

Eastern Kentucky University

Encompass

Honors Theses

Student Scholarship

Fall 2023

Risks of Being a Female Athlete: Prevalence of The Female Athlete Triad and Awareness of it by the Athletic and Student Population

Mary M. Wilson

Eastern Kentucky University, mary_wilson228@mymail.eku.edu

Follow this and additional works at: https://encompass.eku.edu/honors_theses

Recommended Citation

Wilson, Mary M., "Risks of Being a Female Athlete: Prevalence of The Female Athlete Triad and Awareness of it by the Athletic and Student Population" (2023). *Honors Theses*. 983.

https://encompass.eku.edu/honors_theses/983

This Open Access Thesis is brought to you for free and open access by the Student Scholarship at Encompass. It has been accepted for inclusion in Honors Theses by an authorized administrator of Encompass. For more information, please contact laura.edwards@eku.edu.

EASTERN KENTUCKY UNIVERSITY

Risks of Being a Female Athlete: Prevalence of The Female Athlete Triad and Awareness
of it by the Athletic and Student Population

Honors Thesis

Submitted

in Partial Fulfillment

of the

Requirements of HON 420

Fall 2023

By

Mary M. Wilson

Faculty Mentor

Dr. Autumn Whitson, PhD, ATC

Department of Biological Sciences

Risks of Being a Female Athlete: Prevalence of The Female Athlete Triad and Awareness
of it by the Athletic and Student Population

Mary M. Wilson

Dr. Autumn Whitson, PhD ATC

Abstract

The Female Athlete Triad is an interrelationship between energy availability, menstrual dysfunction, and bone health. It effects many female athletes, specifically those that participate in lean physique sports. This condition can cause many issues with one of the most common being time loss injuries from bone stress issues. Athletes and athletic support staff have limited knowledge over the Triad, partially because of limited policies and procedures in place to treat and educate for it. This thesis will conduct a literature review to better understand prevalence and general knowledge of the Female Athlete Triad in athletic populations and to assess the knowledge of the Triad within ECU students. The purpose of this project is to bring attention to the Female Athlete Triad to stress the importance of proper management and prevention.

Keywords: female, athlete, triad, bone mineral density, menstrual dysfunction, energy availability

Table of Contents

List of Tables	v
Acknowledgements	vi
Risks of Being a Female Athlete	1
Introduction.....	1
Background.....	1
<i>Low Energy Availability</i>	<i>2</i>
<i>Menstrual Dysfunction.....</i>	<i>3</i>
<i>Low Bone Mass Density.....</i>	<i>3</i>
<i>Relative Energy Deficiency in Sport (RED-S)</i>	<i>4</i>
Problem.....	5
Thesis Statement.....	6
Literature Review	6
Methods for Literature Review.....	6
Prevalence of the Female Athlete Triad.....	6
Issues caused by the Female Athlete Triad.....	13
Knowledge of the Female Athlete Triad.....	15
Survey/Originality.....	21
Purpose.....	21
Methods.....	21

<i>Sample</i>	21
<i>Instrument</i>	21
Results.....	22
<i>Participant Characteristics</i>	22
<i>Knowledge of the Female Athlete Triad</i>	22
Discussion.....	24
Limitations	24
Care and Prevention	25
Care	25
Prevention	27
Conclusion	28
Tables	29
References	33

List of Tables

Table 1: <i>Participant Characteristics</i>	34
Table 2: <i>General Knowledge Questions and Responses</i>	35
Table 3: <i>Symptom Specific and Experience Based Questions and Responses</i>	36
Table 4: <i>Female Only Questions and Responses</i>	37

Acknowledgements

First, I would like to thank my thesis mentor, Dr. Autumn Whitson. She has been the most supportive during my Honors Thesis process. She has helped me with any aspect of my thesis that you could think of. I have learned new strategies from her that I will be able to use in my future education and career. I would also like to thank my parents for pushing me to apply for the honors program at ECU. Without them, I probably would not have applied. I would also just like to thank them for pushing me to be the best person and student I can be. I would like to thank the Honors Program for giving me many opportunities that I would not have had being a general student. I would like to thank Dr. Liddell for helping guide me through the thesis process and for answering the millions of questions I emailed him. I would also like to thank the SONA System in the Psychology Department at ECU for letting me add my survey to their database. The main reason I received so many responses was because of their program. I would like to thank my survey participants for providing me with new information over the Female Athlete Triad. Lastly, I would like to thank the Data Initiatives program for helping me with my survey creation and data analysis. I had no idea how to create a survey or anything related, and they helped guide me through the process.

Risks of Being a Female Athlete: Prevalence of The Female Athlete Triad and Awareness of it by the Athletic and Student Population

Introduction

Background

Historically, sports have been a male-dominated activity due to the incorrect ideals that vigorous activity would cause girls to become sterile, weak, or masculine (Gregg & Gregg, 2017). These ideals changed around the 1890s when more women started to participate in sports and women's sports slowly developed into what they are today. These days, there are many competitive female athletes that have had tremendous success. Although there is high level of competition, it has also led to an increase in health risks for female athletes. Doctors have been noticing female athletes with symptoms relating to menstrual dysfunction, low energy availability, and osteoporosis for many years. All these symptoms have been connected to a disease called the Female Athlete Triad. The American College of Sports Medicine released a position statement on the Female Athlete Triad that describes it as, "... the interrelationships among energy availability, menstrual function, and bone mineral density, which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and

osteoporosis” (Nattiv et al., 2007). It was first defined by the American College of Sports Medicine in 1992, but has had definition and treatment updates as recent as 2014 (Daily & Stumbo, 2018). This Triad is commonly found in individuals that compete in sports that stress the importance of lean physique, such as cross country or gymnastics. Athletes initially develop issues related to one of the three categories of the Triad. These categories are interconnected, so there is the possibility of other components developing if any symptoms go untreated.

Low Energy Availability

Energy availability (EA) is the balance between energy intake (nutrition) and energy output (exercise). Typically, energy availability is greater than or equal to 45 kcal/kg FFM/day. EA is reserved to perform autonomic functions, like digestion and blood pressure, during exercise. It is harder for the body to perform these functions if less energy is available. Low EA can develop when there is an imbalance between intake and output. Athletes will not be eating enough to equal the energy they are expending. This can be seen from disordered eating or excessive exercise with no diet to compensate. This symptom is found in sports that require a lean physique, as athletes feel pressure to maintain the optimum physique by whatever means necessary (Daily et al., 2018). Low EA can have many effects like causing issues with menstrual dysfunction or bone health. It also can cause issues with other autonomic functions, like gastrointestinal issues or immune functions. An athlete that is not consuming the correct amount of nutrients can also develop issues with athletic performance, cognitive abilities, or muscle growth.

