

The Female Athlete Triad:
Exploring Knowledge Levels
Among Female Adolescent
Athletes

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Abstract

The Female Athlete Triad includes disordered eating, menstrual irregularity, and low bone mineral density and puts female athletes at a higher risk for injury. Multiple studies have suggested education as the best form of prevention. The purpose of this study was to determine the knowledge level of the Female Athlete Triad among high school athletes and to compare those to diet, injury history, and sport. The sample included female athletes from a variety of sports (N=33) ages 13-17. Participants completed a survey that assessed knowledge levels, reported sport and injury history. Diet was assessed through a three day food diary that looked at serving sizes of dairy, non-fat dairy, and fruits and vegetables. Lack of food diary responses limited comparisons of knowledge to just sport and injury history. Small sample size resulted in little statistical significance. Only one question, which addressed the definition of low energy availability, had a statistically significant number of responses among the whole population. Overall, most questions had low numbers of responses. Very low knowledge levels were expressed among the total population, however, athletes participating in soccer showed higher levels of knowledge, as well as athletes that had experienced fewer sports related injuries.

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Introduction

Between the 1988-1989 and the 2007-2008 school years, female athlete participation in high school athletics increased 65.9% from 1.84 million to three million (Rauh, 2010). Many benefits can be gained for girls from sports participation; a study of ninety nine female high school athletes indicated that year round participation in structured weight bearing sports during early adolescence might help young girls enhance bone health (Nichols, 2007). However, there also can be a high risk of injury due to many factors, including components of what is known as the Female Athlete Triad. The Female Athlete Triad is the combination of low energy availability due to disordered eating, menstrual irregularity, and low bone density. Until it was found too specific, the definition of the triad was eating disorders, amenorrhea, and osteoporosis. The difference between disordered eating and eating disorders is that disordered eating can include eating disorders as well as irregular eating habits without a psychological factor. Osteoporosis and amenorrhea were both also generalized to include other diseases and disorders of their nature.

A main danger of the Female Athlete Triad is that it can lead to many serious musculoskeletal injuries. While bone health has been shown to improve with year round participation in weight bearing sports (Nichols, 2007), other factors can contrarily contribute to a decrease in bone health. Some athletes may face more than one of the components of the triad, but as soon as only one develops they are at risk for the other two (Thein-Nissenbaum, 2011). In a 2006 study of 170 female athletes, the prevalence of the full Female Athlete Triad was low; however a substantial percentage of the athletes may have been at risk for long-term health consequences associated with disordered

eating, menstrual irregularity, or low bone mass (Nichols, 2006). In a 2010 study of 163 high school female athletes, it was shown that musculoskeletal injury was associated with disordered eating, menstrual irregularity, and low BMD (Rauh, 2010).

Bone mineral density (BMD) is the density of minerals in a person's bones measured by using an x-ray. Adolescence is an important period for bone development. The results of a study of 127 female long distance runners from ages eighteen to twenty six showed that risk factors for stress fractures include previous stress fractures and low bone density (Kelsey, 2007). Because BMD is a strong factor in avoiding musculoskeletal injury, greater participation in sports could possibly decrease the risk of injury. Female adolescent athletes of a similar chronological and menstrual age that participated in weight-bearing sports for approximately nine or ten months a year, on an average of two hours a day four to five days a week, were shown to have a greater BMD than athletes participating less than five months a year, indicating a positive impact on bone health due to sports participation (Barkai, 2007).

Particular vitamin intake is also key to bone health and preventing the Female Athlete Triad. High intakes of calcium, dairy products, and skim milk were related to lower rates of stress fractures (Nieves, 2010). Higher fruit and vegetable intakes may have positive effects on bone mineral status in both younger and older groups, especially in the spine and femoral neck (Prynne, 2006). Calcium and Vitamin D intakes were found to reduce stress fractures among female navy recruits by twenty percent (Lappe, 2008). Disordered eating can cause low energy availability, which can qualify as either an eating disorder or as a diet that lacks important vitamins and servings. Certain ethnic groups of female athletes, Caucasian and Hispanic, have been shown to be at a high risk for the

development of disordered eating (Pernick, 2007). Additionally, low energy availability can be a main cause of menstrual irregularity, which can later cause low bone mineral density. Athletes who have displayed menstrual irregularity have shown a higher occurrence of musculoskeletal injury (Thein-Nissenbaum, 2012).

