Energy Availability, Menstrual Function, and Bone Mineral Density in Pennsylvania Cross Country Teams – Is the Prevalence of The Female Athlete Triad a Result of Purely the Nature of the Sport or the Intensity Level at Which One Competes?

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**Abstract**

This study sought to determine if the occurrence of the Female Athlete Triad and its components were prevalent in NCAA Women’s Cross Country across all divisional levels (I,II,III) or if the components of the Triad occurred in one division more than another. The study compared the prevalence of risk factors for the Female Athlete Triad amongst NCAA Division I, II, and III women’s cross country teams in Pennsylvania using a survey assessing risk factors for the condition. The results of the study were found to be not significant. Therefore, risk factors for the Female Athlete Triad were not more prevalent in Division I cross country as compared to Division II and Division III cross country.

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**Definition of the Female Athlete Triad**

In 1992, the American College of Sports Medicine (ACSM) defined the Female Athlete Triad as an interrelationship of disordered eating, amenorrhea(abnormal absence of menstruation) and osteoporosis (a medical condition in which the bones become brittle and fragile) (Nattiv et al., 2007). These conditions were often seen in females who participated in activities where a lean physique was valued. In 2007, the ACSM published a new set of criteria to define the Female Athlete Triad, referring to the components of the triad as an interrelationship among energy availability, menstrual function, and bone mineral density. These three components may then clinically manifest to pathological/clinical endpoints that include the development of eating disorders, functional hypothalamic amenorrhea, and osteoporosis (Nattiv et al., 2007).

There have only been two studies of collegiate female athletes that have investigated the simultaneous occurrence of disordered eating, menstrual disorders, and low BMD. One of these studies found that 2.7% of females in seven different collegiate sports are suffering from all three components of the triad(Nattiv et al., 2007). Another study found the prevalence of the entire triad in 4.3% of athletes representing 66 diverse sports (Nattiv et al., 2007). It is important to note that both of these studies defined the triad more narrowly than does the ACSM, meaning that there are likely many more female athletes who do fit the criteria of having the complete triad who should be included in future results of studies assessing for all three triad components in female athletes (Nattiv et al., 2007). There is evidence of an increased incidence of the triad components in women participating in lean sports, and these include those sports that highly involve endurance (distance running), weight class (wrestling), and aesthetic sports (figure skating, ballet) (Mountjoy, 2014).

The Female Athlete Triad should be viewed as an inter-related spectrum of the three conditions, where those affected are distributed along a sliding-scale for each condition. Each component of the Female Athlete Triad has the potential to follow a continuum of healthy, subclinical, and pathological end points (DeSouza et al., 2014). When a female is healthy, each component of the triad is optimized--she has optimal energy availability, optimal bone health, and eumenorrhea (normal/regular menstruation). As the continuum of conditions moves along to a subclinical point, the conditions become more threatening to one’s health­ - a female has reduced energy availability with or without disordered eating, low bone mineral density, and menstrual irregularity. Studies have shown significant health consequences of the triad associated with the subclinical/less severe conditions (DeSouza et al., 2014). At the pathological end point, the conditions of the triad are most severe, resulting in low energy availability with or without an eating disorder, osteoporosis, and functional hypothalamic amenorrhea (Nattiv et al., 2007).

The Female Athlete Triad is unique in that its components are intimately inter-related to one another. The central concept of the triad is energy availability,making energy replacement a crucial interventionin stopping the progression of the triad components to all of their pathological/clinical endpoints (Mountjoy, 2014; Javed, Tebben, Fischer, and Lteif, 2013). To replace depleted energy stores in the body, female athletes must eat a well-balanced diet consisting of carbohydrates, proteins, and fats. A deficiency in energy availability associated with disordered eating can play a causal role in the development of menstrual disturbances. Similarly, an energy deficiency associated with a hypo-estrogenic environment caused by amenorrhea plays a causal role in low bone mineral density (DeSouza et al., 2014). Energy availability affects bone mineral density both directly via metabolic hormones and indirectly via the effects on menstrual function and estrogen (Nattiv et al., 2007). Elite female athletes who train intensely are at a high risk for developing hypothalamic amenorrhea, and this is due primarily to inadequate energy intake. The effects of this menstrual dysfunction can place a female’s body into a chronic estrogen-deficient state, and when this is combined with low intake of calories and micronutrients, the body begins to lose bone mineral density (Mountjoy, 2014).

