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Assessing Athletes' Risk for Developing the Female Athlete Triad at Two Mississippi Universities

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Assessing Athletes' Risk for Developing the Female Athlete Triad at Two Mississippi Universities

by

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ABSTRACT

Despite the health benefits associated with regular exercise, some female athletes experience menstrual dysfunction and low bone mineral density associated with low energy availability as a result of a high volume of exercise and inadequate caloric intake; these three components characterize the female athlete triad (FAT). Prior research explored the severity of the FAT, pre-season screenings, and nutrition intervention methods; however, current research regarding the relationship between the risk for developing the FAT and access to nutrition resources is lacking. The purpose of this study was to assess the risk of female athletes at two Mississippi universities for developing the FAT and determine if there is a correlation between risk for developing the FAT and access to nutrition resources such as a dietitian or peer education programs. Participants were recruited through an email sent to female athletes on eight teams at each university. An online survey incorporating the LEAF-Q and BSQ-16B regarding the athlete's risk for developing the FAT and body satisfaction, respectively, was used to collect data. Participants were also asked about prior nutrition education history, knowledge of the FAT, and demographic questions. Results of this study show a significant difference (p = .007) in mean risk for FAT at The University of Mississippi (M = 8.12) as compared to The University of Southern Mississippi (M = 8.77). Participants in this study classified as at risk for the FAT (n = 12) were significantly more likely (χ^2 = 4.930, df = 1, p = .026) to have previous nutrition education by a registered dietitian. No significant differences were found between BSQ and LEAF-Q scores or LEAF-Q scores relationship with knowledge of the FAT and sport. Furthermore, appropriate nutrition resources for female athletes and athletes in general can provide

necessary information about adequate nutrition for performance and basic healthy body functions.

Keywords: Female athlete triad, college female athletes, body satisfaction, knowledge of the female athlete triad, sport

DEDICATION

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LIST OF ABBREVIATIONS

ACSM	American College of Sports Medicine
EA	Energy Availability
FAT	Female Athlete Triad
Kcal	Kilocalories
LBMD	Low Bone Mineral Density
NCAA	National Collegiate Athletic Association
UM	The University of Mississippi
USM	The University of Southern Mississippi

CHAPTER I: INTRODUCTION

Despite the health benefits associated with regular exercise, some female athletes experience the female athlete triad (FAT), which is characterized by its three components: low energy availability, menstrual dysfunction, and low bone mineral density (Miller et al., 2012). The FAT is defined by one or more of the following conditions: low energy availability, menstrual dysfunction, and low bone mineral density. The FAT has both short-term and long-term effects (Chamberlain, 2018). Low energy availability can be both intentional, as seen with extreme calorie restriction, and unintentional, as seen with unintentional underconsumption of calories. Body satisfaction, genetics, and sport also play a role in the development of the female athlete triad (Blair et al., 2017; Rust, 2002; Tendforde et al., 2018).

All three components of the female athlete triad are present in only 1-5% of female athletes, but 20-25% of female athletes have one or two of the components (Miller et al., 2012). In several studies, athletes underestimated their nutrient needs, which increases their risk of developing low energy availability, the first component of the female athlete triad (Jagim et al., 2019; Shriver et al., 2013; Valliant et al., 2012). Additionally, many women find amenorrhea, which is the loss of menses for more than three months, as a sign of hard work even after being educated on the seriousness of amenorrhea (Clairmont, 2020). This is concerning because if left untreated, the FAT can have permanent effects on the reproductive system, skeletal system, heart, and kidneys (Chamberlain, 2018; Clairmont, 2000). While the best treatment option is prevention, athletes, physicians, and coaches do not know or understand the severity of the FAT thoroughly enough to rely on prevention as the primary treatment option (Curry et al.,

2015; Heffner et al., 2003; Miller et al., 2012;). Treatment for the FAT includes stopping all participation in sports to decrease energy expenditure and educating the athlete on increasing caloric intake (Valliant, et al., 2012).

Research has shown nutrition education leads to higher nutrition knowledge and implementation of nutrition knowledge (Valliant, et al., 2012), but there was limited research evaluating the risk of developing the FAT and access to nutrition resources. The purpose of this study was to assess the risk of female athletes at The University of Southern Mississippi and The University of Mississippi for developing the FAT and determine the correlation, if any, between risk for developing the FAT and access to nutrition resources, such as a dietitian or peer education programs.

This research aimed to answer the following questions:

1. Are college female athletes at risk of developing the female athlete triad?
2. What percentage of college female athletes surveyed are aware of the female athlete triad?
3. What percentage of college female athletes surveyed have been educated on nutrition?
4. Where or from whom do college female athletes receive their nutrition education?
5. What is the relationship between college female athletes' risk for developing the female athlete triad and receiving nutrition education by a registered dietitian?
6. What is the relationship between college female athletes' satisfaction with their bodies and the risk of developing the female athlete triad?
7. Is there a relationship between type of sport and the risk of developing the female athlete triad?

CHAPTER II: LITERATURE REVIEW

In June of 1992 at the American College of Sports Medicine (ACSM), the term female athlete triad (FAT) was first coined (Clairmont, 2000). Active females across the world are affected by the FAT. It is a potentially life-threatening, and certainly a life-altering, medical condition with three components: low energy availability, menstrual dysfunction, and low bone mineral density. While only 1-5% of female exercisers present with all three components of the FAT, 20-25% of female exercisers qualify for one to two of the three cornerstones of the FAT; consequently, having just one of these factors, will minimize the athlete's performance and increase her risk of injury (Miller et al., 2012). Treatment includes close monitoring of progression towards returning to normal weight and normal hormonal function seen with menstruation. When diagnosed with the FAT, the athlete will need to meet with the dietitian frequently and will not participate in practice and play, which will impact the athlete's day to day routine. Therefore, the best treatment option is prevention through screening and monitoring athletes (Coleman & Spain, 2020). The purpose of this literature review is to describe the three primary components of the FAT, risk factors associated with the FAT, and treatment options.