Despite evidence that athletes have a higher knowledge of nutritional information, there is no evidence that this has a positive influence on the athlete's health (Raymond-Barker, 2007). Education on the Female Athlete Triad has been repeatedly recommended for both the athletes and the coaches. Screening for the risk and knowledge of the triad and its effects before the beginning of a sports season could be an effective way of increasing awareness (Brown, 2014).

Due to these various findings of past studies, this study focused on what high school athletes know about how different components of the Female Athlete Triad are related, and how that knowledge compares to certain demographics like injury occurrence, sport, and school. It is hypothesized that there will be a considerably low knowledge level among the athletes, particularly with those with a high amount of sports related injuries.

Methodology

The participants of the study were contacted through the Athletic Departments of the schools where the study took place. Only high school students were included; any middle school students playing for a varsity team were excluded. The participants took part in different sports, in which they stayed separated for the study. An opt out form was distributed to each athlete.

A survey which looked at knowledge of different components of the female athlete triad was distributed to each of the teams. The survey looked at school district and sport played in order to compare their knowledge levels to what school the athlete attended and to what sport they participated in. The survey also asked for an injury history, in which the athletes had to record all sports related injuries, what sport it occurred in and when it occurred. The injury occurrence would be compared to knowledge level by examining each range of number of injuries and answers to the survey questions. A preliminary version of the survey was administered to two teams, in which the questions were written responses. Due to difficulties in analyzing the free response data, the teams that participated in the survey at a later date completed a different version with the questions in multiple choice format. An example of one of the questions asked is:

What causes low energy availability?

- a. The athlete consumes too many carbohydrates.
- b. The athlete does not sleep enough.
- c. There is an imbalance between the exercise and the nutrition.
- d. The athlete has iron deficiency.

For the statistical analysis of the survey answers, a chi-square test was used because many studies similar to this one used the same test. The expected outcomes were determined from answers to similar surveys from previous studies (Brown, 2014 & Simpson, 1998).

The teams who took the second version of the survey were asked to complete a three day food diary, similar to that of the one used in a study aiming to identify the nutrients, foods, and dietary patterns associated with stress fracture risk and changes in bone density (Nieves, 2010). They were asked to record the amount of fruit and vegetables servings, dairy products servings, and nonfat dairy products servings for each day. Along with the food diary, the athletes were given a list of examples of serving sizes of each category [Table 1]:

<p>Fruits and Vegetables:</p> <ul style="list-style-type: none"> ➤ ½ cup of raw fruit ➤ 1 small Banana, orange ➤ ½ large banana, orange, grapefruit ➤ 16 grapes ➤ 1 large plum ➤ ½ apple ➤ ½ pear ➤ ½ cup of raw or cooked vegetables ➤ ½ large bell pepper ➤ 1 large celery stalk 	<p>Dairy Products (Excluding Non-Fat Products):</p> <ul style="list-style-type: none"> ➤ 1 cup of milk ➤ 1 cup yogurt ➤ 2 oz. processed cheese ➤ 1/3 cup of shredded cheese ➤ 1 cup frozen yogurt ➤ 1 ½ cup ice cream 	<p>Non-Fat Dairy Products:</p> <ul style="list-style-type: none"> ➤ ½ nonfat frozen yogurt ➤ 1 cup low fat or skim milk ➤ 1 oz. low fat cheese
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Table 1: Food Servings

