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Risk Factors For The Female athlete Triad in College Age athletes Compared to Non-athletes

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ABSTRACT

RISK FACTORS FOR THE FEMALE ATHLETE TRIAD IN COLLEGE-AGE ATHLETES COMPARED TO NON-ATHLETES

Micaela Miller, M.S.
School of Health Studies
Northern Illinois University, 2018
Dr. Josephine Umoren, Director

The Female Athlete Triad (Triad) is the three interrelated conditions of low energy availability with or without disordered eating, menstrual irregularity or amenorrhea, and osteoporosis and is a health concern that affects active women of all ages who participate in physical activity. Although associations have been found between the individual components of the Triad, research is still limited on all Triad components occurring simultaneously in athletes. In addition, research on the college-age female population is currently limited. The purpose of this study was to examine Triad risk factors in the college-age female athlete population compared to the non-athlete population, specifically focusing on the risk factor of inadequate energy availability and eating disorders.

A non-experimental cross-sectional study design was conducted during the spring semester to assess presence of the Triad risk factors among females attending a midwestern university. A total for 1,537 female students participated in this study. An online survey composed of the LEAF-Q questionnaire and the EAT-26 questionnaire was used to assess the risk factors for the Female Athlete Triad and risk for eating disorders, respectively.
Independent-samples t tests and chi-square tests were used to analyze differences in risk for low energy availability and risk for eating disorders between the two groups of participants. There were no significant differences between the athlete and non-athlete groups risk for the Female Athlete Triad as measured by the mean LEAF-Q scores. However, within the athlete group, associations were found in number of training days, age of first menstrual period, and amenorrhea for three consecutive months. Results showed no significant (p = 0.74) differences between athlete and non-athlete groups in risk for eating disorders using mean EAT-26 scores. More non-athletes (20%) were associated with avoiding foods with carbohydrate content, while a higher number of athletes (4%) were associated with having the impulse to vomit after meals. Additionally, a significant (p = 0.01) difference was found between the athlete and non-athlete groups in their response to the question, “Have you gone on eating binges where you feel that you may not be able to stop?” Overall, there were no significant (p = 0.07) differences between the number of athletes who were considered at risk for both inadequate energy intake and an eating disorder compared to non-athletes.

Associations between athletes and the Female Athlete Triad are evident, but the Triad components are not yet fully understood. Results of this study suggest a need for screening and monitoring female athletes for Triad risk factors.
NORTHERN ILLINOIS UNIVERSITY
DEKALB, ILLINOIS

DECEMBER 2018

RISK FACTORS FOR THE FEMALE ATHLETE TRIAD IN COLLEGE-AGE ATHLETES
COMPAARED TO NON-ATHLETES

BY
MICAELE MILLER

A THESIS SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE
MASTER OF SCIENCE

SCHOOL OF HEALTH STUDIES

Director:
Dr. Josephine Umoren
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The Female Athlete Triad (Triad) is a health concern that affects active women of all ages who participate in physical activity. The three interrelated conditions of the Triad are low energy availability with or without disordered eating, menstrual irregularity or amenorrhea, and osteoporosis. Benefits of exercise include increasing bone mineral density and lean body mass, which may help prevent stress fractures and osteoporosis. However, too much vigorous activity can have a negative effect on female athletes. There are more instances of injuries in high school female athletes than male athletes competing in the same sport, and injuries may lead to a decreased ability to participate in sports, an increase in potential long-term chronic injuries, and musculoskeletal problems that may lead to restrictions of mobility and ability to participate in physical activities later in life.

Some sports, in particular those that emphasize leanness and aesthetic factors, have a higher prevalence of women who suffer from the Female Athlete Triad. These sports include gymnastics, dance, diving, figure skating, aerobics, and running. One study found the prevalence of the Female Athlete Triad to be 60% in long-distance runners and ballet dancers.

The key component of the Triad is low energy intake, which appears to be a precursor for the development of the other two Triad components: menstrual dysfunctions and disordered eating behaviors. Women may continue to perform at high levels of training but limit caloric
intake, creating a caloric deficit. Energy intake of 30 kcal/kg fat-free mass per day or less is associated with the Female Athlete Triad. Although the restrictive eating behavior may not reach the same level as a clinical eating disorder, this low energy intake causes processes that need energy to be disrupted, such as reproduction, estrogen levels, metabolism, thermoregulation, growth, and cellular regulation.

The second Triad component of menstrual dysfunction is associated with the stress of high intensity and volume of training and is more prevalent in athletes than non-athletes. Previous research states that athletes who begin to train before menarche are at the greatest risk for the Triad. The time during menarche is a critical time for peak bone mass accrual for women; thus, women with menstrual dysfunction may not maximize bone mineralization during this time. Today, osteoporosis is known to affect one of three women age 50 and older, and amenorrhea and low body weight are factors that increase the risk of osteoporosis. The American College of Sports Medicine defines low bone mineral density as a “bone mineral density z score of $\leq -1.0$.” Research shows that 10.70% -21.08% of athletes have reduced bone mineral density.

Correlations between disrupted eating behaviors and menstrual irregularity and between menstrual irregularity and low bone mineral density have been found. A study by Cobb in 2003 found that disordered eating may decrease menstruation, resulting in estrogen deficiency and changes in metabolic pathways, thus creating low bone mineral density. The same study found that low body weight was an independent risk factor for low bone mineral density. Additionally, low body weight and oligomenorrhea or amenorrhea were found to be associated.

Although correlations have been found between Triad components, research is still limited on finding all Triad components occurring simultaneously in athletes.
research shows 1.2% of high school varsity sport athletes have been found to have the full Triad simultaneously and 48.2% met at least one component, which indicates that these conditions occur early in female athlete lives. Each disorder of the Triad may lead to a serious medical consequence, and having the full Triad simultaneously can lead to a higher rate of mortality.

Because the presence of the Triad is often underreported, screenings for risk factors and symptoms were created for early identification of the three Triad components in order to lessen the worsening of symptoms and allow opportunity for treatment. Therefore, identifying the risk factors of the Triad is necessary in evaluating for the Triad.

Although research has been conducted on the Female Athlete Triad and its risk factors, current research on the college-age population is limited. Research by Thompson was conducted in 2007 on collegiate track athletes and by Friesen et al. in 2011 on collegiate modern dancers, but there is a lack of studies focusing on collegiate athletes in the past several years. Therefore, there is a need for research on the Triad in the college-age athlete population.

Purpose

The purpose of this study was to examine incidence of Triad risk factors in the college-age female athlete population compared to the non-athlete population. Because the energy availability component of the Triad has been deemed the precursor for developing the other two Triad components, this study focused on low energy availability and eating disorders among female athletes. Specifically, this study was aimed to expand on current literature and
determine if there continues to be a higher prevalence of the Triad risk factor of inadequate energy availability and eating disorders in athletes compared to non-athletes. Because the purpose of this study was to look at risk factors of the Triad components and not outcomes of the Triad, blood samples, bone mineral density, and clinical interviews were not conducted.

Research Questions and Hypothesis

**Research Question 1:** Are female athletes at an increased risk for low energy availability compared to non-athletes?  
*H0:* Female athletes at Midwestern University are not at an increased risk for low energy availability compared to non-athletes.  
*H1:* Female athletes at Midwestern University are at an increased risk for low energy availability compared to non-athletes.

The **variables** needed to test this hypothesis were:  
- Independent variable: Athletes vs non-athletes  
- Dependent variable: Risk for low energy availability

The **data** for each variable consisted of:  
- Independent variable: Group participants identified in the survey (athlete or non-athlete)  
- Dependent variable: Risk for low energy availability as measured by the Low Energy Availability in Females Questionnaire (LEAF-Q) scores.

**Research Question 2:** Are female athletes at an increased risk for an eating disorder compared to non-athletes?  
*H0:* Female athletes at Midwestern University are not at an increased risk for an eating disorder compared to non-athletes.  
*H2:* Female athletes at Midwestern University are at an increased risk for an eating disorder compared to non-athletes.

The **variables** needed to test this hypothesis were:  
- Independent variable: Athletes vs non-athletes  
- Dependent variable: Risk for an eating disorder

The **data** for each variable consisted of:  
- Independent variable: Group participants identified in the survey (athlete or non-athlete)
Dependent variable: Risk for an eating disorder as measured by the Eating Attitudes Test--26 (EAT-26) scores.

Research Question 3: Are female athletes at an increased risk for behavioral eating disorder risk factors compared to non-athletes?

H0: Female athletes are not at increased risk for behavioral eating disorder risk factors compared to non-athletes.
H3: Female athletes are at increased risk for behavioral eating disorder risk factors compared to non-athletes.

The variables needed to test this hypothesis were:
Independent variable: Athletes vs non-athletes
Dependent variable: Risk for behavioral eating disorder factors

The data for each variable consisted of:
Independent variable: Group participants identified in the survey (athlete or non-athlete)
Dependent variable: Risk for behavioral eating disorder factors as measured by EAT-26 Part C.

Research Question 4: Are a significant number female athletes considered at risk for both inadequate energy intake and eating disorders compared to non-athletes?

H0: A significant number of athletes are not considered at risk for both inadequate energy intake and eating disorders compared to non-athletes.
H4: A significant number of athletes are considered at risk for both inadequate energy intake and eating disorders compared to non-athletes.

The variables needed to test this hypothesis were:
Independent variable: Athletes vs non-athletes
Dependent variable: Risk for inadequate energy intake and eating disorders

The data for each variable consisted of:
Independent variable: Group participants identified in the survey (athlete or non-athlete)
Dependent variable: Risk for inadequate energy intake and eating disorders as measured by LEAF-Q and EAT-26 scores.
Operational Definitions

1. Body mass index (BMI): Measures appropriate weight for height. A BMI less than 18.5 is considered underweight, a BMI of 18.5-24.9 is considered normal weight, a BMI of 25-29.9 is considered overweight, and a BMI of 30 or greater is considered obese.

2. Risk for low energy availability: Entails a self-reported assessment using the LEAF-Q survey. Scores from this assessment were summed and a score of 8 or greater is considered to be at risk for low energy availability.

3. Risk for an eating disorder: Entails a self-reported assessment using the EAT-26 survey. Scores from this assessment were summed and a score of 20 or greater is considered to be at risk for an eating disorder.

4. Athlete: A participant who answered “yes” to the question, “Are you a varsity athlete at Northern Illinois University?” on this survey.

5. Non-athlete: A participant who answered “no” to the question, “Are you a varsity athlete at Northern Illinois University?” on this survey.

6. Primary amenorrhea: Is lacking menstruation by 15 years of age.\textsuperscript{11}

7. Secondary amenorrhea: Is lacking three or more consecutive menstrual cycles after menarche has occurred.\textsuperscript{11}
CHAPTER II

METHODOLOGY

Study Design

A non-experimental cross-sectional study design was used to identify risk for Triad components in a college-age population of athletes and non-athletes. An online survey was used to collect the data. The study survey consisted of three main components: (1) the LEAF-Q questionnaire focusing on risk for inadequate energy intake, (2) the EAT-26 questionnaire focusing on risk for an eating disorder, and (3) a demographic information section.

Use of Human Subjects in Research

Prior to the distribution of the survey, written permission to conduct this study was obtained by the Institutional Review Board at Northern Illinois University (Appendix B, Appendix C). Potential participants read a consent form informing them of their rights as well as the benefits and risks of participation before choosing to begin this survey (Appendix D).
Sample Selection

Convenience sampling was used for this study because the researcher was a student within this population, and therefore, this population was easily accessible. The control group was not matched to the athlete samples because this study compared the total group of athlete and non-athlete samples.

In 2017, NIU had a total of 17,169 students enrolled; 12,788 undergraduate students, 4,121 graduate students, and 260 College of Law students. Undergraduate female students represented 49.2% of the population, and graduate female students represented 53.4% of the population. The average age for undergraduate and graduate students was 22 and 32 years old. The undergraduate demographics were 57.0% White, 15.9% Black, 15.4% Hispanic/Latino, 5.0% Asian, and 0.8% unknown.12

Eligibility criteria for participants included being a female student enrolled at NIU and being between the ages of 18-24 years old. Students were recruited through the use of the Monday official announcements and NIU official mass emails sent to all students (Appendix E, Appendix F). Additionally, the university athletic director and female varsity coaches were contacted via email and informed about the survey (Appendix G, Appendix H). At the end of the survey, links to approved sites on the survey topics were included as additional resources for participants (Appendix I).

Study Instruments

A one-time, online survey (Appendix J) consisting of three parts: (1) the LEAF-Q questionnaire (Appendix K), (2) the Eating Attitudes--26 Questionnaire (EAT-26; Appendix L), and (3) demographic and anthropometric information.
The LEAF-Q is a 25-item screening tool used to identify athletes at risk for the Triad, focusing on symptoms of energy deficiency with or without an eating disorder, and includes questions on gastrointestinal symptoms, injury frequency, and menstrual dysfunction. This questionnaire is a complement to other eating disorder screening tools. Each answer has a numeral score associated and these numbers are added up to find a total score for the test. A score of 8 or more on this questionnaire indicates that an athlete is considered to be at risk for the Triad. The author of the LEAF-Q was contacted, and permission was granted to use this questionnaire (Appendix M).

The Eating Attitudes Test--26 (EAT-26) was used to assess the presence of abnormal eating behaviors. The test is a standardized measure of symptoms and behaviors that follow the patterns of eating disorders. The test is not a diagnostic tool for eating disorders. However, it can be used as the first step in a two-step diagnosis process. Individuals who score a 20 or more on this test are considered to be at risk for an eating disorder. There are three subscales within the EAT-26 test: dieting, bulimia and food preoccupation, and oral control. Questions 1, 6, 7, 10, 12, 14, 16, 17, 22, 23, 24, and 26 are dieting scale items; Questions 3, 4, 9, 18, 21, and 25 are bulimia and food preoccupation scale items; and Questions 2, 5, 8, 13, 15, 19, and 20 are oral control subscale items. The answer options for Questions 1-26 are always, usually, often, sometimes, rarely, and never. Each answer has a numeral score associated and these numbers are added up to find a total score for the test. A copy of permission to use the EAT-26 is included in Appendix N. The LEAF-Q and EAT-26 surveys used in this study have been validated and produce reliable data.

The self-reported general demographic and anthropometric information included asking participants if they are a varsity athlete at NIU, their age in years, weight in pounds, height in
feet and inches, year in school, ethnicity, and sport participated (if applicable). The height and weight recorded were used to calculate body mass index (BMI) for each participant.

Data Collection

The recruiting for this study began in March 2018 and data collection began in April 2018. The survey link was made available for participants to access on March 4, 2018. Eligible participants were notified about the survey through the NIU Monday official announcements and NIU mass emails. The official announcements coordinators were contacted one week before the survey was sent out to have the survey approved by the Division of Marketing & Communications. The survey link was included in the Monday morning announcements twice in April as well as a mass email. Additionally, the university athletic director along with all female coaches were contacted in April and informed about the survey.