Menstrual Dysfunction

Menstrual dysfunction is another problem of the Female Athlete Triad. When individuals have negative energy balance, the body limits reproductive physiology to conserve energy (Daily & Stumbo, 2018). The body then has limited calories that can be used which makes it harder for this function to occur. The body stops or slows reproductive physiology so that other bodily functions can use the limited energy.

There is a wide range of how menstrual irregularities will present as a part of the Female Athlete Triad. Eumenorrhea is a regular menstrual cycle of approximately 28 days. Oligomenorrhea is a less extreme possible menstrual irregularity where menstrual cycle intervals are longer than 35 days. Functional hypothalamic amenorrhea is a more severe symptom of the Triad and can present in two forms. Primary amenorrhea is a delay in the first menstruation of an individual. Secondary amenorrhea is an absence of menstrual cycles lasting more than 3 months (Nattiv et al., 2007). Negative effects of menstrual dysfunction include fertility issues, hormonal imbalances, and bone health issues.

Low Bone Mass Density

Lastly, individuals affected by the Female Athlete Triad can have issues with bone mass density. Bone mass density (BMD) is the measure of strength of an individual's bones. The stronger they are, the less likely they are to break during athletic activity. Low BMD can develop from insufficient nutrition, menstrual dysfunction, or a combination of the two. Insufficient nutrition can be an issue because nutrients like vitamin D, calcium, and protein are important for bone growth, but when those are limited in a diet then BMD issues can occur. Menstrual dysfunction is also an issue

because estrogen is important for bone formation. It inhibits bone remodeling and bone resorption and also increases bone formation. When menstrual dysfunction occurs, the body is in an estrogen-deficient state which can lead to decreased BMD and frail bones (Matzkin et al., 2015). Individuals with low BMD are at a high risk of bone stress injuries, such as stress fractures, which can lead to time loss from their sport. Time loss from sport can vary from about a week to 22 days or longer (Rauh et al., 2014). Also, individuals with low BMD are at a higher risk of developing osteoporosis, which is “a skeletal disorder characterized by compromised bone strength predisposing a person to an increased risk of fracture” (NIH Consensus Development Panel on Osteoporosis Prevention, 2001).

BMD is an issue more in women because by the age of 18, most women have reached 90% of their peak bone mass density, whereas men reach it later (Matzkin et al., 2015). Once an individual reaches peak BMD, they can only maintain or lose it. It is important to monitor younger athletes because the Triad can affect their puberty processes (Korsten-Reck, 2011). That being said, teenagers, and specifically females, with insufficient nutrient replenishment of menstrual dysfunction issues may not achieve a sufficient peak BMD (Nose-Ogura et al., 2019). This will cause them to have weaker bones and the potential for more issues in the future.

Relative Energy Deficiency in Sport (RED-S)

A recently defined disease, Relative Energy Deficiency in Sports (RED-S) is a condition that is similar to the Female Athlete Triad. RED-S is an adapted concept from the Triad, but it is a condition that can be found in both men and women. An article in the *British Journal of Sports Medicine* defines it as, “the result of insufficient caloric intake

and/or excessive energy expenditure. Consequences of this low-energy condition can alter many physiological systems, including metabolism, menstrual function, bone health, immunity, protein synthesis, and cardiovascular and psychological health” (Statuta et al., 2017). RED-S focuses mainly on the low energy availability aspect of the Triad.

Treatment for this disease can involve increasing caloric intake and decreasing caloric expenditure to create a healthy balance (Hopkins et al., 2022). This disease is occasionally brought up in studies relating to the Female Athlete Triad, so it is important to note its definition, but it is not the main topic of this thesis.

Problem

The Female Athlete Triad is a serious condition that is affecting a number of female athletes. Many coaches, support staff, and athletes are unaware of the condition until it is too late. Athletes can develop time loss injuries that cause them to take time away from their sport. It can also have negative effects on their mental health. Another problem with the Triad is that society has deemed some of its conditions as “peak athlete shape”. For example, some women believe that having no menstrual cycle is because that individual is working out often and well. These ideas need to be shifted so that individuals are aware of the consequences of the Female Athlete Triad. Another issue with the Triad is that many athletic programs have limited policies put in place to screen or care for the components of the Triad. Many healthcare providers and athletic support staff are unaware of what the Triad is because there is no required education for it. Some collegiate programs, mainly Division 1 programs have some policies in place but more

programs, especially in high schools, need policies put in place to help provide education and proper care for the Female Athlete Triad.

Thesis Statement

The purpose of this thesis project is to conduct a literature review to understand the prevalence of the Female Athlete Triad in female athletes and knowledge of it by the athletic and student populations. This project will also identify the knowledge of the Female Athlete Triad of current and former athletes in the students at Eastern Kentucky University. This project will also bring attention to the Female Athlete Triad to stress the importance of proper management and prevention.

Literature Review

Methods for Literature Review

Articles reviewed in this paper were selected with specific inclusion criteria. All materials were collected through an electronic search through Eastern Kentucky University Databases of Google Scholar or Academic Search Ultimate. When accepting articles for review, they had to be peer-reviewed journals that had been published within the last 10 years. Some publication date exceptions were made for sources, being that they were position statements released when the Triad was first defined. Keywords used for search included: “Female Athlete Triad”, “prevalence”, “female athletes”, “knowledge”, and “effects”.

Prevalence of the Female Athlete Triad

The Female Athlete Triad is a somewhat common condition in female athletes. A study conducted by Melin et al. (2015), assessed the prevalence of Triad conditions in

endurance athletes. Forty women, with a median age of 26 and median exercise time of 11.4 hours a week, were examined to determine if any symptoms of the Triad were present. Bone health, blood pressure, reproductive function, energy metabolism, aerobic capacity, and eating disorders were examined in a two-day time span. Athletes were asked to limit exercise the day prior to examination.

In this study, subjects were grouped by EA amounts: optimal, reduced, and low. Optimal energy availability is approximately greater than or equal to 45kcal/kg FFM/day. This means that there are 45 or more calories per kg of fat free mass available to perform regular metabolic functions. An individual with reduced or low energy availability has less energy available to perform these functions. In this study, 17 subjects were found to have reduced energy availability and eight had low energy availability. The subjects in the low EA group had a mean EA of 19.10 kcal/kg FFM/day (Melin et al., 2015). That means this group individually has about 19 calories per kg of fat free mass available after exercise to perform normal bodily functions. Also, the low EA group had a significantly lower energy intake than the optimal and reduced EA groups and 79% of the low EA group had a higher exercise energy expenditure than the optimal group. Low energy availability was most likely present in this group because they had an energy imbalance. They had too much energy output and not enough energy input.

In this study, 60% of the subjects were diagnosed with menstrual dysfunction. The menstrual dysfunction presented in a wide range such as six with oligomenorrhea, four with primary functional hypothalamic amenorrhea (FHA) and 14 with secondary FHA. Of the 24 women with menstrual dysfunction, 25% had a form of disordered eating

or an eating disorder. Also, 67% of the menstrual dysfunction group had low or reduced energy availability.

