] The female athlete triad poses serious health consequences in the female athlete and is typically more prevalent among certain sports, especially sports emphasizing a lean physique.[30]

According to the ACSM, there are some sports at greater risk than others for developing one or more components of the female athlete triad. These include:[8]

1. Sports in which performance is subjectively scored (dance, figure skating, gymnastics)
2. Endurance sports favoring participants who have a low body weight (distance running, cycling, and cross-country skiing)
3. Sports in which body contour-revealing clothing is worn for competition (volleyball, swimming, diving, and running)
4. Sports using weight categories for participation (wrestling, horse racing, martial arts, and rowing)
5. Sports in which prepubertal body habits favors success (figure skating, gymnastics, and diving)

It is generally accepted development of the female athlete triad follows a typical pattern: the female athlete believes that a lower body weight will improve her performance; therefore, she will begin to restrict her diet using behaviors that are extremely unhealthy.[2,6] The energy restriction and weight control behaviors then lead her to have menstrual dysfunction and proceeding decreased bone mineral density.[2,3,5,6,11-13] This theory shows the triad components are interrelated, in that having one disorder is linked to the others.[2,6] For example, disordered eating has been associated with menstrual dysfunction,[1,6,12,14-17] menstrual dysfunction has been associated with low bone mineral density,[1,6,18-22] and disordered eating has been independently associated with low bone mineral density.[1,6,23-25,27,40]

The Prevalence of the Female Athlete Triad

Several studies have been conducted to investigate the prevalence of the components independently and associated together.[2,6,7,29,33] In a study conducted by Beals and Hill, the purpose of the study was to examine the prevalence of disordered eating, menstrual dysfunction, and low bone mineral density among 112 US collegiate athletes.[6] Only three athletes met the criteria for all three disorders of the triad.[6] Ten athletes met the criteria for two disorders of the triad, one with a combination of disordered eating and low bone mineral density and nine with a combination of disordered eating and menstrual dysfunction.[6] In another study conducted by Nichols et al examined the prevalence of the female athlete triad disorders among 170 high school athletes.[41] Only two athletes met the criteria for all three components of the triad; however, ten girls met the criteria for two components of the triad. 18.2%, 23.5%, and 21.8% met the criteria for disordered eating, menstrual dysfunction, and low bone mineral density, respectively.

These prevalence studies show the number of female athletes developing all three disorders of the triad simultaneously is relatively small.[6,7,41] However, from a health and performance perspective, any occurrence of the components, no matter how small, deserves attention and treatment to prevent the complete triad from occurring.[2] The prevalence of disordered eating and menstrual dysfunction in female athletes is substantial which warrants concern.[1,2,6,7,29,30,33] If not treated, more athletes may eventually suffer from irreversible low bone density.[1,2,7,27,28,40]

Disordered Eating

Disordered eating is typically the first component of the triad to develop, and if not treated properly the athlete can develop more serious consequences with menstrual irregularity and impaired bone health.[2,3,5-8,10,42] The terms disordered eating and eating disorders are frequently, yet mistakenly, used interchangeably.[26] Disordered eating is a broad term used to describe a spectrum of abnormal and harmful eating behaviors that are used as a misguided attempt to lose weight or maintain an unhealthy body weight.[26,27,43,44] This term is used when an athlete is using restrictive eating behaviors; however, do not necessarily reach the level of a clinical eating disorder.[14,33] Conversely, an eating disorder refers to anorexia nervosa, bulimia nervosa, or eating disorder not otherwise specified (EDNOS).[26] These are clinically diagnosable conditions found in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR).[28] To be clinically diagnosed with one of the three eating disorders, one must meet the criteria described in the DSM-IV-TR.[26,28]

The Clinical Eating Disorders

The ACSM defines eating disorders as "a clinical mental disorder defined by

DSM-IV-TR and characterized by abnormal eating behaviors, an irrational fear of gaining weight, and false beliefs about eating, weight, and shape."[10] Athletes suffering from clinical eating disorders go beyond simply being dissatisfied with body weight and often use more extreme measures than abnormal eating patterns and weight control behaviors.[26] Clinical eating disorders are characterized by severe disturbances in eating behavior and body image.[26] Typically when a female athlete has a clinical eating disorder there are psychiatric conditions involved as well.[26] Many suffer from obsessive-compulsive disorder, depression, or anxiety disorder.[26] In addition, the individual may belong to a dysfunctional family, a history of physical or emotional abuse, severe feelings of worthlessness and insecurity, and/or difficulty displaying emotions.[26]

A*norexia Nervosa*

Female athletes displaying characteristics of anorexia nervosa have extreme body image distortion and practice self-starvation.[26] The individual is typically always hungry; however, denies hunger. Individuals with anorexia nervosa are typically goal-oriented and perfectionists; however, also suffer from low self-esteem.[26] A person having anorexia nervosa contains a desire to control everything such as; feelings, food, and weight.[26] This obsession with control and desire to be thin hinders the individual's ability to handle stress and creates a fear of gaining weight and in turn, will spend their days obsessing around not eating and compulsively exercising to lose weight.[26] Typically, no matter how much weight is lost, the individual always suffers through a sense of feeling fat and needing to lose more weight.[26] Table 1 outlines the diagnostic criteria for anorexia nervosa outlined by the DSM-IV-TR.

Table 1

Diagnostic Criteria for Anorexia Nervosa

1. Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g. weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).
2. Intense fear of gaining weight or becoming fat, even though underweight.
3. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.
4. In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g., estrogen administration.)

Source: American Psychiatric Association: Diagnostic Criteria from DSM-IV. Washington, DC, 2000, pp 589.[28]

Bulimia Nervosa

Individuals with bulimia nervosa strive to lose weight and have a drive for thinness; however, they lack the self-control and give in to their hunger.[26] They are typically out-going and self-assured; however, secretly have feelings of worthlessness and low self-esteem.[26] Bulimia nervosa is a clinical eating disorder characterized by repeated cycles of excessive food intakes at one time (binging) followed by episodes of attempting to get rid of the food (purging) usually by self-induced vomiting, laxatives, or excessive exercise.[26] After binging, the individual becomes overwhelmed with a sense of feeling ashamed, which leads to a purging episode providing physiological and psychological relief to him/her.[26] Table 2 outlines the diagnostic criteria of bulimia

nervosa outlined by the DSM-IV. Although menstrual dysfunction is not a diagnostic criterion for bulimia nervosa, it is still very common in bulimic athletes.[26] It is thought to be due to the energy drain and physiological stress elicited by binge-purge cycles.[26]

Table 2

Diagnostic Criteria for Bulimia Nervosa

1. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following: a) eating, in a discrete period of time (e.g., within any 2 hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances; b) a sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating)
2. Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise.
3. The binge eating and inappropriate compensatory behaviors both occur, on average, at least twice a week for 3 months.
4. Self-evaluation is unduly influenced by body shape and weight.
5. The disturbance does not occur exclusively during episodes of Anorexia Nervosa.

Source: American Psychiatric Association: Diagnostic Criteria from DSM-IV. Washington, DC, 2000, pp594.[28]

Eating Disorder Not Otherwise Specified

Eating Disorder Not Otherwise Specified (EDNOS) describes conditions meeting some but not all of the criteria for anorexia nervosa and bulimia nervosa.[26] EDNOS is

used to identify individuals who use unhealthy choices to lose weight that still cause serious consequences if left untreated. Table 3 outlines the diagnostic criteria for EDNOS outlined by the DSM-IV.

Table 3

Diagnostic Criteria for Eating Disorder Not Otherwise Specified

1. For females, all of the criteria for Anorexia Nervosa are met except that the individual has regular menses.
2. All of the criteria for Anorexia Nervosa are met except that, despite significant weight loss, the individual's current weight is in the normal range.
3. All of the criteria for Bulimia Nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur at a frequency of less than twice a week or for a duration of less than 3 months.
4. The regular use of inappropriate compensatory behavior by an individual of normal body weight after eating small amounts of food (e.g., self-induced vomiting after the consumption of two cookies).
5. An individual repeatedly chews and spits out, but does not swallow, large amounts of food.

Source: American Psychiatric Association: Diagnostic Criteria from DSM-IV. Washington, DC, 2000, pp594.[28]

Subclinical Disordered Eating

The term subclinical disordered eating has been used to describe considerable eating pathology and body weight concerns in individuals who do not show significant psychopathological issues seen with clinical eating disorders or who fail to meet the strict

diagnostic criteria for anorexia nervosa, bulimia nervosa, and EDNOS outlined in the DSM-IV-TR.[26] In addition, the ACSM defines disordered eating as "various abnormal eating behaviors, including restrictive eating, fasting, frequently skipped meals, diet pills, laxatives, diuretics, enemas, overeating, binge-eating and then purging."[10] Female athletes with subclinical eating disorders will present with less extreme behavioral indicators and psychological symptoms. In addition, female athletes will use abnormal behaviors simply as a mean of enhancing performance by losing weight or failing to maintain adequate energy availability.[27] Female athletes have attributes making them competitors; however, increase the risk for disordered eating.[45,46] In addition to pressures in society for thinness, female athletes also bear the pressure of the sport's environment, contributing to the onset of disordered eating.[45,47] Whether or not the athlete meets all the diagnostic criteria for a clinical eating disorder should not be of concern, rather the extent of weight control behaviors affecting the athlete's physical and mental health is more important.[26] Any use of unhealthy weight control behaviors can be detrimental to an athlete's performance and health.[26,27] Also, in some cases, disordered eating can be fatal for female athletes.[27]

Consequences of Disordered Eating

Many athletes view excessive exercise and abnormal dieting behaviors as a way to improve performance; however, these practices are overwhelming to their bodies and decrease their athletic performance.[30] Any type of disordered eating behavior used can pose health and performance detriments.[2,26,27,30]

Effects of Disordered Eating on Health

There are serious health consequences as a result of athletes with disordered eating using various weight control behaviors (see Table 4).[2,26,27] These can include nutrient deficiencies, electrolyte imbalances, endocrine abnormalities, menstrual dysfunction, irreversible bone loss, and/or fatal damage to the cardiovascular, metabolic, immune, and gastrointestinal systems.[26]

Effects of Disordered Eating on Performance

Too often, a female athlete believes the result of disordered eating patterns will improve her performance.[26] In actuality, severe or rapid weight loss can be very detrimental to athletic performance.[26] Decreases in performance observed with energy restriction is due to nutrient deficiencies, fatigue, frequent illness, iron deficiency, frequent injuries, and/or reduced cardiovascular function.[26] Energy restriction deprive the body of the energy it needs to help the muscles, carbohydrates needed for glycogen replacement, proteins needed for tissue repair, and micronutrients needed for energy metabolism. Some of the physiological effects of severe or rapid weight loss and the potential impact of performance are listed in table 5.