On the first page of the survey, there was an introduction to the research and instructions on how to give consent. Those who chose to participate in the survey gave their consent by continuing to complete the survey. All responses were recorded anonymously, and all records were password protected and stored in Qualtrics. Records will be kept for three years and will be deleted in Qualtrics after that time. The estimated sample size was 300 participants.

The participants had one month to complete the online survey. The survey closed in May 2018. On the last page of the survey, an email address was provided for participants who wished to participate in a raffle drawing to send their contact information. Three $25 Target gift cards were randomly awarded to participants as an incentive to complete the survey.
Data Analysis

Data was downloaded from Qualtrics for statistical analysis using SPSS version 24.

To test for Hypothesis 1: Female athletes at Midwestern University are at an increased risk for low energy availability compared to non-athletes, an independent-samples t test was used to determine the differences between the means of the two groups. The data needed to test this hypothesis was:

Independent variable: Group participants self-reported in the survey (athlete or non-athlete)
Dependent variable: Risk for low energy availability as measured by LEAF-Q scores

To test for Hypothesis 2: Female athletes at Midwestern University are at an increased risk for an eating disorder compared to non-athletes, an independent-samples t test was used to determine the differences between the means of the two groups. The data needed to test this hypothesis was:

Independent variable: Group participants self-reported in the survey (athlete or non-athlete)
Dependent variable: Risk for an eating disorder as measured by EAT-26 score.

To test for Hypothesis 3: Female athletes are at increased risk for behavioral eating disorder risk factors compared to non-athletes, a chi-square test was used because the data was categorical. The data for each variable consisted of:

Independent variable: Group participants identified in the survey (athlete or non-athlete)
Dependent variable: Risk for an eating disorder as measured by EAT-26 Part C response.

To test for Hypothesis 4: A significant number of athletes will be considered “at risk” for both inadequate energy intake and eating disorders compared to non-athletes, a chi-square test was used because frequency was desired. The data for each variable consisted of:

Independent variable: Group participants identified in the survey (athlete or non-athlete)
Dependent variable: Risk for an inadequate energy intake and eating disorder as measured by LEAF-Q and EAT-26 score.
CHAPTER III

RESULTS

A total of 1,537 students participated in this study out of a total of about 9,422 eligible female students at NIU, representing a total response rate of approximately 16.3% and a female athlete response rate of 51.1% out of a total of 141. Because there is no available information on the number of non-traditional female students at NIU who are likely older than 24 years old, those students were included within this response rate. Therefore, it can be noted that the total response rate is likely higher. Table 1 shows response rates of female athletes representing each female sport at NIU.

Of those who participated in this study, 422 responses were eliminated due to an inadequate number of survey questions answered and were deemed incomplete. All the responses eliminated identified as non-athletes. Overall, 1,115 participants completed all parts of the survey, resulting in a 73% rate of completion of the survey. Of the 1,115 remaining samples, 72 identified as athletes and 1,043 as non-athletes. Because the athlete participants were greatly outnumbered by the non-athlete participants, a random selection of 100 non-athletes was taken using the SPSS random sample function to analyze with the athlete samples as the primary means of analysis. The reduction of samples is represented in Figure 1.
Table 1
Response Rates of Female Athletes by Sport

<table>
<thead>
<tr>
<th>Sport</th>
<th>Total Number of Athletes Listed on 2017-2108 Roster</th>
<th>Number of Samples that Participated</th>
<th>Percent of Athlete Participation Within Each Sport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>11</td>
<td>5</td>
<td>45.50%</td>
</tr>
<tr>
<td>Cross Country</td>
<td>20</td>
<td>13</td>
<td>65.00%</td>
</tr>
<tr>
<td>Golf</td>
<td>8</td>
<td>7</td>
<td>88.00%</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>17</td>
<td>6</td>
<td>35.30%</td>
</tr>
<tr>
<td>Soccer</td>
<td>25</td>
<td>19</td>
<td>76.00%</td>
</tr>
<tr>
<td>Softball</td>
<td>20</td>
<td>10</td>
<td>50.00%</td>
</tr>
<tr>
<td>Tennis</td>
<td>8</td>
<td>1</td>
<td>12.50%</td>
</tr>
<tr>
<td>Track and Field</td>
<td>35</td>
<td>6</td>
<td>17.10%</td>
</tr>
<tr>
<td>Volleyball</td>
<td>14</td>
<td>4</td>
<td>28.60%</td>
</tr>
</tbody>
</table>

n= 1465
(Total number of non-athlete participants who took the survey)

n= 1043
(Total number of non-athlete participants after incomplete surveys were eliminated)

n= 100
(Total number of non-athlete participants after randomly selecting non-athlete participants to analyze with athlete participants)

Figure 1. Reduction in Data for Non-Athletes
Description of the Participants

After random selection of 100 participants from the non-athlete group, the total number of participants in this study was decreased to 172, of which 41.90% represented athletes and 58.10% non-athletes. As illustrated in Table 1, the largest reported sport participated in was soccer, which represented 11.00% of participants, followed by cross country (7.60%), softball (5.80%), golf (4.10%), track and field (3.50%), gymnastics (3.50%), basketball (2.90%), volleyball (2.30%), and tennis (0.60%).

The overall average age of participants was 21.12 ± 1.89 years, with slight differences between the average ages of athlete and non-athlete participants (20.25 ± 1.57, 21.75 ± 1.87, respectively; Table 2. The average weight in pounds for participants was 147 ± 28.36, with athletes reporting a lower average weight and smaller standard deviation than non-athletes (142.24 ± 22.95, 151.61 ± 31.20, respectively). Similarly, the average BMI of athlete participants was lower than that of the non-athlete participants (22.75 ± 4.01, 25.21 ± 5.89, respectively).

A majority of participants were Caucasian (70.30%), with slight differences in distributions of ethnicities among the athlete and non-athlete groups. Overall, most of the study participants were juniors at NIU, while within the athlete group, freshmen were the largest number of participants compared to the non-athlete group, where juniors had the largest number of participants.
Table 2
Characteristics of Female Athlete and Non-Athlete Student Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Participant</th>
<th>Frequency n (%)</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>Athlete</td>
<td>71 (41.30%)</td>
<td>20.25 ± 1.57</td>
</tr>
<tr>
<td></td>
<td>Non- Athlete</td>
<td>99 (57.60%)</td>
<td>21.75 ± 1.87</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>170 (98.80%)</td>
<td>21.12 ± 1.89</td>
</tr>
<tr>
<td><strong>Weight (lbs)</strong></td>
<td>Athlete</td>
<td>71 (41.30%)</td>
<td>142.24 ± 22.95</td>
</tr>
<tr>
<td></td>
<td>Non- Athlete</td>
<td>99 (57.60%)</td>
<td>151.61 ± 31.20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>170 (98.80%)</td>
<td>147.70 ± 28.36</td>
</tr>
<tr>
<td><strong>Height (inches)</strong></td>
<td>Athlete</td>
<td>71 (41.30%)</td>
<td>65.77 ± 3.33</td>
</tr>
<tr>
<td></td>
<td>Non- Athlete</td>
<td>99 (57.60%)</td>
<td>64.80 ± 3.53</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>170 (98.80%)</td>
<td>65.21 ± 3.47</td>
</tr>
<tr>
<td><strong>Body Mass Index (kg/m^2)</strong></td>
<td>Athlete</td>
<td>71 (41.30%)</td>
<td>22.75 ± 4.01</td>
</tr>
<tr>
<td></td>
<td>Non- Athlete</td>
<td>99 (57.60%)</td>
<td>25.21 ± 5.89</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>170 (98.80%)</td>
<td>24.18 ± 5.31</td>
</tr>
<tr>
<td><strong>Year in School</strong></td>
<td>Athlete</td>
<td>Freshman: 20 (11.60%)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Sophomore: 17 (9.90%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Junior: 15 (8.70%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior: 16 (9.30%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate: 3 (1.70%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 71 (41.30%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Freshman: 12 (7.00%)</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Sophomore: 12 (7.00%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Junior: 28 (16.30%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior: 26 (15.10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate: 21 (12.20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 99 (57.60%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Freshman: 32 (18.60%)</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Sophomore: 29 (16.90%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Junior: 43 (25.00%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior: 42 (24.40%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate: 24 (14.00%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 170 (98.80%)</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

Continued on the following page
<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Athlete</th>
<th>Non-Athlete</th>
<th>Total</th>
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<td>African American/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African/Black/Caribbean:</td>
<td>2 (1.20%)</td>
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<td>Asian/Pacific Islander:</td>
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<td>Caucasian:</td>
<td>57 (33.10%)</td>
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<td></td>
</tr>
<tr>
<td>Hispanic/Latino:</td>
<td>8 (4.70%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American:</td>
<td>0 (0.00%)</td>
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<td></td>
<td></td>
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<tr>
<td>Other:</td>
<td>3 (1.70%)</td>
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</tr>
<tr>
<td>Total:</td>
<td>71 (41.30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African/Black/Caribbean:</td>
<td>13 (7.60%)</td>
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<tr>
<td>Asian/Pacific Islander:</td>
<td>10 (5.80%)</td>
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<tr>
<td>Caucasian:</td>
<td>64 (37.20%)</td>
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<tr>
<td>Hispanic/Latino:</td>
<td>9 (5.20%)</td>
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<tr>
<td>Native American:</td>
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<tr>
<td>Other:</td>
<td>3 (1.70%)</td>
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<tr>
<td>Total:</td>
<td>99 (57.60%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>African American/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African/Black/Caribbean:</td>
<td>16 (9.30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian/Pacific Islander:</td>
<td>10 (5.80%)</td>
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<td>Caucasian:</td>
<td>121 (70.30%)</td>
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<td>Hispanic/Latino:</td>
<td>17 (9.90%)</td>
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<tr>
<td>Native American:</td>
<td>0 (0.00%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td>6 (3.50%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>170 (98.80%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport</td>
<td>Athlete</td>
<td>Non-Athlete</td>
<td>Total</td>
<td>N/A</td>
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<tr>
<td>Basketball:</td>
<td>5 (2.90%)</td>
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<tr>
<td>Cross Country:</td>
<td>13 (7.60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golf:</td>
<td>7 (4.10%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnastics:</td>
<td>6 (3.50%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soccer:</td>
<td>19 (11.00%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Softball:</td>
<td>10 (5.80%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tennis:</td>
<td>1 (0.60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track and Field:</td>
<td>6 (3.50%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volleyball:</td>
<td>4 (2.30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>71 (41.30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk to Inadequate Energy Intake

Hypothesis 1: *Female athletes at Midwestern University are at an increased risk for low energy availability compared to non-athletes* was tested using an independent-samples t test of the mean of the LEAF-Q. Results showed no significant differences between the athlete and non-athlete participant mean LEAF-Q scores, $p = 0.28$. Thus, the null hypothesis was not rejected and support was not found for research Hypothesis 1. As shown in Table 3 and Figure 2, athletes who completed the LEAF-Q had a mean score of $7.43 \pm 3.34$, compared to the non-athletes, whose mean score was $6.83 \pm 3.80$.

Additionally, the research hypothesis was further analyzed by examining each individual question and section of the LEAF-Q using a chi-square test of independence. LEAF-Q Question 1.A1, “…how many days absence from training or participation in competition due to injuries have you had in the last year?” was found to be significant between groups ($p < 0.001$; Figure 3). Twenty athletes and 10 non-athletes indicated they were absent from training or physical activity for 1-7 days, nine athletes and four non-athletes being absent 8-14 days, one athlete and one non-athlete being absent 15-21 days, and 13 athletes and one non-athlete being absent 22 days or more in the last year. As shown in Figure 4, significance was also found in LEAF-Q Question 3.2A, “How old were you when you had your first period?” ($p < 0.001$), with 21 athletes and eight non-athletes indicating their first period occurred at age 15 or older. LEAF-Q Question 3.2D, “Have your periods ever stopped for 3 consecutive months or longer?” ($p = 0.02$), was found to be significant, with 31 athletes and 24 non-athletes responding yes, it has happened before, and seven athletes and seven non-athletes responding yes, that is the situation now (Figure 5). Finally, the LEAF-Q injuries subscale incorporating questions 1.A and 1.A1 was
found to be significant between athletes and non-athletes (p < 0.001), with 42 athletes and 16 non-athletes with a score greater than zero (Figure 6).

Table 3
LEAF-Q Mean Scores for Athletes and Non-Athletes

<table>
<thead>
<tr>
<th>LEAF-Q Score</th>
<th>Participants</th>
<th>Mean ± SD Primary analysis</th>
<th>Mean ± SD Secondary analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Athletes:</td>
<td>7.43 ± 3.34</td>
<td>7.43 ± 3.34</td>
</tr>
<tr>
<td></td>
<td>Non-Athletes:</td>
<td>6.83 ± 3.80</td>
<td>5.74 ± 3.15</td>
</tr>
</tbody>
</table>

Figure 2. Mean LEAF-Q Scores by Participant Group
Figure 3. Frequency of LEAF-Q Question 1.A1 Responses by Participant Group

Figure 4. Frequency of LEAF-Q Question 3.2A Responses by Participant Group
Figure 5. Frequency of LEAF-Q Question 3.2D Responses by Participant Group

Figure 6. Frequency of Scores on LEAF-Q Injuries Subscale by Participant Group
A secondary means of analysis was conducted. The data of 1,043 participants in the non-athlete group was compared to the 72 participants in the athlete group. After analyzing the secondary data, all questions mentioned above were found to be significant, as well as LEAF-Q 1.A, “Have you had absences from your training or participation in competitions during the last year due to injuries?” (p < 0.001), with four athletes and 11 non-athletes indicating they had absences from training or participation once or twice during the last year. Also, LEAF-Q 2.C, “How often do you have bowel movements on average?” was significant (p= 0.01), with 29 athletes and 254 non-athletes indicating having a bowel movement several times per day, seven athletes and 150 non-athletes having a bowel movement every second day, and six athletes and 58 non-athletes having a bowel movement twice a week. Finally, the LEAF-Q total score was found to be significant (p= 0.05), which would reject the null hypothesis (Table 3).

Risk to Eating Disorder

Research Hypothesis 2: Female athletes at Midwestern University are at an increased at risk for an eating disorder compared to non-athletes was tested using an independent-samples t test, with the EAT-26 scores serving as the test variable and participant group representing the grouping variable. Results showed no significant differences between athlete and non-athlete participant mean EAT-26 scores, p =0.74. Thus, the null hypothesis was not rejected, and support was not found for the research hypothesis. Athletes scored an average of 8.63 ± 6.94, while non-athletes scored an average of 6.10 ± 6.10 (Table 4, Figure 7).

Individual questions on the EAT-26 survey were examined as further analysis using chi-squared tests of independence. As indicated in Figure 8, results showed significant differences
between athlete and non-athlete participants in Question 7 (p=0.04), “Particularly avoid food with high carbohydrate content,” with 12 athletes responding “often” and one responding “usually” and 10 non-athletes responding “often” and 10 responding “usually.” Question 25, “Have the impulse to vomit after meals,” was also found to be significant (p= 0.04) with three athletes and zero non-athletes responding “often” (Figure 9).