Next, 45% of the subjects had impaired bone health. Three of the subjects in this group were diagnosed with osteoporosis in the lumbar spine and 15 subjects had low BMD. It was also found that 67% of the subjects with impaired bone health also had menstrual dysfunction. Thirty-three percent of the subjects with impaired bone health had a form of disordered eating or an eating disorder.

It should also be noted that many athletes may only present with one condition of the Female Athlete Triad, but those that display two or more conditions are at a higher risk of injury. In this study, “Twenty subjects had one clinical condition (low current EA with or without ED/MD/ osteoporosis), six displayed two conditions, while one subject displayed all three clinical Triad conditions” (Melin et al., 2015). It may not be as common to present with more than one condition, but it is something that should be monitored.

This was a beneficial study that shows the prevalence of the Female Athlete Triad. This study also displayed how the Triad can have a wide range of symptoms and depending on those symptoms will determine how damaging the effects of the Triad will be. Melin et al did mention that more studies should be conducted related to this topic to verify the data presented.

The Female Athlete Triad is a condition that is common in sports that require a lean physique, such as cross country or gymnastics. One study assessed the prevalence of Triad risk factors in high school distance runners (Skorseth et al., 2020). Thirty-eight participants were evaluated, with an average age of 16.9 ± 1.00 . In this study, 76.3% of

participants were classified as having disordered eating habits or an eating disorder, which could lead to low energy availability. A small percentage of participants (23.7%) reported having a delay in their first menstruation, but this may have been due to the majority of participants having been older than the average age of menarche. Some participants (45.9%) did have menstrual dysfunction issues, with seven having oligomenorrhea and 10 with amenorrhea. It was noted that 42.1% of athletes were categorized with low BMD and a few (15.8%) with prior bone stress injuries.

This study also assessed if there was a correlation between Triad risk factors and free triiodothyronine (T_3). T_3 is an important hormone that is secreted from the thyroid gland. Free T_3 specifically is the form that enters the body tissues where needed, compared to bound T_3 which is attached to proteins and does not enter body tissues. T_3 works with another hormone called thyroxine (T_4) to regulate functions in the body like metabolic rate, heart and digestive functions, muscle control, brain development, and bone maintenance (Cleveland Clinic, 2022). It was found that free T_3 was significantly associated with a higher Triad risk score. Individuals with higher Triad risk scores may be lacking in many of the functions discussed earlier. The researchers also noted that T_3 could potentially help in screening and identify Triad risk.

This study was useful in showing the correlation between Female Athlete Triad symptoms in lean physique athletes. Although not all of the individuals developed symptoms, there was still a significant number of girls affected. This study helps to stress the importance of screening and prevention especially in lean physique sports like cross country.

As discussed earlier, the Female Athlete Triad is a somewhat common condition. One population that is at a high risk for Triad development is teenage athletes. In comparison to athletes in their 20s, teenagers are at a higher risk for injury. A recent study, examined whether the Triad increases the risk of stress fractures and if there was a correlation between age and rate of injury (Nose-Ogura et al., 2019). At the Japan Institute of Sports Sciences, 390 female athletes were examined with 147 of the participants reported as teenagers and 243 were women in their 20s. Components of the Triad, such as low energy availability, menstrual dysfunction, and low bone mineral density were assessed. Testing was performed over a four-year time span. In this study, 117 of the participants were diagnosed with amenorrhea where 42 participants had low EA and 68 participants had low BMD. It was also noted that multiple participants had more than one component of the Female Athlete Triad. Out of all participants, 17 athletes had both amenorrhea and low EA and 39 participants had amenorrhea and low BMD. Only two participants had both low BMD and low EA. Also, 16 athletes had all three components of the Triad.

This study also had 36 participants develop stress fractures within the first 3 months of registration. Twenty of these athletes were teenagers and 16 were athletes in their 20s. Of the 36 participants that developed stress fractures, the majority of the athletes had amenorrhea (22) and were also in physique-based sports (23), such as long-distance running and rhythmic gymnastics. Individuals that compete in sports that require a leaner physique typically have a higher risk of developing components of the Triad because they are not intaking enough nutrients to equal their energy output.

A major takeaway from this research was that teenage athletes were at a higher risk of stress fractures due to Female Athlete Triad components compared to athletes in their 20s. It was mentioned that teenage athletes with amenorrhea were 12.9 times more likely to develop stress fractures. Also, teenage athletes with low BMD were 4.5 times more likely to develop stress fractures and teenagers with low EA were 1.1 times more likely to develop stress fractures. Researchers believe that this outcome is due to the age of peak bone mass. Women typically reach peak bone mass density and peak bone mineral content around the age of 21 or 22, whereas males peak around the age of 23 or 24 (Lu et al., 2016). Teenage athletes also have the highest rate of increased BMD development between the ages of 12 and 15 years (Nose-Ogura et al., 2019). If a teenage athlete has insufficient nutrient replenishment and lower body weight, then it is much harder for them to achieve sufficient peak bone mass in the future and then stress fractures are more likely to form. The article also discussed that athletes in their 20s may have not been at risk for stress fractures like teenage athletes because they had a higher muscle mass. A higher amount of muscle mass helps to absorb impact from loading exercises. This area of research does need further examination since it was not a part of the examination process in this study.

This article was exemplary in displaying the prevalence of the Female Athlete Triad. It also showed how teenage athletes with components of the Triad are more at risk for stress fractures than athletes in their 20s. It is important that healthcare providers take age into consideration when helping individuals with the Female Athlete Triad. Also, more policies should be put in place to educate female athletes and coaches on ways to

prevent the Triad. The earlier this condition is prevented, the fewer issues an athlete may have in the future.

The majority of studies conducted on the Female Athlete Triad are with able-bodied athletes. Not as much research is available on athletes with disabilities, but they are still a population that can develop components of the Triad. A study conducted by Brook et al. (2019), aimed to determine the prevalence of the Triad components in elite para athletes. An electronic survey was sent out to U.S. athletes that were attempting to qualify for Paralympic Games, specifically 2016 Rio Summer Paralympic Games or 2018 Pyeongchang Winter Paralympic Games. The survey received 260 responses from athletes. One hundred fifty male athletes did participate in the survey, but their data will not be discussed in depth because they can only develop the components of RED-S and not the Female Athlete Triad. However, 110 female athletes completed the survey, and their data will be further evaluated. The average age of the athletes was 31.7 years and the majority of the participants had experienced either a spinal cord injury or lower extremity amputation.

Menstrual status was assessed in this study, but individuals who were over the age of 50 or currently used oral contraceptive pills were excluded from analysis. This caused 25 female athletes to be eligible for analysis. Of the 25 athletes, 24% had oligomenorrhea and 20% had amenorrhea. Out of all female athletes, eight had a history of one bone stress injury and 5 had a history of two bone stress injuries. Although it is not as common, para-athletes are included in the population that could possibly develop the Female Athlete Triad. This study shows the need to expand education to all possible Triad populations to increase prevention.