Low Energy Availability

Low energy availability (EA) is the first component of the FAT, and it occurs when one's energy expenditure exceeds the energy intake (Ranson et al., 2019). The body does not have enough energy to maintain homeostasis, and, as a result, the athlete will experience "decreased training response, impaired judgement, decreased coordination, decreased concentration, irritability, depression, and decreased endurance performance" (Ackerman et al., 2019, p. 7). Low EA can be quantitatively measured by taking the value

of an individual's energy intake (kilocalories, or kcal) less than energy expenditure (kcal) divided by fat-free body mass (kilograms, or kg). A value less than 45 kcal per kg is indicative of low EA for a female athlete (Ranson et al., 2019). Additionally, the body adapts to low EA by lowering the resting metabolic rate and reducing the secretion of triiodothyronine; therefore, a reduced resting metabolic rate and triiodothyronine level are also signs of low EA.

In the original definition of the FAT that the panel at the ACSM in 1992 provided, the first principle of the FAT was disordered eating (Clairmont, 2000). However, in 2007, the ACSM broadened the first component of the FAT from disordered eating to low EA to include both intentional and unintentional causes of low EA (Ranson et al., 2019). Intentional causes of low EA in college female athletes include disordered eating patterns, eating disorders, and dieting. Unintentional causes of low EA in college female athletes include lack of education, busy schedules, low food availability, and insufficient funds to support an increased energy intake (Gastrich et al., 2020).

The intentional causes of low EA listed above can be considered within the athlete's control (Hesse-Biber, et al., 2006). These intentional causes all stem from the individual seeking extreme measures to control their lives through food and its' relationship to weight management. External factors and influences such as the desire for thinness through culture and/or sport also impact the prevalence of these intentional causes of low EA in college female athletes.

Intentional Causes of Low EA

Comments made by coaches regarding an athlete's weight, physical appearance and stature, and athletic performance can trigger disordered eating habits, an eating

disorder, or extreme dieting. In one study involving coaches (N = 303) of all divisions across the National Collegiate Athletic Association (NCAA), 44% reported weighing and tracking players' body composition. Additionally, 30% of coaches reported suggesting athletes "attempt to lose weight either through restricting food intake or extra practices" (Heffner et al., 2003, p. 217). This is problematic for athletes, as coaches come from a point of influence and inspiration. Comments made by coaches regarding weight, body composition, and dieting have a greater impact to influence athletes to engage in behaviors such as disordered eating or extreme dieting, which are unhealthy and can lead to an eating disorder.

According to Tilgner and Schiller (1989), coaches with or without any formal nutrition knowledge may assume the job to educate athletes on nutrition when a dietitian is not present, which raises concern for the spread of misinformation that could be detrimental to athletes. Coaches may not be educated on the severity of eating disorders within the female athlete community. Heffner et al. (2003) discovered that male coaches and Division I coaches agreed that eating disorders in athletes have been exaggerated. These two studies show coaches lack nutrition education and awareness to current nutrition problems that their athletes may face.

Another potential disordered eating trigger is body dissatisfaction. In one study conducted across three Southern United States universities, it was discovered that females are five times more likely to be dissatisfied with their bodies than their male counterparts (Blair et al., 2017). Disordered eating is common among undergraduate females for a multitude of reasons including increased school performance demands, unpredictability, a new environment, and lack of parental guidance (Kirk et al., 2001). While college female

athletes are no more at risk than college female non-athletes, the increased risk for body dissatisfaction cannot be ignored because this can lead to disordered eating habits, an eating disorder, or extreme dieting to achieve the desired body (Blair et al., 2017).

Additionally, a female athlete's risk for developing low EA through intentional energy restriction is dependent on the sport. Sports that prioritize leanness – such as running, gymnastics, swimming, and dance – elevate an athlete's risk of developing an eating disorder. According to a 2020 analysis of over 10 studies, leanness sports athletes are at a 46.7% risk for developing an eating disorder (Gastrich et al., 2020). While non-leanness athletes, those in sports such as soccer, softball, volleyball, and basketball, are at a 19.8% risk of developing an eating disorder.

Unintentional Causes of Low EA

A female athlete's risk for developing an eating disorder can be influenced by her genetics. Extreme exercise, which is common in collegiate athletes, can trigger eating disorders in those who are predisposed, either biologically or psychologically, to develop mental illness (Rust, 2002).

A primary cause of unintentional low EA is the discrepancy between perceived nutritional needs and actual nutritional needs resulting in inadequate energy intake. In multiple studies, female athletes fail to meet and accurately identify their body's energy macronutrient needs (Jagim et al., 2019; Shriver et al., 2013; Valliant et al., 2012). In a study at The University of Mississippi, a Division I NCAA women's volleyball team consumed only 56% of their average estimated energy needs (Valliant et al., 2012). Additionally, a Midwestern United States Division I NCAA school reported nearly all female participants failed to meet their energy needs (Shriver et al., 2013). Lastly, in a

study involving a Division II NCAA women's lacrosse team, athletes consumed roughly 600 kcal less than recommended on average (Jagim et al., 2019). Athletes in this study reported their perceived energy needs were an average of 2000 kcal. Energy needs were estimated on three levels of activity: low (40 kcals/kg), medium (50 kcals/kg), and high (60 kcals/kg). The estimation of energy needs in this study was 2,756 to 4,134 kcals. Even using the low activity level estimation of energy needs, 2,756 kcals, the athletes in this sample still underestimated their needs by over 700 kcals (Jagim et al., 2019). Researchers agreed that nutrition education is needed for female athletes who may have inadequate energy intake to aid in preventing the development of low EA (Jagim et al., 2019; Shriver et al., 2013; Valliant et al., 2012).