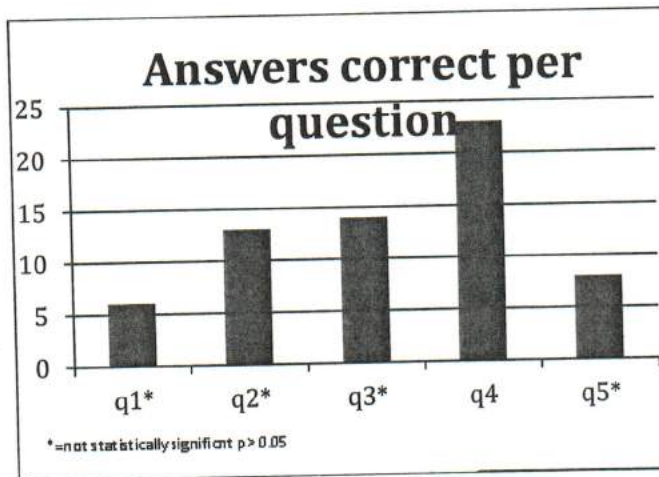
After completing and returning the first food diary, during the middle of the season, they would receive an educational pamphlet on the female athlete triad from the Female Athlete Triad Coalition (femaleathletetriad.org), and then would be asked to complete the same food diary and survey again. The results of the food diary for each category before and after the educational pamphlet would then be compared, as well as the knowledge levels based off of the results of the survey before and after the educational pamphlet.

The data would be analyzed to compare knowledge to sport, knowledge to injury occurrence, average serving size to food diary category, and knowledge level before and after the educational pamphlet.

Data/Results

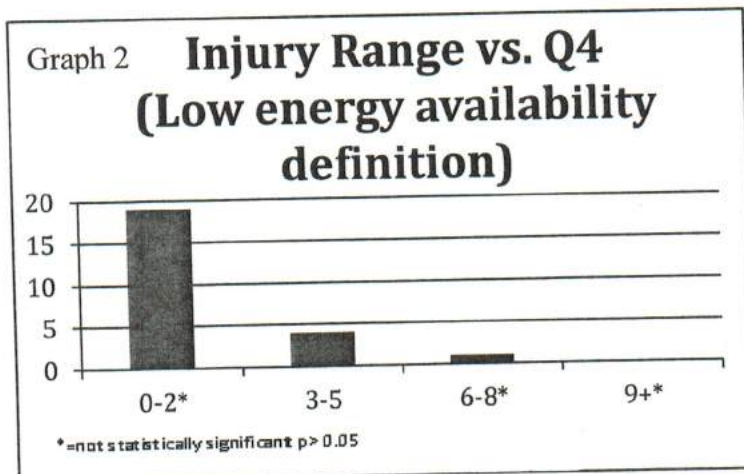
The final number of the sample size was 33 with an average age of 15.48. Basketball had 11 participants (33.33%), soccer had 17 participants (51.51%), Cross country had 2 participants (6.06%), and track had 3 (9.09%). 25 athletes had 0-2 sports related injuries, 6 athletes had 3-5 sports related injuries, 1 athlete had 6-8 sports related injuries, and one had over nine.

For the population as a whole, question 4, regarding the definition of low energy availability, showed the only statistically significant number of correct responses [Graph 1].

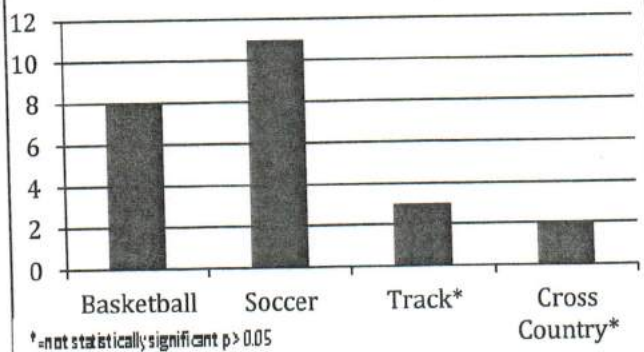


Graph 1:

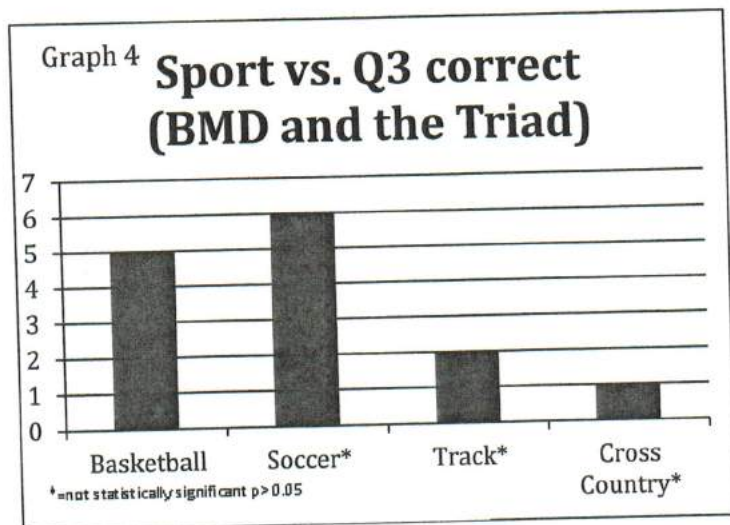
This graph shows the total number of correct responses based on each question. However, question 4 was the only statistically significant value with $p=0.0023$.



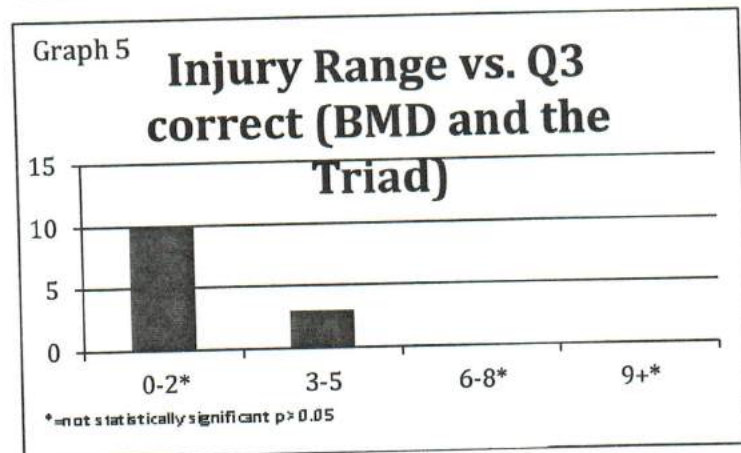
Graph 3 Sport vs. Q4 correct (Low energy availability definition)



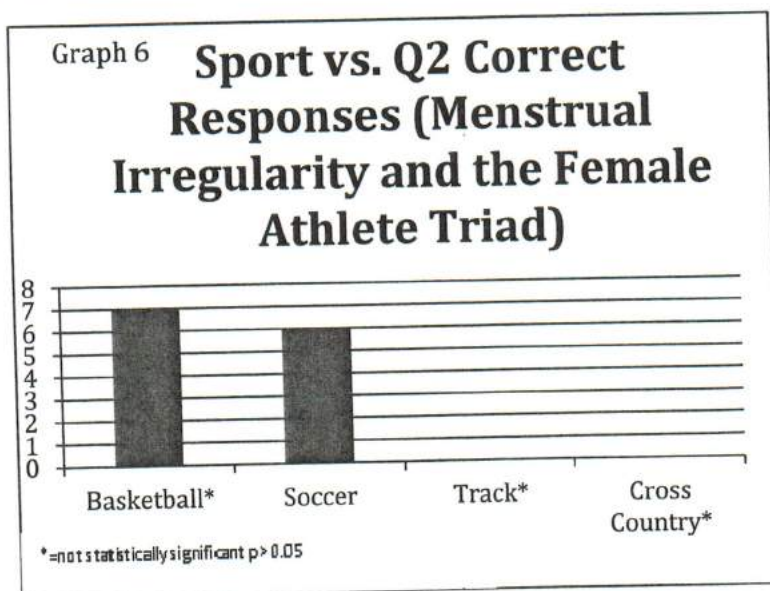
The number of correct responses to question 4 were statistically significant amongst



athletes that had experienced 3-5 sport related injuries ($p=0.0047$) and athletes that participated in soccer ($p=0.045$) and basketball ($p=0.022$). [Graph 2, 3]