It must be noted that many females experience only one or two components of the Female Athlete Triad without meeting complete triad criteria and will present as such in a detailed medical history and physical examination taken by a health care clinician (DeSouza, et al., 2014; Javed et al., 2013). Similarly, those females reaching the pathological end of a certain condition (disordered eating, amenorrhea, osteoporosis) may not exhibit all of the clinical conditions simultaneously (Nattiv et al., 2007). For example, a female’s energy availability is able to fluctuate within a single day, but the effect of energy availability on menstrual status may not become evident for a month or more, with the resulting effects on bone mineral density not being detectable for a year (Nattiv et al., 2007). A female who is at risk, or who is already experiencing any one of the conditions of the Female Athlete Triad, should be evaluated for all three components (Javed et al., 2013).

The ACSM recommends a multidisciplinary treatment for the Female Athlete Triad. The treatment team should include a healthcare provider, a registered dietician, and, for those struggling with disordered eating/eating disorders, a mental health professional (Nattiv et al., 2007). For those female athletes who are struggling with the triad components which have not yet reached their clinical endpoints, early intervention is essential in preventing a progression to the more serious health consequences of clinical eating disorders, amenorrhea, and osteoporosis(Nattiv et al., 2007). Currently there are no guidelines for clearance and return to play of the athlete struggling with the Female Athlete Triad. Many athletes who actively have the triad are being cleared at their pre-participation evaluation to continue participation in athletics because of inadequate assessment protocol and unstructured follow-up(DeSouza et al., 2014). This is important because without intervention by healthcare providers to initiate necessary changes into the lifestyle of an athlete who has the Female Athlete Triad, her condition is likely to progress to clinical endpoints of the disease. This can severely disrupt both the female’s athletic performance and overall health and future wellness of her body.

**Screening for the triad**

The most optimal time to screen female athletes for the triad is annually at the pre-participation physical exam (PPE), in addition to successive health checkups (DeSouza et al., 2014; Javed et al., 2013; Nattiv et al., 2007). The Female Athlete Triad Consensus Panel, which consists of a group of representatives from numerous universities, organizations, and medical fraternities recommends a series of eleven questions for inclusion in the current PPE to screen for the triad(DeSouza et al., 2014). These questions are as follows:

1. Have you ever had a menstrual period?

2.How old were you when you had your first menstrual period?

3.When was your most recent menstrual period?

4. How many periods have you had in the past 12 months?

5.Are you presently taking any female hormones (estrogen, progesterone)

6. Do you worry about your weight?

7. Are you trying to, or has anyone recommended that you gain or lose weight?

8. Are you on a special diet or do you avoid certain types of food or food groups?

9. Have you ever had an eating disorder?

10. Have you ever had a stress fracture?

11. Have you ever been told that you have low bone density (osteopenia or osteoporosis?)

(DeSouza et al., 2014, p. 3).

These questions are sensitive for identifying at-risk athletes requiring further investigation, and they encompass all components for the Female Athlete Triad (Mountjoy, Hutchinson, Cruz, & Lebrun, 2008). The above questionnaire is very much the “gold-standard” for triad screening.

Currently, the standard PPE includes only nine questions that are related to the Female Athlete Triad, and studies have found that upwards of 90% of universities do not use a standardized PPE form (Javed et al., 2013). Mencias, Noon, and Hoch (2012) found that PPE forms used by Division I universities may not effectively screen for the triad and have a limited ability to identify athletes at risk. Though 100% of the universities participating in their research study did require a PPE for incoming athletes, more than half of the schools were using forms missing more than 50% of the recommended screening items for the Female Athlete Triad(Mencias et al., 2012). In addition, the study by Mencias et al. (2012) found that only 32% of the universities required an annual PPE for returning athletes – leaving those female athletes who develop risk factors for the triad after their freshman years vulnerable to progress undetected throughout their sporting careers. In general, the studies note the screening practices for the Female Athlete Triad are insufficient, as is the education to coaches, athletes, and health care providers to identify those females suffering from the Triad in secrecy, and regarding treatment protocol.