Issues caused by the Female Athlete Triad

The Female Athlete Triad is a condition that can cause many issues. One of these issues is time loss injuries. A study by Rauh et al., (2014) found that Triad specific symptoms are associated with musculoskeletal injuries in cross country and track athletes. In this study, 89 high school female cross country and track athletes were monitored for lower extremity musculoskeletal injuries. During the data collection process, 42.7% of participants endured a musculoskeletal injury. The majority of the injuries were of minor severity (1-7 days lost), but 27.7% were moderate injuries (8-21 days lost) and 13.8% were severe injuries (22 or more days lost). These athletes had to take time away from their sport due to Triad influenced injuries. Individuals that developed an injury were noted to have a higher mean score for Eating Disorder Examination Questionnaire (EDE-Q) subscale for weight concern and shape concern compared to non-injured runners (Rauh et al., 2014). Injured runners also had significantly lower BMD at the spine, total hip, and whole-body in comparison to the non-injured athletes. Lastly, it was found that oligomenorrhea and amenorrhea were associated with running-related injuries. The Female Athlete Triad can cause time loss injuries, especially in lean physique sports like cross country, that take the athlete away from their sport. These injuries could potentially be prevented if individuals were aware of how to properly take care of their body. These Triad symptoms can also be used as indicators for which individuals may be more likely to develop an injury in the future.

The type of sport and its intensity an individual competes in can influence their risk of injury. One study examined if there was a correlation between sport intensity and

Female Athlete Triad symptoms (Sawai et al., 2018). Researchers had 551 female collegiate students completed a survey over this topic. In order to have a baseline to follow, 531 of the participants were college athletes and 20 participants were in a control group with no sport activity experience. Individuals were placed into different groups based on their specific sport intensity. The Female Athlete Triad components were somewhat prevalent in this research group. 270 individuals had menstrual dysfunction, 15 had low energy availability, and 108 had low bone density. Also, 62 participants had developed two components of the Triad and 4 individuals had developed all three components. In this study, high intensity sports were found to correlate with a delay in menarche and can contribute to menstrual irregularities. The groups considered for higher intensity sport contained more lean physique sports like gymnastics and cheerleading. It was also noted that highly repetitive, high training volume sports can increase an athlete's risk for musculoskeletal injury. The sports in this group included track and field jumping events, sprinting events and sports that would involve more impact and training volume. Competition levels did not have as much of a correlation to injury as did intensity. With this information, we can educate athletic programs over which sport categories need more monitoring when it comes to the Female Athlete Triad and which groups should receive more education on this topic.

As discussed before, an individual can develop more than one component of the Triad. The number of components an athlete can develop can have an influence on their risk for injury. One study looked to see if there was a correlation between bone stress injuries and combined risk factors of the Triad (Barrack et al., 2014). In total, 259 female athletes with a mean age of 18.1 ± 0.3 years, were assessed to determine the amount of

risk factors they may have had. The study had 28 participants sustain a bone stress injury with the primary sport mode including endurance running, track and field (sprint or field), or dance. They also found that the risk for development of a bone stress injury increased from 15% to 21% with the presence of 1 significant risk factor. The risk increased to 30% with the presence of 2 concurrent risk factors and increased again to 50% with the presence of 3 concurrent risk factors. It is important to monitor the symptoms an individual may develop because that will show the severity of Triad development they may have.

Knowledge of the Female Athlete Triad

Prior studies that have assessed Female Athlete Triad knowledge among athletes and multiple specialty professions have found very limited awareness among these individuals. Athletes are an important population that should be aware of the Triad, but they are not. One study assessed the knowledge and confidence levels of collegiate female cross country athletes and their coaches and athletic trainers (Lodge et al., 2022). In this study, 275 college cross country athletes, 55 cross country coaches, and 30 athletic trainers were assessed to determine their knowledge levels. In this study, athletes were found to have limited knowledge, confidence level, and impact scores of the Triad when compared to their coaches and athletic trainers. There was not a significant difference noted between athletic trainers and coaches.

It was also noted in this study that athletes (68%) and coaches (65%) indicated they had not received education on the Triad. Only 13% of athletic trainers indicated they had not received education on this topic. Also, 84% of athletes, 89% of coaches, and 71%

of athletic trainers indicated they had received no training from their current institution over the Female Athlete Triad or RED-S. Athletes received any information they had from online sources and coaches retained their information from textbooks. It was also indicated that 4% of the noted institutions had policies provided by the athletic department or coaching staff regarding the Triad. Athletes have limited knowledge on the topic of the Triad and part of that is due to limited educational opportunities that should be provided by athletic programs.

In a similar study, they also found that female athletes had limited knowledge on the topic of the Female Athlete Triad (Miller et al., 2012). A survey was sent to 180 women over Triad knowledge. Only 10% of the participants could name all three components of the Triad. Of the participants, 35% indicated that irregular periods are considered normal for an active female with 1 in 2 athletes considering amenorrhea normal in active females. However, 88% of participants did indicate that they would take action if they missed three consecutive periods, but many that indicated the opposite claimed that lack of menstruation should be valued as a success, even potential indicator of weight loss, and no health effects should occur. It is somewhat concerning that amenorrhea is not taken as seriously as it should since it is one of the first signs of Female Athlete Triad development. Athletes are of the most important population to receive education over the Triad to help prevent its development.

As discussed briefly, there can be a variety in knowledge based on the individual's specialty. Knowledge does seem to increase in more sports-based occupations, but that is not an excuse for limited knowledge in other areas. A study conducted by Curry et al. (2015), found that physicians have limited awareness of the

Triad and have limited confidence in treating patients with Triad components. In this study, physicians were asked to complete a survey to assess their Triad knowledge. There were 931 participants with 40% female and 60% male. Only 37% of the participants had heard of the Female Athlete Triad. Of the individuals that indicated that they had heard of the Triad, an average of 2.1 ± 1.1 could properly identify Triad components. It was also noted that 49% of participants did not feel comfortable treating or referring a patient with the Triad. When specific specialties of the physicians were examined, knowledge of the Triad did increase depending on the varying areas. Awareness rates were the highest in orthopedics (80%), obstetrics/gynecology (55%), and physical medicine and rehabilitation/rheumatology (52%). There were no significant differences between the genders of physician.

These findings suggest that there is a lack of education in physician programs relating to the Female Athlete Triad. There may be more education in certain specialties or more occurrence of patients with Triad components to visit those specific specialties since they pertain to Triad treatment. It is important that health-care providers are aware of the Triad so that proper identification can occur which will then lead to beneficial treatment. Physicians are a part of the multi-disciplinary team that assists with Triad care and prevention.