The effects of disordered eating on performance vary greatly and primarily depend upon the severity and length the disordered behavior has been taking place.[2] Also, endurance sports, like running, are likely to be more negatively affected than athletes participating in sports with lower energy demands, like gymnastics.[2]

Table 4.

The Health Consequences of Various Weight Control Behaviors

Weight Control Behavior	Physiological Effects and Health Consequences
Fasting or Starvation	• Promotes loss of lean body mass, a decrease in metabolic rate, and reduction in bone mineral density. • Increases the risk of nutrient deficiencies. • Promotes glycogen depletion, resulting in poor exercise performance.
Diuretics	• Weight loss is primarily water, and any weight lost is quickly regained once is discontinued. • Dehydration and electrolyte imbalances are common and may disrupt thermoregulatory function and induce cardiac arrhythmia.
Laxatives or Enemas	• Weight loss is primarily water, and any weight lost is quickly regained once use is discontinued. • Dehydration and electrolyte imbalances, constipation, cathartic colon, and steatorrhea are common. • May be addictive, and the athlete can develop resistance, thus requiring larger and larger doses to produce the same effect.
Self-Induced Vomiting	• Largely ineffective in promoting weight loss. • Large body water losses can lead to dehydration and electrolyte imbalances. • Gastrointestinal problems, including esophagitis, esophageal perforation, and esophageal and stomach ulcers, are common. • May promote erosion of tooth enamel and increase the risk for dental caries. • Finger calluses and abrasions are often present.
Saunas	• Weight loss is primarily water, and any weight lost is quickly regained once fluids are replaced. • Dehydration and electrolyte imbalances are common and may disrupt thermoregulatory function and induce cardiac arrhythmia.
Excessive Exercise	• Increase risk of staleness, chronic fatigue, illness, overuse injuries, and menstrual dysfunction.

Adapted From: Beals, KA. *Disordered Eating Among Athletes A Comprehensive Guide for Health Professionals.* Champaign, IL: Human Kinetics; 2004:84-85.[26]

Table 5.

Effects of Severe Weight Loss on Performance

Physiological Effect	Effect on Performance
Glycogen depletion	• Premature muscular fatigue (muscle glycogen depletion) • Reduced mental capacity or psychological fatigue (liver glycogen depletion)
Increased lactate production	• Impaired buffering capacity • Premature muscular fatigue
Dehydration	• Impaired thermoregulation (increased risk of heat cramps, heat exhaustion, and heat stroke) • Impaired oxygen transport and nutrient exchange • Premature muscular fatigue
Loss of lean body mass	• Reduced muscular strength and endurance • Decreased anaerobic performance
Reduced cardiac output	• Decreased aerobic (endurance) capacity

Adapted From: Beals, KA. *Disordered Eating Among Athletes A Comprehensive Guide for Health Professionals.* Champaign, IL: Human Kinetics; 2004:84-85.[26]

Screening for Disordered Eating in Female Athletes

Every institution should establish a screening approach to recognize signs and symptoms of disordered eating, harmful weight loss behaviors, and predisposing risk factors associated with the development of disordered eating.[27,48,49] According to the National Athletic Trainers' Association (NATA) position statement on preventing, detecting, and managing disordered eating in athletes; screening for disordered eating is most effectively accomplished during the pre-participation examination by gathering a thorough medical history and a screening tool designed for identifying disordered eating in athletes.[27]

When choosing a screening tool to identify disordered eating in athletes, it is important to use one that has been designed and validated specifically for athletes.[27] Some of the most popular self-report questionnaires: Eating Disorder Inventory (EDI), Eating Disorders Examination (EDE-Q), and Eating Attitudes Test (EAT) are used to screen for characteristics of disordered eating in athletics.[27] However, these screening tools are not specifically tested for validity in athletic populations and may result in inaccurate results.[27] Validated self-report questionnaires are generally insensitive to the needs of the female athlete because the screening tools underestimate or overestimate eating pathology in athletes.[45] Disordered eating is underestimated by excessive exercise in the female athlete may not be the desire to maintain body weight but rather her desire to perform better.[45] Conversely, disordered eating is overestimated due to the female athlete's intense workout schedule and eating patterns may be essential for performance.[45] Therefore, a screening tool that is specifically designed and validated to identify disordered eating in female athletes is crucial.

The Female Athlete Screening Tool (FAST) is specifically designed for use in female athletes to identify disordered eating and accurately assess the reason for the female athlete engaging in abnormal exercise and eating behaviors.[45] It is a self-report 33-item questionnaire scored on a 4-point Likert scale. In pilot testing, FAST proved to have high internal consistency and was validated for use in female athletes.[45] FAST has been shown to be an accurate screening tool to identify disordered eating in female athletes.[45] In addition, the FAST is recommended for use by the NATA in their position statement as an accurate screening tool to identify disordered eating in female athletes.[27]

Prevalence of Disordered Eating in Athletics

Prevalence of clinical eating disorders is considerably low in athletics; however, there is a higher prevalence of disordered eating practices used by athletes that are subclinical in terms of diagnosis.[8] In addition, prevalence studies suggest that female athletes are at greater risk for developing disordered eating than are non-athletes of similar age.[8,45-47,50]

Previous studies have been conducted among female collegiate athletes reporting the prevalence of disordered eating among various sports. Johnson et al reported only 1.1% met the criteria for bulimia nervosa; however, more than one quarter of the participants reported using harmful eating behaviors to lose or maintain their body weight.[4] In another study conducted by Beals and Hill, only three of the athletes had previously been diagnosed with anorexia nervosa or bulimia nervosa. However, 20% of the athletes met the criteria for "disordered eating behaviors," reporting they were dissatisfied with their body shape or weight and used at least one harmful weight control behavior.[6] Lastly, a study conducted by Beals and Manore stated only about 5% of the participants were diagnosed with either anorexia nervosa or bulimia nervosa, whereas about 50% of the participants were classified as being "at risk" for disordered eating.[10] The studies previously mentioned examined female collegiate athletes among various sports. Several studies have been designed specifically to examine disordered eating in collegiate female runners.[30,31,33]

In a study conducted by Thompson, the researcher looked at the characteristics of the female athlete triad strictly in collegiate cross-country runners.[11] In a sample of 300 participants, 19.4% responded they perceived or had been told they had an eating

disorder.[11] The mean age for when the eating disorder began among this group was 15.76 years. Of these individuals, 26.3% stated they received treatment for eating disorders.[11]

In other previous studies focusing primarily on female runners, the researchers identified a range of 11.3% to 27.2% of runners scoring above concerning levels on the Eating Attitudes Test, warning that many of the runners have disordered eating behaviors.[31,51-53]

Energy availability is also an important issue when discussing disordered eating. It has been defined as "the amount of dietary energy remaining for all other physiologic functions after energy has been expended in exercise."[2] Low energy availability is due to an individual consuming too few calories necessary to cover additional energy demands needed from exercise.[2] Low energy availability often results from disordered eating; however, can occur in the absence of disordered eating.[2,34] In the absence of disordered eating, low energy availability is typically caused when an athlete unknowingly fails to meet exercise energy requirements because of time constraints, food availability issues, or lack of nutritional knowledge.[2] When there is low energy availability the body begins to restrain reproductive function and bone formation, which tends to restore the necessary energy balance; however, it impairs menstrual and reproductive function and skeletal health.[34,54,55] In addition, when energy availability is low, macronutrients and micronutrients are also low.[34,56,57] Reduced macronutrients, especially essential amino acids and fatty acids, decrease the body's ability to maintain bone health, maintain muscle mass, repair damaged tissue, and recover from injury.[34] Micronutrients are needed to maintain bone and muscle health, replace red blood cells, and provide co-factors for the energy-producing metabolic pathways.[34] It is well understood that when the body is in

a low energy availability state, it uses the energy used for menstrual function and bone formation to maintain its energy needs; however, the prevalence of energy availability in female athletes is difficult to measure.[2]

According to Beals and Meyer, to date there have been no published studies examining the prevalence of low energy availability among female athletes.[2] This type of research is currently difficult to conduct due to an inability to accurately assess energy intake and exercise energy expenditure.[2] Further, the authors state it is assumed most female athletes suffering from disordered eating are also experiencing low energy availability.[2] However, in a study conducted by Zanker and Swaine, they examined the relation between bone turnover, oestradiol, and energy balance in women distance runners, indicating that of the 33 distance runners who participated, 25 were calculated as being in an "energy deficit" state during the seven day assessment of energy balance.[32]

These prevalent studies indicate subclinical disordered eating behaviors are more common in athletics, especially female runners, than are diagnosed clinical eating disorders.[6,8,29,30,31,33] Even slight disordered eating behaviors, not just clinical eating disorders, pose serious health consequences, performance determinants, and can subsequently lead to other disorders of the female athlete triad.[2,6,10]

Menstrual Dysfunction

The next component of the female athlete triad that typically develops due to disordered eating is menstrual dysfunction.[2,3,5] Many female athletes have the misconception menstrual dysfunction helps their performance.[2] For some female athletes feel relief at the "break."[2] In addition, coaches simply ignore menstrual dysfunction, believing it is a natural result of the female athlete training hard.[2,26] In actuality,

menstrual dysfunction is a clear sign that the female athlete's health is being compromised.[2] The main health consequences of menstrual dysfunction include, but are not limited to, infertility and other reproductive problems, decreased immune function, an increase in cardiovascular risk factors, and decreased bone mineral density and consequentially a risk of premature osteoporosis.[2,5,58]

The ACSM's position on the female athlete triad refers to a spectrum of menstrual function ranging from eumenorrhea to amenorrhea.[10] This position tries to accurately depict more accurately the spectrum of menstrual irregularities that may harm the female athlete, including oligomenorrhea, primary amenorrhea, secondary amenorrhea, and amenorrhea.[2] However, this position stand really only focuses on amenorrhea as the main diagnostic component for the female athlete triad and fails to recognize any type of menstrual dysfunction may progress the female athlete into the triad.[2,6,7,10] A female athlete may or may not progress through menstrual irregularities before developing amenorrhea.[2,59] However, an athlete may experience menstrual disturbances for years without ever experiencing amenorrhea, which is just as harmful as amenorrhea is to the female athlete.[2,7,59,60] There are several different classifications of menstrual dysfunction. It is important to understand the different classifications of menstrual dysfunction, because any type of menstrual disturbance may be harmful to the female athlete.[2,6,7]