**Low energy availability and disordered eating in female athletes**

The ACSM places energy availability on a spectrum from optimal energy availability to low energy availability, with or without an eating disorder (Nattiv et al, 2007, p. 1868). Experiments have shown that dietary restrictions increase a person’s hunger, but the same amount of energy deficit produced by exercise does not. This reveals that low energy availability can occur inadvertently in female athletes without clinical eating disorders, as well as in athletes who do not practice disordered eating or dietary restrictions (Nattiv et al., 2007). Energy availability refers to the amount of dietary energy that is remaining after both exercise and all other physiological functions each day(DeSouza et al., 2014). The remaining calories should be used for activities of daily living including bone growth, reproduction, recovering from training, cognitive function, and cardiovascular function(Mountjoy, 2014). When the body is left in a state of low energy availability, its mechanisms will attempt to maintain body weight at the cost of reducing resting energy expenditure. Though a superficial energy balance is maintained that allows for a female athlete to athletically perform at a high level for a period of time, her body is inevitably stripped of having the complete positive effects of normal cellular maintenance, growth, and reproduction(Javed et al., 2013). Low energy availability plays a causal role in the development and onset of menstrual disturbances associated with exercise, disrupts reproductive function, and negatively impacts both musculoskeletal and cardiovascular health (DeSouza et al., 2014) (Mountjoy, 2014).

Being an athlete in certain sports often comes with an increased pressure to align with a distinct appearance characteristic to that sport. Studies have found that 25% of female athletes participating in endurance sports, aesthetic sports, and weight-class sports had clinical eating disorders as compared to 9% of the general population(Nattiv et al., 2007). Picard (1999) found that these athletes have a greater tendency toward eating disorders than either non-athletes or sports without leanness restrictions. This research shows that athletes participating in sports emphasizing leanness are more prone to participating in unhealthy behaviors that can lead to the development of the Female Athlete Triad. Picard’s (1999) study has also shown that Division I female athletes were more likely to display certain personality traits that are also common in people who are struggling with eating disorders including high self-expectation, competiveness, perfectionism, drive, self-motivation, and feelings of an intense pressure to be slim and perfect(Picard, 1999, p. 584).

Clinical eating disorders sometimes exemplified by female athletes include anorexia nervosa, bulimia nervosa, and eating disorders not otherwise specified (EDNOS). EDNOS are subclinical eating disorders, for which the symptoms of anorexia nervosa and bulimia nervosa are only partially met (Thompson, 2007). Thompson (2007) found that previous or current eating disorders were reported by 19.4% of female collegiate cross country runners. Thompson, Smith, and DiGioacchino (2004) assessed 300 Division I, II, and III female collegiate cross country athletes’ risk of subclinical eating disorders and found that risks for these disorders were significantly higher in Division I female athletes than DIII female athletes.

**Menstrual dysfunction in female athletes**

The ACSM refers to a spectrum of menstrual period status ranging from eumenorrhea (healthy, normal menstrual period) to amenorrhea. Among long-distance runners, prevalence of secondary amenorrhea, which occurs when a woman who has been having normal menstrual cycles stops getting her periods for 6 months or longer, has been reported as high as 65% compared to 2-5% in studies of the general population(Nattiv et al., 2007). Studies have also reported amenorrhea or oligomenorrhea, infrequent menstrual periods, in 23% of NCAA Division I, II, and III female collegiate cross country runners(Thompson, 2007; Thompson et al., 2004). Training duration has been found to correlate with menstrual dysfunction. Amenorrhea incidence increases from 3%-60% as training mileage increases from running fewer than eight weekly miles to more than 70 miles per week(Javed et al., 2013). Studies have also demonstrated that as many as 22% of “lean” sport athletes admitted that they would not seek treatment for amenorrhea, as compared with 3.2% of athletes in non-lean sports(Javed et al., 2013).

The physiological end point of menstrual dysfunction in the Female Athlete Triad is Functional Hypothalamic Amenorrhea, which is a functional disruption of gonadotropin-releasing hormone (GnRH) and luteinizing hormone (LH) pulsatility and secretion that must occur in order for a female’s body to have regular menstrual cycles(Nattiv et al., 2007). The incidence of Functional Hypothalamic Amenorrhea has been reported to be as high as 65% in distance runners(Mountjoy, 2014). When a female athlete enters into an energy deficient state, the hypothalamic-pituitary function is altered in order to allow for essential physiological mechanisms to continue (Javed et al., 2013). This means that an abnormal loss of regular menstrual cycles can cause an increase in hormones that results in an energy conservation state in the body, thereby compromising other normal bodily processes as well (Javed et al., 2013). The consequences of menstrual dysfunction include dependent arterial vasodilation, which reduces the delivery of oxygen to working muscle, impaired skeletal muscle oxidative metabolism, vaginal dryness, and a relative risk for stress fractures two to four times greater than eumenorrheic athletes (Mountjoy, 2014).