Table 4
EAT-26 Mean Scores for Athletes and Non-Athletes

<table>
<thead>
<tr>
<th>EAT-26 Score</th>
<th>Participants</th>
<th>Mean ± SD Primary analysis</th>
<th>Mean ± SD Secondary analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Athletes:</td>
<td>8.63 ± 6.94</td>
<td>8.63 ± 6.94</td>
</tr>
<tr>
<td></td>
<td>Non-Athletes:</td>
<td>6.10 ± 6.10</td>
<td>8.14 ± 5.98</td>
</tr>
</tbody>
</table>

Figure 7. Mean EAT-26 Scores by Participant Group
Figure 8. Frequency of EAT-26 Question 7 Responses by Participant Group

Figure 9. Frequency of EAT-26 Question 25 Responses by Participant Group
As a secondary means of analysis, the data of 1,043 non-athlete samples was analyzed and compared to the group of 72 athlete samples. Results showed no significant differences between athlete and non-athlete participant mean EAT-26 scores, p =0.51. Thus, the null hypothesis was not rejected, and support was not found for the research hypothesis. Several questions in the secondary analysis data were considered significant. Question 2, “Avoid eating when I am hungry” (p= 0.03), found four athletes’ and 49 non-athletes’ responses to be “often” and four athletes’ and 15 non-athletes’ responses to be “usually.” Also, Question 15, “Take longer than others to eat my meals” (p= 0.04), found three athletes and 152 non-athletes responded “often” and five athletes and 17 non-athletes responded “usually.” Question 22, “Feel uncomfortable after eating sweets,” was found to be significant (p= 0.05), with 17 athletes and 146 non-athletes responding “often” and eight athletes and 90 non-athletes responding “usually.” Additionally, Question 24, “Like my stomach to be empty,” and the dieting subscale Questions 1, 6, 7, 10, 11, 12, 14, 16, 17, 22, 23, 24, and 26 were found to be significant (p= 0.04, p= 0.01).

Eating Disorder Behavioral Risk Results

Hypothesis 3: Female athletes are at an increased risk for behavioral eating disorder risk factors compared to non-athletes was tested using a chi-square test of independence. Results shown in Table 5 indicate that a significantly larger number of athletes stated that they have “gone on eating binges where you feel that you may not be able to stop,” p = 0.01 (Question A). Therefore, the null hypothesis was rejected, and these results do support the research hypothesis.
Table 5

EAT-26 Behavioral Questions for Athletes and Non-Athletes

<table>
<thead>
<tr>
<th>EAT-26 Questions</th>
<th>Participants</th>
<th>Number of Participants Considered at Risk</th>
<th>Percent of Total Population</th>
<th>Percent Within the Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Gone on eating binges where you feel that you may not be able to stop?</td>
<td>Athletes: 21</td>
<td>12.20%</td>
<td>29.20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Athletes: 12</td>
<td>7.00%</td>
<td>12.00%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 33</td>
<td>19.20%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>B. Ever made yourself sick (vomited) to control your weight or shape?</td>
<td>Athletes: 11</td>
<td>6.40%</td>
<td>15.30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Athletes: 6</td>
<td>3.40%</td>
<td>6.00%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 17</td>
<td>10.00%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>C. Ever used laxatives, diet pills or diuretics to control your weight or shape?</td>
<td>Athletes: 16</td>
<td>9.30%</td>
<td>22.20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Athletes: 14</td>
<td>8.10%</td>
<td>14.00%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 30</td>
<td>17.40%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>D. Exercised more than 60 minutes a day to lose or to control your weight</td>
<td>Athletes: 6</td>
<td>3.50%</td>
<td>8.30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Athletes: 2</td>
<td>1.20%</td>
<td>2.00%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 8</td>
<td>4.70%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>E. Lost 20 pounds or more in the past 6 months?</td>
<td>Athletes: 5</td>
<td>2.90%</td>
<td>6.90%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-Athletes: 13</td>
<td>7.60%</td>
<td>13.00%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 18</td>
<td>10.50%</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
As a secondary means of analysis, the data of 1,043 non-athlete samples was analyzed and compared to the group of 72 athlete samples. It can be noted that Question A found a significantly greater number of athletes compared to non-athletes at risk when responding to this question, \( p < 0.001 \). Additionally, a significantly greater number of athletes were considered at risk when answering Question B, “Ever made yourself sick (vomited) to control your weight or shape,” \( (p < 0.001) \), and Question D, “Exercised more than 60 minutes a day to lose or to control your weight,” \( (p= 0.001) \).

Combined Questionnaire Results

Hypothesis 4: A significant number of athletes will be considered “at risk” for both inadequate energy intake and eating disorders compared to non-athletes was tested using a Pearson chi-square test. Results found no significant differences between the number of athletes who were considered at risk for both inadequate energy intake and an eating disorder compared to non-athletes, \( p = 0.07 \) (Table 6). Therefore, the null hypothesis was not rejected.

As a secondary means of analysis, the data of 1,043 non-athlete samples was analyzed and compared to the group of 72 athlete samples. Results found significant differences between the number of athletes who were considered at risk for both inadequate energy intake and an eating disorder compared to non-athletes, \( p < 0.001 \). The number of athletes who were at risk was eight, while the number of non-athletes at risk was 25.
Table 6

Number of Individuals Considered to Be “At Risk” for Inadequate Energy Intake and an Eating Disorder

<table>
<thead>
<tr>
<th>Participants</th>
<th>Number of Participants at Risk for Inadequate Energy Intake</th>
<th>Number of Participants at Risk for an Eating Disorder</th>
<th>Total Number of Individuals a Risk for Both Inadequate Energy Intake and an Eating Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes</td>
<td>31</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Non-Athletes</td>
<td>37</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
CHAPTER IV
DISCUSSION

This study examined whether female athletes at a midwestern university exhibited inadequate energy intake and eating disorder risk factors for the Female Athlete Triad compared to other non-athlete students at the same university. It was expected that the athlete group would be at risk for Triad components. They are at risk due to issues with body image and false beliefs that decreased weight will improve athletic performance. Additionally, athletes have added stressors of performing in both academics and in their sport with evaluation from professors, coaches, and family. While the main findings in this study were mixed, analysis did indicate some associations between inadequate energy intake and eating disorder risk in female athletes compared to non-athletes.

Both an eating disorder and inadequate caloric intake without a psychiatric diagnosis can result in low energy availability. In this study, although LEAF-Q scores were greater in athletes than non-athletes, there were no statistically significant differences between average LEAF-Q scores and participant groups. This research contradicts current literature. A study by Clark in 2018 reported that one third of athletes were at risk for low energy availability, and a similar study reported that athletes were most often in a catabolic state. Additionally, the amount of exercise completed by the non-athlete group was unknown and also could have affected results. Two recent studies using recreationally active participants found participants were at risk for low energy availability after completing the LEAF-Q survey. This suggests that if non-athlete groups were active, they also could be at risk for the Triad. The results from this study can be
explained by a small sample size and differences between groups and demographic information. Because there were significant differences identified within participant groups and age, year in school, and ethnicity, this indicates that both groups have slightly different backgrounds, which could cause skewed results.

In the current study, there were no significant differences between athlete and non-athlete participant mean EAT-26 scores. Although the average EAT-26 scores for athletes was greater, similar EAT-26 scores existed between athlete and non-athlete groups. This contradicts current literature as research indicates that female athletes at any level more commonly have eating disorders compared to non-athletes, but the prevalence varies among studies from 16%-47%.

The results of this study may be attributed to the “hidden nature” of risk factors for eating disorders, i.e., or individuals who exhibit symptoms are often secretive or in denial. Additionally, the small sample size could help to explain these results. It can be noted that this study did not ask if participants in the non-athlete group participated in a club sport at NIU or a varsity sport previously at another university, which could have also had an effect on the study’s results.

When focusing on both eating disorder risk and risk for inadequate energy intake, results from this study found no significant differences between the athlete and non-athlete groups when determining the number of participants who were considered at risk for both an eating disorder or inadequate energy intake. However, a greater number of athletes (n= 8) were considered at risk for both inadequate energy intake and an eating disorder compared to non-athletes (n= 4). These results differ from other studies that have been conducted. One study found there is an association between high drive for thinness and exercising women. Similarly, another study reported that a majority of athletes were considered “weight conscious” and authors concluded
that athletes should be screened for compulsive attitudes about exercise and eating due to it increasing risk for the Triad. However, this study did find that more athletes had the impulse to vomit after meals compared to non-athletes, which is consistent with current literature. In 2014 the International Olympic Committee created a list of risk factors that should be assessed for the Triad, and one of the risk factors was pressure to lose weight or frequent weight cycling. This evidence is consistent with another study that found that 50.3% of athletes trained intensely to avoid weight gain and 71.8% worried they would gain weight if unable to exercise or injured. Another study indicated that more athletes were at risk for the Triad who had clinical or subclinical eating disorders.

In this study, more non-athletes indicated that they avoided foods with high carbohydrate content. However, 13 (18%) athletes indicated that they avoided foods with high carbohydrate content. This study also found that more athletes indicated that they have gone on binges where they feel they may not be able to stop. Other studies have found athletes with restrictive eating behaviors. For example, a study by Folscher in 2015 found that half of participants had restrictive eating, with 47.7% limiting fat and calorie intakes and 44.5% limiting carbohydrate intakes. It can be noted that diet restriction is one of the behaviors of eating disorders, and it is the behavior that is most closely associated with bone mineral loss. One possible explanation for athletes restricting is low-carbohydrate diets being publicized in media stating that they will improve body composition and performance even though it is known that carbohydrates fuel the majority of energy during a competition. It can be noted that a dietary analysis was not completed in this study, which would have added additional information to support or dispute these results.
When focusing on the second Triad factor, menstrual irregularity, this study found that more athletes had their periods when they were 15 years old or older, which is considered primary amenorrhea. This study also found that a greater number of athletes have had their periods stop for three consecutive months or more, which is considered secondary amenorrhea. These results are consistent with current literature, that indicates that menstrual disorders occur more often in athletes than the general population (6%-79%). One study found 60% athletes with irregular menstruation and irregular menstruation in 5% of non-athletes, but percentages vary depending on the study methods. It is hypothesized that intense training has a greater effect on premenarcheal athletes compared to athletes who already menstruate because females who are reproductively immature may be more sensitive to the effects of intense training. One study found that one fourth of athletes had delayed menarche. This is concerning because late menarche, oligomenorrhea, and amenorrhea are associated with greater risk for injury. It is also concerning because studies have shown that about half of the participants believed that a cessation in menstruation due to training was normal and athletes were unlikely to consult a medical professional, which decreases the opportunity for intervention.

When focusing on the third Triad factor, this study found that more athletes were absent from training or participation in physical activity due to injuries and for a longer period of time compared to non-athletes. These results are consistent with current research. A study indicated that athletes have greater bone mineral density but have a greater likelihood of becoming injured compared to non-athletes. Also, a correlation has been found between faster race performance, increased training volume, and intensity with increased Triad risk.

It can be noted that there were significant differences identified within participant groups including age, year in school, and ethnicity. Lifestyle, genetic factors, stages of life, cultural
background, and food choices and beliefs likely differ among participants. An individual’s upbringing has a large effect on food choices as well as her current environment. Additionally, college students face many changes as they transition from adolescence to adulthood, creating stressors, new situations, and new beliefs that can influence how the student lives and eats.

Colleges are often viewed as a “melting pot” of students from different backgrounds, ethnicities, religions, and traditions as well as different issues of food availability, food accessibility, socioeconomic statuses, and social pressures, which can all play a role in food choices, beliefs, and attitudes. Additionally, there were 17 two-sport female athletes who participated in both cross country and track and field during the 2017-2018 academic year. Because participants only had the option to choose one participation sport, it is possible that either category may be underrepresented.

Limitations

Limitations of this study primarily include small sample size of 172, with a 73% completion rate of those who participated. As noted above, the sample of participants was gathered through convenience sampling, which is vulnerable to selection bias and may not be representative of the general population. Additionally, due to the nature of the study, all data gathered from the survey and demographic sections of the survey were self-reported. Inaccurate responses could have occurred due to misunderstanding or misinterpretation of questions, fatigue in completing the survey, or disinterest in the survey topic. Also, the topic of the study and questions in the surveys are sensitive in nature as they include topics of menstruation, contraceptive use, and eating disorders. This may have led to individuals choosing to not
participate in the entirety of the survey or underreport symptoms or beliefs about food. Additionally, individuals could be skewed due to attitudes or relationship with food, causing inconsistent responses.

It can be noted that the non-athlete group’s level of physical activity was not assessed in the demographic information section of the survey. Participants likely participate in various levels of physical activity, which could play a role in determining a participant’s weight, body composition, injury risk, menstruation, energy requirements, and overall risk for the Triad, although not technically considered an athlete. Additional data would be needed to assess the effects this limitation had on the data. Also, this study used a cross-sectional study design, which measures a participant’s beliefs at one point in time. Individual and group trends over time would improve the reliability and outcomes of this study.

Strengths of this study include the addition to research on the Triad in the college-age population. This survey also had 51.1% of female athletes participate in this study, which represents a large portion of this population.

Implications for Future Research and Practice

Findings from this study suggest the need for continued research on the Triad in the college-age population to better understand the presence of the Triad, the interrelationship between Triad components, and its effect on female’s health. A strength of this study was the addition and update on research on the college-age population that has not been focused on in several years. Continued research should be considered to determine the most effective method
for education on the Triad for college-age females. Future studies would then benefit from incorporating a follow-up with participants deemed at risk for the Triad.

Additionally, Triad risk factors are complex and often difficult to assess. Athletes would benefit from improved testing methods for Triad risk factors or possible requirements to be tested before participation of a sport to improve early identification of symptoms.

Finally, individual sports require significantly different energy needs, and athletes would benefit from energy guidelines specific to their sport, allowing athletes, coaches, parents, and dietitians a better understanding of athletes’ needs and allow dietitians to provide more accurate recommendations.
CHAPTER V

CONCLUSION

The Female Athlete Triad is a complex syndrome that has components whose relationship is not yet fully understood. Research has previously been conducted on this topic, but new research is needed focusing on the college-age population. The main findings in this study were mixed, but some associations were found between inadequate energy intake and eating disorder risk in female athletes compared to non-athletes. Research from this study points to a need for screening all athletes for Triad risk factors due to the Triad’s prevalence. Focusing on the Triad risk factors will potentially help continue future research and programs to improve the health of female athletes of all ages and levels of athletics.
REFERENCES


APPENDIX A
REVIEW OF LITERATURE
LITERATURE REVIEW

Overview

In 1972, Title IX, also known as the Educational Amendment Act of 1972, was enacted, making it illegal for gender discrimination in education programs funded by the government. Women’s participation began to increase in athletics in high school and college. Since Title IX, participation in female high school sports has increased by 900% and intercollegiate athletics have increased by 450%.  

