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Female Athlete Triad: Evaluation of the Cumulative Risk Assessment Tool for Female Collegiate Athletes

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ABSTRACT

Content: As the pressure on collegiate and elite female athletes to perform at their highest possible capabilities has grown, so to have the consequences associated with their high energy expending lifestyles. The Female Athlete Triad (Triad) is a syndrome defined as having one or more of the following conditions: LEA with or without disordered eating, menstrual dysfunction, and/or low BMD. Due to potential long-term, irreversible health consequences of the Triad, the Female Athlete Triad Coalition developed a risk assessment tool known as the Triad CRA to identify at-risk athletes and subsequent return-to-play status. **Objective:** To determine the risk classification and return-to-play status for each female collegiate student-athlete according to the Triad CRA, and to examine the efficacy of the Triad CRA. **Design:** This was a retrospective study designed to investigate the efficacy of the Triad CRA. The data analyzed was part of a larger study.[56] **Setting:** Research laboratory. **Participants:** This study re-evaluated previously collected data from local female collegiate student-athletes (n = 125). The student-athletes included were from the disciplines of equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20), and ballet (n=28). **Interventions:** Independent variables included sport type. **Main Outcome Measures:** Dependent variables included Triad CRA classifications (low, moderate, high) and corresponding return-to-play status (full clearance, provisional clearance, restricted from training). **Results:** Overall, significant differences were found between sport type and CRA scores ($P = .035$) and LEA with or without an ED risk ($P \leq 0.01$). For LEA with or without ED risk, 2.4% (n=3/125) of student-athletes were classified as low risk, 34.4% (n=43/125) were moderate risk, and 63.2% (n=79/125) were high risk. Significant differences were also found between return-to-play status and sport type ($P = .045$). Full clearance was given to 24.0% (n=30/125) of athletes, provisional/ limited clearance was

given to 74.4% (n=93/125) and restricted from training and competing was given to 1.6% (n=2/125). **Conclusion:** Since it was predicted that the majority of the study's female student-athletes would be placed in the moderate risk category, the hypothesis was supported because 74.4% of student-athletes were assigned moderate risk (provisional clearance). Another important finding was that 34.4% of all athletes had moderate risk and 63.2% of athletes had high risk for LEA with or without ED risk. Since LEA with or without ED risk has been shown to have potential long-term, irreversible health consequences, an athlete could be considered high risk and suffer future medical consequences without having a clinical ED diagnosis and, therefore, it should not be used as criteria in the Triad CRA. Lastly, any athlete classified as moderate or high risk warrants greater surveillance and further investigation into their health status before healthcare providers can confidently allow them a safe, full clearance on training and competing.

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List of Abbreviations

BMD	Bone Mineral Density
BMI	Body Mass Index
CAT	Clinical Assessment Tool
CRA	Cumulative Risk Assessment
DE	Disordered Eating
EA	Energy Availability
ED	Eating Disorder
EEE	Exercise Energy Expenditure
EI	Energy Intake
FFM	Fat Free Mass
LEA	Low Energy Availability
RED-S	Relative Energy Deficiency in Sports
Triad	Female Athlete Triad

FEMALE ATHLETE TRIAD: EVALUATION OF THE CUMULATIVE RISK ASSESSMENT TOOL FOR FEMALE COLLEGIATE ATHLETES

CHAPTER I

INTRODUCTION

The Female Athlete Triad (Triad) is a syndrome related to low energy availability (LEA) that affects female athletes worldwide and can be caused either intentionally or unintentionally by the athlete.[1,2] In 2007, the American College of Sports Medicine released a statement and officially defined the Triad as having one or more of the following conditions: LEA (with or without disordered eating), menstrual dysfunction, or low bone mineral density (BMD).[1] Energy availability (EA) is the amount of energy a person's body has to perform its normal physiological functions and is calculated by taking a person's dietary intake and subtracting their exercise energy expenditure (EEE) from it.[60] When EA levels below 30 kcal/kg of fat free mass (FFM) are sustained for long periods of time, the person can potentially suffer long-term, irreversible health consequences to almost all of their organ systems.[1,2] For this reason, LEA is a dangerous condition and justifies the need to limit an athlete's participation when they are identified as having it, that way they can take time to raise their EA back to a normal physiological level that can properly sustain their body's needs.

Over the last 3 decades, researchers have extensively studied the Triad and as a result the Female Athlete Triad Coalition developed a risk assessment tool known as the Triad Cumulative Risk Assessment (Triad CRA) to identify at-risk athletes.[2] The Triad CRA classifies the athlete as either high, moderate, or low risk by examining 6 different factors and giving each athlete a numerical point value that places them in their respective risk category.[2] An athlete who is assigned the low risk category is given full clearance to compete and practice.[2] Those who are

given a moderate risk classification are given provisional/ limited clearance and those who are determined to be high risk are restricted from all training and competing.[2]

Due to the creation of other LEA risk assessment tools, such as the Relative Energy Deficiency in Sports (RED-S) Clinical Assessment Tool (CAT),[3] there is currently a sense of ambiguity among clinicians as to which tool should be used in order to most accurately predict an athlete's risk for injury and other future medical consequences. By determining the most effective tool for risk classification for female athletes, medical professionals can properly decide on whether or not it is safe for an athlete to be practicing/ competing, and therefore potentially prevent future injuries. The purpose of this project is to determine the risk classification and return-to-play status for each female collegiate student-athlete according to the Triad CRA. It was hypothesized that there will be more student-athletes assigned to the moderate risk category of the CRA than the low or high-risk categories.

CHAPTER II

LITERATURE REVIEW

Introduction

The Triad has been extensively studied over the past few decades and has been identified as a strong predictor of decrements in performance and future injuries among female athletes.[1] However, a large proportion of female athletes and health care providers do not understand this condition and its negative implications on future health.[50, 51, 52] There have also been recent objections to the Triad model and calls to make it encompass a wider range of physiological issues caused by LEA.[3] The purpose of this study is to investigate how restrictive the Triad CRA is by using 6 distinct risk factors to determine an athlete's return-to-play status, in order to keep female athletes safer while training and competing.

Female Athlete Triad (Triad)

As previously mentioned, the Triad is a complex condition that involves LEA with or without disordered eating (DE) or an eating disorder (ED), menstrual disturbances, or low BMD.[1,2] However, only one of these underlying components is needed for an athlete to be diagnosed with the condition. Additionally, researchers believe that LEA may be the underlying cause of the two other components of the Triad, since menstruation and BMD are restored once energy availability is normalized.[1,2,3] It is important to understand that all 3 components of the Triad are on a spectrum with EA ranging from optimal EA to LEA with or without DE/ED, menstrual health ranging from eumenorrhea to hypothalamic amenorrhea, and bone mineral density ranging from optimal bone health to osteoporosis.[2, 18] Since the Triad is on a spectrum from healthy to undetected subclinical and noticeable clinical conditions, it highlights the importance of identifying athletes with subclinical abnormalities, which will allow for earlier

intervention and prevention for the athlete from developing a clinical condition with more severe health consequences.[2]