Eumenorrhea is defined as normal menses, specifically menstrual cycles recur at a median interval of 28 days with a standard deviation of 7 days.[10] Oligomenorrhea when translated literally means irregular menses.[10] It is also frequently described for diagnosis purposes as an excessive amount of time between cycles (greater than 35 days between

cycles).[2,7,8,10,34,61] Amenorrhea is an absence of the menstrual cycle.[1,2,7,8,10] Amenorrhea is typically subdivided into two categories: primary and secondary amenorrhea. Primary amenorrhea is the absence of menstruation by the age of 15 years old in a female with secondary sex characteristics.[2,10] Secondary amenorrhea is classified as amenorrhea occuring after menarche and for diagnosis purposes requires the absence of three or more consecutive menstrual cycles.[1,2,5,7,8,61,62] It is clearly understood that menstrual dysfunction may occur in a spectrum ranging from eumenorrhea to amenorrhea and how it relates to exercise; however, the specific etiology of menstrual dysfunction is unknown.[2,5,7,8]

Etiology of Menstrual Dysfunction in Female Athletes

Endocrine and neuroendocrine experts suggest menstrual dysfunction in female athletes is due to a disruption of pulsatile secrection of lutenizing hormone (LH) by the pituitary gland which in turn is caused by a secretion of gonadotropin-releasing hormone by the hypothalamus.[2,63,64] However, the specific etiology responsible for the cessation of secretions are unknown, although many theories have been proposed.[2,63,64]

The original theory developed to explain the etiology of menstrual dysfunction is low body weight, specifically low body fat, is the primary cause in female athletes.[2,8] However, recent research suggests neither body weight nor body fat composition varies significantly between amenorrheic and eumenorrheic female athletes.[2,9,33,35] The next theory is the exercise-stress hypothesis. This theorized stress put on the female's body during exercise activated the hypothalamic-pituitary-adrenal axis, which in turn disrupts the gonadotropin-releasing hormone pulse generator; therefore, resulting in menstrual dysfunction.[2,63]

The most recent theory, and most widely accepted, is the energy availability theory.[2,8,12,54,64] This theory, developed in a series of studies by Loucks et al states the female athlete who fails to provide sufficient calories to meet energy requirements her body needs may place her in a negative caloric state.[2,8,12,54,64] This low caloric intake results in decreased levels of lutenizing hormone (LH) altering menstruation.[2,8,12,54,64] Other studies have supported this theory that chronic energy deficit is the etiology of menstrual dysfunction. Menstruation requires a small amount of energy and when the female body is starving for energy, ceasing menstruation appears to be the body's adaptive energy-conserving mechanism.[1,12,14,16,32,33,62,65] Although, the exact etiology is unknown, literature suggests that menstrual dysfunction is prevalent in female athletes.

Prevalence of Menstrual Dysfunction in Athletics

The prevalence of menstrual dysfunction in female athletes is from 6% to 79%.[2,5,42,63] More specifically, menstrual dysfunction has been reported as high as 65% among female runners.[1] The wide range of prevalence percentages in female athletics can be explained by methodological differences among various studies attempting to measure menstrual dysfunction.[2] Some of the methodological differences include, but are not limited to, differences in athletic population studied (type of sport, level of sport), various definitions of menstrual dysfunction, and athletes underreporting the incidence of menstrual dysfunction.[2,30] Nonetheless, menstrual dysfunction is very high in female athletics, and prevalence depends on the type, intensity, and duration of exercise, especially in endurance sports like running where there is a focus on leanness, as well as the athlete's nutritional status.[42]

Currently, amenorrhea is the diagnostic component for the female athlete triad.[10] However, the prevalence of amenorrhea in female athletes is relatively small.[2,6,7,30,33] In addition, researchers discovered oligomenorrhea is more prevalent in female athletes than amenorrhea. [2,6,7,30,33] In a study conducted by Burrows et al of the 82 active females participating in the study only 2% were amenorrheic, whereas, 20% of the participants were classified as oligomenorrheic.[7] More specifically, a study designed to research menstrual dysfunction in female runners found of the 91 participants only 10% were classified as amenorrheic and 36% were classified as oligomenorrheic.[33]Another study researching menstrual dysfunction in female runners suggest of the 300 participants 5.3% were classified as amenorrheic and 17.7% were classified as oligomenorrheic.[30]

These prevalence studies suggest menstrual dysfunction is very common among female athletes, especially runners.[7,30,33] Amenorrhea is the most recognizable symptom of the female athlete triad. However, in these studies amenorrhea is significantly seen less than oligomenorrhoea.[2,6,7,30,33] Recent studies suggest even slight menstrual irregularities deviating from the average of 12 cycles per year produce an oestrogen-deficient environment enough to decrease bone remodeling and increase fracture risk.[7,35] In addition, Brunet reported slight disruptions in the menstrual cycle can produce effects similar to menopause, which decreases estrogen production.[8] This decrease in hormone production is shown to lead to decreased bone mineral density.[8,66] These finding are very significant. As the current female athlete triad components stand, women would be overlooked on this criterion. As a result, there is significant risk of hindering bone health and progressing to more severe menstrual dysfunctions.[7]

Bone Health

The third and final component of the female athlete triad is osteoporosis.[10] The ACSM defined osteoporosis as "a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced skeletal fragility and increased risk of fracture."[5,8] The most current ACSM position stand on the female athlete triad refers to a spectrum of bone mineral density (BMD) ranging from optimal bone health to osteoporosis.[10] However, this new position stand refers to the most extreme end of bone health, osteoporosis, as the final diagnostic component of the female athlete triad and does not take into account that the middle of the bone mineral density spectrum can pose serious health consequences to female athletes.[7]

Bone Remodeling and Etiology of Low Bone Mass in Athletes

Bone remodeling is a continuous process.[8,67] The bone is constantly being degraded and replenished.[8,67] This remodeling requires different cycles of bone resorption and formation.[8,67] Two different types of bone cells are responsible for the cycles of bone formation and resorption. Osteoblasts are cells responsible for bone formation during the remodeling phase.[8] Osteoclasts are responsible for bone resorption.[8] When BMD is decreasing, osteoclasts activity is greater than osteoblasts resulting in decreased BMD.[8] Osteoclasts mediate bone resorption by proteolytic digestion.[8] A long process follows where osteoblasts lay down new bone matrix.[8] However, for the matrix to become fully mineralized, several phases need to occur.[2] There are three primary factors that influence bone remodeling: a) hormonal status, b) dietary intake, and c) weight-bearing physical activity.[67] BMD is negatively impacted, when any of these primary factors are compromised.[67] For example, when hormonal status is compromised, BMD begins to

decrease. In addition, an energy deficit can also have an effect on bone remodeling, also compromising BMD.[55,67-69]

Estrogen has many important functions in the human body. With respect to bone health, estrogen has direct effects on osteoblasts and osteoclasts.[8] Osteoblasts and estrogen increase cell proliferation and proteins that alter bone remodeling.[8] Perhaps the most important function of estrogen related to bone health is estrogens inhibit cytokine production associated with osteoclast activity.[2,8,70] Cytokine inhibition in the female athlete induces accelerated bone resorption, thus resulting in low bone mineral density.[2,10]

In addition to a hypoestrogenic state playing a role in decreasing BMD, a direct effect through low energy availability is seen as a possible etiology of low BMD.[2,71] Research suggests female athletes, at risk for disordered eating, present with low BMD without having any type of menstrual dysfunction.[2,33,72] It is theorized that energy and nutrient deficit affects metabolic substrates and hormones. For example, insulin, growth hormone, insulin-like growth factor-1, cortisol, and thyroid hormone, all important in bone remodeling, separate from a hypoestrogenic state.[2,10,71]

Previous studies suggest moderate weight-bearing exercise increases bone density.[67] However, recent literature shows excessive exercise that is enough to start menstrual dysfunction and negative energy balances the positive effects of weight-bearing exercise is reduced and is associated with decreased BMD, even in weight bearing sites.[2,42] Exercise type, for example, impact versus non-impact, influences osteogenic response and can lead to either higher or lower values of bone mineral density at different sites.[37,73] Strength-based and high impact sports show to have higher bone

mineral density, whereas non-weight bearing sports have shown to have lower bone mineral density.[37]

Diagnosis of Low Bone Mineral Density in Athletes

Although a dual energy radiographic absortiometry (DXA) scans are the most reliable test to measure bone mineral density, there is a debate as to how to score premenopausal females in the diagnosis of low bone mineral density.[2] Further, in many cases and especially in an athletic setting, a DXA scan is not always available for the assessment of an athlete's bone health.[2,6] Therefore, Beals and Meyer stated "it is reasonable to assume, however, that an athlete's bone strength has suffered if she presents with amenorrhea for longer than 6 months or has experienced frequent phases of oligomenorrhea and possibly a stress fracture."[2] Also, certain risk factors are shown to be associated with low bone mineral density. These include: a family history of osteoporosis, diagnosis of scoliosis, history of stress fractures, and dairy product intake.[6,21,72,74,75] In addition, Nattiv stated that BMD declines as the number of missed menstrual cycles increase, and the loss of BMD may not be fully reversible.[10] Stress fractures occur more frequently in female athletes with menstrual irregularities and/or low BMD[10,76-78] with the risk for a stress fracture being two to four times greater in amenorrheic athletes versus eumenorrheic athletes.[10,76] Also, stress fractures occur when an athlete has nutritional deficits and low BMD.[10,62,79] Therefore, when a DXA scan is unavailable, it is reasonable to assume if an individual suffers from: disordered eating, menstrual dysfunction, a history of stress fractures, and/or has one or more of the associated risk factors, one's bone density is sacrificed.[2,6,21,72,74,75]