The American College of Sports Medicine (ACSM) first recognized the Female Athlete Triad in 1997 and defined it as three interrelated disorders: of disordered eating behaviors, amenorrhea, and osteoporosis.  In 2007, the Triad definition was rewritten to include athletes who are on the spectrum of the three Triad components. The Triad affects both female athletes and active women.  

Athletes fit the Triad definition if they have decreased energy availability and/or an eating disorder, menstrual irregularity and/or amenorrhea, low bone density and/or osteoporosis, or anything in between these conditions.  

The ACSM has changed its stance on the Triad. Athletes who do not have symptoms of all three of the Triad factors can still be at risk for the Triad.  In fact, all three Triad components occurring at the same time is not common. There is a higher prevalence of individual components of the Triad being present among all ages and levels of competition in athletes.  A meta-analysis study found that only a small percentage of athletes from many sports have symptoms of all three Triad factors (0-15.9%), while a larger number of athletes show symptoms of one or two factors of the Triad (2.7-27.0% and 16-60%).  After Title IX was enacted,
increased instances of eating disorders, amenorrhea, and stress fractures were reported. However, these factors were not viewed as interrelated until 1997.¹

Females in today’s society feel pressure to conform to the norms and unrealistic standards set by the media about their physical appearance. Although many women feel a desire to look the way media portrays as beautiful, trying to reach these standards may have a negative effect on their health. ¹

Currently, it is recognized that the Triad affects both elite and recreationally active women. However, the relationship between the symptoms of the Triad is not yet fully understood.¹ It has been suggested that the three Triad factors (disordered eating, amenorrhea, and osteoporosis) are interrelated and possibly causal of each other. For example, it has been shown that energy deficiency is the cause for functional hypothalamic amenorrhea (FHA), which occurs when there is a hormone disruption due to low body weight. Studies have also found that secondary amenorrhea affects bone mass by limiting a woman’s ability to reach peak bone mass. Results from case studies have additionally found that non-cognitive disordered eating can create an increase in bone fracture.¹

Studies on the Female Athlete Triad have also found that the Triad symptoms can occur with or without the other two symptoms and do not directly cause the other symptoms. A study by Gibbs, which will be discussed in more detail in this paper, found that a far larger number of athletes had one or two symptoms of the Triad than the number of athletes who showed all three symptoms. This may show that the symptoms are interrelated but not interdependent.¹,⁴
Prevalence of the Female Athlete Triad

Some sports have a higher prevalence of the Female Athlete Triad. It is known that the prevalence of the Triad is 2% to 3% higher in sports that have aesthetic aspects or weight categories. For example, sports like gymnastics, dance, and figure skating have subjectivity scores. Endurance sports like distance running and cycling favor athletes who have a low body weight. Swimming and diving require athletes to wear revealing clothing for competition. Wrestling and martial arts have weight classes for athletes. In gymnastics and figure skating, pre-pubertal body shapes are favored. A study on 1,620 Norwegian athletes found clinical eating disorder prevalence to be about 25% in male and female athletes participating in aesthetic sports, endurance sports, and weight-class sports. In 2008, the National Athletic Trainer Association stated that eating disorder prevalence may be up to 62% and 33% for female and male athletes.

Low Energy Intake and Disordered Eating

An estimated ten million women in the United States will have an eating disorder in their lifetime. However, this is probably a large underestimation because individuals with eating disorders are often secretive or in denial. Ninety percent of those who look for help for eating disorders are women. Eating disorder prevalence is similar within Western counties. Eating disorders are far less prevalent in developing countries than in Western countries. A study in Finland that focused on how to describe the development and outcomes of anorexia nervosa within the population using lifetime prevalence, incidence rates, five year anorexia nervosa recovery rates, and eating disorder symptoms screenings. The study found that 50% of the individuals who had anorexia nervosa in their community had not been identified.
The Triad often begins with energy restriction and/or increase in exercise due to pressure felt by individuals to look attractive, causing the other two factors of the Triad. Women who exercise and partake in disordered eating behaviors have been shown to have increased scores on high drive for thinness and body dissatisfaction on the Eating Disorder Inventory-2 (EDI-2) and increased score on dietary cognitive restraint on the Three-Factor Eating Questionnaire (TFEQ). High drive for thinness is a factor that has been a proposed contributor to the Triad development. High dietary cognitive restraint “is characterized by a conscious restriction of energy intake in order to achieve or maintain a desired body weight.” Those with high dietary cognitive restraint monitor their caloric intake and control their weight. In 2013, Gibbs conducted four studies that had cross-sectional designs and studied active women between the ages of 18 and 35 years old. Data was collected using exercise history exams, maximal oxygen uptake test, a psychometric measurement of eating disorders and behaviors test (EDI-2), monitoring of a menstrual cycle, a DEXA scan, a three-day nutritional log, and menstrual and urinary tests.

The first study focused on determining energy deficiency and menstrual irregularity in exercising women and found that active women with a high drive for thinness showed risk factors for chronic energy deficiency. These include suppressed resting energy expenditure and increased menstrual irregularity compared to women without a high drive for thinness. The second study focused on energy availability and menstrual irregularity in exercising women and found that active women with a high dietary restraint had lower energy availability and increased menstrual irregularity compared to women with healthy dietary cognitive restraint.

In the third study, the author focused on how increased energy intake affected psychometric indicators of disordered eating habits in exercising women with menstrual
irregularities and found that refeeding did not increase dietary cognitive restraint or negatively affect drive for thinness, body dissatisfaction, or bulimia scores. Finally, in study four individual and combined risk factors for the Female Athlete Triad and low bone mineral density were used to find the cumulative effect of Triad risk on bone mineral density in exercising woman and found that there was a cumulative effect of the risk for the Triad on a women’s bone mineral density. The author concluded that there is an association between increased drive for thinness and dietary cognitive restraint and Triad risk factors in active women. Additional findings included that increased energy intake with monitoring can have a positive impact on eating behaviors and weight gain in active women, and active women with more than one risk factor for the Triad have an increased risk for low bone mineral density.4

Athletes are more susceptible to developing eating disorders because of issues with body image and a false belief that decreased weight will improve performance.3 A study on Australian athletes found that body dissatisfaction and disordered eating patterns were more common in athletes at any competitive level than non-athletes.8 Another study found that restrictive eating behaviors and disordered eating can occur in female athletes in high school.3 This can occur due to the need to preform in the sport, maintain sociocultural norms, and body dissatisfaction that stems from idealistic views of body image. Eating disorder prevalence has been found to increase by 10% in athletes compared to non-athletes.3 This shows the importance of nutrition education for athletes to help prevent disordered eating behaviors and prevent long-term health issues.3

Energy deficiency in athletes can be seen through energetic and endocrine hormone disruption causing suppressed resting energy expenditure and changes in fasting hormone levels. This then causes energy-conserving adaptations including thermoregulation and cellular
maintenance. This causes changes in metabolism and reproduction because reproduction is not needed for the body’s survival. Disordered eating in active women has also shown to negatively affect menstrual status and bone density.

Diagnosing eating disorders has challenges because there are no standardized assessment tools and criteria to determine if an eating disorder is present. Eating disorders may exist in 1% to 62% of female athletes, depending on the sport they play. Anorexia nervosa and bulimia nervosa prevalence is higher in elite athletes (13.5%) than it is in non-athletes (3.1%). This prevalence is even greater in female athletes in aesthetic sports.

Many studies have focused on determining eating disorder prevalence among female athletes. One study asked 522 elite female athletes from 35 sports and 448 non-athletes between the ages of 12 and 35 years old to fill out a questionnaire, complete a clinical examination, and participate in an interview. Authors found that 18% of athletes had an eating disorder, while only 5% of non-athletes had an eating disorder. The same study also found that the athletes under-reported their eating disorder symptoms compared to the non-athletes. A similar study found that 20% of athletes had eating disorders and 9% of non-athletes had eating disorders.

A study by Martinsen and Sundgot-Borgen was designed to determine the prevalence of eating disorders in male and female adolescent elite athletes and age-matched non-athletes. Six hundred and seventy-seven high school students from 16 randomly selected high schools were used as participants. The study included two phases. Phase one was a self-reported questionnaire and phase two was a clinical interview. The study found that eating disorder prevalence is higher in athletes than non-athletes and higher in female athletes than male athletes. The authors hypothesized that eating disorder prevalence was higher in athletes because athletes have the added pressure and responsibility of performing both in school academics and in their sport.
Additional stressors may include daily evaluation by coaches, long training time, decreased performance, and family pressure.\textsuperscript{12}

A study by Torstveit and Sundgot-Borgen wanted to determine the percent of elite athletes at risk for the Female Athlete Triad compared to non-athletes. The female elite athletes and non-athletes were from Norway and between the ages of 13 and 39 years old. The athletes and non-athletes took a questionnaire about training, physical activity patterns, menstrual history, oral contraceptive use, weight history, eating patterns, and dietary history and the Body Dissatisfaction and Drive for Thinness Scale from the Eating Disorder Inventory (EDI). Authors found that more controls compared to athletes were at risk for the Triad. More controls used pathogenic weight control methods and also had a higher score on the body dissatisfaction test. However, a larger number of athletes had menstrual irregularities and stress fractures. A larger number of athletes in aesthetic sports (66.4\%) were at risk for the Triad compared to athletes who played non-aesthetic sports (52.6\%). The authors concluded that athletes in aesthetic sports and non-athletes were more at risk for the Triad than athletes competing in non-aesthetic sports.\textsuperscript{13}

The classifications of eating disorders include anorexia nervosa, bulimia nervosa, binge eating disorder, and eating disorders not otherwise specified (EDNOS).\textsuperscript{14} In 2013, the Diagnostic and Statistical Manual of Mental Disorders V (DSM-5) updated diagnostic criteria for eating disorders. These new criteria were made to decrease the number of individuals who would be considered to be in the EDNOS category to help improve descriptions of symptoms and increase eating disorder symptoms. This is because based on the DSM-IV, a study found that 81\% of children and 75\% of adults had eating disorders that were classified as EDNOS.\textsuperscript{8}

Individuals diagnosed with anorexia nervosa are “less than minimally normal weight in
adults and less than expected weight in children and adolescence.” Patients having a fear of gaining weight can be inferred instead of having to be explicitly spoken. Individuals also now do not need to have amenorrhea to be diagnosed with anorexia nervosa. The definition of bulimia now includes binges and compensatory behaviors for an average of one a week for three or more months. Binge eating disorder was added to the DSM-5 and EDNOS is broken down to the following categories: “other specified feeding or eating disorder,” which categorizes individuals who specifically do not fit into another category, and “unspecified feeding or eating disorder,” which is used when there are not clear reasons why an individual does not fit into another category.⁸

Anorexia is characterized by refusing to be a normal body weight. Bulimia is characterized by repeated binge eating and use of laxatives, diuretics, fasting, excessive exercise, or other medications. Decreased energy availability is the effect of decreased energy intake caused by lack of caloric intake compared to exercise or consciously restricting calorie intake. Conscious calorie restriction can lead to eating disorders. Body mass index (BMI) lower than 17.5 in athletes can show inadequate energy stores. It is harder to determine energy availability in athletes who have a BMI within normal range.³

Other mental health issues are often present in individuals with eating disorders, including depression, anxiety, obsessive-compulsive disorder, and substance abuse disorder. In a retrospective cohort study by Rosling et al., the authors followed Swedish patients 18 years or older with eating disorders from 1974 to 2001 and focused on mortality, causes of death, and co-morbidity of these patients. Clinical records from the Uppsala University Hospital and the Swedish Causes of Death Register were used to find data. The authors found that 50% of the subjects with eating disorders had depression and 25% had substance abuse. Substance abuse has
been found to be prevalent in 30% of bulimia patients. Binge eating disorder has been known to occur with depression, bipolar disorder, anxiety, bulimia nervosa, kleptomania, and body dysmorphic disorder. It is important for health care professionals to screen for other mental health conditions.\(^8,15\)

Doyle-Lucas et al. studied the physical and behavioral characteristics of female elite ballet dancers compared to sedentary non-dancing subjects. Thirty dancing and non-dancing women ages 18 to 35 years old were the subjects in the study. Irregular menses and low energy availability occurred more in the dancers than non-dancers. Dancers also had lower resting metabolic rates, even though both dancers and non-dancers had similar fat-free mass. Six of the 15 dancers had low bone mineral density, menstrual irregularities, and eating disorders with low energy availability. The study suggests that resting metabolic rate may indicate low energy availability. The authors stated that a similar study should be conducted on a larger scale. Interventions to increase energy availability in female ballet dancers should also be implemented to promote the dancer health.\(^16\)

Friesen et al. studied body composition, bone mineral density, eating behaviors, and menstrual dysfunction in 61 collegiate modern dancers from ages 18 to 25 years old. They found that bone mineral density in the spine and right and left hips was greater in the modern dance majors than the control group. The control had a higher total body fat percentage. Diet intakes in both groups were similar, except fat intake was lower in the modern dancers than in the control group. Eating disorders and secondary amenorrhea were more prevalent in the modern dancer group. Primary amenorrhea, oligomenorrhea, or the use of birth control was not found to have significant differences in groups. The authors concluded that the modern dancers had a higher incidence of eating disorders and menstrual dysfunction even though they had healthy body
weights. The higher bone mineral density in modern dancers may be due to the strength associated with modern dancing. The authors suggest that educating dancers about healthy body composition and optimal performance is important. Dance educators should also avoid encouraging excessive leanness in their dancers and encourage energy balance to keep healthy bones. More research needs to be conducted on the differences among dance departments at other universities and professional modern dancers.17

Cobb et al. studied the relationship between disordered eating, menstrual irregularity, and low bone mineral density in runners. Ninety-one female subjects ages 18 to 26 who were competitive distance runners participated in the study. Oligomenorrhea and amenorrhea are associated with eating disorders. Runners with oligomenorrhea and amenorrhea had lower bone mineral density than eumenorrheic (normal menstruation) runners at the spine and whole body. Runners who were eumenorrheic with higher eating disorder scores had lower bone mineral density than eumenorrheic runners who had normal levels of eating disorder scores at the spine, with trends at the hip and whole body. Authors concluded that disordered eating was associated with low bone mineral density when there is menstrual irregularity in competitive female distance runners. The Female Athlete Triad was found to be “more hidden” than the authors had hypothesized. Subjects with an average body fat of 22% were amenorrheic and subjects with higher eating disorder inventory scores had an average of 25% body fat. Those who had components of the Female Athlete Triad were not readily discernable. Authors recommend that screening should be conducted for eating disorders and menstrual irregularity. Education on the Female Athlete Triad should be provided for all competitive female endurance athletes.18
Menstrual Irregularity

Menstrual function can be affected by exercise. Pressure to obtain an unrealistic weight or level of thinness and increase control of one’s weight can create exercise-associated menstrual disturbances. Amenorrhea is defined as lacking a menstrual cycle. The two categories of amenorrhea are primary and secondary amenorrhea. Primary amenorrhea is lacking menstruation by 15 years of age. Secondary amenorrhea is lacking three or more consecutive menstrual cycles after menarche has occurred. Oligomenorrhea is characterized as a decreased frequency of menstrual cycles or menstrual cycles occurring at intervals longer than 35 days.