**Bone mineral density in female athletes**

The ACSM refers to a spectrum of BMD ranging from optimal bone health to osteoporosis in the Female Athlete Triad (Nattiv et al., 2007). A systematic review of studies found that the prevalence of osteoporosis ranges from 0%-13% in female athletes compared to 2.3% -12% in a normal population distribution(Nattiv et al., 2007). Proper assessment of a female athlete’s BMD reflects her working history of energy availability, menstrual status, genetic endowment, and nutritional, behavioral, and environmental factors (Nattiv et al., 2007).

Studies have shown that bone formation is impaired within five days of the onset of low energy availability in healthy, sedentary women, and that extreme measures to restrict the availability of usable energy in the body causes a disconnection between the actions of bone remodeling and resorption(Javed et al., 2013). Bone stress injuries are more common in female athletes with menstrual irregularities and/or low BMD (Desouza et al., 2014). However, the onset of amenorrhea does not cause osteoporosis immediately- skeletal demineralization will occur and move a female athlete towards the pathological end of the spectrum(Nattiv et al., 2007). Restoring regular menses will begin to improve BMD in an amenorrheic athlete, but it is important to note that BMD is not fully reversible(Nattiv et al., 2007).

Bone stress injuries often result from chronic, repetitive training and can range from a stress reaction to a fracture involving the cortex of a bone(Mountjoy, 2014). In Thompson et al.’s (2004) study of 300 NCAA Division I-III female collegiate cross country runners, 24% reported having a stress fracture. Some data has shown that endurance runners have lower BMD as compared with other athletes such as sprinters, basketball players, and gymnasts(Joffe, 2016). However, evidence also exists that has shown weight-bearing exercises to be osteo-protective, particularly if the motions are repetitive, such as in distance running(Javed et al., 2013).

Both low energy availability and hypoestrogenism due to menstrual dysfunction have independent and cumulative effects on bone health in female athletes. In studies comparing BMD and bone microarchitecture among amenorrheic, eumenorrheic, and non-athletes, it was found that increasing the duration of amenorrhea results in a steeper loss of BMD, as well as lessens the positive impact that exercise has on skeletal health(Javed et al., 2013). A combination of low BMD and a reduced number of menstrual cycles has been associated with a prolonged recovery period for female athletes who become injured(Mountjoy, 2014).

**Pressure to perform and its relation to the health of female athletes**

Female athletes often derive a large component of their self-worth from their perceived athletic competence. Saint-Phard, Brent, Marx, and York (1999) found that there was a direct correlation between perceived athletic competence and self-worth for collegiate female athletes. Saint-Phard et al. (1999) also found that elite female collegiate athletes actually have lower self-esteem than female non-athletes.

The desire to succeed and align with bodily appearance expectations as competition level increases often drives female athletes into unhealthy behaviors. The study by Thompson et al. (2004) has shown that NCAA Division I female collegiate cross country runners athletes spent significantly more time exercising weekly (11 hours/week) than DII or DIII female runners (8 hours/week). The research performed by Thompson et al. went on to find that DI female cross country runners valued exercise and a controlled training regimen more, tied more of their personal identity to exercise, and reported enjoying competition more than DII or DIII female runners. The study concluded by finding that Division I female collegiate runners were at a higher risk for developing subclinical eating disorders than the other divisions(Thompson et al., 2004). A different study by Christy Picard (1999) that specifically examined eating attitudes among a sample of NCAA DI, DII, and non-athletes found that athletes at higher levels of competition showed more signs of pathological eating and were at an increased risk for the development of eating disorders. Higher subjective levels of competiveness, pressure to perform, and prevalence of a drive for thinness were reported amongst Division I athletes than those competing in DIII(Picard, 1999).