Low Energy Availability with or without DE/ED

It has been established that in healthy women optimal energy availability occurs around 45 kcal/kg fat free mass (FFM) per day.[60] Clinical LEA appears when an athlete has less than 30 kcal/kg FFM available to support the normal physiological functions of their body.[1,2,61] Subclinical LEA occurs when EA is between 30 and 45 kcal/kg FFM per day.[1,2,61]When these systems do not have enough dietary energy to support their functions, it can lead to long-term medical consequences such as impaired cardiovascular, endocrine, reproductive, skeletal, gastrointestinal, renal, and/or central nervous systems, and the individual's mental health.[1,2] It is also important to note that LEA can be caused either intentionally (i.e., DE, clinically diagnosed ED, intentional weight loss without DE, or inadvertent undereating)[2] or unintentionally by the athlete.[1-3] Unintentional LEA occurs when the athlete does not know how much energy they are burning during exercise nor the amount of dietary energy needed to meet these energy demands. Conversely, intentional LEA occurs when an athlete either lowers their energy intake (EI) by intentionally eating less or when they intentionally raise their EEE to exceed their EI.[2]

Due to the rise of ED prevalence among teenagers, especially elite adolescent athletes, the concern around athletes' eating behaviors has grown recently.[16,17] The prevalence of eating disorders such as anorexia nervosa or bulimia nervosa in elite athletes was found to be 13.5%, whereas in nonathletes it was 3.1%.[17] This demonstrates athletes may be more susceptible than the general population to developing an ED and thus suffering from LEA. Additionally, athletes who have the highest risk for DE or a clinical ED are those in sports emphasizing a thin body shape, a high power-to-weight ratio, and/or those utilizing weight categories.[53] Since athletes

participate in training and eating patterns that are unique from the general population, the concept of anorexia athletica was created to identify eating disorders among athletes who do not meet the diagnostic criteria of traditional anorexia nervosa or bulimia nervosa.[54] It was found that when examining pre-professional ballet dancers, 1.9% were diagnosed with a clinical ED yet 5.8% were diagnosed with anorexia athletica.[55] This supports the notion that athletes may be experiencing a higher prevalence of DE than what is typically reported and this should be taken into account when screening athletes for Triad components.

Menstrual Cycle Disturbances

Women suffering from the Triad can have their menstrual health affected in many ways including delayed menarche, subclinical menstrual disorders, oligomenorrhea, and amenorrhea.[1] Oligomenorrhea occurs when the time between menstrual cycles is longer than 35 days and amenorrhea occurs when an individual does not begin menstruation by age 15 or when an individual who was previously menstruating ceases to have a menstrual cycle for more than 3 months.[22] It is estimated that a quarter of active women experience some form of menstrual cycle dysfunction, regardless of sport type.[20]

Reductions in EA below 30 kcal/kg of FFM per day for as short as 5 days have been shown to slow the normal pulse frequency of luteinizing hormone (LH) which is associated with delays in folliculogenesis, luteal phase shortening, and other severe menstrual disturbances.[5,6] Previous studies have also shown that reduced LH pulse frequency occurs regardless of whether the decrease in EA is from diet, exercise, or both.[7] Furthermore, studies have shown that although no clear threshold for EA exists at which ovarian function is disturbed, there is a linear relationship between EA and risk of menstrual dysfunction, and that when EA is below 30 kcal/kg of free fat mass the risk for menstrual cycle disturbances increases to 50% or higher.[15]

Although extensive research has been conducted to study the relationship between LEA and menstrual dysfunction, it is not currently known as to what magnitude of change in LH pulsatility is needed to induce the menstrual cycle disturbances associated with the Triad.[14]

Bone Mineral Density (BMD)

Energy availability is also important for maintaining skeletal health. Evidence has shown that LEA can be associated with altered bone parameters independent of estrogen status,[8,9] and can affect bone-related hormones.[10,11,12,13] Within 5 days of the onset of LEA, bone formation by osteoblasts begins to be impaired and during extreme energy restriction (10 kcal/kg of free fat mass per day) the balance of bone remodeling between osteoclasts and osteoblasts will become further altered due to the increase in bone resorption.[10]

Since osteoporosis usually refers to a bone strength condition in postmenopausal women where they are predisposed to a higher risk of fracture, the International Society for Clinical Densitometry uses Z scores to express the bone health of children and premenopausal women.[18] To diagnose osteoporosis for this population, the individual must have both a fracture history and low BMD, which is a Z score below -2.0 for their age and gender group.[23] However, athletes have 5-15% higher BMD than nonathletes;[24] therefore, the American College of Sports Medicine has defined low BMD in athletes to be BMD Z score from -1.0 to -2.0 and osteoporosis as BMD Z score less than -2.0 with the presence of secondary clinical risk factors.[1] Additionally, the interrelatedness of the Triad components is further supported since research has shown that a history of disordered eating and menstrual dysfunction can increase the risk of low BMD for athletes.[23] Finally, BMD is an extremely important component for adolescents, as this is a critical period in life for bone mass accumulation and exercise-induced low BMD may cause individuals

to not reach their potential biological peak bone mass, which puts them at a higher risk of stress fractures for the rest of their lives.[1,25]

Health Consequences of the Triad

One major consequence seen in amenorrheic athletes experiencing energy deficits is the presence of impaired endothelial function due to hypoestrogenism which increases the risk of developing cardiovascular disease in the future.[26,27,46] Next, energy deficiency negatively impacts exercise performance because it causes maximal oxygen consumption (VO_2 max) to decrease by as much as 28% for elite female athletes.[28] Further research has found that high school athletes with DE are twice as likely to suffer a musculoskeletal injury.[29] Similarly, research has shown that LEA may affect the durability of tissues such as muscle, tendon, and ligaments, which puts athletes at higher risk for nonfracture injuries.[48,49] Also, it was found athletes in a study who were classified as high risk were 3.8 times more likely to suffer a prospective bone stress injury than those who were classified as low risk.[45] Another study found LEA causes hormone disruptions which were characterized by suppressed metabolic and reproductive hormones, suppressed bone formation, and increased bone resorption.[7,10,11] LEA was also identified to have a causal role in the initiation of exercise-associated menstrual dysfunction.[6] Amenorrheic athletes have also been shown to have the most unfavorable lipid profile (higher total cholesterol and LDL) compared with oligomenorrheic and eumenorrheic athletes.[47] Other medical complications of the Triad can include disorders that affect the endocrine, gastrointestinal, renal, and neuropsychiatric systems.[1,46]

Prevalence in Athletes

Previous studies have shown that among US high school and collegiate female athletes, the prevalence of having all 3 Triad components is estimated to range from 0-1.2%.[19,20,21] However, a more recent meta-analysis on the prevalence of the individual Triad components among athletes across all

levels reported that 0-15.9% exhibited all 3 conditions, 2.7-27% exhibited any 2 of the conditions, and 16-60% exhibited 1 of the conditions.[4] Furthermore, LEA has been shown to be the most prevalent Triad component among female athletes and is the suspected underlying cause for the physiological changes to the reproductive system and bone seen with the Triad.[1,2,3] Sport type also plays a huge role in determining the prevalence of the Triad. For athletes who compete in "lean sports" such as ballet, gymnastics, or endurance running, the prevalence of the Triad is 2 to 3 times higher than it is for athletes who compete in non-lean sports.[1]