Athletes have increased nutrient needs because of the amount of training needed. Therefore, active female athletes are more at risk for unintentional low EA because of inadequate energy intake than a non-active female (Jagim et al., 2019). In several studies, nutrition education has been shown to increase caloric intake which, in turn, decreases caloric deficit thereby decreasing the chance of low EA (Jagim et al., 2019; Shriver et al., 2013; Valliant et al., 2012). In addition to increased caloric needs, athletes require different proportions of macronutrients. Macronutrients are energy-providing nutrients including, protein, carbohydrates, and fat. Protein and carbohydrates are macronutrients that athletes need more of than non-athletes. Protein aids in muscle synthesis and repair, and carbohydrates are the body's primary source of fuel. Athletes are recommended to consume 1.2-1.6 grams of protein per kg of body weight whereas non-athletes are recommended .8 grams of protein per kg of body weight (Burke et al., 2004). Athletes are recommended to consume 5 to 10 grams of carbohydrates per kg of body weight whereas

non-athletes are recommended to consume five to seven grams of carbohydrates per kg of body weight (Phillips et al., 2007). A diet consisting of higher proportions of calories, carbohydrates, and protein than normal will promote recovery, growth, and glycogen storage for enhanced performance (Burke et al., 2004).

In order to meet these heightened energy needs, college athletes may need to consume more than just three meals a day. However, college athletes live busy lives filled with classes, training sessions, and homework, interrupting mealtimes and/or time for meal preparation. With an increase in energy expenditure, there is an increase in energy needs, which requires a greater number of groceries, time to prepare food, and time to eat which can present a challenge (Valliant et al., 2012). In one study, 29% of athletes reported eating fewer than three meals a day, and 27% reported eating fewer than two snacks a day (Shriver et al., 2013). In another study, 72.7% of athletes reported skipping meals; of the 72.7%, 54.5% attribute meal skipping to lack of time (Valliant et al., 2012).

Lastly, an individual's access to food could cause low EA. The most pivotal factors related to access to food for college athletes are transportation and financial means (Misener, 2020). Not all communities have public transportation, which provides an individual with access to a grocery store if he or she is without a car. Additionally, college athletes rarely have time for a job on top of coursework and team obligations, so their grocery budget may not be able to support the food required to sustain energy balance.

Low EA can be a result of many factors both intentional and unintentional. When an athlete is in low EA, the body is taxed which leads to muscle degradation, declined performance, poor recovery, and increased risk of injury (Valliant et al., 2012). The basis

of low EA is rooted in the fact that suboptimal energy intake will result in suboptimal performance, and low EA is the first component of the FAT.

Menstrual Dysfunction

Menstrual dysfunction occurs after prolonged low EA, and it can be anything from abnormal pain in the luteal phase of one's menstrual cycle to amenorrhea which is "the absence or abnormal cessation of the menses" (The Practice Committee of the American Society for Reproductive Medicine, 2004). Amenorrhea can be either primary or secondary. Primary amenorrhea is diagnosable at 15 years of age once a female has failed to menstruate. If primary sex characteristics are developed before the age of 10, menses should occur within five years to not be considered primary amenorrhea. Secondary amenorrhea is when the regular menses cycle stops for at least three months. The four common causes of amenorrhea are polycystic ovary syndrome, hypothalamic amenorrhea, hyperprolactinemia, and ovarian failure. Hypothalamic amenorrhea, though not a type of amenorrhea, correlates to psychogenic stress along with weight changes, undernutrition, and excessive exercise which can all, respectively, be results of low EA, lack of knowledge, and higher expectations as a college athlete.

While menstrual dysfunction is the second cornerstone of the FAT, in one study, 35% of female athletes view amenorrhea as normal, and they believe it means that the athlete is training hard (Miller et al., 2012). Additionally, in Miller et al. (2012), some women admitted that after education on the health risks of amenorrhea, they would not consider it an issue of concern. While amenorrhea is only present in 2-4% of all childbearing-aged women, the incidence percentage increases to 40% for female athletes (Clairmont, 2020). Allowing the Miller et al. (2012) study to represent female athletes on

a larger scale, it is concerning that 40% of female athletes experience amenorrhea, and 35% of female athletes do not see any issue with amenorrhea. Some, even after education, see amenorrhea as a normal and healthy body process.

With the absence of a menstrual cycle because of hypothalamic amenorrhea, hormones are not regulated correctly (Rust, 2002). Gonadotropin-releasing hormone is never secreted from the hypothalamus. In females, the function of the gonadotropin-releasing hormone is to signal the pituitary gland to stimulate the ovaries through the release of luteinizing hormone and follicle-stimulating hormone. Without these two hormones, the menstrual cycle is suppressed, which results in the suppression of the production of estrogen and progesterone. Therefore, without a menstrual cycle, estrogen is not regulated. Estrogen is needed for bone construction, which means amenorrhea directly inhibits bone construction and can lead to lowered bone mineral density. With continued hormonal imbalances and low EA, infertility becomes a long-term concern for female athletes (Chamberlain, 2018).

Low Bone Mineral Density

The last FAT component is low bone mineral density (LBMD). Exercise is one of three ways to increase bone mineral density. Bone density increases as muscles are pulling on the bone as they do when contracting during exercise (Silver et al., 2018). However, Hoch et al. (2009) found that 13-19% of high school female athlete participants had LBMD even though athletes reportedly have higher bone mineral density than non-athletes (Nose-Ogura et al., 2018). LBMD is tested using dual energy x-ray absorptiometry machine to calculate a z-score. A z-score compares the participants bone mineral density with age and sex-matched controls; for post-menopausal women, a *t*-test

will be used, which does not account for age and sex controls. A z-score less than -2.0 indicates low bone mineral density (Thein-Nissenbaum & Carr, 2011). The occurrence of LBMD in female athletes may be caused by several factors including the type of sport and the presence of other triad components.