Alternatively, a study that examined collegiate athletic trainers found that they had more knowledge over the Female Athlete Triad (Kroshus et al., 2018). In this study, 285 athletic trainers were recruited to complete a survey over Triad and RED-S awareness. Of the participants, they had on average been certified as an athletic trainer for 18.31 ± 9.02 years and had been employed at their present institution for 10.62 ± 7.51

years. It was found that 98.61% of the respondents had heard of the Triad. A smaller amount (32.98%) had heard of RED-S, but that may have been due to the recent defining of the term compared to this study's publication. Participants were asked to correctly identify Triad components with 93.33% correctly identifying that one Triad component involves bone health. Similarly, 95.09% could correctly identify that a component of the Triad involves menstrual dysfunction. Also 94.74% could correctly indicate that one component of the Triad involved energy imbalance, disordered eating, or adequate nutrition.

The survey also assessed screening programs at the participants' institutions. Researchers found that 59.93% of respondents indicated that their athletic program screens for eating disorders and 70.55% of respondents indicating that their athletic program screens for menstrual dysfunction. The most common referral practice assessed in this study was referral to a sports medicine physician for Triad related issues, like menstrual dysfunction. It was also noted from this survey that women were more likely to correctly identify more components than men, but a high percentage of men could identify correct components and appeared to have a good understanding of the Triad. There were some differences between the division of competition in reference to screening and referral practices. For example, 70.16% of screening occurred in Division I programs, 48.28% of Division II, and 49.37% of Division III. This variance could be due to the number of resources each division has access to at their athletic program, with Division I programs most likely having the best access to resources.

This study displays that collegiate athletic trainers can identify the Female Athlete Triad and help to care for athletes that develop it. There is also some form of education

that prepares these athletic trainers to work with athletes and specifically the Triad. The form education received by the study subjects over the Triad was not specified but a possible education program could have been continuing education, which could also be implemented in different specialties to educate others on the Triad.

There can occasionally be differences in how men and women perceive the Triad and its components. Specialty of an individual can limit this difference. For example, in the study discussing athletic trainers from Kroshus et al. (2018), there were minimal difference between male and female athletic trainers. Results differed in a study that compared knowledge of the Female Athlete Triad in high school coaches. A survey was completed by 227 coaches over Triad knowledge and perception. One finding of this study was that female coaches rated certain behaviors and symptoms a more serious health risk when compared to men. For example, female coaches rated low EA and menstrual disturbances as significantly more serious to health than male coaches. They also rated disordered eating and over exercising more serious to health than male coaches. Male coaches were also found to "...more frequently communicating with their athletes about getting their body to an ideal level for performance in their sport, eliminating certain foods from their diet, and taking certain supplements" (Kroshus et al., 2014).

There were no reported gender differences in referral and management decisions, with all coaches using similar strategies to help treat their athletes. It was also noted that few coaches reported policies in place to deal with disordered eating, repeated stress fractures, or menstrual irregularity. With no gender differences, 88% of coaches indicated they felt it would be beneficial to do some sort of Triad screening during sport

participation clearance. This study shows that male coaches could have a negative influence over Triad symptom develop and treatment, which is why education to all individuals should occur so that there are no unequal perceptions.

Part of the reason why athletes and support staff have limited knowledge of the Female Athlete Triad is because there are few policies and procedures put in place to educate individuals on the topic. A study assessed the awareness of U.S. high school nurses over the Female Athlete Triad and their referral behaviors (Kroshus et al., 2015). This study had 370 nurses respond to the survey. Only 28.4% had heard of the Triad and less than one fifth indicated that they could identify the components of the Triad. Few respondents indicated that their school had policies in place to deal with Triad symptoms. Only 10.8% had policies for disordered eating, 0.9% for menstrual irregularities, and 4.3% for repeated stress fractures. Also, 48% of nurses indicated that they had met all coaches for female sports and only 25.3% indicated that they work with coaches to help prevent health issues. There are few requirements in place to help prevent the Triad and this lack of education is shown in the limited knowledge of athletic support staff. The majority of the participants in this study indicated they were open to learning more and would like Triad related policies implemented in their athletic programs. There is needed improvement in this education, and it should not be hard to implement since athletic support staff indicate they are open to learning more.

Survey/Originality

Purpose

A survey was created for this thesis project with the objective of assessing the knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sports (RED-S) in the student population at Eastern Kentucky University.

Methods

Sample

The population for this survey was current and former student athletes that were current students at Eastern Kentucky University (EKU). The survey was added to the Sona System in the Psychology department at EKU. The Sona System is a research participant management system. The survey was also distributed through word of mouth and flyers placed around campus. Initially, a total of 90 survey responses were collected. Any incomplete survey responses were removed from the data set. After this alteration, there was a total of 72 completed survey responses. Data was collected from September 2023 to October 2023. All research activities were approved by the Institutional Review Boards of Eastern Kentucky University (IRB #5396). It was hypothesized that EKU students would have limited knowledge of the Female Athlete Triad and related content.

Instrument

The survey was created through the Qualtrics survey system. The questionnaire was based off of previously reviewed surveys (Kroshus et al., 2015; Lodge et al., 2022; Miller et al., 2012). The content of the survey was adapted to be appropriate for the selected population. Individuals were asked to complete the survey according to their own knowledge with no use of outside sources. The content of the questionnaire covered

knowledge of the Female Athlete Triad and RED-S, Triad symptom knowledge, and coach interaction. Each question's results were analyzed individually after data collection had occurred. Some questions in the survey were assessing how the participant felt about certain topics related to the Female Athlete Triad. Other questions were associated with correct and incorrect answers, so knowledge and perception of the Triad was based off the accuracy to those questions. Data was analyzed using descriptive statistics and frequencies and percentages were reported for the results of each question.

Results

Participant Characteristics

A total of 72 completed responses were collected. A full demographic breakdown can be found in Table 1. Of the respondents, 88.9% were female and the average age 19.42 years. The majority (90%) of the respondents were former athletes with the remainder being current athletes. There was also a variety in total years of participation with 31% of participants having 1-3 years of participation, 26% of participants having 4-7 years of participation, 11% of participants having 8-10 years of participation and 32% of participants having 10 or more years of participation in their sport. There was also an assortment of sport type of the participants including: cheer, volleyball, basketball, cross country, track and field, marching band, gymnastics, football, weightlifting, softball, tennis, soccer, baseball, dance, swimming, wrestling, and golf.