Prevention, Screening, and Treatment of the Triad

Proper prevention of the Triad requires understanding and recognizing its warning signs early. Warning signs that athletes, coaches, athletic trainers, and physicians should all be able to recognize in an athlete include decline in performance, weight loss, mood changes, frequent illness or injury, stress fractures, and dissatisfaction with body size or image.[18] The most convenient time to screen athletes for the Triad is through a yearly preparticipation evaluation (PPE) since it is required for sports participation at the collegiate and high school levels.[1,30] The Triad Coalition has created their own set of screening recommendations for PPE that includes a 12-item questionnaire.[31] However, over half of NCAA Division I universities use forms missing more than 50% of the recommended screening items.[32] Furthermore, the current PPE form endorsed by the American Academy of Pediatrics (AAP), American Academy of Family Physicians, and American College of Sports Medicine only contains 7 of the 12 recommended screening items,[32,33] and most of the omitted questions are those concerning disordered eating. This is a major issue and one that needs to be resolved urgently in order to protect the health of female athletes. As recognition of the Triad and its components is becoming more common in female athletes, the need for a standardized PPE containing all 12 recommended screening items is crucial in order to properly identify at risk athletes and prevent sequela associated with the

Triad.[1,31] It is also important to recognize that an athlete who is at risk for or experiencing 1 of the Triad components needs to be evaluated for all 3 components.[18]

In order to treat the sequela of LEA, such as menstrual cycle disturbances and low BMD, a firm understanding of LEA etiology is needed. The Triad Coalition Consensus Statement has identified the following four pathways as causes of LEA: disordered eating (DE), clinical eating disorder (ED), weight loss without DE, and inadvertent undereating.[2] In order to prevent and treat all four of these possible causes, nutritional education is needed. Treatment of DE requires medical attention, while treatment of a clinical ED requires medical and psychological interventions. Unfortunately, the degree to which inadvertent undereating contributes to the Triad is unclear; possible causes for it could include limited access to or affordability of food.[14]

Treatment of the Triad also requires a multidisciplinary approach and should involve consultations with a physician, a registered dietitian, and, if an ED is diagnosed, a mental health professional.[34,35] Physical therapists, coaches, and family members can also play an important role in supporting the athlete during treatment.[1] Additionally, strong evidence suggests that in order to successfully treat the Triad, the athlete must increase their EA by either increasing their dietary intake or decreasing their EEE, which will consequently restore both menstrual function and increase BMD.[1,36,37] The current recommended energy intake for active women is 2300 to 3000 kcal per day.[38,39] For athletes experiencing severe DE, athletes diagnosed with a clinical ED, and those who refuse to comply with recommendations, it is advised to have a mental health professional involved in their treatment.[1,35] Also, the use of individual psychotherapy, cognitive behavioral therapy, and family therapy have all been shown to be beneficial in treating the Triad, with family therapy being particularly useful for treatment of young athletes.[40]

Pharmacological treatments such as antidepressants and anxiolytics prescribed by mental health professionals can be used to treat EDs for individuals diagnosed with the Triad.[1] Taking calcium and vitamin D supplements can help to improve skeletal health and to prevent stress fractures in athletes.[1,41,42] Oral contraceptives have not been shown to be a consistently effective treatment for improving BMD without also increasing EA in women with exercise-induced amenorrhea.[43,44] All injuries must be completely healed and the athlete must receive approval from a physical therapist or physician before resuming their training.[1,35]

Triad Cumulative Risk Assessment (CRA)

The risk assessment tool created by the Female Athlete Triad Coalition in 2014 is known as the Cumulative Risk Assessment (CRA). It identifies 6 different risk factors that are used to determine if an athlete is at low, moderate, or high risk for developing the Triad. The risk factors that it examines are Low EA with or without DE/ED, Low Body Mass Index (BMI), Delayed Menarche, Oligomenorrhea/amenorrhea, Low BMD, and Stress Fractures. For each risk factor there are specific criteria that places the athlete at either low, moderate, or high risk for that particular condition and the athlete is given either 0, 1, or 2 points per category, respectively. Therefore, the minimum number of points an athlete could have is 0 and the maximum would be 12. The number of points the athlete has is then used to determine their return-to-play status. An athlete with a cumulative score of 0-1 point is given full clearance. An athlete with a cumulative score of 2-5 points is given provisional/ limited clearance which means their training will be modified as specified by a physician with the possibility of status changing depending on their clinical progress. Finally, an athlete with a cumulative score $\geq$ 6 points is restricted from training/ competition at the present time or disqualified from play due to it being deemed unsafe by a medical professional. It is recommended by the Consensus Panel that anyone diagnosed

with anorexia nervosa or moderate-to-severe bulimia nervosa should be disqualified from training and competition and seek immediate treatment from a multidisciplinary team.[2]

Conclusion

Even after decades of extensive research, there are still many areas of the Triad and its components that are not well understood and require further investigation. It is a complex condition that can affect females of all ages in every sport. The 3 components are all on spectrums and an athlete at risk or experiencing subclinical or clinical conditions of 1 category need to be evaluated for all 3 components. LEA appears to be the underlying problem behind many of the physiological disorders associated with the Triad, thus interventions should be aimed at correcting it through increased DI or decreased EEE. The known health consequences of the Triad range from those that are seen early on such as menstrual dysfunction to those that may not appear for decades such as endothelial dysfunction and subsequent cardiovascular disease. The Triad CRA is the tool currently being used to identify athletes who are at risk for or already experiencing components of the Triad. It examines 6 risk factors and classifies an athlete as either low, moderate, or high risk for that category and uses a cumulative point scale to determine an athlete's subsequent return-to-play status. A multidisciplinary approach involving physicians, dietitians, psychiatrists, athletic trainers, coaches, and even family members is needed to effectively treat an athlete suffering from the Triad or one of its components. Additionally, a major issue is the lack of standardized screening for the Triad and the inadequacy of those currently being used at both the high school and collegiate levels. Ultimately, the most urgent need is to raise education of what the Triad is and what its warning signs are in order to prevent its onset or facilitate earlier detection and intervention.

CHAPTER III

METHODS

Study Design

This was a retrospective study designed to examine the efficacy of the Triad CRA. The data analyzed was part of a larger study.[56] Independent variables included sport type. Dependent variables included Triad CRA classifications (low, moderate, high) and corresponding return-to-play status.

Participants

This study included the re-evaluation of local female collegiate student-athletes' (n = 125; 19.8 ± 2.01 years) previously collected data. The student-athletes included are from the disciplines of equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20), and ballet (n=28). To be included in the study, student-athletes had to have participated in a previous study in press, and researchers were able to link study data to medical/injury data from the sports medicine clinic.[56] Student-athletes with a significant amount of missing medical/injury data were excluded from this study. The University of South Carolina's Institutional Review Board approved the original study as well as provided approval to retrospectively use old medical records from the participants athletic training clinic documents.

Instruments

Previously Collected Data: Basic demographic information included but was not limited to age, sport type, anthropometric measurements (e.g., height, weight, body fat percent, BMI, fat free mass, etc.), eating disorder risk (Eating Disorder Inventory-3 and Symptoms Checklist), 7-day dietary intake and exercise logs used to determine EA (ESHA food processor 8.0, Salem,

OR), bone mineral density (via Dual-Energy X-ray Absorptiometry-DXA), age of menarche, menstrual status, and self-reported injury and medical history.[56]

Medical Record Data: Medical records were accessed using the electronic system Athena and digitized medical charts. All medical records were deidentified for data analysis and recoded with an identification number. In addition to anthropometric measurements, the participants' age, bloodwork, number and location of injury, previous/current dieting, menstrual history, and current medication were recorded. This data was then used to classify each student-athlete using the Triad CRA.