This research study will survey members of female cross country teams about each athlete’s personal experiences with any of the three aspects of the Female Athlete Triad. The following criteria of schools in Pennsylvania will be used: NCAA DIII University, NCAA DII University, and NCAA Division I University. This study hypothesizes to find that there will be the highest prevalence of aspects of the triad in Division I cross country, second most in Division II, and third most in DIII cross country. This is based on the above research that Division I female runners have been found to display characteristics of disordered eating at a higher occurrence than Division III female runners (Picard,1999). Division I female runners have also been found to spend more time exercising than female Division II or Division III runners, as well as experienced increased competiveness and related more of their personal identity to their success in the sport (Thompson, et al., 2004). Division I female cross country athletes also must often perform at a more advanced level than Division II or Division III runners, due in part to increased monetary resources being dedicated to scholarships and other resources for the athletic departments at Division I institutions (NCAA,2016).

**Methods**

**Participants**

A total of 43 female collegiate cross country athletes took the survey used in this study. A total of 18 athletes were from a single team at a Division I institution, 13 athletes from a Division II institution, and 12 athletes from a Division III institution. The participants were invited to be included in this study through email. A total of 11 of the athletes (26%) reported participating in cross country for 1-3 years, 15 athletes (35%) participating for 4-6 years, 10 athletes (23%) participating for 7-9 years, and 7 (16%) athletes participating for 10-12 years.

**Materials**

An online survey was created using the suggested Female Athlete Triad screening questions from the Pre-Participation Physical Evaluation. These screening questions were prepared and recommended for use by the 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad (DeSouza et al., 2014). The beginning survey questions determine the grade of the survey taker, the number of years she participated in cross country, if she ever obtained “varsity” status (placing within the top 7 on team) in college cross country, and the division level of her school. The survey then included two specific questions for each of the three Triad components aiming to determine if a survey taker demonstrated a known risk factor for each component. The survey was created for use in an online format using Google Forms. The survey was used to provide this study with numerical data showing the total number of risk factors for the Female Athlete Triad condition each athlete on her respective team reported to experience.

To obtain participants, I personally contacted the head coaches at each institution involved in the study. When both the head coach and the Institution’s IRB approved my research, the link to the survey, along with a description of how to complete it and what the results would be used for, was e-mailed to the head cross country coach of the institution, accompanied by directions to request the survey’s distribution to their female cross country team via email from the head coach for team members to then voluntarily take by following the provided link.

**Design and procedure**

Participants who chose to take the survey would click on the email link, bringing them to the survey located on Google Forms. The participants would answer the 11 multiple choice yes or no questions. The total time to take the survey varied individually but lasted less than five minutes for each participant. Each female athlete involved in this study took identical surveys and completed the surveys individually and voluntarily answered each question.

**Results**

Alpha was set at .05. A 1-way ANOVA was run on the total Female Athlete Triad score to compare the three athletic divisions, and the results were found to be not significant; *F* (2,40) = .80, *p*=.454. Results from the survey question regarding female hormones and proper period regulation (Question #11) was removed due to insufficient numbers of responses to the question. Refer to Table 1 for means.

A 1-way ANOVA showed that there was no significant difference in mean past participation years in cross country between the three divisions; *F* (.2, 40) = .18, *p*=.839. Pearson’s correlation was run to compare past cross country participation years and total risk factors for the Female Athlete Triad; *r* (41) = + .272, *p*= .078, which was not significant but revealed a “trend” with a 92% confident positive relationship.

**Table**

Table 1: Mean Female Athlete Triad Score as a function of Division for Cross Country Athletes

Division

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

F. A. T. Score I II III

M 1.8889 2.0769 1.5000

SE .29024 .34828 .26112

**Discussion**

The results of this study display that there was no significant, measureable difference of risk for the Female Athlete Triad amongst the three divisions of female collegiate cross country runners studied. Therefore, the Female Athlete Triad was not found to be prevalent in a certain division level more so than the others. These results fail to support the hypothesis that the Female Athlete Triad would be most prevalent in Division I female collegiate cross country runners as compared to those in Division II or Division III. The study, however, did reveal that each cross country team demonstrated a mean score for an overall risk factor for the Female Athlete Triad, as seen in Table 1. This shows that although evidence was not found supporting the occurrence of the Female Athlete Triad being most prevalent in Division I cross country, survey results demonstrated that the Female Athlete Triad is in existence across all divisional levels of the surveyed teams. This fact contributes to past research that the Female Athlete Triad is shown to manifest in the sport of cross country.