Prevalence of Low Bone Mineral Density in Female Athletes

The prevalence of low BMD and osteoporosis in athletes is difficult to measure because of the differences in diagnostic criteria used among various organizations.[2,6] The World Health Organization has a classification system for postmenopausal women. When using this classification, the prevalence of osteopenia in female athletes has been reported between 22% and 50%, with a low prevalence of osteoporosis.[2,36] However, considering the new International Society for Clinical Densitometry (ISCD) and International Olympic Committee (IOC) criteria, women with low T-scores or Z-scores would now be considered as having low BMD for their chronological age.[2] In a study conducted by Torstveit and Sundogt-Borgen, the researchers found that 10.7% had a BMD below the expected range for their age using the new criteria.[2,80] Nonetheless, research studies are discovering that osteopenia is more prevalent in female athletes than osteoporosis.[7]

In a study conducted by Beals and Hill, the researchers investigated the prevalence of low bone mineral density among 112 US collegiate athletes.[6] In this study the researchers found, none of the athletes met the classification for osteoporosis; however, eleven athletes could have been classified with low bone mineral density.[6] In addition, these researchers looked at factors that are associated risks for low bone mineral density. These factors include family history of osteoporosis, diagnosis of scoliosis, stress fracture prevalence, and dairy product intake.[6,21,72,74,75] Twelve athletes reported a family history of osteoporosis, three reported being diagnosed with scoliosis, twenty-one athletes reported suffering a stress fracture during their collegiate career, and fifty-one stated they consumed less than one serving of dairy products per day.[6] In a similar study, of the 82

active female participants, only 3% were classified as having osteoporosis.[7] Conversely, 24% were classified as having osteopenia.[7]

In another study conducted by Mudd et al. examined bone mineral density specifically in collegiate female athletes.[37] Between running and track there were 33 participants of the 99 total participants. This group demonstrated to have the lowest bone mineral density values than any other sport studied.[37] They exhibited the lowest total body bone mineral density, lumbar spine, and pelvis.[37] This finding was surprising to the authors considering running is a high-impact sport which would be expected to increase lower body bone mineral density.[37] However, this could have been due to these athletes having decreased calcium intake, menstrual disturbances, disordered eating, or not enough energy intake relative to energy expenditure.[37]

These prevalence studies show that the diagnosis of osteoporosis in female athletes is very rare.[2,6,7,37] However, diagnosis of osteopenia or low bone density in general is more common.[2,6,7,36] This is important because any loss of bone mineral density may not be completely reversed once menstruation is resumed or a healthy body weight is maintained.[40,81,82] This predisposes the female athlete to stress fractures, osteoporotic fractures later in life, and the associated increase in morbidity and mortality.[7,82]

New Components to the Female Athlete Triad

Research has questioned the accuracy of the current components of the female athlete triad in identifying athletes being at risk for the female athlete triad.[7,36] The strict criteria: eating disorders, amenorrhea, and osteoporosis does not allow early identification of females at risk.[7] In a literature review by Khan et al, examined the

prevalence of osteoporosis and osteopenia in female athletics, questioning if osteopenia should replace osteoporosis as the defining criteria for the female athlete triad.[36] Between all of the studies osteoporosis ranged from 0% to 13%, while osteopenia ranged from 1.4% to 50%.[36] This shows that osteoporosis can, and does occur in female athletes; however, requiring this condition as a diagnosis component in the female athlete triad relegates the syndrome to relative obscurity.[36] Further, if osteopenia was accepted as criteria for impaired bone health, the female athlete triad would have an increased prevalence thus more clinical relevance.[36]

In a study conducted by Burrows et al., the researchers examined the effectiveness of the current components of the female athlete triad (disordered eating, amenorrhea, and osteoporosis) in identifying all physically active females at risk of long-term health problems.[7] Eighty-two females who met the criteria participated and were given a questionnaire to assess osteoporosis risk, menstruation, and diet history.[7] A DXA scan was also performed on each participant. Participants were defined as fulfilling the current female athlete triad criteria if they were diagnosed with one or more of the following[7]:

1. Any of the disordered eating categories assessed according to the DSM-IV criteria.
2. Amenorrhea (0-3 cycles per year) according to the menstrual information taken from the menstrual questionnaires.
3. Osteoporosis based on T-scores at either the femoral neck (recalculated T-scores) or lumbar spine site, according to the NHANES III criteria (GE Lunar).

The results indicated only 5% fulfilled the criteria of amenorrhea, 15% fulfilled the criteria of disordered eating, and only 2% fulfilled the criteria of osteoporosis.[7] None of the participants fulfilled two of more of the current triad components.[7] However, 22% reported menstrual irregularities (oligomenorrhea or amenorrhea), 36% were diagnosed with an array of disordered eating practices, and 18% reported low bone health (osteopenia or osteoporosis).[7] None reported all three components together.[7] In conclusion, 55% of participants would have been identified "at risk" by using long-term health criteria.[7] Thus, the current triad criteria would have missed 33% of females who were at risk for long-term health problems.[7] This study's results showed that the current triad components do not identify all females at risk of long-term negative health problems.[7] In addition, with the criteria to be diagnosed with the current components of the triad being so strict, it does not warrant that having any one component of the triad can be detrimental to a female athlete and once the athlete is diagnosed with the full blown female athlete triad many of the affects on her health are irreversible at that point.[7] Therefore, this study suggested the triad components should change to identify females at risk using the terms disordered eating, exercise-related menstrual alterations, and osteopaenia.[7] If the components of the triad had more lenient criteria, diagnosis would be earlier and the affects would be early enough in the spectrum that could still be prevented and/or irreversible.[7]

Summary

Females participating competitively in athletics increased dramatically over the last thirty years. [2,6,8] Female participation in sports can be beneficial to an individual; however, the desire to be successful can be overpowering to a female athlete causing

serious health implications.[5] The female athlete triad is a series of interrelated disorders—clinical eating disorders, amenorrhea, and osteoporosis.[5] Each of these components of the triad has a spectrum of seriousness and a female athlete having one or more of the components of the triad can pose serious health consequences that potentially are irreversible.[2,7,81,82]

The female athlete triad should provide health care providers with guidelines to allow early identification of female athletes at risk to optimize health benefits gained from exercise.[7] However, the number of female athletes meeting the strict criteria of the current female athlete triad components is relatively low.[2,6,7] Many female athletes suffer from milder forms of the components—disordered eating and menstrual dysfunction which may manifest into increased amount of injuries and an irreversible decrease in bone mineral density.[6,7,33] These female athletes would be overlooked by the current criteria of the female athlete triad; however, suffer potentially irreversible health consequences as well.[7] Therefore, researchers are questioning the effectiveness in the current female athlete triad components in identifying female athletes at risk for health decrements.[7]

CHAPTER III

METHODOLOGY

Selection of Participants

Participants will be recruited from current members of a Division I midwestern university cross country, track and field team. The criteria for the participant to be included in the research study are: (1) must be a current NCAA Division I Student Athlete on the cross country, track and field team; (2) must be between the ages of 18-25; and (3) currently not pregnant.

Research Design

The research study will utilize a purposive sample with a descriptive no control design. Those who meet the inclusion criteria will be approached individually by the researcher, before or after practices, to ask her participation. The participant will be given an informed consent outlining how the study will be conducted and what will be asked of them. Once the participant has read the informed consent, she will be notified by completing the Female Athlete Screening Tool and Student-Athlete Questionnaire indicates her consent to participate. The athletes will complete the Female Athlete Screening Tool and the Student-Athlete Questionnaire upon agreement to the informed consent. The participant is done with the research once she has completed the questionnaires and nothing else will be asked of her.

Instruments

The Female Athlete Screening Tool is a self-report instrument used to identify disordered eating pathology in female athletes.[45] It is a 33-question screening tool developed to be sensitive to the unique needs of the female athlete.[45] Specifically, it was designed to assist in the identification of athletes: (1) who engage in excessive exercise for the purpose of weight loss, (2) who are perfectionists, (3) who have concerns with body size and shape, and (4) engage in abnormal eating behaviors.[45] This screening tool is scored on a 4-point Likert scale, ranging from one to four, the higher number the higher the probability of disordered eating behavior.[45] The overall total score is calculated and severity of disordered eating is based on the following classification system: (1) subclinical scores ranging from 77 to 94, and (2) clinical scores greater than 94.[45]

This is the first screening tool to accurately assess eating pathology in female athletes.[45] Reliability analysis indicated a high internal consistency of the screening tool showing a Cronbach's alpha as 0.87.[45] To demonstrate discriminant validity female athletes with disordered eating scored significantly higher on the Female Athlete Screening Tool than athletes without disordered eating and non-athletes with disordered eating ($p < 0.001$).[45] Correlation analysis showed the Female Athlete Screening Tool was strongly correlated to two previous disordered eating questionnaires, the Eating Disorder Examination-Questionnaire (0.60, $P < 0.05$) and Eating Disorder Inventory (0.89, $P < 0.001$).[45]

The Student-Athlete Questionnaire is designed to assess risk and prevalence for impaired bone health, menstrual dysfunction, nutritional concerns, and body

dissatisfaction concerns. This questionnaire was developed by the researcher derived from various Pre-Participation Questionnaires and an extensive review of the literature of pertinent questions used to asses disordered eating, menstrual dysfunction, and impaired bone health.[26]

Disordered Eating Measures

Disordered eating will be measured using the Female Athlete Screening Tool and the Student-Athlete Questionnaire under nutritional history and weight history. For the purpose of this research study, participants are classified as having a clinical eating disorder if their total score on the Female Athlete Screening Tool falls under the clinical range of >94,[45] and/or they meet they state they have current or previous history of anorexia nervosa, bulimia nervosa, or EDNOS. Participants will be considered at risk for or as having a subclinical eating disorder if their total score on the Female Athlete Screening Tool falls under the subclinical range of 77 to 94,[45] and/or the athletes report they are dissatisfied to very dissatisfied with their body weight, size, or shape and engage in at least one pathogenic weight control behavior.[6]

Menstrual Dysfunction Measure

Menstrual dysfunction will be measured using the menstrual history section in the Student-Athlete Questionnaire. Participants will be classified as having amenorrhea if they have missed 3 or more consecutive menstrual periods, which would be categorized under the diagnosis of the female athlete triad. Athletes are considered to be at risk for menstrual dysfunction if they have one of the following: (1) oligomenorrhea as greater than 35 days between periods, (2) have fewer than 12 cycles in the past 12 months, (3) fewer than 6 cycles in the past 6 months, (4) greater than 10 day variation in their cycle,

and (5) if they are taking birth control hormones in order to regulate their menstrual cycle.[6]

Bone Health Measure

Although a DXA scan is the most accurate test to analyze bone density, in many instances, as with this research study, a DXA scan was not available for assessment of an athlete's bone health.[2] Literature suggests, in cases where a DXA scan is not available, it is reasonable to assume an athlete's bone strength has suffered if she presents with any type of menstrual dysfunction and has a history of a stress fracture.[2] In addition, risk factors associated with low bone mineral density include a family history of osteoporosis, diagnosis of scoliosis, stress fracture prevalence, and dairy product intake below the recommended daily amount.[6,21,72,74,75]

For the purpose of this study, participants are considered to have low bone density if the athlete has a history of amenorrhea and a history of a stress fracture. In addition, the participant will be considered to have low bone density if they state they have previously been diagnosed with low bone density on the Student-Athlete Questionnaire. Participants are classified at risk for impaired bone health if they met any of the aforementioned risk factors associated with low bone mineral density and any menstrual dysfunction or subclinical disordered eating.