Triad Cumulative Risk Assessment (Triad CRA): The Triad CRA was used to identify risk classification for all female student-athletes. For each student-athlete, the Triad CRA scored the following 6 risk factors: LEA with or without an ED risk, low BMI, delayed menarche, amenorrhea/oligomenorrhea, low BMD and stress reaction/fracture history.[2] The evaluation criteria used in this study are presented in Table 1. Each athlete's overall raw score was then used to categorize the athlete's return-to-play status as either high (restricted from training), moderate (provisional/limited clearance), or low (full clearance).

Study Procedures

The original study received approval from the Institution Review Board from the University of South Carolina. All variables mentioned above in the instrument section were analyzed for statistical significance. The data was then coded and used to identify risk classification on the Triad CRA according to its guidelines.[2] After calculating each athlete's raw cumulative score, the athlete's return-to-play status was determined to be either full clearance, provisional/ limited clearance, or restricted from training.

Data Analysis

SPSS statistical software (Version 27; SPSS Inc, Armonk, NY) was used for all analyses. We calculated power using G*Power software 3.1.9.4. This study used an alpha of .05 and had a moderate effect size. The power calculation indicated that a sample of 80 subjects was needed, with estimated power of 0.95. This study used 125 collegiate athletes; therefore, the study met power expectations. Descriptive statistics (mean and standard deviations) were calculated for age, weight, height, BMI, body fat percentage, fat free mass, EA, and BMD Z-Score. Frequencies were calculated for within each sport type, as well as across all sports. Next, all data was recoded to reflect a standardized categorization for comparisons [high (restricted from training), moderate (provisional/limited clearance), or low (full clearance)]. A Chi square analysis was used to examine relationships between classification risk (high, moderate, and low) and sport type (equestrian, volleyball, softball, beach volleyball, soccer, ballet). Significance level was set at $P < 0.05$ for all analyses.

CHAPTER IV

RESULTS

Results

This study initially examined 127 female collegiate athletes for Triad components; however, final results only included data from 125 athletes due to incomplete data from 2 of the initial participants. First, demographic information was collected on age, height, weight, BMI, body fat percent, fat free mass, EA, and BMD Z-score which is shown in Table 2. Next, Table 3 shows the mean raw scores and standard deviations of the Triad CRA risk factors for each sport and for all athletes. However, BMD Z-scores were classified as low risk (0 points) for all 125 participants and for this reason the data was not included in Table 3. Finally, Table 4 displays a breakdown of risk categorization (low, moderate, high) for each Triad CRA risk factor by sport, which is expressed as the number of athletes and the relative percent. The number and percent of athletes who were given full clearance, provisional clearance, or restricted from training is also shown for each sport in Table 4. Similar to Table 3, BMD data was not reported in Table 4 since 100% of athletes were classified as low risk.

Triad CRA Scores for All Athletes and by Sport

Overall significant differences were found between sport type and the Cumulative Risk scores ($F_{5,124}$=2.481, P = .035) and LEA with or without an ED risk ($F_{5,124}$=6.987, P ≤ .01). Softball displayed the highest cumulative score (2.76 ± 1.25) with the lowest score being soccer (1.70 ± 1.17). When examining scores for LEA with or without an ED, softball also displayed the highest score (1.88 ± 0.33) with the lowest score being from soccer (1.05 ± .046). No significant differences were found across Low BMI ($F_{5,124}$=1.325, P = .258), Delayed menarche ($F_{5,124}$=0.886, P = .493), Amenorrhea/Oligomenorrhea ($F_{5,124}$=0.704, P = .622), and Stress

reaction/fractures ($F_{5,124}$=1.710, P = .138). Data for mean Triad CRA scores and standard deviation by sport can be found in Table 3.

Risk Classification and Return-to-Play Status for All Athletes and by Sport

Overall, significant differences were found between LEA with or without ED risk and sport type ($\chi^2_{10,125} = 32.45$, $p \leq .01$), with 2.4% (n=3/125) of student-athletes being low risk, 34.4% (n=43/125) being moderate risk, and 63.2% (n=79/125) being high risk. Figure 1 illustrates the data for risk categorization for LEA with or without ED by sport. Significant differences were also found for return-to-play status and sport type ($\chi^2_{10,125} = 18.679$, $p = .045$). Overall, full clearance was given to 24.0% (n=30/125) of all athletes, provisional/ limited clearance was given to 74.4% (n=93/125) and restricted from training and competing was given to 1.6% (n=2/125). Figure 2 illustrates the data for return-to-play status by sport.

No significant differences were found for sport type and low BMI ($\chi^2_{5,125} = 6.594$, $p = .253$), delayed menarche ($\chi^2_{10,125} = 10.77$, $p = .376$), amenorrhea/oligomenorrhea ($\chi^2_{10,125} = 6.712$, $p = .752$), and stress reaction/fractures ($\chi^2_{10,125} = 11.85$, $p = .295$). For BMI, out of all 125 athletes 96.0% (n=120/125) were low risk and 4.0% (n=5/125) were moderate risk. For delayed menarche, across all athletes 80.8% (n=101/125) were low risk, 11.2% (n=14/125) were moderate risk, and 8.0% (10/125) were high risk. For all athletes, amenorrhea/ oligomenorrhea had 69.6% (n=87/125) low risk, 17.6% (n=22/125) moderate risk, and 12.8% (n=16/125) high risk. Lastly, for history of stress reactions/ fractures, 96.8% (n=121/125) of all athletes were low risk, 1.6% (n=2/125) were moderate risk, and 1.6% (n=2/125) were high risk. Finally, 100% of our student-athletes were at low risk for low BMD.

CHAPTER V

DISCUSSION AND CONCLUSION

This study was designed to examine the efficacy of the Triad CRA and to use its guidelines to determine the risk classification and return-to-play status for female collegiate student-athletes. The results of this study demonstrate that LEA with or without ED risk is an issue that an overwhelming majority of female student-athletes may be facing. Additionally, significant differences were found between sport and mean cumulative risk score, as well as between sport and return-to-play status. This study may be useful for others trying to study the complexity of the Triad and to identify women's collegiate sports that require greater vigilance from clinicians and other health professionals.

Triad CRA Scores for Athletes

The overall mean cumulative score of all athletes examined using the Triad CRA was 2.40 points out of a total possible 12 points. Not surprisingly, the LEA risk factor contributed the most to that mean with an average score across all teams of 1.61 points out of a possible 2 points, which is consistent with other studies.[63,66] This indicates that the vast majority of athletes were identified as either moderate or high risk for that particular factor. Since we had data calculated for every athlete's EA, this study was able to use criteria that were slightly different for assessing LEA with or without ED risk than what the Triad CRA normally uses. This study defined low risk as not having LEA or being at risk for an ED, moderate risk as having LEA or being at risk for an ED, and high risk as having LEA and being at risk for an ED (Table 1). The Triad CRA traditionally only categorizes an athlete as high risk for LEA if they have been clinically diagnosed with an ED;[2] however, the American College of Sports Medicine has emphasized that any study requiring a diagnosed ED for high-risk classification will underestimate the prevalence

of LEA.[1] Thus, our methodology for assessing this specific risk factor may be more accurate than the currently used model. Additionally, the results across all sports for LEA with or without ED were found to be significant. Softball was found to have the highest mean at 1.88 points and soccer had the lowest mean at 1.05. The results for cumulative risk score across all sports were also found to be significant. Once again, softball had the highest mean cumulative risk score at 2.76 points and soccer had the lowest mean cumulative risk score at 1.70 points.