Question 3, regarding the relationship between bone mineral density and the Female Athlete Triad, saw a statistically significant number of responses among athletes with 3-5 injuries of 3 ($p=0.0028$) and those who participated in basketball of 5 ($p=0.021$). [Graph 4, 5]

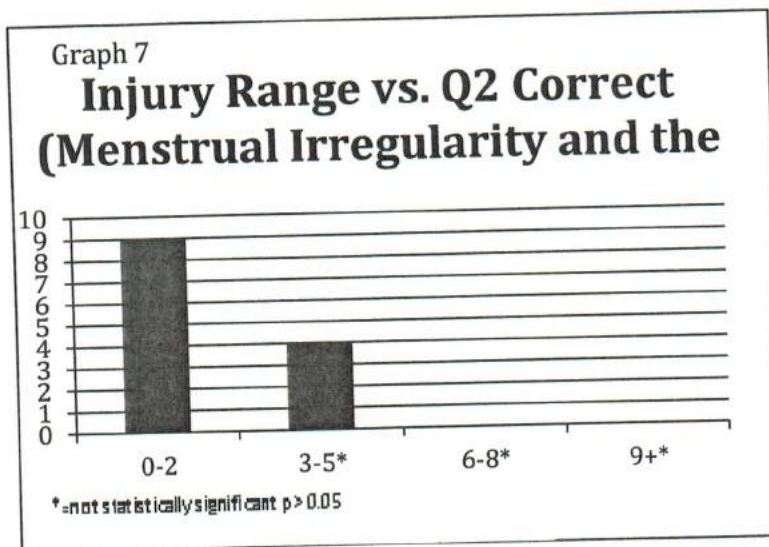


Athletes that played soccer and had 0-2 injuries had statistically significant responses to question 2, regarding menstrual irregularity and its relationship to the Female Athlete Triad, with $p=$

0.0004 and $p=0.0071$, respectively. Nine athletes with 0-2 sport related injuries correctly responded, and 6 soccer players correctly responded. [Graph 6, 7]

For sample size reasons, athletes that participated in track and cross country and athletes that had 6-8 or 9+ injuries showed no statistically significant results.

Due to the lack of returned food diaries that portion and the educational portion were omitted from the study, the only comparisons to be made were knowledge vs. sport and knowledge vs. injury history.



Conclusion

The results from the survey responses showed the most statistically significant number of responses among soccer players. However, overall there was a low number of correct responses, indicating a low knowledge level among the high school population. Athletes with fewer injuries showed to have higher knowledge of the female athlete triad and its individual components, which supported the hypothesis.

Discussion

My results supported the hypothesis that an issue that so closely affects female

athletes is not widely known among the actual participating athletes. This should call for more education among high school teams as well as teams at other levels. Information gathered from my study and ones like it could be used for education of individual athletes and teams (Brown, 2014). A quick way to address the issue of knowledge would be educating coaches, who would then assess the knowledge of their athletes at the beginning of the season (Brown, 2014).

Something as simple as informing athletes of the dangers of the triad can prevent many injuries and participation time lost, and save money spent on surgeries and physical therapy. A stress fracture, which is very closely associated with the Female Athlete Triad can take up to six weeks of treatment for most bones, this time lost could easily be prevented with education (Fullem, 2000).

During and after the experiment several issues were apparent that could have been improved upon; those that were discovered while the study was taking place were modified to address the problems. An initial issue of the study was the formatting of the survey, which at first asked the participants to write in their responses. The problem with this was that it would be difficult to gauge a uniform level of knowledge from original answers, thus making it difficult to perform statistical analyses. To address this issue, the survey was changed to a multiple choice format. Another problem that was faced was the lack of food diary responses due to lack of interest and incentive to complete the paperwork. This was addressed by modifying the study and selecting different particular variables to compare.

In this study, sample size became an issue and caused problems with the statistical significance of the results. Initial numbers of participants were approximately in the 60-

70 range, but the final count resulted in lower numbers in the 30-40 range. Some suggestions for future study would be to enforce the completion of the food diaries more strictly and have a larger sample size overall.

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