Results of this study also reveal that there was not a significant difference in mean past participation years in cross country between the three divisions studied. This means that each cross country team studied consisted of similar numbers of athletes who have participated in the sport for a similar number of years. When the participants’ answers of their past participation years in the sport of cross country was compared to the total risk factor for the Female Athlete Triad, it is compelling to note that results revealed a near-significant trend demonstrating that as an athlete’s years of participation in cross country increased, so did their risk for having the Female Athlete Triad. This infers that the female runners in this study were more likely to experience the Female Athlete Triad if they have been participating in cross country for more years than their peers who have not been participating in cross country for as long. This idea can demonstrate the possibility that the likelihood of a runner to develop the Female Athlete Triad does not necessarily occur due to the intensity/division level at which a female athlete competes in cross country, but rather as a result of the number of years she has been a competitor in the sport.

There were flaws in this study that may have affected the results. The sample size of this study was small and partial and only represented a very limited percentage of the female cross country teams and athletes currently competing in the NCAA. For this research to be more accurate more teams should have participated in the study. The three cross country teams studied were also not similar in terms of overall school size, competiveness and scoring within respective conference and national levels, and survey response rate. For results to be more accurate, the schools involved in the study must be more similar in these three conditions. Further studies may also attain more accurate results if more than two questions assessing for each of the three risk factors were used to determine the overall risk for the Female Athlete Triad.

Though there were not significant results from this study, past literature has explored important components that served as a basis for this research. The Female Athlete Triad screening questions proposed by DeSouza et al. (2014) was effective in obtaining results from participants in relaying each athlete’s experience with the Female Athlete Triad as used in the survey design of this study. In agreement with the findings of Mountjoy (2014), increased evidence of the Female Athlete Triad was found in the three cross country teams as the sport consists of highly trained endurance athletes. This study, as well as studies by Thompson, Smith, and Dioacchino (2004) and Thompson (2007), found that eating disorders occurred in Division I-III female collegiate runners. The occurrence of amenorrhea and oligomenorrhea was reported by this study as well as those done by Thompson (2007), Thompson et al. (2004), and Mountjoy (2014). Data was reported in this study as well as in Mountjoy’s (2014) study that Division I-III runners report having stress fractures. The results of this study were also inconsistent with results of past studies included in the literature review of this research. Christy Picard’s (1999) study demonstrated that Division I female athletes are more likely to experience characteristics defining eating disorder patients, whereas this study did not find a significant difference between Division I and Division II and Division III female runners’ risk of this aspect of the triad

Past research on the Female Athlete Triad in cross country has mostly consisted of studies using samples of Division I-III runners as a combined group in comparison to a sample of non-athletic females. In research specifically comparing Division I female runners to Division II or Division III runners, prior studies focus primarily on disordered eating. This research is unique in that it compared the three collegiate divisional levels directly against one another, and provided data on the occurrence of the Female Athlete Triad based on all three of its components. This study confirmed that the Female Athlete Triad is affecting collegiate cross country athletes even in small samples and that there may be a relationship between the number of years a female athlete participates in cross country and her risk for developing the Female Athlete Triad. These results are applicable to current athletes, coaches, and athletic departments across the NCAA as well as healthcare providers. All of those involved in the sport of cross country, as well as all other female sports, must be educated about the condition to be able to diagnose and treat those female athletes suffering from the Female Athlete Triad. This education will allow athletes, coaches, athletic departments, and healthcare providers to become aware of the major risk factors and behaviors indicative of the condition. This research provides further insight on where the Female Athlete Triad is occurring and the tendency of the condition to occur in those female runners who have participated in cross country the longest.

Future research can be conducted to expand upon this study. This research did not contain a large sample size of participants, and so forthcoming studies should recruit more teams across all NCAA divisional levels consisting of institutions with varying population sizes and competiveness within their respective conferences. This research also did not include results from middle school, high school, or professional female cross country athletes to discern if any of these groups share notable similar or different occurrence rates of the Female Athlete Triad as compared to NCAA cross country. Further research can be conducted on verifying a trend between the number of years an athlete participates in cross country and the increased risk for developing the Female Athlete Triad. To improve external validity in future version of this study, larger and more diverse sample sizes should be used as well as an increase in number and specificity of risk factor screening questions provided on the survey.

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1. \* Hannah Weber, a student at Saint Francis University, tied for second place in the Delta Epsilon Sigma annual scholarly research undergraduate national writing competition. [↑](#footnote-ref-1)