Some other important results to note, although not significant, appeared for the low BMI and stress reactions/ fractures categories. Ballet and equestrian were the only sports to have a mean score above 0 for the low BMI risk factor. This could potentially be because they are aesthetic sports and there is a higher drive for thinness in these types of sports. Additionally, equestrian and volleyball were the only 2 sports to have a mean score above 0 for the history of stress reactions/ fractures category. Finally, it is important to note that 100% of athletes in this study were found to have low risk for BMD and therefore the mean score for that category across all sports was 0 points. This was unexpected since previous findings among a similar population of athletes had 27.0% in the moderate risk category and 14.6% in the high-risk category for BMD.[63]

Risk Classification and Return-to-Play Status

The only significant results from this portion of the study came when comparing risk classification for LEA with or without ED risk and return-to-play status across all sports. When examining LEA with or without ED risk across all athletes, 2.4% were classified as low risk, 34.4% were classified as moderate risk, and 63.2% were classified as high risk. These results are similar to a previous study that found that 52% of collegiate NCAA Division I track and field female athletes were identified with clinical LEA.[64] However, the prevalence of LEA with or

without disordered eating patterns has been shown to vary greatly between studies.[65] When looking at each individual sport, soccer had 15% of their team classified as low risk for LEA with or without ED but no other sport had any athletes classified as low risk. For the high risk classification, softball had the highest percent at 88.2% of team members and soccer had the lowest percent at 20% of team members. These results were surprising since previous studies have shown that athletes in lean or aesthetic sports, such as ballet and equestrian, are at the highest risk for LEA.[18] Other studies have also shown a significant association between drive for thinness and LEA.[57,58] Yet our study found softball players, who had the highest average weight and BMI, to have the highest percent of players at risk for having LEA with or without ED risk (Table 4). This supports the notion that body weight and body composition should not confidently be used to assess energy balance and energy availability,[59,60,62] and that all female collegiate athletes- not just those in lean or aesthetic sports- should be screened thoroughly for the Triad.[1]

Although the results for low BMI risk were not significant, it was interesting to see that 96% of all athletes had a healthy BMI and only 4% had a moderately low BMI. Equestrian had 10.3% of team members in the moderate risk category and ballet had 7.1% in the moderate risk category. As previously mentioned, these are aesthetic sports which could be a potential reason that these results were seen. All other teams had 100% of their athletes in the low-risk category. Holtzman et al. also found that for their study participants of the 6 risk factors, low BMI was the least common risk factor,[63] and for our study it was the second least common behind low BMD.

The results for delayed menarche and amenorrhea/oligomenorrhea were also found to be not significant. Across all athletes, 8.0% were found to be in high risk for delayed menarche and 12.8% were at high risk for amenorrhea/oligomenorrhea. These results were somewhat similar to

another study that found 6.2% of their female athletes to be at high risk for delayed menarche and 26.5% to be at high risk for amenorrhea/ oligomenorrhea.[63]

Results for history of stress reactions/ fractures were also not significant but an interesting finding was that equestrian was the only sport to have athletes in the high-risk category, at 6.9% of their team. For moderate risk, equestrian had 3.4% of their team and volleyball had 7.7%. All other sports had 100% of team members in the low-risk category for this factor. These findings suggest that equestrian and volleyball athletes may have an elevated risk for developing a bone stress injury, even when they have normal BMD Z-scores.

Finally, when examining return-to-play status across all sports, 24.0% received full clearance, 74.4% received provisional/ limited clearance, and 1.6% were restricted from training/ competing. These results were found to be significant. Previous research conducted on female athletes aged 15-30 years found that 54.7% of athletes received provisional clearance and 7.9% were restricted from training.[63] The previous findings are slightly different than our own, however, in that study as well as ours the majority of athletes landed in the moderate risk category. Softball and ballet were the only sports that had an athlete classified as restricted from play, which represented 5.9% and 3.6% of their teams, respectively. When comparing provisional clearance classification by sport, softball had the highest percent at 88.2% and soccer had the lowest percent at 45%. The reverse was true for full clearance classification with softball having only 5.9% of team members and soccer having 55% of team members in that category.

Limitations

Although this study found significant differences for LEA with or without ED risk, Triad CRA score, and return-to-play status between all sports, certain limitations should be acknowledged. First, it is our assumption that athletes accurately and truthfully provided all of

their self-reported data such as food and exercise logs (which were used to calculate EA) and injury history. It is possible that our student-athletes either intentionally or unintentionally underestimated their EI, which could be a possible explanation for why the vast majority of student-athletes were recognized as having subclinical or clinical LEA. Next, we did not have DXA scans for volleyball or beach volleyball players and thus could not determine their BMD Z-score. Therefore, in order to calculate their risk for low BMD we had to go off of their medical records of stress injuries and fractures. We did not find any stress injuries or fractures to high-risk areas for any of those athletes and we concluded that they would all be classified as low risk for low BMD. Next, many of the medical records used were missing data, which could have impacted risk classification. Also, for the DXA scans we used full body scans instead of segmental scans so the Z-score could have differed depending on what type of scan was used. Finally, our data cannot be widely generalized to all female student-athletes since it came from sports teams at the same school and it is possible that results at other schools could vary due to differences in their school's training or nutrition programs for athletes.

Future Research

Future research should focus on investigating reasons for differences in Triad component outcomes between sports and examining if differences in conditioning or nutrition programs could be a factor behind why certain sports teams at the same school appear to have more athletes at risk than others. This study is also a precursor to a future study that will be comparing risk classification of student-athletes using the Triad CRA versus risk classification using the RED-S CAT in order to investigate differences between the tools and determine which is a more accurate predictor of risk and which should be the standard tool used by healthcare professionals.

Clinical Significance and Conclusion

Despite certain limitations, the Triad CRA provides health care professionals an easy tool to quickly screen female athletes for Triad components. Our hypothesis was supported since we expected the majority of student-athletes to be assigned the moderate risk category (provisional clearance) and 74.4% were placed there. Another important finding was that 34.4% of all athletes had moderate risk and 63.2% of athletes had high risk for LEA with or without ED risk. Additionally, the goal was to examine the efficacy of the Triad CRA as a risk assessment tool in order to keep female athletes safer while training and to provide clinicians with more evidence on outcomes for the assessment tool. Since LEA with or without ED risk has been shown to have potential long-term, irreversible health consequences,[1,2] it is our belief that an athlete could be considered high risk and suffer future medical consequences without having a clinical ED diagnosis and, therefore, it should not be used as criteria in the Triad CRA. Instead, when the data is available, an athlete should be assigned for low risk when they show no signs of LEA or ED risk, moderate risk when they have either one, or high risk when they possess both. Also, the lack of standardized screening processes for the Triad is an issue that needs immediate addressal, since better screening will allow for prevention and earlier intervention when treating athletes at risk for or already experiencing the Triad. Finally, in regards to best practice for clinicians, risk classification results seem to vary by tool used (Triad CRA or RED-S CAT) and female athlete population studied, but the majority of athletes were placed in the moderate or high risk categories for both tools.[63,66] However, despite differing results, it is our belief that any athlete classified as moderate or high risk warrants greater surveillance and further investigation into their health status before healthcare providers can confidently allow them a safe, full clearance on training and competing.