Data Collection

Each participant will be evaluated for their potential of being at risk for the female athlete triad components using the Female Athlete Screening Tool and the Student-Athlete Questionnaire. The screening tool and questionnaire will be administered by the principal investigator.

Handling of Data

Every effort will be made to ensure confidentiality of the participants in this research study. This study will be conducted anonymously; therefore, no names will be placed on any of the documents. The principal investigator will assign a random number to each of the packets, which include the informed consent, Female Athlete Screening Tool, and the Student-Athlete Questionnaire. The records containing the random numbers will be placed in a locked box immediately after completion of the packets. The locked box will be transported by the principal investigator to the thesis advisor's office where the packets will be kept in a locked cabinet. The locked cabinet will be located at Oklahoma State University in the thesis advisor's office. The principal investigator and thesis advisor will be the only individuals with access to the locked cabinet. The data will be entered and saved on the principle investigator's personal laptop. After completion of the data analysis the Female Athlete Screening Tool and the Student-Athlete Questionnaire will be shredded.

Analysis of Data

Disordered eating, menstrual dysfunction, and bone health data will be collated as percentages of participants having one or more of the components. It will be determined if the participants fall under the current components of the female athlete triad or if they are at risk for the female athlete triad and potential future health decrements.

Participants were defined as fulfilling the current female athlete triad criteria if they were diagnosed with all of the following:

1. Clinical disordered eating: state they currently have or previous history of anorexia nervosa, bulimia nervosa, or EDNOS and/or a total score on the Female Athlete Screening Tool falls under the clinical score of >94.[45]
2. Amenorrhea: as defined as 0-3 cycles per year, according to the menstrual information taken from the Student-Athlete Questionnaire. [1,2,5,7,8,61,62]
3. Osteoporosis: based on current or history of a stress fracture according to the musculoskeletal history taken from the Student-Athlete Questionnaire and a history of amenorrhea.[2]

Participants were defined as fulfilling the criteria for being at potential risk for future health decrements if they met one or more of the following:

1. Participants will be considered at risk for or as having a subclinical eating disorder if their total score on the Female Athlete Screening Tool falls under the subclinical range of 77 to 94,[45] and/or the athletes report that they are dissatisfied to very dissatisfied with their body weight, size, or shape and engage in at least one pathogenic weight control behavior according to the Student-Athlete Questionnaire.[2,26]
2. Participants were considered to be at risk for menstrual dysfunction if they had one or more of the following: (1) oligomenorrhea as greater than 35 days between periods, (2) have fewer than 12 cycles in the past 12 months, (3) fewer than 6 cycles in the past 6 months, (4) greater than 10 day variation in their cycle, and/or (5) if they are taking birth control hormones in order to regulate their menstrual cycle. [2,7,8,10,34,61]

3. Participants were considered to be at potential risk for low bone mineral density if they met one of the above criteria and met one of the risk factors associated with low bone mineral density a family history of osteoporosis, diagnosis of scoliosis, stress fracture prevalence, or dairy product intake below the recommended daily allowance.[2]

It will then be determined what percentage of female athletes would be overlooked by the current strict criteria female athlete triad components.

This research study will utilize a non-parametric statistic analysis utilizing the Statistical Package for the Social Sciences (SPSS) with a pre-determined alpha set at $P < (.05)$. The specific data analysis technique utilized will be a Mann-Whitney U Test on menstrual, dietary, and bone data to test for significant differences between menstrual dysfunction (menstrual dysfunction current standards versus menstrual dysfunction at risk), disordered eating (disordered eating current standards versus disordered eating at risk), and bone health (bone health current standards versus bone health at risk). The Mann-Whitney U Test will also be performed to test for significant differences between groups; disordered eating and menstrual dysfunction, disordered eating and bone health, and menstrual dysfunction and bone health.

CHAPTER IV

FINDINGS

Introduction

The purpose of this study was to determine if the current components of the female athlete triad are effective in identifying collegiate female athletes who are at potential risk of developing long-term health consequences. The null hypothesis was there is no difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements. The alternative hypothesis stated there is a difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements.

Participants who met the inclusion criteria of the study were asked to complete the Female Athlete Screening Tool (FAST) and the Student-Athlete Health Questionnaire. Various descriptive statistics were utilized from the instruments to determine if the participants met the current standards of the female athlete triad or if they were considered as being at risk of developing long-term health consequences.

Participant Profile and Demographics

A total of 25 participants completed the FAST and Student-Athlete Health Questionnaires. The subjects were all female and current members of a Division I midwestern university cross country, track and field team. All participants were between the ages of 18 and 23, with the average age being 19.68 years old.

There were 18 participants stated they were Caucasian (72%), 4 stated they were African American (16%) and 3 stated they were other (12%). Height of the participants ranged from 62 inches to 74 inches. Average height for the participants was 66.96 inches. Weight of the participants ranged from 109 pounds to 287 pounds. Average weight for the participants was 140.4 pounds. Participant demographics are summarized in Table 6.

Table 6.

Demographics of Participants

Demographic	**Participants N (%)**	**Mean**
Ethnicity:		
Caucasian	18 (72%)	
African American	4 (16%)	
Other	3 (12%)	
Age:		**19.68**
18	5 (20%)	
19	9 (36%)	
20	5 (20%)	
21	3 (12%)	
22	1 (4%)	
23	2 (8%)	
Height (in):		**66.96**
Weight (lbs):		**140.04**

Descriptive Statistics of the Components

Participants were defined as fulfilling the current female athlete triad criteria if they were diagnosed with all of the following:

1. Clinical disordered eating: state they currently have or previous history of anorexia nervosa, bulimia nervosa, or EDNOS and/or a total score on the Female Athlete Screening Tool falls under the clinical score of >94.
2. Amenorrhea: as defined as 0-3 cycles per year, according to the menstrual information taken from the Student-Athlete Questionnaire.
3. Osteoporosis: based on current or history of a stress fracture according to the musculoskeletal history taken from the Student-Athlete Questionnaire and a history of amenorrhea.

Participants were defined as fulfilling the criteria for being at risk for the female athlete triad if they met one or more of the following:

1. Participants will be considered at risk for or as having a subclinical eating disorder if their total score on the Female Athlete Screening Tool falls under the subclinical range of 77 to 94, and/or the athletes report that they are dissatisfied to very dissatisfied with their body weight, size, or shape and engage in at least one pathogenic weight control behavior according to the Student-Athlete Questionnaire.
2. Participants were considered to be at risk for menstrual dysfunction if they had one or more of the following: (1) oligomenorrhea as greater than 35 days between periods, (2) have fewer than 12 cycles in the past 12 months, (3) fewer than 6 cycles in the past 6 months, (4) greater than 10 day variation in their cycle, and/or

(5) if they are taking birth control hormones in order to regulate their menstrual cycle.

3. Participants were considered to be at potential risk for low bone mineral density if they met one of the above criteria and met one of the risk factors associated with low bone mineral density a family history of osteoporosis, stress fracture prevalence, or dairy product intake below the recommended daily allowance.

Table 7 reports the descriptive statistics of disordered eating current standards, disordered eating at risk, menstrual dysfunction current standards, menstrual dysfunction at risk, bone health current standards, and bone health at risk. The means closest to 2.00 represent those participants not having one of the components and the means closest to 1.00 represent those participants exhibiting one of the components.

Table 7.

Mean and Standard Deviation Scores

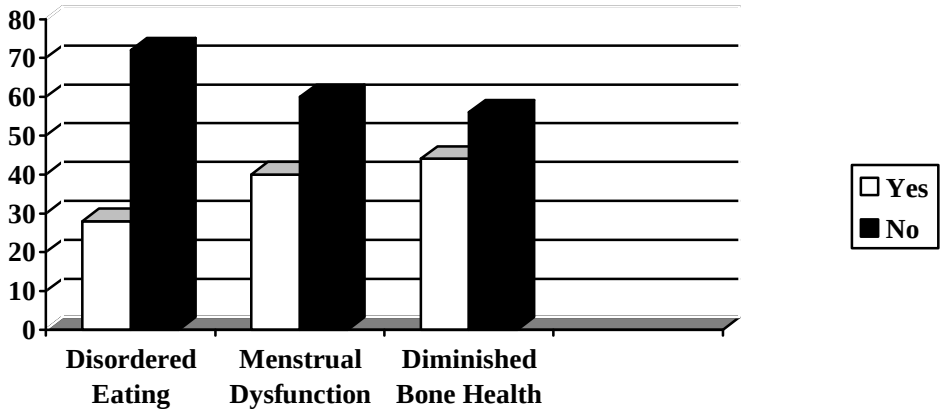
Components	**Mean**	**Standard Deviation**
Disordered Eating Current Standards	2.00	.000
Disordered Eating At Risk	1.72	.458
Menstrual Dysfunction Current Standards	2.00	.000
Menstrual Dysfunction At Risk	1.60	.500
Bone Health Current Standards	2.00	.000
Bone Health At Risk	1.56	.507

When the frequencies were analyzed it was suggested that none of the participants met any of the current standards of the female athlete triad components. Figure 1 shows

the frequencies of the participants who are at risk for disordered eating, menstrual dysfunction, and diminished bone health.

Figure 1.