Knowledge of the Female Athlete Triad

A mix of results were collected in this survey. As hypothesized, a majority of the respondents had heard of the Female Athlete Triad (82%) or RED-S (76.4%) (Table 2). Only nine participants indicated that they could name any components of the Female

Athlete Triad. Those nine respondents were asked if they could list any of the three components. Only one individual was able to correctly identify all three components, however the majority (44%) could correctly identify at least one component. Low energy availability was identified most frequently compared to menstrual dysfunction and low bone mass density. When asked if female athletes must have all three components of the Triad to have the Female Athlete Triad, 65% of respondents indicated “maybe”. Only five individuals responded “yes” to this question. When given a list of possible populations, 47 participants indicated that the population that could suffer from the Triad are all physically active females. Some results collected differed from the original hypothesis (Table 3). For example, 88.9% of respondents indicated that female athletes are at risk for osteoporosis. Most participants indicated that disordered eating practices can lead to lack of periods. Many participants (57%) could not correctly identify Triad symptoms when given a list of correct and incorrect options. When asked if any participants had been told to decrease their weight to improve athletic performance, mixed results were produced with 38 respondents indicating “yes”, 31 respondents indicating “no”, and three respondents indicating “maybe”.

Some questions, like those relating to menstrual dysfunction, were designated only for female respondents ($n = 64$). These questions and responses can be found on Table 4. Most respondents (39.1%) somewhat disagreed with the statement, “Having an irregular menstrual cycle is often a sign that the athlete is in peak competitive shape”. Only one participant strongly disagreed with this statement, but two participants strongly agreed, and 13 participants somewhat agreed. Also, 27% of respondents neither agreed nor disagreed with the statement. Many respondents felt that it is not okay to miss a

period if pregnancy has not occurred, with 20 respondents replying with “definitely not” and 21 respondents replying with “probably not”. It could not be determined whether female respondents felt comfortable discussing menstrual irregularities with their coaches. Some participants were comfortable, while others were not.

Discussion

This survey produced a variety of results, some of which were hypothesized, and some were not. It was expected that participants would not have heard of the Female Athlete Triad, which would lead to them also having limited knowledge on the topic. Respondents had limited knowledge of the Triad and its specific symptoms and components. This result was assumed as other research has found that student athletes have limited knowledge on the topic, especially when compared to coaches and athletic trainers (Lodge et al., 2022). This could be due to the likelihood that coaches and athletic trainers receive education on the Triad, even if it is minimal education. Other studies have also found athletes to have a lack of knowledge of this topic, with many participants in the studies unable to correctly identify the 3 components of the Triad. There were some results that were not hypothesized that showed that the participants had more knowledge pertaining to symptom specific questions. This shows that there is some education over general Triad topics, but the Female Athlete Triad is not discussed as often.

Limitations

There were many strengths of this study, but there were multiple limitations. One limitation of the study was that majority of the participants ended up being females. This made it difficult to assess if there were any gender differences over knowledge of the

Female Athlete Triad. The high rate of female participants could have been correlated to a higher interest to the topic or a decreased interest by potential male participants.

Another limitation to this study was that questions were not indicated as required on the survey instrument leading to some responses being excluded from the initial data set.

This issue was due to human error. More responses could have potentially been collected if questions were indicated as required. A cross sectional analysis was unable to occur for the data collected since many questions did not correlate with one another. If another study like this were to occur, then questions should be formatted so that this analysis could occur. For future research, a survey should be sent to athletic programs at ECU to determine if any policies or procedures are in place to treat or educate athletes and support staff on the topic of the Female Athlete Triad. It currently cannot be determined to what extent of screening and education the school would have due to it being a smaller Division I school.

Care and Prevention

Care

Since the Female Athlete Triad can present in a number of ways, it is important to create an individualized plan per person. Research has found that athletes physical and physiological attributes can present in a number of ways (Thein-Nissenbaum & Hammer, 2017). An individualized plan will be the most beneficial to help the athlete return to normal. It is also highly recommended to utilize a multidisciplinary team during the rehabilitation process. An example of this team would include: health care provider, mental health practitioner, dietician, gynecologist, physical therapist or athletic trainer,

coaches, and parents (Thein-Nissenbaum & Hammer, 2017). First, the athlete will visit their health care provider to determine if any other clinicians should be involved in the rehabilitation process.

The first component of the Triad that is typically treated first is low energy availability. Management can be dependent on how it initially developed. If it was due to some form of nutrition insufficiencies, then the athlete can work with a registered dietitian to create a diet that will properly replenish their energy output. Nutritional counseling is very important to these individuals because it may be harder for them to follow hunger cues so a predetermined schedule should be made (Temme & Hoch, 2013). If low EA developed due to excessive caloric expenditure, then that is when the athlete can work with an individual like a personal trainer, physical therapist, or athletic trainer (depending on what they have access to) to create a workout plan that will mirror caloric intake.

Once energy availability has been restored, then menstrual functioning should start to return to a normal state. This can sometimes be apparent in slight weight gain and BMI increase. It may also take some time for the menstrual cycle to return. One study found an average resumption of menses to be 15.6 ± 2.6 months for all menstrual dysfunctions noted. Specifically amenorrheic women restored menses in 17.7 ± 4.8 months and oligomenorrheic women in 14.5 ± 3.4 months (Arends et al., 2012). Some pharmacologic therapies, such as hormone replacement therapy or oral contraceptive pills have been used to treat menstrual dysfunction, but have not been proven beneficial (Matzkin et al., 2015). To restore menstrual function, it is important that the athlete focuses on restoration of energy availability.

Restoration of energy availability and menstrual cycles should help to increase bone mass density. The athlete can also replace cardiovascular training with resistance training or minimize cardiovascular training and increase resistance training. This form of exercise has been found to increase BMD in the body (Ducher et al., 2011).

Pharmacologic treatment can also be used to treat bone health issues, but similar to menstrual dysfunction, not much benefit has been found. Some have even found that the use of oral contraceptives can decrease BMD (Scholes et al., 2011).

Prevention

The main method for prevention of the Female Athlete Triad is education. Many female athletes are unaware of the potential effects that sports can have on their body. As long as athletes are aware of the general effects of behaviors like insufficient nutrition, over exertion, and menstrual issues, they will know when to ask for help. The American Academy of Orthopedic Surgeons states, “Education of athletes is crucial to prevention. If athletes can understand the importance of optimal energy availability and how it directly affects bone and reproductive health, the pathology associated with the components of the triad may be avoided” (Matzkin et al., 2015). Proper upkeep of one’s body is the main method of prevention, which can only occur with education.

Appropriate education can occur with the establishment of policies and procedures to require screening, treatment, and education, especially within athletic programs. The American College of Sports Medicine recommends, “that national and international governing bodies of sports and athletic organizations put procedures and policies in place to eliminate potentially harmful weight loss practices of female athletes. Procedures and policies are not specified, because best practices may be sport-specific”

(Nattiv et al., 2007). The establishment of these policies will also help to provide the best quality information to athletes and athletic support staff so that misinformation is not utilized. Some education may also need to be utilized by non-athletic specialties like physicians, so they can have adequate referral strategies when they have a patient with Triad components.