Physical activity increases bone mineral density in sports that are multi-directional and high impact such as volleyball, other ball sports, and gymnastics. An increase in bone mineral density because of exercise is not seen to the same degree with low-impact and no-impact sports as it is with high-impact sports. Distance running is a low-impact sport, and swimming and cycling are no-impact sports (Tendforde et al., 2018). Tendforde et al. (2018) measured the bone density of 323 Division I athletes using dual energy x-ray absorptiometry and discovered that 10% of the female athletes met the criteria for LBMD. The 10% that met the LBMD criteria were primarily from low or no-impact sports namely, cross-country and swimming. Additionally, female athletes do not maintain bone mineral density as well as male athletes (Ireland et al., 2020). Therefore, all female athletes regardless of sport are at an increased risk for developing LBMD, and the type of sport only increases the risk for developing LBMD.

Any component of the triad decreases a female athlete's bone mineral density (Tendforde et al., 2018). Low body mass index and amenorrhea, the second component of the FAT, are predictors of LBMD. Low bone mineral density can occur as a side effect of exercise-induced hypothalamic amenorrhea resulting from low estrogen regulation (Rachner et al., 2011). Low estrogen regulation leads to insufficient bone reconstruction, which leaves the bones weak and brittle. This leads to the first signs of LBMD: stress fractures, shin splints, and broken bones (Nose-Ogura et al., 2018).

Without intervention, LBMD can lead to osteoporosis. Osteoporosis is a "disease characterized by a systemic impairment of bone mass and microarchitecture that results in fragility fractures" (Rachner et al., 2011, p. 1276). Osteoporosis risk increases with age and typically develops one to two years before menopause or around age 50 (National Institute of Arthritis and Musculoskeletal and Skin Diseases, 2019). However, with the FAT, young female athletes begin to develop osteoporosis at a much younger age because of menstrual dysfunction. Over time, LBMD can result in permanent bone damage. However, LMBD harms more than just the skeletal system as it can also cause systemic problems for the heart and kidneys because of the extra calcium circulating in the bloodstream (Clairmont, 2000). Excess circulating calcium begins to be deposited throughout the body. Calcium deposits can lead to the development of atherosclerosis, chronic kidney disease, and diabetes. In order to avoid these chronic conditions, athletic staff personnel should focus on treatment strategies.

Treatment

Early detection is the best treatment for the FAT. Current research recommends yearly FAT screening for female athletes at yearly pre-participation physical examinations (Coleman & Spain, 2020). Coleman and Spain (2020) provide an 11-question survey to evaluate each component of the triad. Curry et al. (2015) surveyed 931 physicians on their knowledge of the FAT, and they found that only 37% of primary care physicians, those who would be performing pre-participation physical examinations, were aware of the FAT, which makes early detection less likely.

Treatment for the FAT involves treating each component that is present, which can include low EA, menstrual dysfunction, and/or LBMD. Low bone mineral density is

treated by addressing its causes: low EA and hormonal dysfunction. Current protocol suggests immediate restriction in athletics events and practice once a female athlete has developed the FAT, she should immediately be restricted from play (Valliant, 2016). Treating each component of the FAT starts with increased energy intake and reduced energy expenditure to increase overall available energy. Increasing energy availability will aid in menstrual function, which helps increase bone mineral density. A caloric surplus of 200-600 kcal is suggested (Nose-Ogura et al., 2018). This will aid in gaining recently lost weight, and the main goal of weight gain is to return to the previous weight when menstruation was normal. Additionally, research shows athletes should aim to reach and maintain a body mass index of at least 18.5.

If menstrual function has not returned in a year, the athlete may benefit from hormonal treatment (Chamberlain, 2018). A transdermal estradiol patch has been shown to assist with hormone regulation and increase bone mineral density. However, the use of hormone treatment with the FAT should be cautioned because it can hide the symptoms of menstrual dysfunction namely, amenorrhea (Ackerman et al., 2019).

While the athlete is working to achieve a goal weight and resume menstruation, she may benefit from psychological care as she deals with withdrawals from team activities. Counseling is an effective intervention especially if she has low EA because of an eating disorder (Valliant, 2016). There are no standardized guidelines for athletes to return to play (Coleman & Spain, 2020). The best practice for collegiate sports dietitians is to follow extensive monitoring and intervention and include an interdisciplinary team when needed. It is recommended that the interdisciplinary care team, usually including a

certified specialist in sports dietetics, physician, and psychologist, should be in agreeance with the athlete's return to play (Valliant, 2016).

Research was conducted to evaluate education, including peer education programs, educational videos, and education by a registered dietitian as an effective nutrition intervention strategy for the FAT (Brown et al., 2020; Kunkel et al., 2001). Peer education programs and educational videos have been successful educational interventions in previous studies to increase overall nutrition knowledge and raise awareness of the FAT. Peer education was administered to athletes by undergraduate nutrition students. The same test was taken before and after the education sessions to determine if athletes gained general and sports nutrition knowledge; athletes scored significantly higher on the post-test indicating that peer education programs can be a successful education intervention (Kunkel et al., 2001). Brown et al. (2020) used a 10-minute education video to explain the FAT. They also administered the same test before and after the video to gauge the athletes' knowledge of the FAT. Scores improved significantly after the video, which indicates that an educational video is effective for nutrition education.

Registered dietitians can also educate female athletes on the FAT. Education has shown successful implementation of nutrition knowledge in the daily lives of college female athletes. In the Valliant et al. (2012) study, athletes received individualized nutrition education based on their personalized needs. Before education, athletes met 56% of their caloric needs, 47% of carbohydrate needs, and 59% of protein needs. After the education, the measured intake increased, respectively, to 70%, 66%, and 72%.

Results indicate that education administered by a registered dietitian produces necessary dietary changes in female athletes.