Triad Individual Percentages



Female Athlete Triad

None of the participants met any of the current standards for the fully developed female athlete triad. The percentages of the individual at risk components are outlined in figure 1. There were 12 of the 25 participants (48%) meeting the criteria of being at risk for the female athlete triad. These findings are summarized in table 8. There were eight participants (32%) that were considered at risk for the female athlete triad by meeting two or more of the components. Of these eight, 2 participants (8%) were considered at risk for disordered eating and diminished bone health, 1 participant (4%) was considered at risk for disordered eating and menstrual dysfunction, and 5 participants (20%) were considered at risk for menstrual dysfunction and diminished bone health. The remaining four participants (14%) met the criteria of all three components as being at risk for the female athlete triad. Overall, 48% of the participants would be considered as being at risk

for the female athlete triad components and would be overlooked by the current standards of the female athlete triad.

Table 8.

Summary of Percentages of At Risk for Female Athlete Triad

Components At Risk	Number of Participants	Percentage
DE and MD	n = 1	4%
DE and BH	n = 2	8%
MD and BH	n = 5	20%
DE, MD, and BH	n = 4	14%

Note: n = 12, 48%
DE = Disordered Eating, MD = Menstrual Dysfunction, BH = Diminished Bone Health

Mann-Whitney U Comparisons Between Components

The Mann-Whitney U test was utilized to compare scores between the components of those at risk for disordered eating versus menstrual dysfunction, disordered eating versus bone health, and menstrual dysfunction versus bone health. The researcher set the significance level at $P \leq .05$. Disordered eating versus menstrual dysfunction showed no significance at $P \leq .375$, disordered eating versus bone health suggested no significance at $P \leq .243$, and menstrual dysfunction versus bone health indicated no significance at $P \leq .777$. Therefore, none of these comparisons suggested any statistical significance. A Mann-Whitney U test was not performed between the components of the current standards because no participant in this study met the current standards of the components.

Mann-Whitney U Comparisons Between the Current Standards and At Risk

The original research question is as follows: are the current female athlete triad components effective in identifying those female athletes who are at risk of long-term health consequences? The researcher utilized the Mann-Whitney U test to compare significances between each component of the triad; those meeting the current standards versus those who are at risk of the component. The significance level was set at $P \leq .05$. When comparing disordered eating current standards versus disordered eating at risk there was a suggested significance with a score of $P \leq .005$, menstrual dysfunction current standards versus menstrual dysfunction at risk showed a significance of $P \leq .001$, and bone health current standards versus bone health at risk showed a significance of $P \leq .001$. Each of these comparisons suggested statistical significance. When comparing those participants who met the current standards of the female athlete triad versus those participants at risk of the female athlete triad, the Mann-Whitney U test analyzed a significant difference at $P \leq .001$.

Conclusion

For participants in this research study, none met the current standards of the female athlete triad; whereas, twelve would be considered being at risk of the female athlete triad. The Mann-Whitney U tests performed, further indicates a suggested significance between those who met the criteria for being at risk for the female athlete triad and those meeting the current standards of the female athlete triad. For the hypothesis proposed, the current study rejects the null hypothesis and therefore will utilize the alternative hypothesis which suggests that there was a difference in the

effectiveness of the current female athlete triad components in identifying those female athletes at risk of long-term health consequences.

CHAPTER V

CONCLUSION

The focus of this study was to determine if the current components of the female athlete triad were effective in identifying female athletes at risk for long-term health consequences. The null hypothesis was there is no difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements. The alternative hypothesis stated, there is a difference in the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for health decrements.

Summary of the Study

Participants were recruited from Division I midwestern university cross country, track and field team. Participants meeting the inclusion criteria were approached individually to ask their participation in this study. Those agreeing to participate, completed the Female Athlete Screening Tool (FAST) and the Student-Athlete Health Questionnaire. From the information gathered from the two questionnaires, using criteria set by the researcher, it was determined whether the participant met the criteria for the current standards of the female athlete triad or was considered at risk for the female athlete triad.

This study had a total of 25 participants who completed both the FAST and the Student-Athlete Health Questionnaire. Each participant was a current member of

a Division I midwestern university cross country, track and field team. All participants were between the ages of 18 and 23 years old and none of the participants were pregnant at the time of participation in this study.

Non-parametric statistical analysis was used utilizing the Statistical Package for the Social Sciences (SPSS). Descriptive statistics and frequencies were gathered and reported from the data. The specific data analysis technique used was a Mann-Whitney U test with a pre-determined alpha $P \leq .05$. The Mann-Whitney U was used to compare scores between components for those at risk of: disordered eating versus menstrual dysfunction, disordered eating versus diminished bone health, and menstrual dysfunction versus diminished bone health. This test was also used to compare statistical significances between each component of the triad; those meeting the current standards versus those who are at risk of the component.

Discussion of Findings

Mann-Whitney U Comparison Between Components

A Mann-Whitney U test was used to compare scores of the participants scoring at risk for: disordered eating, menstrual dysfunction, and diminished bone health. The comparison of disordered eating versus menstrual dysfunction scored at $P \leq .375$. While a comparison of disordered eating and diminished bone health scored at $P \leq .243$. Lastly, menstrual dysfunction versus diminished bone health was at the level $P \leq .777$. These results suggest no statistical significance. These three findings refute previous literature that suggested the female athlete triad components are interrelated, in that having one disorder is linked to the others.[2,6] Further, previous research found disordered eating to be associated with menstrual dysfunction,[1,6,12,14-17] menstrual dysfunction is associated with

low bone mineral density,[1,6,18-22] and disordered eating is independently associated with low bone mineral density.[1,6,23-25,27,40] A potential reason why the current study yielded no significance was due to the small participant sample size. Previous research discovering this association between components had a range of 100-300 participants involved in the study; whereas, this research study had only 25 participants.[2,6] A larger sample size would potentially show a more reliable and/or valid association between components.

Percentages of the Components

The percentages of participants meeting the criteria for being at risk of disordered eating, menstrual dysfunction, and diminished bone health were outlined in figure 1. No participants in this study met the criteria for a clinical eating disorder. The percentage of participants who were at risk for disordered eating was 28%. This is consistent with previous literature indicating disordered eating behaviors are more common in female athletes than are diagnosed clinical eating disorders.[6,8,29,30,31,33] Specifically, in a study conducted by Beals and Hill, only three of athletes had previously been diagnosed with a clinical eating disorder; whereas, 20% of the participants met the criteria for "disordered eating behaviors."[6] Thus, the current study is consistent with previous literature. Disordered eating behaviors, rather than clinical eating disorders, are more common in female athletes. These harmful behaviors pose serious health and performance consequences on the female athlete.

The current study discovered, of the 25 participants, 28% were at risk for disordered eating. Previous studies looking at disordered eating specifically in runners, identified a range of 11.3% to 27.2% scoring above concerning levels on the Eating Attitudes Test.[31,51-53] In the current study, an increased percentage of participants at risk

for disordered eating was identified compared to previous studies discussed in the literature review. The increase could be due to the fact that the Female Athlete Screening Tool; which is specifically used for female athletes to identify disordered eating and to accurately assess the reason the female athlete engages in abnormal exercise and eating behaviors.[45] This is an interesting discovery because some of the most popular self-report questionnaires, like the Eating Attitudes Test used in previous research, are not specifically tested for validity in athletic populations and may result in invalid results.[27] This indicates when screening female athletes at risk for disordered eating behaviors it is important to use a screening tool specifically designed for female athletes.

Currently, amenorrhea is the diagnostic component for the female athlete triad.[10] The current female athlete triad components fails to recognize any type of menstrual dysfunction may progress the female athlete into the triad.[2,6,7,10] The current study suggests none of the participants met the criteria for the current standards of amenorrhea. However, 40% of the participants were considered at risk of menstrual dysfunction. This is consistent with the literature, specifically, Burrows et al. reported only 2% of participants were amenorrheic, whereas, 20% were classified as having any form of menstrual dysfunction.[7] In a study looking specifically at female runners only 10% were amenorrheic and 36% were classified as having any form of menstrual dysfunction.[33] In these previous studies, the prevalence of amenorrhea is significantly lower than menstrual dysfunction. The current study is consistent with previous literature suggesting menstrual dysfunction is more prevalent in female athletes, especially runners. This is an important discovery because as the current triad's inclusion criteria stands, females suffering from menstrual irregularities could potentially be overlooked for intervention. However, even

slight menstrual irregularities deviating from the average of 12 cycles per year produce an oestrogen-deficient environment large enough to decrease bone remodeling and increase the risk of fracture.[7,35] Therefore, female athletes with any type of menstrual dysfunction, not just amenorrhea, suffer serious health consequences.

The final component of the female athlete triad, osteoporosis, is used as the diagnostic component of the female athlete triad.[7,10] However, none of the participants in the current study met the current standards for osteoporosis. In actuality, 44% were discovered to be at risk for diminished bone health. This finding is similar to a study conducted by Burrows et al. who found only 3% were classified as having osteoporosis; however, 24% were classified as having osteopenia.[7] Therefore, the current study is consistent with previous literature suggesting diminished bone health is more prevalent than osteoporosis. Even minor diminished bone health causes the female athlete to be prone to increase in injuries, susceptible to stress fractures and osteoporotic fractures later in life.[7,82] More importantly, a slight decrease in bone density is irreversible even when a healthy weight is maintained and menstruation is restored.[40,81,82] The current study, along with previous literature, demonstrates the importance that female athletes suffering from decreases in bone density potentially are being overlooked for treatment because they do not fit the strict criteria for osteoporosis.

Current Standards of the Female Athlete Triad Versus At Risk

None of the participants in the current study met the criteria for the current standards of the female athlete triad. However, 48% (see table 8) met the researcher's criteria for being at risk of the female athlete triad and therefore would be overlooked by the current female athlete triad components. This is similar to the findings reported by

Burrows et al. Five percent of the participants met the criteria of amenorrhea, 15% meet criteria of disordered eating, and 2% met the criteria of osteoporosis.[7] None met two or more components of the current triad.[7] Therefore, none would be considered as having the female athlete triad.[7] From this group, 22% was identified as at risk of long-term health problems by the researcher.[7] In addition, 22% reported menstrual irregularities, 15% met the criteria of disordered eating, and 18% reported low bone health.[7] None of the participants reported all three conditions together.[7] Overall, 55% of the participants would be identified as being "at risk".[7] Thus, the current female athlete triad criteria would have missed 33% of females who were at risk.[7] This study, by Burrows et al., and the present study suggest that disordered eating, menstrual irregularities, and diminished bone health is more prevalent in female athletes and has more serious long-term health consequences than the current components of the female athlete triad. As stated previously, being at risk for one component of the triad can further progress a female athlete into worsening conditions of the triad. Therefore, it is important to note having one component is placing the female athlete at risk for developing the other components. These findings of the current study are further signified by the results of the Mann-Whitney U test performed on the current standards of each component versus the at risk groups of each component tested individually. Also, a Mann-Whitney U test was performed on the female athletes meeting the criteria of the female athlete triad current standards versus the female athletes meeting the criteria for the female athlete triad at risk. When comparing disordered eating current standards versus disordered eating at risk there was a suggested significance with a score of $P \leq .005$, menstrual dysfunction current standards versus menstrual dysfunction at risk showed a significance of $P \leq .001$,

and bone health current standards versus bone health at risk showed a significance of $P \leq .001$. When comparing those participants who met the current standards of the female athlete triad versus those participants at risk of the female athlete triad the Mann-Whitney U test analyzed a significant difference at $P \leq .001$. Each of these groups were statistically significant, further suggesting the current components of the female athlete triad are ineffective in identifying female athletes at risk for long-term health consequences.