Conclusion

In conclusion, the Female Athlete Triad is a serious condition that affects many female athletes. It is an interrelationship between energy availability, menstrual dysfunction, and bone mineral density that can be present in numerous ways and have varying effects on those who develop its components. Currently, the athletic and student populations have limited knowledge over the Triad, so its risks are not emphasized enough to athletes. This is causing many individuals to develop time loss injuries that can take them away from their sport, or potentially cause other issues that may affect them later in life. It is critical that adequate education is provided to athletes, coaches, athletic trainers, health care providers, and anyone else who may work with athletes so this condition can be prevented and properly treated.

Tables

Table 1. Participant Characteristics (n = 72)

Variable	%	n
Gender		
Male	9.72%	7
Female	88.89%	64
Non-binary	1.39%	1
Age		
18 years	29.17%	21
19 years	20.83%	15
20 years	4.17%	3
21 years	13.89%	10
22 years	5.56%	4
23 years or older	26.39%	19
Type of athlete		
Current Athlete	9.72%	7
Former Athlete	90.28%	65
Total years of participation		
1-3 years	30.56%	22
4-7 years	26.39%	19
8-10 years	11.11%	8
10 or more years	31.94%	23

Table 2. General Knowledge Questions and Responses (n = 72)

Statement and Response	%	n
I have heard of the Female Athlete Triad prior to this survey		
No, I have not heard of it	81.90%	59
Yes, I have heard of it and know about it	1.39%	1
Yes, I have heard of it but don't know much about it	16.70%	12
I have heard of the Relative Energy Deficiency in Sports (RED-S) prior to this survey		
No, I have not heard of it	76.39%	55
Yes, I have heard of it and know about it	22.22%	16
Yes, I have heard of it but don't know much about it	1.39%	1
Do you know any of the components of the Female Athlete Triad?		
Yes	12.50%	9
No	87.50%	63
If you have heard of the Female Athlete Triad, can you list any of the three components that you may know? (n = 9)		
One correct component	44.44%	4
Two correct components	22.22%	2
Three correct components	11.11%	1
Zero correct components	22.22%	2
Do female athletes have to have all 3 aspects of the Triad simultaneously to have the Female Athlete Triad?		
Yes	6.94%	5
No	29.17%	21
Maybe	65.28%	47
Those who could suffer from the Female Athlete Triad are ...		
all athletes	18.06%	13
all physically active females	65.28%	47
female athletes with bad medical history	9.72%	7
none of the above	6.94%	5

Table 3. Symptom Specific and Experience Based Questions and Responses (n = 72)

Statement and Response	%	n
Are female athletes at risk for osteoporosis (brittle bones, break often)?		
Yes	88.89%	64
No	11.11%	8
Are you aware that participating in disordered eating practices can lead to lack of periods?		
Yes	80.56%	58
No	11.11%	8
Maybe	8.33%	6
Signs and symptoms of the Female Athlete Triad (select all that apply)		
One correct symptom	0.00%	0
Two correct symptoms	8.33%	6
Three correct symptoms	12.50%	9
Four correct symptoms	31.94%	23
At least one incorrect	56.94%	41
None of the above	4.17%	3
Have you ever been told that if you were to decrease weight, your athletic performance would improve?		
Yes	52.78%	38
No	43.06%	31
Maybe	4.17%	3

Table 4. Female Only Questions and Responses (n = 64)

Statement and Response	%	n
Having an irregular menstrual cycle is often a sign that the athlete is in peak competitive shape		
Strongly agree	3.13%	2
Somewhat agree	20.31%	13
Neither agree nor disagree	26.56%	17
Somewhat disagree	39.06%	25
Strongly disagree	1.56%	1
Do you feel that it is okay to miss a period or consecutive periods if pregnancy has not occurred?		
Definitely not	31.25%	20
Probably not	32.81%	21
Might or might not	18.75%	12
Probably yes	12.50%	8
Definitely yes	4.69%	3
I am/was comfortable discussing menstrual irregularities with my coaches (n = 65, non-binary included)		
Extremely uncomfortable	13.85%	9
Somewhat uncomfortable	27.69%	18
Neither comfortable nor uncomfortable	24.62%	16
Somewhat comfortable	20.00%	13
Extremely comfortable	13.85%	9

References

- Arends, J. C., Cheung, M.-Y. C., Barrack, M. T., & Nattiv, A. (2012). Restoration of menses with nonpharmacologic therapy in college athletes with menstrual disturbances: A 5-year retrospective study. *International Journal of Sport Nutrition & Exercise Metabolism*, 22(2), 98–108.
- Barrack, M. T., Gibbs, J. C., De Souza, M. J., Williams, N. I., Nichols, J. F., Rauh, M. J., & Nattiv, A. (2014). Higher incidence of bone stress injuries with increasing Female Athlete Triad-related risk factors: A prospective multisite study of exercising girls and women. *American Journal of Sports Medicine*, 42(4), 949–958.
- Brook, E. M., Tenforde, A. S., Broad, E. M., Matzkin, E. G., Yang, H. Y., Collins, J. E., & Blauwet, C. A. (2019). Low energy availability, menstrual dysfunction, and impaired bone health: A survey of elite para athletes. *Scandinavian Journal of Medicine & Science in Sports*, 29(5), 678–685.
- Cleveland Clinic. (2022, February 14). T3 (Triiodothyronine) Test: What It Is, Function & Levels. *Cleveland Clinic*, My.Clevelandclinic.Org.
<https://my.clevelandclinic.org/health/diagnostics/22425-triiodothyronine-t3>
- Curry, E. J., Logan, C., Ackerman, K., McInnis, K. C., & Matzkin, E. G. (2015). Female Athlete Triad awareness among multispecialty physicians. *Sports Medicine - Open*, 1(1), 38. <https://doi.org/10.1186/s40798-015-0037-5>
- Daily, J. P., & Stumbo, J. R. (2018). Female Athlete Triad. *Primary Care: Clinics in Office Practice*, 45(4), 615–624. <https://doi.org/10.1016/j.pop.2018.07.004>

- Ducher, G., Turner, A. I., Kukuljan, S., Pantano, K. J., Carlson, J. L., Williams, N. I., & De Souza, M. J. (2011). Obstacles in the optimization of bone health outcomes in the Female Athlete Triad. *Sports Medicine*, *41*(7), 587–607.
<https://doi.org/10.2165/11588770-000000000-00000>
- Fryar, C., Howell, D. R., Seehusen, C. N., Tilley, D., Casey, E., & Sweeney, E. A. (2021). Time loss injuries among former collegiate gymnasts: The influence of Female Athlete Triad symptoms ...Pediatric Research in Sports Medicine (PRiSM), 8th Annual Meeting, 28-30 January, 2021. *Orthopaedic Journal of Sports Medicine*, *19*, 307–308. <https://doi.org/10.1177/2325967121S00171>
- Gregg, E. A., & Gregg, V. H. (2017). Women in sport: Historical perspectives. *Clinics in Sports Medicine*, *36*(4), 603–610. <https://doi.org/10.1016/j.csm.2017.05.001>
- Hopkins, C. S., Hopkins, C., & Mackin, J. (2022). Relative energy deficiency in sport: Health implications in female athletes. *Women's Healthcare: A Clinical Journal for NPs*, *10*(4), 38–45. <https://doi.org/10.51256/WHC082238>
- Kroshus, E., DeFreese, J. D., & Kerr, Z. Y. (2018). Collegiate athletic trainers' knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport. *Journal of Athletic Training (Allen Press)*, *53*(1), 51–59.
<https://doi.org/10.4085/1062-6050-52.11.29>
- Kroshus, E., Fischer, A. N., & Nichols, J. F. (2015). Assessing the awareness and behaviors of U.S. high school nurses with respect to the Female Athlete Triad. *The Journal of School Nursing : The Official Publication of the National Association of School Nurses*, *31*(4), 272–279.
<https://doi.org/10.1177/1059840514563760>