A study found that 25% of active women have had menstrual irregularities. Oligomenorrhea, primary amenorrhea, and secondary amenorrhea are common disorders of female athletes who compete in “lean sports.” Oligomenorrhea and secondary amenorrhea occur in 12% to 79% of female athletes. Oligomenorrhea occurs in 65% of girls in their first year of menarche, which makes it difficult to diagnose. In female runners, amenorrhea prevalence can increase from 3% to 60% as the distance run increases from less than 8 to over 70 miles or 113 km per week.

Although researchers are currently not sure of the pathophysiology, menstrual irregularity is correlated with hormone imbalance. It is known that the gonadotropin-releasing hormone has unpredictable secretions into the body, which affects estrogen release from the ovaries. This in turn can result in amenorrhea. Low levels of estrogen have also been associated with amenorrhea, which may occur because estrogen levels that are stored in adipose tissue are decreased with decreased body fat due to inadequate energy intake. Eating disorders and
decreased intake of dairy products can also cause the development of amenorrhea and secondary osteoporosis.\textsuperscript{4,14}

A study by Stefani et al. compared menstrual disorders in female athletes and sedentary females. The study also focused on myocardial performance of female athletes in varying sports. Participants in this study were an average age of 18 years old. Participants were divided in to three groups depending on the sport they were involved in (rhythmic gymnastics, swimming, and volleyball). Data was collected from echocardiography, biopendance analysis, and a questionnaire. The results of this study found that anthropometric data was normal. There was no association found between menstrual irregularities and BMI. Echocardiography data was found to be within normal range. Cardiac mass index was found to be normal for all athletes, but swimmers had higher values. The authors concluded that even though some female athletes reported menstrual irregularities, a relationship between menstrual irregularities and the sports practiced was not found.\textsuperscript{19}

An observational cross-sectional study by Nichols et al. focused on the Female Athlete Triad among high school athletes. One hundred and seventy athletes from six high schools in southern California who played eight sports participated in the study. Interview-assisted questionnaires were used to collect information on disordered eating and menstrual status and dual-energy x-ray absorptiometry was measured at the hip, spine, and total body to determine bone mineral density. Results indicated that 18.2\% of athletes had disordered eating, 23.5\% reported menstrual irregularity, and 21.8\% had low bone mass. Ten subjects met the criteria for two components of the Triad and two girls met the criteria for all three components. Oligomenorrheic and amenorrheic subjects had a higher average of eating restraint and scores on the Eating Disorder Examination Questionnaire than eumenorrheic athletes. Athletes who
presented with oligomenorrhea or amenorrhea were found to have significantly lower average bone mineral densities. Although low levels of all three aspects of the Female Athlete Triad were found in their sample, a substantial percentage of subjects are at risk for long-term health consequences associated with the Triad. The advantage of the study is it studied high school females, whereas many studies have focused on collegiate or elite athletes, and it also focused on more than one sport. Limitations include self-reporting, the possibility of under-reporting, diet recall, and lack of laboratory data on menstrual function. The authors suggest that screening for aspects of the Triad in female athletes will identify athletes at high risk and eliminate or prevent the risk factors. They also recommend education and interventions for high-school-aged female athletes on the Female Athlete Triad.9

Bone Mineral Density

Osteoporosis is defined as “a skeletal disorder characterized by compromised bone strength predisposing a person to increased risk of fracture.”1 In osteoporosis, low bone mass is present and there is microarchitectural deterioration of the tissue in the bone, which causes skeletal fragility and a greater risk for fracture. This definition is hard to apply to women who are pre-menopause. The International Society for Clinical Densitometry states that when determining children and premenopausal women’s bone mineral density, Z scores should be used to compare the BMD of this population to the number of standard deviations their BMD is away from the average BMD for age and gender.1

Stress injuries often occur in the tibia, metatarsals, fibula, navicular, sesamoid, sacrum, femur, and ribs.20 The risk factors for stress fractures include corticosteroid or thyroid medications, smoking, a low-calcium diet, age, amenorrhea, hormonal components, metabolic
components, biomechanical components, musculoskeletal components, family history for osteoporosis, alcohol, medications, sedentary lifestyle or exercise level, and lack of hormone replacement therapy post-menopause. A small muscle size or an abrupt increase in training can also increase fracture risk.\textsuperscript{5,14,21}

Bone stress injuries caused by structural or biomechanical irregularities can cause imbalances that can have negative effects on the bone and increase fracture risk. Calcium, vitamin D, vitamin K, vitamin C, magnesium, and iron nutritional deficiencies may inhibit new bone formation. Chronic inadequate caloric intake can decrease leptin, estradiol, and insulin levels and increase cortisol levels, which lower osteoblast activity and increase bone resorption. This causes an uneven bone turnover that can decrease the ability for new bone to be formed and the ability for micro-damage to be fixed.\textsuperscript{5,20} Decreased estrogen levels can also cause bone fracture because estrogen helps to increase calcium absorption, bone formation, and remodeling. Estrogen also increases cell proliferation and decreases cytokine production that affects bone reabsorption.\textsuperscript{5}

Women are eight times more likely to develop osteoporosis than men because of a decrease in baseline bone mass and increase in bone absorption at menopause.\textsuperscript{14} By age 18, 90% of peak BMD is built in women. Most bone growth occurs between 11 and 14 years old. Adequate nutrition and exercise helps to develop a healthy BMD. When one reaches peak BMD, BMD cannot increase; it can only be maintained or decreased.\textsuperscript{3} The Triad occurring in adolescence may be even more harmful because this is the time of maximal increases and growth in bone to peak bone mass.\textsuperscript{21} Long-term case studies need to be conducted on athletes who regain normal reproductive function and if they are able to regain the BMD that they lost.\textsuperscript{5}

Athletes may have a higher BMD that non-athletes.\textsuperscript{5} Athletes are also more likely to
endure injuries, including fractures, compared to non-athletes. “Stress fractures are fatigue fractures of bone caused by repeated submaximal stress and can delay return to sport by weeks to months.” Endurance athletes like long distance runners and track and field athletes commonly get stress fractures on the foot, tibia, and fibula. A study found that 10% of all female athletes get stress fractures. Twenty-two percent of female track and field athletes get stress fractures. However, BMD prevalence varies between athletes. Osteoporosis occurrence can be from 0% to 13%. Stress fractures may be found in up to 17% of female athletes with low BMD and menstrual irregularity. Data on low BMD prevalence in female athletes is limited because mechanical loading is different for every sport. For example, gymnastics and running have a high level of mechanical loading, while cycling and swimming have a low level.

Level of mechanical loading also varies among sports. Mechanical loading is high in sports like gymnastics and low in swimming and cycling. This causes differences in bone loss in different skeletal bones. For example, clinical densitometry has found low BMD in athletes to be between 4.1% to 13% and professional dancers up to 46.5%. Bone stress injuries have also been found to affect 8.3 to 52.0% of female endurance runners or track and field athletes.

When participating in weight-bearing activities, loading on the bone allows the bone to be exposed to stress and deformation or strain. Micro-cracks are created in bone if the strain on the bone reaches a certain threshold. Recovery and nutrition for healthy people are used to heal the micro-cracks in the bone. If the micro-crack does not heal, the crack can expand or other micro-cracks can form into one large micro-crack causing bone stress injuries. The treatment for stress injuries is to eliminate all weight-bearing exercise anywhere from six weeks to over six months.

Weight bearing exercise can also help to increase BMD.
exercise include increase in BMD, increased bone stiffness, and increased failure to load at weight-bearing spots on the bone.\textsuperscript{21} These benefits are lost in female athletes with amenorrhea and athletes with low energy intake. Female athletes with amenorrhea and oligomenorrhea are more likely to get stress fractures than female active and non-active women with oligomenorrhea even if the females with oligomenorrhea and amenorrhea intake greater amounts of vitamin D and calcium. This is because women with oligomenorrhea and amenorrhea have low estrogen levels, which can cause osteoporosis and fractures.\textsuperscript{4,21} Low energy intake when compared to exercise energy expenditure can make the likelihood of low BMD and impaired bone microarchitecture increase.\textsuperscript{4} A calorie-deficient diet is independently negatively correlated with reproductive health, bone health, and gonadal steroid levels. This has a negative effect on the bone. Low calorie intake also has negative effects on hormones IGF-1, leptin, and peptide YY, which all also affect the bone.\textsuperscript{21}

An experiment by Ackerman et al. called “Fractures in Relation to Menstrual Status and Bone Parameters in Young Athletes” focused on the comparison among athletes with oligomenorrhea and amenorrhea (AA), eumenorrheic athletes (EA), and non-athletes to assess the relationship with bone density and strength. One hundred seventy-five women from the ages 14 to 25 participated in this study. A DEXA scan was used to obtain data on areal bone mineral density in the spine, hip and whole body. HRpQCT was used to find bone structure at the radius and tibia, which was analyzed using finite element analysis to find strength. The authors found that weight-bearing athletic activities increased bone mineral density. However, weight-bearing athletic activities may also increase the risk for stress fracture in women with menstrual irregularity. They also found that differences in bone microarchitecture and strength were larger in participants with oligomenorrhea and amenorrhea with more than one stress fracture. The
strengths of this study were the large sample size of athletes with oligomenorrhea and amenorrhea (100 athletes). The weaknesses of this study were it was a cross-sectional study and there was retrospective self-reporting of fractures, training, and menstrual status. Further studies need to focus on the differences between bone susceptibility and amenorrhea, which leads to increased bone injuries.21

A study by Barrack et al. determined the effect of one or combined risk factors for the Female Athlete Triad, energy availability, menstrual function, and bone mass and prevalence of bone stress injury in active women. Two hundred fifty-three women with an average age of 18 years old participated in this study. Data collected from participants included anthropometric characteristics, eating attitudes and behaviors, menstrual function, sports participation or exercise, and pathological weight control behaviors. A DEXA scan was used to measure bone mass. The study then followed the participants to determine which participants had injury occur. The study found that 10.8% of participants (28 participants) had a bone stress injury. The authors concluded that individuals with one Female Athlete Triad risk factor had an increase risk of bone stress injury by 15-20%, while individuals with more than one risk factor had an increased risk of bone stress injury by 30-50%. They concluded that the risk of bone stress injury increases when the number of risk factors for the Female Athlete Triad increases.20

A between-groups cross-sectional study conducted by Mudd et al. compared site-specific bone mineral density to find predictor variables of bone mineral density measurements. Subjects were 99 female varsity athletes participating in gymnastics, softball, cross country, track, field hockey, soccer, crew, swimming, and diving. Lowest total body and specific site bone mineral density for every site except leg scores was runners when compared with gymnastics and softball players. A lower average leg bone mineral density was found in swimmers and divers except in
runners and rowers. Mass and sport were found to predict total body bone mineral density. When all sports were compared, the lowest site-specific bone mineral density was found in runners and swimmers. Future studies should focus on including detailed training, injury, menstrual, and dietary histories with a larger sample size. Longitudinal studies also need to be conducted on how bone health is affected by intensive training over time in female athletes.\textsuperscript{22}

A prospective cohort study by Rauh et al. focused on the components of the Female Athlete Triad and musculoskeletal injury in high school female athletes. One hundred sixty-three female athletes involved in eight sports in the southern California area in the 2003-2004 school year participated in this study. Injury reports, the Eating Disorder Examination Questionnaire, a dual-energy x-ray absorptiometry scan that measures bone mineral density and lean tissue mass, anthropometric measurements, and a menstrual history and demographic characteristics questionnaire were used to obtain information on subjects. Sixty-one athletes reported 90 musculoskeletal injuries. History of oligomenorrhea or amenorrhea in the last year and low bone mineral density were associated with an increased occurrence of musculoskeletal injury. Bone mineral density below a $Z$ score of 2, disordered eating, history of oligomenorrhea or amenorrhea, and low bone mineral density were found to be associated with musculoskeletal injury. The authors concluded that oligomenorrhea or amenorrhea and low bone mineral density were associated with musculoskeletal injuries. They suggest programs be implemented that identify and prevent disordered eating and menstrual dysfunction to help improve bone mineral densities in high school female athletes to help decrease the prevalence of musculoskeletal injuries. Limitations of the study include self-reporting, lack of data on energy availability and calcium intake, the Triad components were not examined separately, and the Triad components were not compared to individual sports. Further information is suggested for prospective studies.
with larger sample sizes on sport injuries and the Triad components in female high school athletes. Research also needs to be conducted on the interactions of the Triad components and other variables that make athletes more susceptible to injury. The authors suggest that a study be conducted on an intervention program for high school athletes, parents, coaches, athletic trainers, and sports health care professionals to educate them on the effects of the Female Athlete Triad and healthy eating behaviors.23

A prospective study by Hoch et al. studied the prevalence of the Female Athlete Triad in high school varsity athletes in multiple sports versus the control group of sedentary students. Eighty varsity athletes and 80 sedentary students were the subjects of the experiment. Questionnaires, blood tests, and bone mineral density testing was used to obtain information. Low energy availability was found in both the athletes and the control group; 54% of athletes reported menstrual abnormalities while only 21% of sedentary students reported abnormalities; 30% of sedentary students had low bone density compared to 16% of athletes. Results indicated that 78% of high school athletes and 65% of sedentary students qualified for one or more components of the Female Athlete Triad. Limitations of this study include the use of a three-day diet recall and the accuracy and honesty of subjects. Bone mineral density was also only measured at one point in time. Because most of the subjects reported having low energy availability without eating disorders, the authors concluded that implementing education programs in elementary schools that focus on low energy availability, menstrual abnormalities, low bone mineral density, and calcium recommendations would help improve the prevalence of the Female Athlete Triad.24

A study by Thompson in 2007 examined calcium intake and the prevalence of disordered eating and menstrual dysfunction in female cross-country runners. Twenty-nine collegiate teams
from 22 states and 300 female cross-country runners from 44 states and one foreign country completed the survey. The return rate was 34.12%. The average age of the female participants was 19.64 years old and 90.3% of the subjects reported to be White. Thompson used the Orientation to Exercise Questionnaire to assess the level of risk for progression toward subclinical and clinical eating disorders and the Calcium Rapid Assessment Method to estimate the calcium intake of subjects from a 24-hour recall. Information about weight, height, exercise time, perceptions of eating disorders, and menstrual statues was also obtained. The study found that the mean age of those who reported having an eating disorder started at 15.76 years old; 26% reported to have received treatment for their eating disorder. With regards to menstrual cycle, 77% of female participants reported they had normal menstrual cycles, 5.3% had amenorrhea, and 17.7% had oligomenorrhea. Subjects indicated that they exercised 544.72 minutes per week. As the units of BMI increased, the level of calcium intake decreased by 58.64%. Scores for self-loathing, which is a subscale of the Orientation to Exercise Questionnaire, characterized as, “I hate my body when it won’t do what I want,” increased as BMI increased. The subjects who reported having or previously having an eating disorder had a higher score on the Orientation to Exercise Questionnaire.