Conclusion

The FAT is characterized by low EA, menstrual dysfunction, and/or LBMD (Miller et al., 2012). Many athletes do not meet their nutritional needs, which exposes them to developing the FAT and the serious short-term and long-term consequences associated with the FAT (Chamberlain, 2018; Jagim et al., 2019; Shriver et al., 2013; Valliant et al., 2012). Treatment for the FAT varies from case to case, but the foundation of FAT treatment is increasing caloric intake and decreasing expenditure (Nose-Ogura et al., 2018). Education on the FAT and personalized nutrient needs may help avoid low EA, which is the first component of the FAT (Valliant et al., 2012). Further research is needed to assess the risk of female college athletes developing the FAT in correlation with the target populations' access to nutrition resources such as a dietitian and peer mentors. The purpose of the present study is to assess the risk of female athletes at The University of Southern Mississippi and The University of Mississippi for developing the FAT and determine the correlation, if any, between risk for developing the FAT and access to nutrition resources, such as a dietitian or peer education programs.

CHAPTER III: METHODOLOGY

Design of Study

This quantitative study used online survey methodology to measure the risk of developing the FAT of female athletes at the University of Southern Mississippi (USM) and the University of Mississippi (UM). This study was approved by the University of Southern Mississippi Institutional Review Board and the University of Mississippi Institutional Review Board (Appendix B). Informed consent was obtained from participants before continuing to the survey questions.

Study Sample and Procedures

Participants

Data were collected from female student-athletes at USM and UM between January 23, 2023, and February 20, 2023. In this study, a purposive sample represented the two universities' female student-athlete populations and included any undergraduate students between 18 and 26 years of age. Participants were recruited through an email sent to all female athletes at each university, with the exceptions of the rifle team at The University of Mississippi and the beach volleyball team at The University of Southern Mississippi. These two teams were excluded because the sports were not offered at both schools. Teams included in the research were basketball, cross country, golf, soccer, softball, tennis, track and field, and volleyball.

Data Collection Survey

The survey was developed using the low-energy availability in females questionnaire (LEAF-Q) developed by Melin et al. (2014) and the body shape questionnaire (BSQ-16B) developed by Evans and Dolan (1993). The LEAF-Q is tested

and validated with 78% sensitivity and 90% specificity when classifying risk for the FAT (Melin et al., 2014). The LEAF-Q is a 25-item self-report questionnaire with three sections of questions related to injuries, gastrointestinal function, and menstrual function and use of contraceptives. Each question is scored on its own scale depending on the severity the response poses for the athlete's health. For instance, a response stating the athlete has never menstruated will carry a higher score than a response stating the athlete was 15 years or older. The first three items of the LEAF-Q focus on injury and if an injury has stopped the athlete from participating in competitions or training in the last year. The second section covers gastrointestinal function and includes four questions to determine the athlete's normal gastrointestinal function. The rest of the items on the LEAF-Q ask the athlete about her menstruation and the use of contraceptives. Scores below 8 indicate no risk of developing theFAT while scores of 8 and above indicate athletes are at risk of developing the FAT.

The BSQ-16B is tested and validated with test-retest reliability of .88 and internal consistency of .95 (Hudson, 2008; Pook et al., 2008). This 16-item self-report questionnaire is designed to assess concern over body shape and body dissatisfaction. The BSQ-16B is measured on a six-point scale from 1 (never) to 6 (always) with higher scores indicating greater body shape dissatisfaction.

Demographic questions were added to the survey and included age, race/ethnicity, college classification, selection of college attendance, selection of sport, history of nutrition education, and awareness of the FAT. Refer to Appendix C for the survey tool.

Data Collection

Participants were recruited to take the online survey during the spring 2023 semester through an email invitation. The survey was presented through the online platform Qualtrics to record and organize data as participants respond. Participants were informed that the survey is anonymous unless they choose to provide their contact information for a chance to enter the drawing for a gift card. However, upon data analysis, email addresses were dissociated from participants' responses by omitting it from the data file. Three reminder emails to recruit participation were sent to athletes at each school.

Data Analysis

Data analyses were conducted using IBM SPSS Statistics 25 software to compute frequencies, means, and cross-tabulations of female athlete triad risk among female student-athletes. Descriptive statistics were used to calculate frequencies of survey items. Chi-square Tests of Independence were used to determine associations between 1) at risk FAT athletes and education by a registered dietitian, and 2) at risk FAT athletes and body dissatisfaction. Student t-tests were calculated to examine significant differences between mean scale scores.

CHAPTER IV: RESULTS

A total of 52 participants were included in this study. Partial data were collected for 5 of these participants. The population was primarily white and non-Hispanic or Latino. The average age of participants was 20 years with freshmen and sophomores accounting for 59% of participants. Of the 47 participants who completed the entire survey, 30 were attending USM and 17 were attending UM. Demographics are presented in Table 1.

Table 1: Demographic Characteristics of Sample Study (*N = 47)*

Characteristic	*f*	%
Race		
Asian	1	2.1
Black or African American	7	14.9
White	37	78.7
Asian and White	1	2.1
Black or African American and White	1	2.1
Ethnicity		
Hispanic or Latino or Spanish origin	4	8.5
Not Hispanic or Latino or Spanish origin	43	91.5
College Classification		
Freshman	14	29.8
Sophomore	11	23.4
Junior	8	17.0
Senior	5	10.6
Graduate Student	9	19.1
College Attending		
The University of Southern Mississippi	30	63.8
The University of Mississippi	17	36.2
	M	*SD*
Age	20.2	1.46

The mean LEAF-Q score for the sample (N = 52) was 8.33, (SD = 18.61), which indicates risk for the FAT. There was a significant difference (p = 0.007) between LEAF-Q scores for female athletes at USM (M = 8.8) and female athletes at UM (M = 8.1). The risk for developing the FAT was distributed evenly across all college classifications. When asked about their awareness of the FAT, 46 of respondents selected, "Never heard of it." Regarding previous nutrition education, 47 reported previous nutrition education. Sixteen athletes selected education by a registered dietitian (RD), and 14 athletes selected college professor (nutrition course) as the primary source of nutrition education.