Conclusions

For the participants in this research study, none met the current standards of the female athlete triad. However, twelve participants would be considered being at risk of the female athlete triad. The Mann-Whitney U tests performed, further indicates a suggested significance between the female athletes at risk for the female athlete triad versus the female athletes meeting the current standards for the female athlete triad. For the hypothesis proposed, the current study rejects the null hypothesis and therefore will utilize the alternative hypothesis which suggests that there is a difference in the effectiveness of the current female athlete triad components in identifying those female athletes at risk of long-term health consequences.

The female athlete triad should provide health care providers with guidelines to allow early and proper identification of female athletes at risk of irreversible long-term health consequences. From previous literature and the current study, it is clear the number of female athletes meeting the strict criteria of the current female athlete triad is relatively low. Further, many female athletes are suffering from milder forms of the components such as disordered eating, menstrual dysfunction, and diminished bone

health. Any form of the components is harmful from a health and performance perspective and may potentially be fatal. These female athletes are being overlooked by the current components of the female athlete triad and potentially not receiving the intervention needed. If an individual is at risk for one component, they should potentially be considered at risk for the female athlete triad.

In conclusion, the current research study and previous literature suggests that the current female athlete triad components are ineffective in identifying female athletes who are at risk for long-term health consequences. This study further indicates the need for future research to develop a model that provides a more encompassing approach to the issue of the female athlete triad.

Recommendations for Further Research

There are several recommendations for future studies and for health care professionals interested in this topic. First, future studies should use a larger sample size possibly by inviting other track programs across the country to participate in the study. This would be more feasible for random assignment which would allow parametric analysis. Results would be more reliable representation of the general female athlete population. In addition, it would be interesting to compare results between throwers, sprinters, and distance runners in order to determine prevalence of the female athlete triad among different types of female athletes. Secondly, future studies also should not limit the sample population to just cross country and track. By using various sports comparisons, it would allow researchers to identify which sports are more prevalent for the female athlete triad. Further, it would identify the type of female athlete who is most and least at risk. The third recommendation is it may be of benefit to have the researcher

be anonymous to the participants. Because the researcher in this study is affiliated with the midwestern university cross country, track and field team and even though the study was completely anonymous, the participants may be more comfortable with providing more accurate answers on the questionnaires if they did not know the researcher. This may eliminate any fear the participant may have in being discovered having these personal issues. Lastly, standard definitions and criterion need to be set for the components. Many previous studies use their own definitions and criterions for various menstrual dysfunctions, disordered eating, and bone health. This makes it difficult to analyze and provide accurate results and conclusions.

Concluding Comments

The results of this study support the general literature questioning the ineffectiveness of the current female athlete triad in identifying female athletes at risk of long-term health consequences. As in previous studies addressed in the literature review, 48% of the female athlete participants in this study are at risk for long-term health consequences and would be overlooked by the current standards of the female athlete triad. More importantly, they potentially would be overlooked for intervention. If health care providers are educated on the warning signs of the female athlete triad as clinical eating disorders, amenorrhea, and osteoporosis then these female athletes would not be treated for disordered eating, menstrual dysfunction, and diminished bone health which cause the same long-term health decrements. Therefore, more research is necessary to develop an all encompassing model of the female athlete triad so all female athletes in danger of disordered eating, menstrual dysfunction, and diminished bone health can receive proper care.

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APPENDICES

Appendix A

Institutional Review Board Approval

Oklahoma State University Institutional Review Board

Date:	Friday, January 09, 2009
IRB Application No	ED08189
Proposal Title:	The Effectiveness of the Female Athlete Triad Components in Identifying Collegiate Athletes at Potential Risk of Long-Term Health Problems
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 1/8/2010

Principal Investigator(s):

Christina Bahner
1200 N. Perkins Rd. Apt. D2
Stillwater, OK 74075

Suzanne Konz
194 Colvin Center
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

✓ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sheila Kennison, Chair
Institutional Review Board

Appendix B

Script

Script

The researcher is currently conducting a research study addressing the effectiveness of the female athlete triad components in identifying collegiate athletes on the Oklahoma State University's Female Cross Country and Track and Field team at potential risk of long-term health problems. You have met the criteria provided by the researcher to be considered for this study. There will be no negative consequences for deciding not to participate. If you do wish to participate you will be asked to complete the Female Athlete Screening Tool and the Student-Athlete Questionnaire. These questionnaires will screen for potentially being at risk for one or more of the components of the female athlete triad. In addition, for participating you will gain knowledge on the components of the female athlete triad and ways to prevent you from developing the components in the future. Would you be interested in participating?

Appendix C

Informed Consent

Informed Consent

Project Title: The Effectiveness of the Female Athlete Triad Components in Identifying Collegiate Athletes at Potential Risk of Long-Term Health Problems

Investigators:

Christina Bahner, ATC/LAT
Dr. Suzanne Konz

Purpose:

The current female athlete triad components, as stated in the American College of Sports Medicine's position stand, refer to interrelationships between eating disorders, amenorrhea, and osteoporosis. However, by the time the female athlete meets the criteria of the current components, many of the effects are irreversible at that point. The purpose of this research study is to assess the effectiveness of the female athlete triad components in identifying collegiate athletes on the Oklahoma State University's Female Cross Country and Track and Field team at potential risk of long-term health problems.

Procedures:

You will be asked to complete the Female Athlete Screening Tool and the Student-Athlete Questionnaire at the time of admission to the research study. It will be asked of you to complete both questionnaires as honestly and accurately. All answers will remain strictly confidential. Completion of the questionnaires will take approximately an hour to complete. Once completed, you are done with the research study and nothing else will be asked of you.

Risks:

There are no known risks associated with this research study which are greater than those ordinarily encountered in daily life.

Benefits:

A potential benefit from participation in this research study may include increased knowledge of the female athlete triad and knowledge on the prevention of the components of the female athlete triad. In addition, becoming aware of you potentially being at risk for one or more of the components of the female athlete triad.

Confidentiality:

The research of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you. Research records will be stored securely and only researchers and individuals responsible for research oversight will have access to the records. It is possible that the consent process and data collection will be observed by research oversight staff

responsible for safeguarding the rights and wellbeing of people who participate in research.

The investigator (Christina Bahner) will ensure the confidentiality of all information requested by assigning a random number to packets containing the informed consent form, Female Athlete Screening Tool and the Student-Athlete Questionnaire. No names will be collected for this research study. The records with the associated random numbers will be kept in a locked cabinet by the investigator. The locked cabinet will be located at Oklahoma State University in the thesis advisor's office (Dr. Suzanne Konz). The investigator and thesis advisor will be the only individuals with access to the locked cabinet. Only the random number will appear on reports and the thesis paper. The data will be entered and saved on the investigator's personal laptop. After completion of the data analysis the Female Athlete Screening Tool and the Student-Athlete Questionnaire will be shredded. The documents will be maintained approximately 2 years from initiation of the study.

Compensation:

I understand that no funds have been set aside by Oklahoma State University to compensate me for participating in this research study.

Contacts:

If you have any questions about the research you may contact Christina Bahner, ATC/LAT, Principal Investigator 660.221.6065. Or Dr. Suzanne Konz, thesis advisor at 405.744.4480.
Or
If you have any questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405.744.1676 or irb@okstate.edu.

Participant Rights:

Participation is voluntary and you may discontinue the research activity at any time without reprisal or penalty.

I have read and fully understand the consent form. I understand that my completion and submission of the Female Athlete Screening Tool and the Student-Athlete Questionnaire indicates my consent to participate in the research study.

Appendix D

Female Athlete Screening Tool

Female Athlete Screening Tool

Please answer as completely as possible.

Key: **Exercise =** Physical activity ≥ 20 minutes.
Practice = Scheduled time allotted by coach to work as a team or individually in order to improve performance.
Training = Intense physical activity. The goal is to improve fitness level in order to perform optimally.

1. I participate in additional physical activity ≥ 20 minutes in length on days that I have practice or competition.
   1) Frequently 2) Sometimes 3) Rarely 4) Never

2. If I cannot exercise, I find myself worrying that I will gain weight.
   1) Frequently 2) Sometimes 3) Rarely 4) Never

3. I believe that most female athletes have some form of disordered eating habits.
   1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

4. During training, I control my fat and calorie intake carefully.
   1) Frequently 2) Sometimes 3) Rarely 4) Never

5. I do not eat food that have more than 3 grams of fat.
   1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

6. My performance would improve if I lost weight.
   1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

7. If I got on the scale tomorrow and gained 2 pounds, I would practice or exercise harder or longer than usual.
   1) Frequently 2) Sometimes 3) Rarely 4) Never

8. I weight myself _____.
   1) Daily 2) 2 or more times a week 3) Weekly 4) Monthly or less

9. If I chose to exercise on the day of competition (game/meet), I exercise for

   1) 2 or more hours 2) 45 minutes to 1 hour 3) 30-45 minutes 4) less than 30 minutes

10. If I know that I will be consuming alcoholic beverages, I will skip meals on that day of the following day.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

11. I feel guilty if I choose fried foods for a meal.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

12. If I were to be injured, I would still exercise even if I was instructed not to do so by my athletic trainer or physician.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

13. I take dietary or herbal supplements in order to increase by metabolism and/or to assist in burning fat.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

14. I am concerned about my percent body fat.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

15. Being an athlete, I am very conscious about consuming adequate calories and nutrients on a daily basis.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

16. I am worried that if I were to gain weight, my performance would decrease.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

17. I think that being thin is associated with winning.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

18. I train intensely for my sport so I will not gain weight.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

19. During season, I choose to exercise on my one day off from practice or competition.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

20. My friends tell me that I am thin but I feel fat.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

21. I feel uncomfortable eating around others.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

22. I limit the amount of carbohydrates that I eat.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

23. I try to lost weight to please others.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

24. If I were unable to compete in my sport, I would not feel good about myself.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

25. If I were injured and unable to exercise, I would restrict my calorie intake.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

26. In the past 2 years, I have been unable to compete due to an injury
    1) 7 or more times 2) 4-6 times 3) 1-3 times 4) No significant injuries

27. During practice, I have trouble concentrating due to feeling of guilt about what I have eaten that day.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

28. I feel that I have a lot of good qualities.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

29. At times I feel that I am no good at all.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

30. I strive for perfection in all aspects of my life.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

31. I avoid eating meat in order to stay thin.
    1) Strongly Agree 2) Agree 3) Disagree 4) Strongly Disagree

32. I am happy with my present weight.
    1) Yes 2) No

33. I have done things to keep my weight down that I believe are unhealthy.
    1) Frequently 2) Sometimes 3) Rarely 4) Never

Appendix E

Student-Athlete Health Questionnaire

Student-Athlete Health Questionnaire

Please answer all questions honestly and accurately. All responses will remain CONFIDENTIAL.