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Table 1: Application of Triad CRA for Screening

Risk Factors	Study Data, Survey or Medical Record Data	Scoring
1. LEA with or with an ED/DE	• Eating Disorder Inventory-3 • Eating Disorder Inventory-3 Symptom Checklist • Previous Study Data on LEA	• Low Risk (0 points)– No dietary restrictions (no LEA and no ED risk) • Moderate Risk (1 Point) – ED risk OR LEA • High Risk (2 Points) – LEA with ED risk
2. Low BMI	• Previous Study Data on Measured Height & Weight were used to calculate BMI	• Low Risk (0 points) – BMI ≥ 18.5 OR ≥90% estimated weight or weight stable • Moderate Risk (1 Point) – BMI 17.5 < 18.5 OR <90% estimated weight OR 5 to < 10% weight loss/month • High Risk (2 Points) – BMI ≤ 17.5 OR <85% estimated weight OR ≥10% weight loss/month
3. Delayed Menarche	• Menstrual Cycle Survey	• Low Risk (0 points) – Menarche < 15 years • Moderate Risk (1 Point) – Menarche 15 to < 16 years • High Risk (2 Points) – Menarche ≥ 16 years
4. Amenorrhea/Oligomenorrhea	• Menstrual Cycle Survey & Medical Records	• Low Risk (0 points) – > 9 menses in 12 months • Moderate Risk (1 Point) – 6-9 menses in 12 months • High Risk (2 Points) – <6 menses in 12 months
5. Low BMD	• Dual-Energy X-ray Absorptiometry-DXA	• Low Risk (0 points) – Z-score ≥ -1.0 • Moderate Risk (1 Point) – Z-score -1.0 < -2.0 • High Risk (2 Points) – Z-score ≤ -2.0
6. Stress Reaction/Fracture	• Medical Records	• Low Risk (0 points) – None • Moderate Risk (1 Point) – 1 • High Risk (2 Points) – 2, ≥ 1 high risk or of trabecular bone sites (lumbar spine, femoral neck, sacrum, pelvis)

Table 2: Demographic Information

Self-reported and measured physical measurements for female collegiate athletes (n=125) by sport: equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20) and ballet (n=28). Values are presented in Mean ± Standard Deviation. An $\alpha = 0.05$ was used to determine significance.

Demographics	All	Equestrian	Volleyball	Softball	Beach Volleyball	Soccer	Ballet	P-value
Age (years)	19.8 ± 2.01	19.4 ± 1.3	19.2 ± 1.2	19.6 ± 1.1	19.9 ± 1.5	19.8 ± 1.3	20.4 ± 3.5	0.45
Height (cm)	167.8 ± 15.3	166.2 ± 5.1	176.4 ± 6.0	168.6 ± 5.3	174.5 ± 5.6	161.5 ± 34.8	165.3 ± 6.8	0.03
Weight (kg)	63.6 ± 9.2	61.7 ± 7.1	68.7 ± 6.1	72.5 ± 11.2	63.3 ± 5.1	65.4 ± 9.3	56.7 ± 6.9	≤ .01
BMI (kg/m^2)	22.7 ± 3.4	24.0 ± 4.7	22.1 ± 1.7	25.5 ± 3.4	20.8 ± 1.6	23.2 ± 2.5	20.7 ± 1.8	≤ .01
Body Fat Percent (%)	25.8 ± 5.5	29.4 ± 4.5	22.4± 3.6	27.4 ± 5.2	20.4 ± 3.7	23.4 ± 6.2	28.0 ± 3.7	≤ .01
FFM (kg)	47.1 ± 6.1	46.5 ± 3.9	52.0 ± 3.7	50.6 ± 5.8	50.3 ± 3.5	49.0 ± 4.8	39.5 ± 4.2	≤ .01
EA kcal/kg FFM	17.8 ± 17.0	21.9 ± 9.9	2.0 ± 12.0	7.8 ± 6.4	12.4 ± 9.6	42.3 ± 18.4	12.2 ± 11.3	≤ .01
BMD Z-Score	1.7 ± 1.2	1.3 ± .9	-	3.3 ± .9	-	1.7 ± 1.0	1.1 ± .8	≤ .01

Table 3: Triad Cumulative Risk Assessment Scores

Raw scores for the Triad CRA for female collegiate athletes (n=125) by sport: equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20) and ballet (n=28). Values are presented in Mean ± Standard Deviation. An $\alpha = 0.05$ was used to determine significance.

Risk Factors	All	Equestrian	Volleyball	Softball	Beach Volleyball	Soccer	Ballet	P-value
LEA with or w/o ED Risk	1.61 ± .54	1.66 ± 0.48	1.62 ± 0.51	1.88 ± 0.33	1.72 ± 0.46	1.05 ± 0.60	1.71 ± .46	≤ .01
Low BMI	.04 ± .20	.10 ± .31	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	.07 ± .26	0.26
Delayed Menarche	.27 ± .60	.14 ± .44	.08 ± .28	.41 ± .80	.33 ± .59	.35 ± .75	.32 ± .61	0.49
Amenorrhea	.43 ± .71	.38 ± .68	.23 ± .44	.47 ± .80	.56 ± .86	.30 ± .57	.57 ± .79	0.62
Stress Reaction/FX	.05 ± .28	.17 ± .54	.08 ± .28	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.14
Cumulative Risk Score	2.40 ± 1.21	2.45 ± 1.02	2.00 ± 0.82	2.76 ± 1.25	2.61 ± 1.38	1.70 ± 1.17	2.68 ± 1.28	0.04

Note: BMD- 100% were low risk for all sports.

Table 4: Risk Classification and Return-to-Play (RTP) Status
Calculated risk classification and return-to-play status for female collegiate athletes (n=125) by sport: equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20) and ballet (n=28). Values are presented in sample size and percent. An $\alpha = 0.05$ was used to determine significance.