The relationship between female athletes at risk for the FAT and education by an RD was significant (χ^2 = 4.930, df = 1, p = .026). Those who were at risk were more likely to be educated by an RD (n = 12) compared to those who were not at risk (n = 4). No significant difference was found between those at risk for the FAT and body dissatisfaction. Results of the Chi-square Test of Independence are presented in Table 2.

Table 2: Relationship between At Risk for FAT and RD Education

	At risk	Not at risk
Educated by an RD	12	4
Not education by an RD	15	21

The sample was too small to calculate correlations for the sport played and risk for the FAT. Table 3 presents descriptive statistics for participation and mean scores for the LEAF-Q and BSQ-16B separated by sport and university for 47 participants as well as overall mean scores by university. Seven participants elected to skip the question asking to select the sport(s) she participates in, and five participants failed to complete

any demographics questions including sport and university. Participants were allowed to select more than one sport, and 11 participants selected two sports.

Table 3: Mean Scores for LEAF-Q and BSW by Sport and University (*N = 47)*

Sport	*n*	%	LEAF-Q *M*	*SD*	BSQ *M*	*SD*
Basketball	2	4.3	5.50	2.50	24.00	4.00
USM	1	2.1	3.00		20.00	
UM	1	2.1	8.00		28.00	
Golf	4	8.5	4.50	2.29	49.00	9.03
USM	4	8.5	4.50	2.29	49.00	9.03
UM						
Soccer	6	12.8	11.17	2.97	45.00	11.79
USM	5	10.6	12	2.53	47.00	11.95
UM	1	2.1	7.00		35.00	
Tennis	1	2.1	11.00		59.00	
USM	1	2.1	11.00		59.00	
UM						
Track and Field	9	19.1	9.11	3.64	45.89	18.81
USM	4	8.5	8.50	3.04	38.25	21.88
UM	5	10.6	9.60	3.98	52.00	13.04
Track and Field/Cross Country	10	21.3	9.40	2.58	33.4	11.50
USM	3	6.4	11.33	2.36	46.00	0.82
UM	7	14.9	8.57	2.19	28.00	9.58
Track and Field/Volleyball	1	2.1	3.00		40.00	
USM	1	21	3.00		40.00	
UM						
Volleyball	7	14.9	10.70	5.57	51.43	15.63
USM	6	12.8	12.00	4.97	51.83	16.85
UM	1	2.1	3.00		49.00	
No Sport Selected	7	14.9	5.71	2.76	41.86	17.88
USM	5	10.6	5.6	3.26	32.20	10.09
UM	2	4.3	6.0	0.00	66.00	7.00

University	*n*	%	LEAF-Q*	*SD*	BSQ	*SD*
USM	30	63.8	8.77	4.61	43.77	15.64
UM	17	36.2	8.12	3.08	41.18	16.97`

*Indicates $p < .05$.

CHAPTER V: DISCUSSION AND CONCLUSION

The purpose of this study was to assess the risk for developing the FAT in female athletes at UM and USM. The study explored athletes' awareness for the FAT, prior nutrition education, primary nutrition resource, relationship between risk for FAT and body satisfaction, history of nutrition education by an RD, sport(s) played, and university attendance. Overall, 51.9% of the sample (N = 52) was at risk for developing the FAT with USM having a significantly higher mean LEAF-Q score than UM (p = 0.007*)*. A higher mean LEAF-Q score indicates a greater number of participants at risk for developing the FAT, which could indicate the need for more nutrition education and nutrition interventions for the USM female athlete population.

The University of Mississippi employs a staff of dietitians to consult their various sports teams, and USM does not employ nutrition personnel for their athletics department. Sports dietitians are tasked with educating athletes on their needs, monitoring for disordered eating habits and weight loss, and creating intervention strategies when problems arise (Valliant, 2016). The present study showed that those who were at risk for the FAT were more likely to be educated by an RD than those who were not at risk for developing the FAT. This could be from closely monitoring female athletes for FAT signs and referring her to an RD for education, or it could show that nutrition education does not reduce FAT risk. However, 60.8% of athletes admitted that they never heard of the FAT, which may indicate that the prior nutrition education reported by 81% of the respondents did not include education related to the FAT.

There were no significant results found between sport and risk for the FAT, but soccer, volleyball, track and field, and track and field/cross country were the four teams

with the highest LEAF-Q scores. Of these four, track and field and track and field/cross country are considered leanness sports, which also have an increased occurrence of disordered eating as opposed to non-leanness sports (Gastrich et al., 2020). The current study and Gastrich et al.'s study both found that leanness sports have an increased occurrence of disordered eating. However, volleyball and soccer are not leanness sports, but they both were among the teams with the highest mean LEAF-Q scores. While volleyball is not a leanness sport, their uniforms are typically two-inch inseam spandex shorts and a tank top, which could lead to a higher concern for body shape potentially leading to low EA. Lastly, soccer is neither a leanness sport nor one with a revealing uniform, but the LEAF-Q mean was an 11.17, which was the highest team mean recorded. While there were no significant results found, soccer has the highest percent of internet resources as primary source of nutrition education and only 33% of soccer players reported an RD as the primary source of nutrition education.

There were no significant differences between LEAF-Q scores and BSQ-16B scores indicating no relationship between risk for developing the FAT and body dissatisfaction. This is consistent with previous research where body satisfaction and disordered eating were independent from one another (Blair et al., 2017). However, body satisfaction scores among college classification were highest in sophomores, which contradicts Blair et al.'s (2017) findings that freshmen had the highest body dissatisfaction. This provides rationale for more research on body satisfaction and disordered eating among different college classifications as this subject is not fully understood.

Findings from this study showed a high percentage of female athletes who received nutrition education, but the mean LEAF-Q score of the sample was classified as at risk. Secondly, this study provides evidence for targeting nutrition education on the FAT and monitoring for the FAT to freshmen and sophomores as they reported the greatest body LEAF-Q scores. While the majority of the athletes in this study at two Mississippi universities received nutrition education, the mean score indicated they were at risk for the FAT. A possible reason could be that athletes are not implementing the education due to various reasons (e.g., busy schedules, lack of time and resources) (REF). Therefore, more research is needed on the impact of nutrition education for female college athletes.