The limitations to the Thompson study was that even though the surveys were anonymous, coaches collected the surveys and athletes may have thought the coaches would read over the information before submitting it. Subjects who viewed their BMI as high may have felt sensitive about their body size, and this could have had an influence on their questionnaire responses. There was also a low return rate for the surveys. Thompson concluded that female collegiate cross-country runners should be screened for menstrual irregularities to help decrease the prolonged amenorrhea because this can lead to a decrease in bone mineral densities. Future
research should study if the use of hormone replacement therapy (HRT) to regulate menstrual cycle affects the health of female athletes. Athletes should be encouraged to increase their calcium intake to help decrease bone loss. Nutrition education and education on the Female Athlete Triad should be provided to these athletes to help decrease disordered eating and the pursuit of a low body fat level. Longitudinal studies are needed to examine how training intensity, hormone replacement therapy, body fat, and body weight influence menstrual irregularities and the health of female runners.
REFERENCES


Application for Institutional Review of Research
INvolving Human Subjects

Note: Please complete this form thoroughly keeping in mind that the primary concern is the potential risk (economic, ethical, legal, physical, political, psychological/emotional, social, breach of confidentiality, or other) to the participants. Provide copies of all materials to be used in the investigation. The Institutional Review Board (IRB) must have enough information about the transactions with the participants to evaluate the risks of participation.

Name(s) and employee ID for faculty, Z-ID for students
Maeve Miller (807906)

Status: Faculty □ Graduate Student □ Undergraduate Student

Department:
School of Health Studies

Mailing Address (if not department):

Phone: E-mail: m807906@students.wvu.edu

Project Title:
Risk Factors for the Female Athlete Triad in College Age Athletes Compared to Non-Athletes

Proposed Data Collection Start Date: 01/16/2015

Note: Unless the authorized institutional reviewer (e.g., chair or designee) has deemed the protocol form that IRB review is not needed, all projects must receive formal written authorization from the IRB Chair or an IRB member designated by the Chair prior to the start of data collection.

Type of Project (Check one)
□ Departmental Research (Faculty/student projects not externally funded and not indicated below)
□ Graduate Thesis/Dissertation (IRB application should be submitted AFTER proposal defense)
□ Undergraduate Project (Senior thesis/capstone, research project, independent study)
□ Externally Sponsored Research

A complete copy of the grant proposal or contract must accompany this application form for IRB review to take place.

□ Title of grant proposal (if different from IRB protocol):

□ Name of principal investigator on grant proposal:

□ Office of Sponsored Projects file number (Note: this is not the grant number):

□ Other

[1]

Revised 01/15
Part I. Purpose and Procedures:

1) Describe the purpose of your study and the reason(s) this study is needed. Include any necessary background information and a description of your hypothesis or your research question.

The Female Athlete Triad is a health concern that affects active women of all ages who participate in sports or physical activity. The three interrelated conditions of the Triad are low energy availability with or without disordered eating, menstrual irregularity or amenorrhea, and osteoporosis. Exercise is important and has many positive benefits including increasing bone mineral density and lean body mass, which may help prevent stress fractures and osteoporosis. However, too much vigorous activity can have a negative effect on female athletes. Higher levels of injuries in high school athletes are found among females compared to males in the same sport. This leads to a decreased ability to participate in sports, potential long-term chronic injuries, and musculoskeletal problems that may lead to restrictions of mobility and ability to participate in physical activities later in life.

Some sports in particular, those that emphasize leanness and aesthetic factors, have a higher prevalence of women who suffer from the Female Athlete Triad. These sports include, gymnastics, dance, diving, figure skating, aerobics, and running. Some studies have found that the prevalence of the Female Athlete Triad to be 60% in long-distance runners and ballet dancers.

The key component to the Triad is low energy intake, which appears to be a precursor for the development of the other two components.

Although research has been conducted on the Female Athlete Triad, current research on the college-age population is limited. Thompson studied collegiate track athletes in 2007, and Priesen et al. studied collegiate moderate dancers in 2011, but there haven’t been any studies focusing on collegiate athletes in the past seven years. Research needs to be conducted on the prevalence of the Triad risk factors in college-age athletes. The purpose of this study is to examine the extent of a female college-age athlete’s risk for the Female Athlete Triad. The research questions include:

- To what extent are female athletes at Midwestern University at risk for low energy availability compared to non-athletes?
- To what extent are female athletes at Midwestern University at risk for an eating disorder compared to non-athletes?
- To what extent is there an association between energy availability and risk for an eating disorder?

2) The following items will help the IRB reviewers understand the step-by-step procedures of your study:

2A) Explain the participant eligibility and exclusion criteria that will be used.

The study population will be drawn from female non-athletes and all female athletes at participating in varsity basketball, cross country, golf, gymnastics, soccer, softball, tennis, track and field, and volleyball. Eligibility to participate in this study includes being 18 years of age or older and female students currently enrolled at Northern Illinois University.

2B) Explain the recruitment procedures (how will participants learn about the study?). If using the snowballing technique, please explain who contacts potential participants (other participants or the researcher). Please attach recruitment scripts, flyers, or footage.

The recruitment will be done through the use of the Monday Official Announcements and mass emails sent to all students. The Official Announcements coordination will be contacted one week before the survey will be sent out to have the survey approved. I will need to submit an approval form to the Division of Marketing & Communications to ask to send my survey to students. Once approved, the survey will be sent out through a mass email.

Additionally, the university athletic director as well as all female coaches will be contacted and informed about the survey (Appendix A, B). They will be asked to inform athletes about the survey. On the first page of the survey, there will be an introduction to the research and instructions on how to give consent (Appendix C). Those who choose to participate in the survey will give their consent by completing the complete the survey. The estimated sample size is 200 participants. Three $25 Target gift cards will be randomly awarded to participants as an incentive to complete the survey.
2C) Explain the consent process (verbal and/or written procedures for informing participants of the nature of the study and what they will do).

[Please attach all documents (assent, consent, parent permission) that are appropriate for each group of subjects participating in the study. Consent forms should be prepared for adult participants (age 18 or over). Assent forms should be prepared for minor subjects appropriate to their ages, and permission form(s) for parents or legally authorized representatives should also be prepared. For children too young to comprehend a simple explanation of participation, parental permission is sufficient only if the research will provide direct benefit to the subject, a member of the subject’s family, or other children with the same condition as the subject.]

On the first page of the survey, there will be an introduction to the research and instructions on how to give consent. Those who choose to participate in the survey will give their consent by continuing on to complete the survey (Appendix C).

2D) Describe the data collection procedures including what data will be collected, how it will be collected (include a description of any interventions to be used), the duration of participation in the study session(s), and how the session(s) will end.

The method used to collect data is an online three part survey. The first part will be LEAF-Q questionnaire (Appendix D) which is a 25-item questionnaire used to determine if athletes are at risk for low energy availability using gastrointestinal symptoms, injury frequency, and menstrual dysfunction. A score of 8 or more on this questionnaire indicates that an athlete is considered to be at risk for the Triad. The author of the LEAF-Q was contacted and permission was granted to use this questionnaire (Appendix E).

The second part is the Eating Attitudes Test-20 (EAT-20 (Appendix F) will be used to assess any abnormal eating behaviors. Permission was granted for the use of this survey (Appendix G). The test is a standardized measure of symptoms and behaviors that follow the patterns of eating disorders. The test is not a diagnostic tool for eating disorders. However, it can be used as the first step in a two-step diagnostic process. Individuals who score a 20 or more on this test will be considered to be at risk for an eating disorder. There are three subscales within the EAT-20 test: dieting, bulimia and food preoccupation, and oral control. The subscale scores are found by adding the questions that were assigned to a subscale. Questions 1, 6, 7, 10, 12, 14, 16, 17, 22, 23, 24, and 26 are dieting scale items. Questions 2, 5, 8, 13, 15, 19, and 20 are oral control subscale items. The answer options for questions 1-26 are always, usually, often, sometimes, rarely, and never. Each answer has a numerical score associated with it and these numbers are added up to find a total score for the test. A list of resources will be provided to participants at the end of the survey (Appendix H).

The third part is self reported general demographic and anthropometric information will include asking participants their age in years, weight in pounds, height in feet and inches, year in school, ethnicity, and sport participated or not participated. Height and weight recorded will be used to calculate body mass index (BMI) for each participant.

The study is proposed to take approximately 10-15 minutes. The last part of the survey will include a list of eating disorder resources and will provide an email address to send contact information for those who wish to participate in the drawing for gift cards.

The participants will have about one month to complete the online survey, after one month, the surveys will close. The survey will be featured on the Official Monday Announcements twice, and two reminder emails with the survey link will be sent during this month to remind participants to complete it. There will be two announcements and two reminder emails sent to students. Participants will be eligible to enter into a drawing to win a $25 Target gift card.

2E) If applicable, explain the procedures for providing compensation.

2F) If applicable, explain the procedures for debriefing participants. Please attach a debriefing script or sheet.

Reminder: Attach copies of all questionnaires, surveys, interview questions, listing of all information/data to be collected, etc. It is the responsibility of the researcher to obtain any relevant permission for copyrighted materials. If the research involves an oral interview or focus group discussion that could evolve as it progresses, include a list of discussion topics and
any "starter" questions for each topic that can reasonably be expected to be covered. If a draft of a written questionnaire or survey is attached, it should be clearly labeled as such and a final version must be submitted before data collection begins.

**Part II: Research Participants**

3) Participant demographics:

- Gender: [ ] M [ ] F [ ] Both

- Exposed age(s):

- Are any subjects under age 18? [ ] Yes [ ] No

- Potentially vulnerable populations (please indicate if any of the following groups are the target population of the study):
  - Pregnant women & fetuses
  - Prisoners
  - Decisively impaired/mentally disabled
  - Specific ethnic group(s) (list in box):

If any potentially "vulnerable populations" have been indicated above, please explain the necessity for using this particular group, or if specific groups are excluded from the study, please indicate the exclusion criteria used.

- Target number of participants in the entire study (including controls) from start to finish (keep in mind that this is just an estimate of the total):

4) Please explain any outside institutional (i.e., schools, hospital(s) approval you will need to obtain and how approval will be sought. Provide scripts, letters, or emails containing any information that will be used to obtain needed approvals/permission. It is the responsibility of the researcher to follow all applicable policies of any outside institution(s).

**Part III: Risk/Benefit assessment**

5) What knowledge/benefit(s) to the field will be gained from the study?

This study will contribute to current research on the Female Athlete Triad in the college-age population. The most recent data on this population was in 2011. Therefore, more current research is needed.

6) What direct benefit(s) are there to the participant(s) (if any) from the proposed research? (For example, learning a new skill, psychological benefit, teaching experience) [Please note that compensation is NOT considered a direct benefit.]

There is no direct benefit to the participants. However, the data generated may be used to provide better nutrition and health support for collegiate female athletes to improve nutritional health.

7) Describe any potential risks (breach of confidentiality, economic, ethical, legal, physical, political, psychological/emootional, social, or other) to the subjects posed by the proposed research. (Note: Some studies may have "no reasonably foreseeable risks." Investigators are required to report all unexpected and/or adverse events to the IRB. Therefore, it is important that you list all reasonably anticipated risks because unexpected adverse events may need to be reported by NIH to OHRP.

There are no reasonably foreseeable risks for this study.

8) Federal regulations require that researchers use procedures to minimize any risks to participants. What procedures will be used to minimize each risk and/or deal with the challenge(s) stated in "7" above?

[ ]

Revised 01/2015
9) If support services are required to minimize risk of harm to participants, explain what will be provided (list of services available). [A resource list for the DeKalb area is available on the ORC website – if using this, please provide a copy with your application.]

A list of eating disorder resources will be included at the end of the study.

10) How do the potential benefits of the study justify the potential risks to the participants?

There are no foreseeable risks, but student athletes may benefit from nutritional education that may result from the data collected.

Part IV: Consent Document Variations

11) Will audio, video, or film recording be used? Yes ☐ No ☑

If yes, specify the recording format to be used.

Please keep in mind that specific consent must be sought in the informed consent document(s) by including a separate signature/date line giving consent for recording. This is in addition to the signature/date line giving consent to participate in the research project.

12) Will this project require the use of consent/assent documents written in a language other than English? Yes ☐ No ☑

Reminder: If non-English documents will be used, please have the document translator provide documentation (email or written) that the translation is equivalent to the English version. [This can be done after the protocol is approved in order to minimize the number of changes needed.]

13) Are you requesting a waiver of a signed informed consent document? Yes ☐ No ☑

Please indicate the justification for requesting this waiver:

☐ The only record linking the subject to the research would be the signed consent document and the principal risk of the research would be breach of confidentiality.

☐ The research involves minimal risk to the subjects and involves no procedures for which written consent is normally required outside of the research context (e.g., online surveys).

14) Are you requesting a waiver/alteration of some other aspect of the informed consent document? [This section is relevant for studies involving deception.]

Yes ☐ No ☑

14a) Please explain which aspects of informed consent will be missing or altered along with a justification for the change.

14b) Please explain how the project meets all of the following criteria:

1) The research presents no more than minimal risk of harm to the participants.

2) The waiver/alteration will not adversely affect the rights or welfare of the participants.

3) The research could not practically be carried out without the waiver or alteration.

[5]

Revised 01/2015
4) Whenever appropriate, the participants will be provided with additional pertinent information after participation.

15) Will any HIPAA protected health information be collected as part of the data? Yes ☐ No ☐
   [Please provide a copy of your HIPAA disclosure form to be given to participants.]

16) Will any protected school records be collected as part of the data? Yes ☐ No ☐
   [Please provide the procedures for protecting the information.]

Part V: Confidentiality and Anonymity

17) Will identifying information be connected to the data (even through an identification key linking identities to a pseudonym or code that is kept separate from the data)? Yes ☐ (confidential data) No ☐ (anonymous data)

18) If you answered yes to question #17, describe precautions to assure the privacy of the subjects, and the confidentiality of the data, both in your possession and in reports and publications.

19) If you are collecting your data through an on-line survey tool, will the survey instrument collect email and/or IP addresses with the data? Yes ☐ No ☐ N/A ☐
   The survey will be written so that email/IP addresses are NOT collected
   IP and/or email addresses WILL be collected with the data
   I am not using an online survey tool.

20) How will the records (data, recordings, and consent forms) be stored? Also indicate how long records will be kept and how and when they will be disposed of.
   The records will be stored in [location] for three years after completion of the study and then deleted.

Part VI: Projects Involving Deception [complete only if your study includes deception]

21) Describe the deception being used. Be sure to clarify whether this is deception by omission (an important aspect of the study is withheld from the participants) or revelation (the participant is misled about some aspect of the study) or both. [Complete item 21 if aspects of consent are missing]

22) Why is deception a necessary and unavoidable component of the experimental design?