Risk Factors and RTP Status	All	Equestrian	Volleyball	Softball	Beach Volleyball	Soccer	Ballet	P-value
LEA with or w/o ED Risk								≤ 0.01
Low Risk	3 (2.4)	0 (0)	0 (0)	0 (0)	0 (0)	3 (15.0)	0 (0)	
Moderate Risk	43 (34.4)	10 (34.5)	5 (38.5)	2 (11.8)	5 (27.8)	13 (65.0)	8 (28.6)	
High Risk	79 (63.2)	19 (65.5)	8 (61.5)	15 (88.2)	13 (72.2)	4 (20.0)	20 (71.4)	
Low BMI								.253
Low Risk	120 (96.0)	26 (89.7)	13 (100)	17 (100)	18 (100)	20 (100)	26 (92.9)	
Moderate Risk	5 (4.0)	3 (10.3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (7.1)	
High Risk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Delayed Menarche								.376
Low Risk	101 (80.8)	26 (89.7)	12 (92.3)	13 (76.5)	13 (72.2)	16 (80.0)	21 (75.0)	
Moderate Risk	14 (11.2)	2 (6.9)	1 (7.7)	1 (5.9)	4 (22.2)	1 (5.0)	5 (17.9)	
High Risk	10 (8.0)	1 (3.4)	0 (0)	3 (17.6)	1 (5.6)	3 (15.0)	2 (7.1)	
Amenorrhea/ Oligomenorrhea								.752
Low Risk	87 (69.6)	21 (72.4)	10 (76.9)	12 (70.6)	12 (66.7)	15 (75.0)	17 (60.7)	
Moderate Risk	22 (17.6)	5 (17.2)	3 (23.1)	2 (11.8)	2 (11.1)	4 (20.0)	6 (21.4)	
High Risk	16 (12.8)	3 (10.3)	0 (0)	3 (17.6)	4 (22.2)	1 (5.0)	5 (17.9)	
Stress Reactions/FX								.295
Low Risk	121 (96.8)	26 (89.7)	12 (92.3)	17 (100)	18 (100)	20 (100)	28 (100)	
Moderate Risk	2 (1.6)	1 (3.4)	1 (7.7)	0 (0)	0 (0)	0 (0)	0 (0)	
High Risk	2 (1.6)	2 (6.9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Return-to-Play								.045
Full Clearance	30 (24)	5 (17.2)	4 (30.8)	1 (5.9)	4 (22.2)	11 (55.0)	5 (17.9)	
Provisional Clearance	93 (74.4)	24 (82.8)	9 (69.2)	15 (88.2)	14 (77.8)	9 (45.0)	22 (78.6)	
Restricted from Training	2 (1.6)	0 (0)	0 (0)	1 (5.9)	0 (0)	0 (0)	1 (3.6)	

Note: BMD – 100% were low risk for all sports.

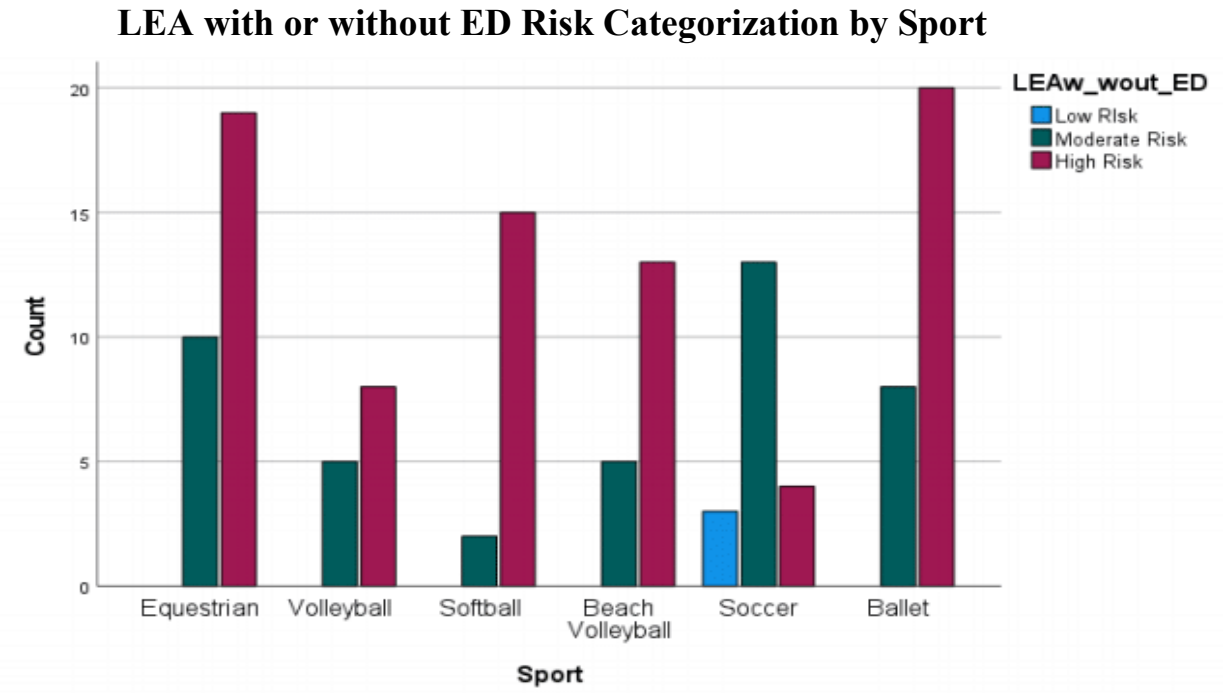

Figure 1: Risk classification for LEA with or without ED broken down by sport.