Strengths of this study include collecting data at two universities within the same state and NCAA Division I classification that would have similar resources available to athletes. Secondly, assessing the relationship between athletes who are at risk for the FAT and education by an RD has not been studied in the current literature and indicates a gap in the research. Additionally, participant responses were disassociated from email addresses, which encouraged participation and honest responses to sensitive questions. Lastly, the study's survey tool incorporated two tested and validated survey tools to collect quantitative data, which strengthens the reliability of the data collected.

Limitations to this study include a small sample size (18% response rate), although an incentive for participation was included in the recruitment email and several reminder emails were sent. Additionally, the survey did not include coaches as a primary source of nutrition knowledge. This is a limitation because nutrition education sometimes falls to coaches who do not have adequate knowledge of nutrition to give accurate and

evidence-based practice advice to athletes (Tilgner & Schiller, 1989). Data were collected through a self-report survey, and participants may have selected answers that are socially acceptable. Lastly, the data collection period at UM was shorter and during the busiest weeks of the spring semester for female athletes, which may have limited response rates despite the three reminder emails.

Further research is needed to develop effective nutrition education materials, intervention techniques, and monitoring tools on the FAT for registered dietitians to implement in practice with female athletes. Additionally, further research with a larger sample size would be beneficial to determine those athletes who may be at risk for developing the FAT and are in need of intervention.

APPENDIX A: IRB Approval Letter

Office *of*
Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

118 COLLEGE DRIVE #5116 • HATTIESBURG, MS | 601.266.6756 | WWW.USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident submission on InfoEd IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER:	23-0012
PROJECT TITLE:	Assessing Athletes' Risk for Developing the Female Athlete Triad at Two Mississippi Universities
SCHOOL/PROGRAM	Nutrition & Food Systems
RESEARCHERS:	PI: Laura Warren Investigators: Warren, Laura~Huye, Holly~
IRB COMMITTEE ACTION:	Approved
CATEGORY:	Expedited Category
PERIOD OF APPROVAL:	27-Jan-2023 to 26-Jan-2024

Donald Sacco

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX B: RECRUITMENT LETTER

Subject line: Female athlete research participation needed

Body:

Hello,

I am a Senior Honors College student working on my thesis about the female athlete triad. The purpose of this study is to assess the risk of female athletes at The University of Southern Mississippi and The University of Mississippi for developing the female athlete triad (FAT) and determine the correlation, if any, between risk for developing the FAT and access to nutrition resources, such as a dietitian or peer education programs. This data may provide nutritional professionals with a better understanding of the prevalence of the FAT and successful intervention strategies. The Institutional Review Board at The University of Southern Mississippi has approved this study (protocol number 23-0012).

Participation will take between 10-15 minutes and consists of an online survey. No information will be collected that could personally identify you. In appreciation for your time, I am offering a drawing for 25 $50 Amazon gift cards. At the end of the survey, you may enter an email address to enter the gift card giveaway. Your email address will be removed from your survey submission. Your participation is voluntary, and you may withdraw from the study at any time. By completing the survey, you may help us better understand how nutrition experts can help female athletes like you.

Thank you for your time and consideration. If you have any questions about the study, you can contact us by email listed below.

Click here to take the survey Assessing Athlete's Risk for Developing the Female Athlete Triad at Two Mississippi Universities

Sincerely,

Laura Grace Warren
The University of Southern Mississippi
Laura.warren@usm.edu

Dr. Holly Huye
Thesis Advisor
The University of Southern Mississippi
Holly.huye@usm.edu

APPENDIX C: SURVEY

The purpose of this study is to assess the risk of female athletes at The University of Southern Mississippi and The University of Mississippi for developing the female athlete triad (FAT) and determine the correlation, if any, between risk for developing the FAT and access to nutrition resources, such as a dietitian or peer education programs. This data may provide nutritional professionals with a better understanding of the prevalence of the FAT and successful intervention strategies.

Participation is voluntary and participants can choose to skip any question they are not comfortable with answering. Participation should take 10-15 minutes. Thank you for your time.

I understand that participation in this project is completely voluntary, and I may withdraw at any time without penalty, prejudice, or loss of benefits. Unless described above, all personal information will be kept strictly confidential, including my name and other identifying information. All procedures to be followed and their purposes were explained to me. Information was given about all benefits, risks, inconveniences, or discomforts that might be expects. Any new information may affect my willingness to continue participation in the project.

Consent to participate in research

By clicking the box below, I give my consent to participate in this research project. ***If you do not wish to participate in this study, please close your browser now.***

__ Yes, I consent to participate

Are you 18 years of age or older?

a. Yes

b. No (Survey ends)

For the following questions, please select one answer

1. Have you had absences from your training, or participation in competitions during the last year due to injuries?
    a. No, not at all
    b. Yes, once or twice
    c. Yes, three or four times
    d. Yes, five times or more
2. If yes, for how many days absence from training or participation in competition due to injuries have you had in the last year?
    a. 1-7 days
    b. 8-14 days
    c. 15-21 days
    d. 22 days or more
3. If yes, what kind of injuries have you had in the last year?