23) Debriefing of participants will be:
   ☐ Immediate (directly following the research session)
   ☐ Delayed
   ☐ Full (all aspects of deception will be revealed)
   ☐ Partial (some aspects of deception will remain unexplained)

   a) If debriefing is delayed, why is the delay necessary, and when will it occur?

[6]

Revised 01/2015
b) If debriefing is partial, why is the partial debriefing necessary? Would the participant be harmed in any way by full debriefing? [ ]

c) If debriefing is partial, will full debriefing occur later? [ ]

d) Does the presence of deception increase risk of harm to the participants? [ ]

e) Is the respondent free to withdraw his/her data after being fully debriefed? [ ]

24) Who will provide the debriefing? [ ]

Reminder: Please include a copy of your debriefing script/sheet with this application.

Part VII: Credit and Compensation

25) If participants will receive course credit for participation, please describe it below. [ ]

N/A

26) If participants will receive some other form of compensation for participation, please describe it below. [ ]

N/A

27) Describe any alternative tasks that will be available for participants to earn the credit or compensation. [ ]

N/A

Part VIII: Conflict of Interest

28) Do any of the researchers conducting this study have any potential conflicts of interest? [ ]

[Conflicts of interest may include financial or personal interest, or any condition in which the investigator’s judgment regarding a primary interest may be biased by a secondary interest.]

Yes [ ] No [X]

29) If yes to the above question, please describe the nature of the conflict of interest. [ ]

N/A

Part IX: Researcher Qualifications

30) In addition to listing the investigators’ names, indicate their qualifications to conduct procedures to be used in this study.

Micada Miller: graduate student took research methods course, Dr. Unsoere: faculty advised and researched.

31) State the date of completion of the CITI Human Subjects Protection training program(s) for the individuals listed in the question above. The required course is “Social & Behavioral Research - Basic/Refresher, Basic Course”. The required CITI training is accessible from the ORC1 website at http://www.niu.edu/orc1/human_research/training/index.shtml. If you have comparable training, please attach certification verifying this. [Note: NIU policy requires that research investigators must complete appropriate training before conducting human subjects research.] [ ]

Micada Miller: Fall 2016, Dr. Unsoere: April 2015

[7] Revised 01/2015
To be completed by investigator and confirmed by advisor (if student project) and departmental reviewer. Initials indicate all required sections ratified that application is complete.

Checklist of items required to accompany completed application form:

1. Complete grant proposal/contract (for externally funded projects)
2. All surveys, questionnaires, interview questions, or other instruments to be used
3. Subject recruitment/retention materials
4. Informed consent documents (must select at least one):
5. Consent form for adults (if participants are age 18 or over)
6. Assent form for minors (if participants are under age 18)
7. Parental permission form (if participants are under age 18)

Initial indicating all listed materials are attached and application is complete; INCOMPLETE APPLICATIONS WILL NOT BE PROCESSED. The investigator will be notified of deficiencies in the application via e-mail from the Office of Research Compliance and Integrity (ORCI); if no response is received by the ORCI thirty (30) days the application will be considered withdrawn.

Investigator Advisor (if student project) Department Chair/Designee

REQUIRED SIGNATURES: ALL PROJECTS

CERTIFICATION
I certify that I have read and understand the policies and procedures for research projects that involve human subjects and that I intend to comply with Northern Illinois University Policy. Any changes in the approved protocol will be submitted to the IRB for written approval prior to those changes being put into practice unless it involves an immediate safety issue for the subject during a procedure. (In such instances, the researcher is required to promptly notify the IRB after the fact.) I also understand that all non-exempt projects require review at least annually.

Investigator(s) Signature(s) Date

Signature of Faculty Advisor
(Student Project Only) Date

Authorized Departmental Review:

☐ Project qualifies for Administrative Review.
   Cite the appropriate exempt category:

☐ Project qualifies for Subcommittee Review.
   Cite the appropriate expedited category:

☐ Project is referred for review by the convened IRB.

Revised 01/2015
<table>
<thead>
<tr>
<th>Signature of Authorized Departmental Reviewer</th>
<th>Printed name</th>
<th>Date</th>
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</table>

Return this form, together with necessary documentation, to the Office of Research Compliance and Integrity, Lowden Hall, 301. For information or additional assistance with the approval process, please call the office at (815) 753-8588 or access the ORCI web page at [www.rru.edu/orci](http://www.rru.edu/orci).
Office of Research Compliance, Integrity & Safety
Division of Research & Innovation Partnerships

Approval Notice
Initial Review

27-Mar-2018

TO: Micaela Miller
   School of Health Studies

RE: Protocol # HS18-0078 “Risk factors for the female athlete triad in college age athletes compared to non-athletes”

Your Initial Review submission was reviewed and approved under Expedited procedures by Institutional Review Board #1 on 27-Mar-2018. Please note the following information about your approved research protocol:


If your project will continue beyond that date, or if you intend to make modifications to the study, you will need additional approval and should contact the Office of Research Compliance and Integrity for assistance. Continuing review of the project, conducted at least annually, will be necessary until you no longer retain any identifiers that could link the subjects to the data collected. Please remember to use your protocol number (HS18-0078) on any documents or correspondence with the IRB concerning your research protocol.

Please note that the IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Unless you have been approved for a waiver of the written signature of informed consent, this notice includes a date-stamped copy of the approved consent form for your use. NIU policy requires that informed consent documents given to subjects participating in non-exempt research bear the approval stamp of the NIU IRB. This stamped document is the only consent form that may be photocopied for distribution to study participants.

It is important for you to note that as a research investigator involved with human subjects, you are responsible for ensuring that this project has current IRB approval at all times, and for retaining the signed consent forms obtained from your subjects for a minimum of three years after the study is concluded. If consent for the study is being given by proxy (guardian, etc.), it is your responsibility to document the authority of that person to consent for the subject. Also, the committee recommends that you include an acknowledgment by the subject, or the subject’s representative, that he or she has received a copy of the consent form. In addition, you are required to promptly report to the IRB any injuries or other unanticipated problems or risks to subjects and others. The IRB extends best wishes for success in your research endeavors.
APPENDIX D
PARTICIPANT CONSENT FORM
Dear Participant,

Welcome to my survey. My name is Micaela Miller, and I am a graduate student in the nutrition and dietetics program. I am required to complete a thesis to graduate with a Master of Science degree from Northern Illinois University. My study is assessing the risk factors of the Athlete Triad among females. The Female Athlete Triad is the interrelationship among menstrual irregularity, low energy availability, and low bone density that can occur in active women and female athletes. Questions in this survey include topics of menstruation, injuries, contraceptive use, and eating habits.

Completion of this survey will take between 10 and 15 minutes, and those who participate will be entered into a drawing to win a $25 Target gift card. Consent for participation in this survey will be given by continuing on to complete the survey. Risks of participation include breach of confidentiality. Confidentiality will be protected through the use of Qualtrics, a monitored and audited data collecting system. All data published or presented will be reported as group data, and individual data will not be shared with any department or the public. Participation in this survey is voluntary, and there will be no penalties for deciding not to participate. Please note that you must be a female student to participate.

If you have any questions about this project, please do not hesitate to contact me (z1807967@students.niu.edu) or my thesis director, Dr. Josephine Umoren (jxu1@niu.edu). Information on rights of research participants is available through the Northern Illinois Institutional Review Board, 815-753-8588 or jgommel@niu.edu.

Thank you for your assistance in this important work,

Micaela Miller
Nutrition and Dietetics Graduate Student
Northern Illinois University
APPENDIX E
MONDAY OFFICIAL ANNOUNCEMENTS
NIU female student volunteers needed

All female NIU students are invited to participate in a graduate thesis project that will contribute to research on the Female Athlete Triad. Questions in this survey include topics of menstruation, injuries, contraceptive use and eating habits.

Completion of this anonymous survey will take between 10 and 15 minutes, and those who participate will be entered into a drawing to win a $25 Target gift card.

The link to this survey can be found here: https://niu.az1.qualtrics.com/jfe/form/SV_9gfu7ldh1SSYCN.

If you have any questions about this project, please contact Micaela Miller at z1807967@students.niu.edu.
NIU female student volunteers needed

All female NIU students are invited to participate in a graduate thesis project that will contribute to research on the Female Athlete Triad. Questions in this survey include topics of menstruation, injuries, contraceptive use and eating habits.

Completion of this anonymous survey will take between 10 and 15 minutes, and those who participate will be entered into a drawing to win a **$25 Target gift card.**

The link to this survey can be found here: [https://niu.az1.qualtrics.com/jfe/form/SV_9ogfu7ldh1SSYCN](https://niu.az1.qualtrics.com/jfe/form/SV_9ogfu7ldh1SSYCN).

If you have any questions about this project, please contact Micaela Miller at [z1807967@students.niu.edu](mailto:z1807967@students.niu.edu).
APPENDIX G
EMAIL TO ATHLETIC DIRECTOR
Letter of Recruitment

March 2018

Dear Mr. Frazier,

My name is Micaela Miller, and I am a graduate student in the nutrition and dietetics program. I am required to complete a thesis to graduate with a Master of Science degree from Northern Illinois University. I am interested in studying the risk factors of the Athlete Triad among female college athletes. I am writing to you because I need your help. I am inviting your athletes to participate in my research project, and I would like your support in encouraging participation. The study aims to determine if there is an association between competitive college female athletes and the Female Athlete Triad.

If your athletes agree to participate, they will be completing an online survey regarding attitudes towards eating and energy intake. Completion of this survey will take between 10 and 15 minutes, and athletes who participate will be entered into a drawing to win a $25 Target gift card. Please note that all the information collected will be kept confidential and will not be shared with the athletic department or the public.

The link to my survey can be found below:
https://niu.az1.qualtrics.com/jfe/form/SV_9ogfu7Idh1SSYCN

If you have any questions, please contact me by phone at (847) 708-0688 or email at z1807967@students.niu.edu.

Thank you again for considering this research opportunity,

Micaela Miller
APPENDIX H
EMAIL TO COACHES
Letter of Recruitment

March 2018

Dear Coaches,

My name is Micaela Miller, and I am a graduate student in the nutrition and dietetics program. I am required to complete a thesis to graduate with a Master of Science degree from Northern Illinois University. I am interested in studying the risk factors of the Athlete Triad among female college athletes. I am writing to you because I need your help. I am inviting your athletes to participate in my research project, and I would like your support in encouraging participation. The study aims to determine if there is an association between competitive college female athletes and the Female Athlete Triad.

If your athletes agree to participate, they will be completing an online survey regarding attitudes towards eating and energy intake. Completion of this survey will take between 10 and 15 minutes, and athletes who participate will be entered into a drawing to win a $25 Target gift card. Please note that all the information collected will be kept confidential and will not be shared with the athletic department or the public.

The link to my survey can be found below:
https://niu.az1.qualtrics.com/jfe/form/SV_9ogfu7Idh1SSYCN

If you have any questions, please contact me by phone at (847) 708-0688 or email at z1807967@students.niu.edu.

Thank you again for considering this research opportunity,

Micaela Miller
APPENDIX I
EATING DISORDER REFERENCES
The following are a list of eating disorder resources:

National Eating Disorder Association (http://www.nationaleatingdisorders.org/)

Eating Disorder Hope (https://www.eatingdisorderhope.com/treatment-centers/illinois-il)

Psychology Today (https://www.psychologytoday.com/)
APPENDIX J
ONLINE SURVEY
Q1 Dear Participant, Welcome to my survey. My name is Micaela Miller, and I am a graduate student in the nutrition and dietetics program. I am required to complete a thesis to graduate with a Master of Science degree from Northern Illinois University. My study is assessing the risk factors of the Athlete Triad among females. The Female Athlete Triad is the interrelationship among menstrual irregularity, low energy availability, and low bone density that can occur in active women and female athletes. Questions in this survey include topics of menstruation, injuries, contraceptive use, and eating habits. Completion of this survey will take between 10 and 15 minutes, and those who participate will be entered into a drawing to win a $25 Target gift card. Consent for participation in this survey will be given by continuing on to complete the survey. Risks of participation include breach of confidentiality. Confidentiality will be protected through the use of Qualtrics, a monitored and audited data collecting system. All data published or presented will be reported as group data, and individual data will not be shared with any department or the public. Participation in this survey is voluntary, and there will be no penalties for deciding not to participate. Please note that you must be a female student to participate. If you have any questions about this project, please do not hesitate to contact me (z1807967@students.niu.edu) or my thesis director, Dr. Josephine Umoren (jxu1@niu.edu). Information on rights of research participants is available through the Northern Illinois Institutional Review Board, 815-753-8588 or jgommel@niu.edu. Thank you for your assistance in this important work, Micaela Miller Nutrition and Dietetics Graduate Student Northern Illinois University

Q67 Are you a varsity athlete at Northern Illinois University?

☐ Yes (1)

☐ No (2)
Q2 Have you had absences from your training, or participation in competitions during the last year due to injuries?

- No, not at all (1)
- Yes, once or twice (2)
- Yes, three or four times (3)
- Yes, five times or more (4)

Display This Question:
If Have you had absences from your training, or participation in competitions during the last year due to injuries? != No, not at all

Q3 For how many days absence from training or participation in competition due to injuries have you had in the last year?

- 1-7 days (1)
- 8-17 days (2)
- 15-21 days (3)
- 22 days or more (4)

Display This Question:
If Have you had absences from your training, or participation in competitions during the last year due to injuries? != No, not at all

Q4 What kind of injuries have you had in the last year?

--------------------------------------------------------------

Display This Question:
If Have you had absences from your training, or participation in competitions during the last year due to injuries? != No, not at all

Q4 What kind of injuries have you had in the last year?

--------------------------------------------------------------
Q6 Do you feel gaseous or bloated in the abdomen when you do not have your period?

- Yes, several times a day (1)
- Yes, several times a week (2)
- Yes, once or twice a week or seldom (3)
- Rarely or never (4)

Q7 Do you get cramps or stomach ache which cannot be related to your menstruation?

- Yes, several times a day (1)
- Yes, several times a week (2)
- Yes, once or twice a week or more seldom (3)
- Rarely or never (4)

Q8 How often do you have bowel movements on average?

- Yes, several times a day (1)
- Yes, several times a week (2)
- Yes, once or twice a week or more seldom (3)
- Rarely or never (4)
Q9 How would you describe your normal stool?

- Normal (soft) (1)
- Diarrhea-like (watery) (2)
- Hard and dry (3)

Q11 Do you use oral contraceptives?

- Yes (1)
- No (2)

Display This Question:
If Do you use oral contraceptives? = Yes

Q12 Why do you use oral contraceptives?

- Contraception (1)
- Reduction of menstruation pains (2)
- Reduction of bleeding (3)
- To regulate the menstrual cycle in relation to performances ect.. (4)
- Otherwise menstruation stops (5)
- other (6) ________________________________
Q13 Have you used oral contraceptives earlier?

- Yes (1)
- No (2)

Q14 When and for how long?