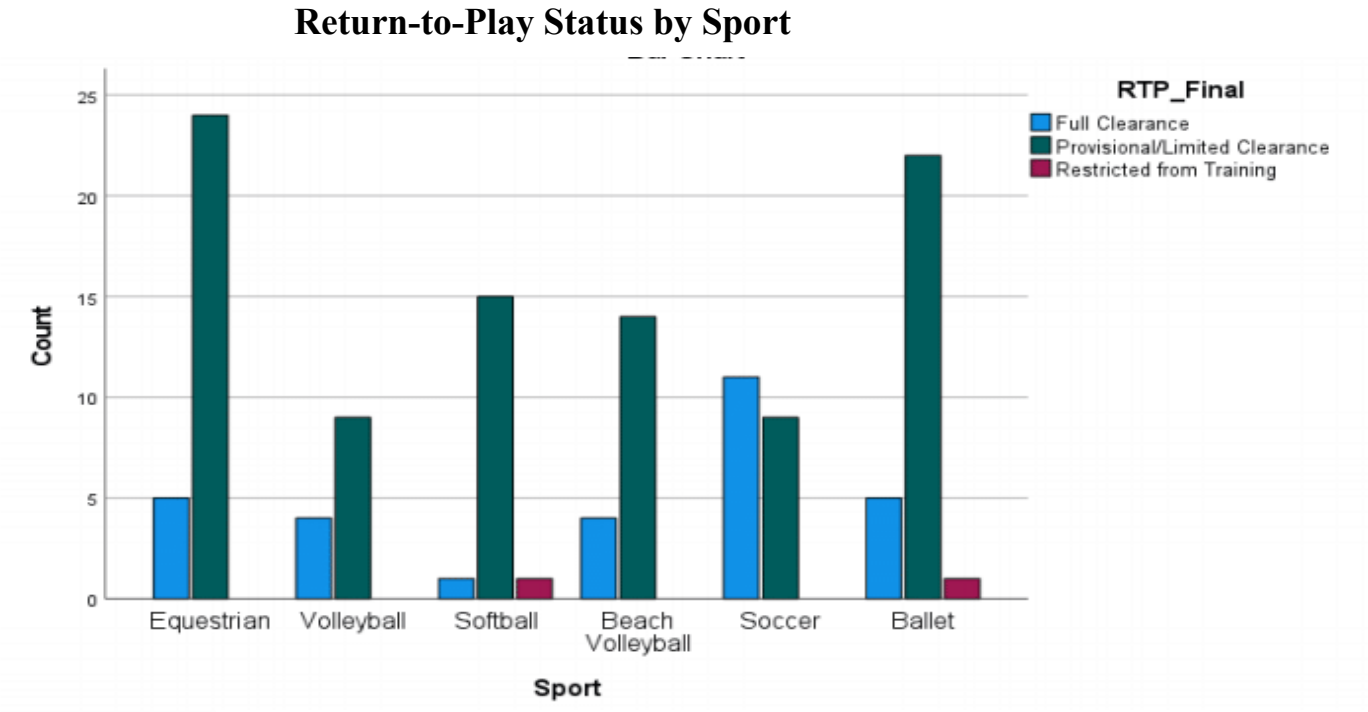

Figure 2: Return-to-play status variation across each sport

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL AND CONSENT FORMS

UNIVERSITY OF SOUTH CAROLINA

OFFICE OF RESEARCH COMPLIANCE

INSTITUTIONAL REVIEW BOARD FOR HUMAN RESEARCH
EXPEDITED AMENDMENT APPROVAL LETTER

Toni Torres-McGehee, PhD
College of Education
Department of Physical Education
1300 Wheat Street, Blatt PE Center 218
Columbia, SC 29208

Study Title: *Examination of Energy Availability in Physically Active Populations*

Dear Dr. Torres-McGehee:

The University of South Carolina Institutional Review Board (USC IRB) approved Amendment **Ame2_Pro00019277** by **Expedited** on **10/4/2016**.

The Office of Research Compliance is an administrative office that supports the University of South Carolina Institutional Review Board. If you have questions, contact Arlene McWhorter at arlenem@sc.edu or (803) 777-7095.

Sincerely,

Lisa M. Johnson
IRB Manager

UNIVERSITY OF
SOUTH CAROLINA

OFFICE OF RESEARCH COMPLIANCE

INSTITUTIONAL REVIEW BOARD FOR HUMAN RESEARCH
DECLARATION of NOT HUMAN SUBJECTS

Toni Torres-McGehee, PhD
College of Education
Department of Physical Education
1300 Wheat Street, Blatt PE Center 218
Columbia, SC 29208

Re: **Pro00099029**

Dear Dr. Toni Torres-McGehee:

This is to certify that Research Proposal entitled ***Examination of mental health disorder risks in NCAA Division-I student-athletes*** was reviewed on **3/31/2020** by the Office of Research Compliance, an administrative office that supports the University of South Carolina Institutional Review Board (USC IRB). The Office of Research Compliance, on behalf of the Institutional Review Board, has determined that the referenced study meets the Not Human Subject criteria set forth by the Code of Federal Regulations (45 CFR 46) of:

a. the specimens and/or private information/data were not collected specifically for the currently proposed research project through an interaction/intervention with living individuals AND

b. the investigator(s) including collaborators on the proposed research cannot readily ascertain the identity of the individual(s) to whom the coded private information or specimens pertain

No further oversight by the USC IRB is required; however, the investigator should inform the Office of Research Compliance prior to making any substantive changes in the research methods, as this may alter the status of the project.

If you have questions, contact Lisa M. Johnson at lisaj@mailbox.sc.edu or (803) 777-6670.

Sincerely,

Lisa M. Johnson
ORC Assistant Director and IRB Manager

APPENDIX B

FEMALE ATHLETE TRIAD COALITION TRIAD CRA SCORING CRITERIA[2]

Risk Factors	Magnitude of Risk		
	Low Risk = 0 points each	Moderate Risk = 1 point each	High Risk = 2 points each
Low EA with or without DE/ED	☐ No dietary restriction	☐ Some dietary restriction‡; current/past history of DE;	☐ Meets DSM-V criteria for ED*
Low BMI	☐ BMI ≥ 18.5 **or** ≥ 90% EW** or weight stable	☐ BMI 17.5 < 18.5 **or** < 90% EW **or** 5 to < 10% weight loss/month	☐ BMI ≤17.5 **or** < 85% EW **or** ≥ 10% weight loss/month
Delayed Menarche	☐ Menarche < 15 years	☐ Menarche 15 to < 16 years	☐ Menarche ≥16 years
Oligomenorrhea and/or Amenorrhea	☐ > 9 menses in 12 months*	☐ 6-9 menses in 12 months*	☐ < 6 menses in 12 months*
Low BMD	☐ Z-score ≥ -1.0	☐ Z-score -1.0*** < - 2.0	☐ Z-score ≤ -2.0
Stress Reaction/Fracture	☐ None	☐ 1	☐ ≥ 2; ≥ 1 high risk or of trabecular bone sites†
Cumulative Risk (total each column, then add for total score)	**____ points +**	**____ points +**	**____ points = ____ Total Score**

Figure 4 Female Athlete Triad: Cumulative Risk Assessment. The cumulative risk assessment provides an objective method of determining an athlete's risk using risk stratification and evidence-based risk factors for the Female Athlete Triad.[16 17 46] This assessment is then used to determine an athlete's clearance for sport participation (figure 5). ‡Some dietary restriction as evidenced by self-report or low/inadequate energy intake on diet logs; *current or past history[41 57]; ** ≥90% EW[66 91 100 107]; absolute BMI cut-offs should not be used for adolescents. ***Weight-bearing sport[2]; † high-risk skeletal sites associated with low BMD and delay in return to play in athletes with one or more components of the Triad include stress reaction/fracture of trabecular sites (femoral neck, sacrum, pelvis).[18 83] BMD, bone mineral density; BMI, body mass index; DE, disordered eating; EA, energy availability; EW, expected weight; ED, eating disorder.

APPENDIX C
FEMALE ATHLETE TRIAD COALITION RETURN-TO-PLAY STATUS CRITERIA[2]

	Cumulative Risk Score*	Low Risk	Moderate Risk	High Risk
Full Clearance	0 – 1 point	☐		
Provisional/Limited Clearance	2 – 5 points		☐ Provisional Clearance ☐ Limited Clearance	
Restricted from Training and Competition	≥ 6 points			☐ Restricted from Training/ Competition-Provisional ☐ Disqualified

Figure 5 Female Athlete Triad: Clearance and Return-to-Play (RTP) Guidelines by Medical Risk Stratification. *Cumulative Risk Score determined by summing the score of each risk factor (low, moderate, high risk) from the Cumulative Risk Assessment (figure 4). Clearance/RTP status for athletes moderate-to-high risk for the Triad: provisional clearance/RTP—clearance determined from risk stratification at time of evaluation (with possibility for status to change over time depending on athlete's clinical progress); limited clearance/RTP—clearance/RTP granted, but with modification in training as specified by physician (with possibility for status to change depending on clinical progress and new information gathered); restricted from training/competition (provisional)—athlete not cleared or able to RTP at present time, with clearance status re-evaluated by physician and multidisciplinary team with clinical progress; disqualified—not safe to participate at present time. Clearance status to be determined at future date depending on clinical progress, if appropriate. It is the recommendation of the Consensus Panel that athletes diagnosed with anorexia nervosa who have a body mass index (BMI) <16 kg/m^2 or with moderate-to-severe bulimia nervosa (purging >4 times/week) should be categorically restricted from training and competition. Future participation is dependent on treatment of their eating disorder, including ascertainment of BMI >18.5 kg/m^2, cessation of bingeing and purging and close interval follow-up with the multidisciplinary team.