- Kroshus, E., Sherman, R. T., Thompson, R. A., Sossin, K., & Austin, S. B. (2014). Gender differences in high school coaches' knowledge, attitudes, and communication about the Female Athlete Triad. *Eating Disorders: The Journal of Treatment & Prevention*, 22(3), 193–208.
<https://doi.org/10.1080/10640266.2013.874827>
- Laframboise, M. A., Borody, C., & Stern, P. (2013). The Female Athlete Triad: A case series and narrative overview. *Journal of the Canadian Chiropractic Association*, 57(4), 316–326.
- Lodge, M. T., Ackerman, K. E., & Garay, J. (2022). Knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport among female cross-country athletes and support staff. *Journal of Athletic Training (Allen Press)*, 57(4), 385–392. <https://doi.org/10.4085/1062-6050-0175.21>
- Lu, J., Shin, Y., Yen, M.-S., & Sun, S. S. (2016). Peak bone mass and patterns of change in total bone mineral density and bone mineral contents from childhood into young adulthood. *Journal of Clinical Densitometry : The Official Journal of the International Society for Clinical Densitometry*, 19(2), 180–191.
<https://doi.org/10.1016/j.jocd.2014.08.001>
- Matzkin, E., Curry, E. J., & Whitlock, K. (2015). Female Athlete Triad: Past, present, and future. *Journal of the American Academy of Orthopaedic Surgeons*, 23(7), 424–432. <https://doi.org/10.5435/JAAOS-D-14-00168>
- Melin, A., Tornberg, Å. B., Skouby, S., Møller, S. S., Sundgot-Borgen, J., Faber, J., Sidelmann, J. J., Aziz, M., & Sjödén, A. (2015). Energy availability and the

Female Athlete Triad in elite endurance athletes. *Scandinavian Journal of Medicine & Science in Sports*, 25(5), 610–622.

Miller, S. M., Kukuljan, S., Turner, A. I., van der Pligt, P., & Ducher, G. (2012). Energy deficiency, menstrual disturbances, and low bone mass: What do exercising Australian women know about the Female Athlete Triad? *International Journal of Sport Nutrition & Exercise Metabolism*, 22(2), 131–138.

<https://doi.org/10.1123/ijsnem.22.2.131>

Nattiv, A., Loucks, A. B., Manore, M. M., Sanborn, C. F., Sundgot-Borgen, J., & Warren, M. P. (2007). The Female Athlete Triad. *Medicine & Science in Sports & Exercise*, 39(10), 1867–1882. <https://doi.org/10.1249/mss.0b013e318149f111>

NIH Consensus Development Panel on Osteoporosis Prevention, D., and Therapy. (2001). Osteoporosis prevention, diagnosis, and therapy. *JAMA*, 285(6), 785–795. <https://doi.org/10.1001/jama.285.6.785>

Nose-Ogura, S., Yoshino, O., Dohi, M., Kigawa, M., Harada, M., Hiraike, O., Onda, T., Osuga, Y., Fujii, T., & Saito, S. (2019). Risk factors of stress fractures due to the female athlete triad: Differences in teens and twenties. *Scandinavian Journal of Medicine & Science in Sports*, 29(10), 1501–1510.

<https://doi.org/10.1111/sms.13464>

Rauh, M. J., Barrack, M., & Nichols, J. F. (2014). Associations between the Female Athlete Triad and injury among high school runners. *International Journal of Sports Physical Therapy*, 9(7), 948–958.

Sawai, A., Mathis, B. J., Natsui, H., Zaboronok, A., Mitsuhashi, R., Warashina, Y., Mesaki, N., Shiraki, H., & Watanabe, K. (2018). Risk of female athlete triad

development in Japanese collegiate athletes is related to sport type and competitive level. *International Journal of Women's Health*, 10, 671–687.

<https://doi.org/10.2147/IJWH.S175446>

Scholes, D., Hubbard, R. A., Ichikawa, L. E., LaCroix, A. Z., Spangler, L., Beasley, J.

M., Reed, S., & Ott, S. M. (2011). Oral contraceptive use and bone density

change in adolescent and young adult women: A prospective study of age,

hormone dose, and discontinuation. *The Journal of Clinical Endocrinology and*

Metabolism, 96(9), E1380. <https://doi.org/10.1210/jc.2010-3027>

Skorseth, P., Segovia, N., Hastings, K., & Kraus, E. (2020). Prevalence of Female

Athlete Triad risk factors and iron supplementation among high school distance

runners: Results from a triad risk screening tool. *Orthopaedic Journal of Sports*

Medicine, 8(10), 1–7. <https://doi.org/10.1177/2325967120959725>

Statuta, S. M., Asif, I. M., & Drezner, J. A. (2017). Relative Energy Deficiency in Sport

(RED-S). *British Journal of Sports Medicine*, 51(21), 1570.

<https://doi.org/10.1136/bjsports-2017-097700>

Temme, K. E., & Hoch, A. Z. (2013). Recognition and rehabilitation of the Female

Athlete Triad/Tetrad: A multidisciplinary approach. *Current Sports Medicine*

Reports, 12(3), 190. <https://doi.org/10.1249/JSR.0b013e318296190b>

Tenforde, A. S., Beauchesne, A. R., Borg-Stein, J., Hollander, K., McInnis, K., Kotler,

D., & Ackerman, K. E. (2020). Awareness and comfort treating the Female

Athlete Triad and Relative Energy Deficiency in Sport among healthcare

providers. / Bewusstsein über und Kenntnisse bei der Behandlung der „Female

Athlete Triad“ und des relativen Energiedefizits im Sport. *German Journal of Sports Medicine / Deutsche Zeitschrift Fur Sportmedizin*, 71(3), 76–80.

Thein-Nissenbaum, J., & Hammer, E. (2017). Treatment strategies for the female athlete triad in the adolescent athlete: Current perspectives. *Open Access Journal of Sports Medicine*, 8, 85–95.