________________________________________________________________

Q15 Do you use any other kind of hormonal contraceptives? (e.g. hormonal implant or coil)

- Yes (1)
- No (2)
Q16 What kind?

- Hormone patches (1)
- Hormonal ring (2)
- Hormonal coil (3)
- Hormonal implant (4)
- Other (5)

Q17 How old were you when you had your first period?

- 11 years or younger (1)
- 12-14 years (2)
- 15 years or older (3)
- I don't remember (4)
- I have never menstruated (5)

Q18 Did your first menstruation come naturally (by itself)?

- Yes (1)
- No (2)
- I don't remember (3)

Display This Question:

If How old were you when you had your first period? != I have never menstruated
Q19 What kind of treatment was used to start your menstrual cycle?

- Hormonal treatment (1)
- Reduced amount of exercise (2)
- Weight gain (3)
- Other (4)

Q20 Do you have normal menstruation?

- Yes (1)
- No (2)
- I don’t know (3)
Q21 When was your last period?

- 0-4 weeks ago (1)
- 1-2 months ago (2)
- 3-4 months ago (3)
- 5 months ago or more (4)

Display This Question:  
If Do you have normal menstruation? = Yes

Q22 Are your periods regular? (Every 28th to 34th day)

- Yes, most of the time (1)
- No, most not (2)

Display This Question:  
If Do you have normal menstruation? = Yes

Q23 For how many days do you normally bleed?

- 1-2 days (1)
- 3-4 days (2)
- 5-6 days (3)
- 7-8 days (4)
- 9 days or more (5)

Display This Question:  
If Do you have normal menstruation? = Yes
Q24 Have you had problems with heavy menstrual bleeding?

- Yes (1)
- No (2)

Display This Question:
If Do you have normal menstruation? = Yes

Q25 How many periods have you had during the last year?

- 12 or more (1)
- 9-11 (2)
- 6-8 (3)
- 3-5 (4)
- 0-2 (5)

Page Break

Display This Question:
If Do you have normal menstruation? = No
Or Do you have normal menstruation? = I don’t know

Q26 When did you have your last period?

- 2-3 months ago (1)
- 4-5 months ago (2)
- 6 months ago or more (3)
- I’m pregnant and therefore do not menstruate (4)
Display This Question:
If How old were you when you had your first period? ! I have never menstruated

Q27 Have your periods ever stopped for 3 consecutive months or longer (besides pregnancy)?

☐ No, never (1)

☐ Yes, it has happened before (2)

☐ Yes, that's the situation now (3)

Display This Question:
If How old were you when you had your first period? ! I have never menstruated

Q28 Do you experience that your menstruation changes when you increase your exercise intensity, frequency, or duration?

☐ Yes (1)

☐ No (2)
Q29 How? (check one or more options)

☐ I bleed less (1)
☐ I bleed more (2)
☐ I bleed fewer days (3)
☐ I bleed more days (4)
☐ My menstruation stops (5)

Q30 Check a response for each of the following statements:

Q31 Am terrified about being overweight.

☐ Always (1)
☐ Usually (2)
☐ Often (3)
☐ Sometimes (4)
☐ Rarely (5)
☐ Never (6)
Q32 Avoid eating when I am hungry.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q33 Find myself preoccupied with food.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q34 Have gone on eating binges where I feel that I may not be able to stop.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q35 Cut my food into small pieces.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q36 Aware of the calorie content of foods that I eat.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q37 Particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes, etc.)

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q38 Feel that others would prefer if I ate more.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q39 Vomit after I have eaten.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q40 Feel extremely guilty after eating.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q41 Am preoccupied with a desire to be thinner.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q42 Thing about burning up calories when I exercise.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q43 Other people say that I am too thin.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q44 Am preoccupied with the thought of having fat on my body.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q45 Take longer than others to eat my meals.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q46 Avoid foods with sugar in them.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q47 Eat diet foods.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q48 Feel that food controls my life.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q49 Display self-control around food.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q50 Feel that others pressure me to eat.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q51 Give too much time and thought to food.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q52 Feel uncomfortable after eating sweets

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q53 Engage in dieting behavior.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q54 Like my stomach to be empty

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)

Q55 Have the impulse to vomit after meals.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q56 Enjoy trying new rich foods.

- Always (1)
- Usually (2)
- Often (3)
- Sometimes (4)
- Rarely (5)
- Never (6)
Q61
In the past 6 months have you:

Q62 Gone on eating binges where you feel that you may not be able to stop (defined as eating much more than most people would under the same circumstances and feeling that eating is out of control)

○ Never (1)
○ Once a month or less (2)
○ 2-3 times a month (3)
○ Once a week (4)
○ 2-6 times a week (5)
○ Once a day or more (6)

Q63 Ever made yourself sick (vomited) to control your weight or shape?

○ Never (1)
○ Once a month or less (2)
○ 2-3 times a month (3)
○ Once a week (4)
○ 2-6 times a week (5)
○ Once a day or more (6)
Q64 Ever used laxatives, diet pills or diuretics (water pills) to control your weight or shape?

- Never (1)
- Once a month or less (2)
- 2-3 times a month (3)
- Once a week (4)
- 2-6 times a week (5)
- Once a day or more (6)

Q65 Exercised more than 60 minutes a day to lose or to control your weight?

- Never (1)
- Once a month or less (2)
- 2-3 times a month (3)
- Once a week (4)
- 2-6 times a week (5)
- Once a day or more (6)

Q66 Lost 20 pounds or more in the last 6 months

- Yes (1)
- No (2)
Q68 Age in years

- 18 (1)
- 19 (2)
- 20 (3)
- 21 (4)
- 22 (5)
- 23 (6)
- 24 (7)

Q69 Weight in pounds (lbs)

______________________________

Q70 Height in feet and inches

______________________________
Q71 Year in school

- Freshman (1)
- Sophomore (2)
- Junior (3)
- Senior (4)
- Graduate student (5)

Q72 Ethnicity

- African American/African/Black/Caribbean (1)
- Asian/Pacific Islander (2)
- Caucasian (3)
- Hispanic/Latino (4)
- Native American (5)
- Other (6)

Display This Question:

If Are you a varsity athlete at Northern Illinois University? = Yes
Q73 What varsity sport do you participate in?

- Basketball (1)
- Cross Country (2)
- Golf (3)
- Gymnastics (4)
- Soccer (5)
- Softball (6)
- Tennis (7)
- Track and Field (8)
- Volleyball (9)
Q74 The following are a list of eating disorder resources: National Eating Disorder Association: (http://www.nationaleatingdisorders.org/) Eating Disorder Hope: (https://www.eatingdisorderhope.com/treatment-centers/illinois-il) Psychology Today: (https://www.psychologytoday.com/)

Q75 If you are interested in entering into a raffle to win a Target gift card, please email your contact information to giftcardraffle1111@gmail.com

End of Block: Default Question Block
1A: Have you had absences from your training, or participation in competitions during the last year due to injuries?
- No, not at all
- Yes, once or twice
- Yes, three or four times
- Yes, five or times or more

1A1: If yes, for how many days absence from training or participation in competition due to injuries have you had in the last year?
- 1-7 days
- 8-14 days
- 15-21 days
- 22 days or more

1A2: If yes, what kind of injuries have you had in the last year?

2A: Do you feel gaseous or bloated in the abdomen, also when you do not have your period?
- yes, several times a day
- yes, several times a week
- yes, once or twice a week or more seldom
- rarely or never

2B: Do you have cramps or stomach ache which cannot be related to your menstruation?
- yes, several times a day
- yes, several times a week
- yes, once or twice a week or more seldom
- rarely or never

2C: How often do you have bowel movements on average?
- several times a day
- once a day
- every second day
- twice a week
- once a week or more rarely

2D: How would you describe your normal stool?
- normal (soft)
- diarrhea-like (watery)
- hard and dry

3.1A: Do you use oral contraceptives?
- yes
- no

3.1A1: If yes, why do you use oral contraceptives?
- Contraception
- Reduction of menstrual pains
- Reduction of bleeding
- To regulate menstrual cycle in relation to performance
- Otherwise menstruation stops
- Other

3.1A2: If no, have you used oral contraceptives earlier?
- yes
3.1A2: If yes, when and for how long?
3.1B: Do you use any other kind of hormonal contraceptives?
- yes
- no
3.1B1: if yes, what kind?
- hormonal patches
- hormonal ring
- hormonal coil
- hormonal implant
- other
3.2A: How old were you when you had your first period?
- 11 years or younger
- 12-14 years
- 15 years or older
- I don't remember
- I have never menstruated (if you answered "I have never menstruated" there are no further questions to answer)
3.2B: Did your first menstruation come naturally?
- yes
- no
- I don't remember
3.2C: Do you have normal menstruation?
- yes
- no (go to question C6)
- I don't know (go to question C6)
3.2C1: If yes, when was your last period
- 0-4 weeks ago
- 1-2 months ago
- 3-4 months ago
- 5 months ago
3.2C2: if yes, are your periods regular? (every 28th to 34th day)
- yes, most of the time
- no, mostly not
3.2C3: if yes, for how many days do you normally bleed?
- 1-2 days
- 3-4 days
- 5-6 days
- 7-8 days
- 9 days or more
3.2C4: if yes, have you ever had problems with heavy menstrual bleeding
- yes
- no
3.2C5: if yes, how many periods have you had during the last year?
- 12 or more
3.2C6: If no or “I don’t remember” when did you have your last period?
- 2-3 months ago
- 4-5 months ago
- 6 months ago or more
- I’m pregnant and therefore do not menstruate

3.2D: Have your periods ever stopped for 3 consecutive months or longer (besides pregnancy)
- no, never
- yes, it’s has happened before
- yes, that’s the situation now

3.2E: Do you experience that your menstruation changes when you increase your exercise intensity, frequency, or duration?
- yes
- no

3.2E1: If yes, how
- if bleed less
- I bleed fewer days
- My menstruation stops
- I bleed more
- I bleed more days
APPENDIX L
EAT-26 QUESTIONNAIRE
Eating Attitudes Test (EAT-26)©

Instructions: This is a screening measure to help you determine whether you might have an eating disorder that needs professional attention. This screening measure is not designed to make a diagnosis of an eating disorder or take the place of a professional consultation. Please fill out the below form as accurately, honestly and completely as possible. There are no right or wrong answers. All of your responses are confidential.

Part A: Complete the following questions:
1) Birth Date: Month: Day: Year: 2) Gender: Male Female
3) Height: Feet: Inches: 4) Current Weight (lbs.): 5) Highest Weight (excluding pregnancy):
6) Lowest Adult Weight: 7) Ideal Weight:

Part B: Check a response for each of the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Some times</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Am terrified about being overweight.</td>
<td></td>
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<tr>
<td>2. Avoid eating when I am hungry.</td>
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</tr>
<tr>
<td>3. Find myself preoccupied with food.</td>
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<tr>
<td>4. Have gone on eating binges where I feel that I may not be able to stop.</td>
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</tr>
<tr>
<td>5. Cut my food into small pieces.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Aware of the calorie content of foods that I eat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Particularly avoid food with a high carbohydrate content (i.e., bread, rice, potatoes, etc.)</td>
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<td></td>
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<tr>
<td>8. Feel that others would prefer if I ate more.</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>9. Vomit after I have eaten.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Feel extremely guilty after eating.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Am preoccupied with a desire to be thinner.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Think about burning up calories when I exercise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Other people think that I am too thin.</td>
<td></td>
<td></td>
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<td>14. Am preoccupied with the thought of having fat on my body.</td>
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<td>15. Take longer than others to eat my meals.</td>
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<td>16. Avoid foods with sugar in them.</td>
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<td>17. Eat diet foods.</td>
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<td>18. Feel that food controls my life.</td>
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<td>19. Display self-control around food.</td>
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<td>20. Feel that others pressure me to eat.</td>
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<td>21. Give too much time and thought to food.</td>
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<td>22. Feel uncomfortable after eating sweets.</td>
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<td>23. Engage in dieting behavior.</td>
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<td>24. Like my stomach to be empty.</td>
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<td>25. Have the impulse to vomit after meals.</td>
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</tbody>
</table>

Part C: Behavioral Questions: In the past 6 months have you:

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Once a month or less</th>
<th>2-3 times a month</th>
<th>Once a week</th>
<th>2-6 times a week</th>
<th>Once a day or more</th>
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</thead>
<tbody>
<tr>
<td>A Gone on eating binges where you feel that you may not be able to stop?</td>
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<td>B Ever made yourself sick (vomited) to control your weight or shape?</td>
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<tr>
<td>C Ever used laxatives, diet pills or diuretics (water pills) to control your weight or shape?</td>
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<td>D Exercised more than 60 minutes a day to lose or to control your weight?</td>
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<td>E Lost 20 pounds or more in the past 6 months</td>
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</table>

* Defined as eating much more than most people would under the same circumstances and feeling that eating is out of control

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APPENDIX M
PERMISSION FOR LEAF-Q
Dear Micaela

Thank you for your e-mail and interest in using the LEAF-Q. The questionnaire and scoring key are published as Supplemental Digital Content in Br J Sports Med, but you are not alone having problems finding it:-)

I have attached the LEAF-Q and the current scoring key that we used in the LEA study on elite female endurance athletes.

Please consider;

1) Including the EDI, EAT-26, EDE-Q or BEDA-Q as a complementary screening tool since the construct of the LEAF-Q is to investigate the physiological consequences of energy deficiency and not to identify athletes at risk for ED/DE.

2) The scoring key of the LEAF-Q is not final and needs to be re-evaluated in every new group of athletes. Especially in young athletes, and the questions concerning injuries in regard to the Triad - if you for instance include soccer players or gymnasts = odd impact sports - they normally have high BMD independent of low energy availability/MD compared to e.g. endurance athletes, although they are high risk sports when it comes to injuries.

Best regards

Dr Anna Melin
Assistant professor Section for Clinical and Preventive Nutrition
Department of Nutrition, Exercise and sports
University of Copenhagen
+46 73 26 29 714
APPENDIX N
PERMISSION FOR EAT-26
Hello,

Thank you for your request for permission to reproduce and use the EAT-26. The EAT-26 is protected under copyright; however, all fees and royalties have been waived because it has been our wish for others to have free access to the test.

Please consider this e-mail as granting you permission to reproduce the test for the purpose suggested in your request if the EAT-26 is cited properly. The correct citation is: "The EAT-26 has been reproduced with permission. Garner et al. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. Psychological Medicine, 12, 871-878."

You can download a copy of the scoring instructions and the test on the homepage of the EAT-26 website. If you use the written version of the test, it is recommended that you provide respondents with the link to the EAT-26 website (www.eat-26.com) so that they can learn more about the test.

Again, thank you for requesting permission to reproduce and use the EAT-26. If you intend on publishing your work, please send me your results so that they can be included in a research database being developed on the EAT-26 website (www.eat-26.com).

Best wishes,

David M. Garner, Ph.D.
EAT Copyright Holder
President & CEO
River Centre Clinic
5465 Main Street
Sylvania, OH 43560
dmgarner@gmail.com