Demographic Information

1. Primary sport you participate in:_____
2. Years of participation in your sport: lifetime_____ collegiate_____
3. Age:_____
4. Ethnicity: African American____ Asian____ Caucasian____ Hispanic____ Native American____ Other____
5. Year in school: Freshman___ Sophomore___ Junior___ Senior___ Graduate___

Musculoskeletal History

1. Have you ever been diagnosed with a stress fracture? Yes___ No___
   *If you answered YES, how many stress fractures have you had and when?
   _____(lifetime) approximate ages _____ Injury Site_____

   _____(college) approximate dates_____ Injury Site_____
2. Have you ever been diagnosed or treated for low bone density? Yes___ No___
   If YES, please explain below approximate dates and how you were treated.
3. Have you suffered any traumatic fractures? Yes___ No___
   *If you answered YES, how many fractures have you had? _____
4. Is there a history of osteoporosis (thin or weakened bones) in your family? Yes___ No__
5. Have you sustained any other musculoskeletal injuries (muscle, tendon, or ligament)? Yes___ No___
   *If you answered YES, please describe the injury/injuries and date(s) sustained below.

Menstrual History

1. Have you ever had a menstrual period? Yes___ No___
2. How old were you when you had your first menstrual period? _____

3. When was your last menstrual period? ____/____ (month/year)

4. How many menstrual periods have you had in the last 12 months?_____
   In the last 6 months?_____

5. Please describe the regularity of your cycle. (Please check one)
   ___I am very regular (within 3 days) ___I am somewhat regular (4-10 day variation)
   ___I am very irregular (variation greater than 10 days)

6. How many days do your menstrual periods last? _____

7. How would you describe your menstrual bleeding?
   ____ Light ____ Moderate ____Heavy

8. Are there changes in your menstrual period during your athletic "season?"
   ___Yes ___No
   *If you answered YES, please describe the changes below.

9. Have you ever gone for 3 or more months without having a menstrual period?
   ___Yes ___No
   *If you answered YES, how many times have you gone 3 or more months without having a period? _____
   *If you answered YES, how many months did you go without menstruating?
   _____

10. Do you currently take birth control pill or hormones? ____Yes ____No
    *If you answered YES, why are you using them?
    ___Birth Control ___Regulate Menstrual Cycle ___Both

11. Please describe any other menstrual irregularities or problems not already covered in the above questions.

Nutrition History

1. ***Primary*** source of nutrition information/education (please check one)
   ___Magazines ___Textbooks ___Peers ___Dietitian ___Coach ___Physician
   ___Other Medical Profession ___Health Food Store ___Other (describe)_____

2. Have you ever been diagnosed or treated for anorexia nervosa, bulimia nervosa, or any type of disordered eating? Yes____ No_____
   *If you answered YES, please explain and list your age and length of time the eating disorder lasted.

3. Are you currently being treated for an eating disorder? Yes___ No___

4. How many meals (breakfast, lunch, dinner) do you usually eat per day? (check one)
   ___1-2 ___3-4 ___5-6 ___more than 6

5. How many snacks (sports bar, piece of fruit) do you usually eat per day? (check one)
   ___1-2 ___3-4 ___5-6 ___more than 6

6. Do you skip meals?
   ____ Yes, frequently ____Yes, occasionally ____No

7. Are you a vegetarian? Yes___ No___

8. Do you limit/restrict the ***amount*** or ***type*** of food you eat to control your weight? Yes____ No_____
   *If you answered YES, please explain below.

9. Please check the average number of dairy (milk, yogurt, cheese) products you typically eat.
   ___ 0 ___ 3-4 per week ___1-2 per day ____1-2 per week ___5-6 per week ___3-4 per day

10. Do you take vitamin or mineral supplements?
    ___ Yes, daily ___Yes, but not every day ___No
    *If you answered YES, please indicate what types of supplements below.

11. Have you ever used any of the following to lose weight (Please circle all that apply):
    Diet pills? Vomiting? Laxatives? Diuretics? Excessive Exercise?

12. Do you think your diet is nutritionally adequate? ____Yes ____No

13. Please list below all the foods you ate yesterday.

Weight History

1. Height: ____/____(feet/inches)

2. Weight: _____ (pounds)

3. Length of time (months) at current weight?:_____

4. How many times has your weight fluctuated by at least 5 pounds in the last year? _____

5. What is your ideal weight? _____ (pounds)

6. Do you consciously control your weight for your sport? ____Yes ____No

7. When your season is over and you stop or reduce your training, do you:
   ___gain weight (amount:_____) ___lose weight (amount:_____)
   ___ maintain weight

8. How often are you dieting ***during the season***?
   ___never ___rarely ___sometimes ___often ___always

9. How often are you dieting ***during the off-season or when you stop or reduce training***?
   ___never ___rarely ___sometimes ___often ___always

10. Which of the following are you currently trying to do about your weight?
    ___lose weight ___gain weight ___stay the same weight

11. What percentage of your exercise is aimed at weight control?
    ___0% ___≤25% ___26%-50% ___51%-75% ___76%-100%

12. I presently think of myself as being:
    ___very underweight (>10 lb) ___slightly underweight (5-10 lb) ___at an ideal weight
    ___slightly overweight (<10 lb) ___moderately overweight (10-20 lb)
    ___very overweight (>20 lb)

13. Other people say that I am presently:
    ___very underweight (>10 lb) ___slightly underweight (5-10 lb) ___at an ideal weight
    ___slightly overweight (<10 lb) ___moderately overweight (10-20 lb)
    ___very overweight (>20 lb)

14. Do you feel pressure to achieve or maintain a particular body weight?
    ____Yes ____No
    *If you answered YES, from whom do you feel pressure? (check all that apply)
    ____myself ___parents ___teammates ___society ___coach ___trainers
    ____boyfriend/partner ___friends

15. How satisfied are you with your body weight?
    ___very satisfied ___satisfied ___neutral ___dissatisfied ___very dissatisfied

16. How satisfied are you with your current body size or shape?
    ___very satisfied ___satisfied ___neutral ___dissatisfied ___very dissatisfied

VITA

Christina R. Bahner

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTIVENESS OF THE FEMALE ATHLETE TRIAD COMPONENTS IN IDENTIFYING COLLEGIATE ATHLETES AT POTENTIAL RISK OF LONG-TERM HEALTH CONSEQUENCES

Major Field: Health and Human Performance Emphasis in Exercise Science

Biographical:

Education: Graduate from Sacred Heart High School, Sedalia, Missouri in May, 2003; received a Bachelor of Science degree in Sports Medicine and Athletic Training with minors in Nutrition and Biomedical Sciences from Missouri State University, Springfield, Missouri in May, 2007; completed the requirements for the Master of Science in Health and Human Performance at Oklahoma State University, Stillwater, Oklahoma in May, 2009.

Experience: Graduate Assistant Athletic Trainer for Oklahoma State University's Women's Cross Country, Track, and Field team, 2 years

Professional Memberships: National Athletic Trainers' Association, Oklahoma Athletic Trainers' Association

Name: Christina R. Bahner Date of Degree: May, 2009

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE EFFECTIVENESS OF THE FEMALE ATHLETE TRIAD COMPONENTS IN IDENTIFYING COLLEGIATE ATHLETES AT POTENTIAL RISK OF LONG-TERM HEALTH CONSEQUENCES

Pages in Study: 77 Candidate for the Degree of Master of Science

Major Field: Health and Human Performance

Scope and Method of Study: Research on the effects of excessive exercise on female athletes has increased to investigate three distinct, yet interrelated disorders: eating disorders, amenorrhea, and osteoporosis collectively termed the female athlete triad. However, previous literature has found few female athletes develop the female athlete triad according to the strict criteria of the components. When a female athlete does develop all three components, many of the effects are irreversible at that point. In addition, previous research suggests disordered eating, menstrual dysfunction, and subsequent impaired bone health is just as harmful to the female from a health and performance perspective. The purpose of this study was to examine the effectiveness of the current components of the female athlete triad in identifying female athletes at risk for future long-term health consequences. A purposive sample with a descriptive no control design was utilized. Twenty-five females from a Division I midwestern university cross country, track and field team participated in the study. Each participant completed the Female Athlete Screening Tool and the Student-Athlete Health Questionnaire. The information received from the questionnaires was analyzed and it was determined if the athlete met the current standards for the female athlete triad or met the standards for being at risk for the female athlete triad. A Mann-Whitney U non-parametric procedure was utilized to compare components.

Findings and Conclusions: No participant in this study met the current standards for the female athlete triad; however, 48% were considered at risk for the female athlete triad and would be overlooked by the current standards of the female athlete triad. Specifically, of the 48%, 32% were at risk for the female athlete triad by meeting two of more of the components and 14% met the criteria of all three components as being at risk for the female athlete triad. The present study suggests the current components of the female athlete triad are ineffective in identifying female athletes at risk for long-term health consequences. Therefore, further research is needed to develop a model that provides an all-around approach to the issue of the female athlete triad, specifically disordered eating, menstrual dysfunction, and impaired bone health.

ADVISER'S APPROVAL: Dr. Suzanne Konz