    For the following questions, please select one answer
4. Do you feel gaseous or bloated in the abdomen, also when you do not have your period?
    a. Yes, several times a day
    b. Yes, several times a week
    c. Yes, once or twice a week or more seldom

d. Rarely or never

5. Do you get cramps or stomach ache which cannot be related to your menstruation?
    a. Yes, several times a day
    b. Yes, several times a week
    c. Yes, once or twice a week or more seldom
    d. Rarely or never
6. How often do you have bowel movements on average?
    a. Several times a day
    b. Once a day
    c. Every second day
    d. Twice a week
    e. Once a week or more rarely
7. How would you describe your normal stool?
    a. Normal (soft)
    b. Diarrhea-like (watery)
    c. Hard and dry

For the following questions, please select one answer

8. Do you use oral contraceptives?
    a. Yes
    b. No
9. If yes, why do you use oral contraceptives?
    a. Contraception

b. Reduction of menstrual pains

c. Reduction of bleeding

d. To regulate the menstrual cycle in relation to performances etc.

e. Otherwise menstruation stops

f. Other

10. If no, have you used oral contraceptives earlier?

a. Yes

b. No

11. If yes, when and for how long?

12. Do you use any other kind of hormonal contraceptives? (e.g. hormonal implant or coil?

a. Yes

b. No

13. If yes, what kind?

a. Hormonal patches

b. Hormonal ring

c. Hormonal coil

d. Hormonal implant

e. Other

14. How old were you when you had your first period?

a. 11 years or younger

b. 12-14 years

c. 15 years or older

d. I don’t remember

e. I have never menstruated (if you have answered “I have never menstruated” there are no further questions to answer)

15. Did your first menstruation come naturally (by itself)?

a. Yes

b. No

c. I don’t remember

16. If no, what kind of treatment was used to start your menstrual cycle?

a. Hormonal treatment

b. Weight gain

c. Reduced amount of exercise

d. Other

17. Do you have normal menstruation?

a. Yes

b. No (go to question 23)

c. I don’t know (go to question 23)

18. If yes, when was your last period?

a. 0-4 weeks ago

b. 1-2 months ago

c. 3-4 months ago

d. 5 months ago or more

19. If yes, are your period regular? (every 28^{th} to 24^{th} day)

a. Yes, most of the time

b. No, mostly not

20. If yes, for how many days do you normally bleed?

a. 1-2 days

b. 3-4 days

c. 5-6 days

d. 7-8 days

e. 9 days or more

21. If yes, have you ever had problems with heavy menstrual bleeding?

a. Yes

b. No

22. If yes, how many period have you had during the last year?

a. 12 or more

b. 9-11

c. 6-8

d. 3-5

e. 0-2

23. If no or “I don’t remember,” when did you have your last period?

a. 2-3 months ago

b. 4-5 months ago

c. 6 months ago or more

d. I’m pregnant and therefore do not menstruate

24. Have your periods every stopped for 3 consecutive months or longer (besides pregnancy)?

a. No, never

b. Yes, it has happened before

c. Yes, that's the situation now

25. Do you experience that your menstruation changes when you increase exercise intensity, frequency, or duration?

    a. Yes

    b. No

26. If yes, how? (check one or more options)

    a. I bleed less

    b. I bleed fewer days

    c. My menstruation stops

    d. I bleed more

    e. I bleed more days

For the following questions, please select one answer that reflects your thoughts over the past 4 weeks.

27. Have you been so worried about your body shape that you have been feeling you ought to diet?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

28. Have you been afraid that you might become fat (or fatter)?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

29. Has feeling full (e.g., after eating a large meal) made you feel fat?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

30. Have you noticed the shape of other women and felt that your own shape compared unfavorably?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

31. Has thinking about your shape interfered with your ability to concentrate (e.g., while watching television, reading, listening to conversations)?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

32. Has being naked, such as when taking a bath, made you feel fat?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

33. Have you imagined cutting off fleshy areas of your body?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

34. Have you not gone out to social occasions (e.g., parties) because you have felt bad about your shape?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

35. Have you felt excessively large and rounded?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

36. Have you thought that you are in the shape you are because you lack self-control?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

37. Have you worried about other people seeing rolls of fat around your waist or stomach?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

38. When in company have you worried about taking up too much room (e.g., sitting on a sofa, or a bus seat)?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

39. Has seeing your reflection (e.g., in a mirror or shop window) made you feel bad about your shape?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

40. Have you pinched areas of your body to see how much fat there is?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

41. Have you avoided situations where people could see your body (e.g., communal changing rooms or swimming baths)?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

42. Have you ever been particularly self-conscious about your shape when in the company of other people?

1	2	3	4	5	6
Never	Rarely	Sometimes	Often	Very Often	Always

43. Please select your age:

    a. 18
    b. 19
    c. 20
    d. 21
    e. 22
    f. 23
    g. 24
    h. 25
    i. 26

44. Please select your race

    a. American Indian or Alaska Native
    b. Asian
    c. Black or African American
    d. Native Hawaiian or Other Pacific Islander

e. White

45. Please select your ethnicity:

a. Hispanic or Latino or Spanish Origin

b. Not Hispanic or Latino or Spanish Origin

46. Please select your college classification:

a. Freshman

b. Sophomore

c. Junior

d. Senior

e. Graduate Student

47. Please select the college you attend:

a. The University of Southern Mississippi

b. The University of Mississippi

48. Please select what sport you play:

a. Basketball

b. Cross country

c. Golf

d. Soccer

e. Softball

f. Tennis

g. Track & field

h. Volleyball

49. Have you previously been educated on nutrition?

a. Yes

b. No

50. If so, what was the primary resource?

a. Registered Dietitian

b. College Professor (Nutrition Course)

c. Internet resources

d. Primary care physician

51. What is your level of awareness of the Female Athlete Triad?

a. Never heard of it

b. I remember learning it, but cannot recall key details

c. I know the basics

d. I have in depth knowledge of it

52. Do you wish to include an email address to be entered into a drawing to win a $50 Amazon gift card?

a. Yes

b. No

53. If yes, enter email address here:

Disclaimer: If you feel that you may have an eating disorder, you can find treatment professionals in your area by contacting the National Eating Disorders Association (NEDA) Helpline Monday through Thursday, 9am-9pm or Friday 9am-5pm ET at (800) 931-2237 or www.nationaleatingdisorders.org/helplinechat. The University of Southern Mississippi's Student Counseling Services offers free and confidential mental health services to currently enrolled students and their office can be reached at (601) 266-4829. The national suicide hotline phone number is 988 and is available in 24 hours a day in English or Spanish.

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