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The prevalence of risk factors associated with the female athlete triad among Eastern Illinois University female cross country runners

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THE PREVALENCE OF RISK FACTORS ASSOCIATED WITH THE FEMALE ATHLETE TRIAD AMONG EASTERN ILLINOIS UNIVERSITY FEMALE CROSS COUNTRY RUNNERS

(TITLE)

BY

Rachel Renee Snow, ATC

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Eastern Illinois University, 2012

DEDICATION

I would like to dedicate this master's thesis to my strongest supporters and my best friends: my parents, Verlin and Trish Snow, my fiancé, Mitch McFarland, my two sisters, Liz Snow and Jill Bergmann, my brother, Jason Jones, and my grandmother, Mary-Margaret Rusch. I would not have been able to overcome the many obstacles and frustrations I experienced along the way without their continuous words of encouragement and loving guidance. I thank God every day for each of these wonderful people in my life. I would have never achieved my goals without them. I love each of them more than any words could ever describe. I am forever blessed.

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To my parents, grandmother, brother, sisters, and future in-law family – For their love, guidance, support, friendship, encouragement and faith in me throughout the years.

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ABSTRACT

THE PREVALENCE OF RISK FACTORS ASSOCIATED WITH THE FEMALE ATHLETE TRIAD AMONG EASTERN ILLINOIS UNIVERSITY FEMALE CROSS COUNTRY RUNNERS

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Three main components structure the Female Athlete Triad which are, disordered eating, amenorrhea, and low bone mineral density. This could be a dilemma for athletes because the elements of the triad may contribute to major health issues in the future. The purpose of this study was to investigate the prevalence of risk factors associated with the Female Athlete Triad among Eastern Illinois University female cross country runners. Thirteen subjects ranging in age from 18 – 22 years participated in this study. A five part questionnaire was utilized to determine the subject's demographics, exercise history, dietary habits, menstrual history, and skeletal health risk level.

The most significant result from the questionnaire was related to menstrual history. Fifty-four percent (7 of 13) of the subjects were found to be positive for a type of menstrual dysfunction. Primary amenorrhea, secondary amenorrhea, and oligomenorrhea were present in one or more of these athletes. One hundred percent (13

of 13) of the subjects were found to have habits and perceptions of overtraining; this could lead to menstrual dysfunction, stress fractures, or other overuse injuries in the future. Twenty-three percent (3 of 13) of the subjects had experienced a stress fracture while training. Additionally, as a team, the subjects trained seven days per week and had a mean mileage per week (in-season) of 59.64 ± 4.1.

In the dietary habits section, participants were asked approximately how many calories they consumed daily. The mean was 2,500 ± 549.2 kcal/day. Considering the magnitude of training, this caloric intake might not have been sufficient for their energy needs. The subjects were asked a series of questions in regard to disordered eating habits. Fifteen percent (2 of 13) of the subjects were considered positive for the risk factors associated with disordered eating. All subjects were found to be 'low risk' using the skeletal health risk screening instrument.

In summary, 61.5% (8 of 13) of the subjects met risk factor criteria for one component of the Female Athlete Triad. Eight percent (1 of 13) of the participants met risk factor criteria for two components, and none of the participants met risk factor criteria for all three of the components of the Female Athlete Triad. It was concluded that the prevalence of the full triad was not in existence within this population; however, a substantial percentage of the athletes may be at risk for long term health consequences associated with menstrual dysfunction and disordered eating. The data suggested that female cross country intercollegiate athletes may be at a significant risk for menstrual dysfunction. Educational efforts for the prevention of the Female Athlete Triad are recommended.

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CHAPTER I

INTRODUCTION

As the number of women participants in sport proliferates, understanding the factors that leads to the syndrome known as the Female Athlete Triad becomes increasingly important. The Female Athlete Triad is composed of three components: amenorrhea, disordered eating, and osteopenia (Prentice, 2011). It is common for Division I collegiate female athletes to have the pressure to be strong competitors, have the ideal bodyweight, and have the perfect physique for their specific sport (Burrows & Bird, 2000). With intense pressure, athletes may go to great extremes to achieve success and in the process damage their health (Burrows & Bird, 2000). Any female athlete could be at potential risk for developing the triad. While any female athlete could be at risk, those who participate in sports where lower body fat percentages are thought to be beneficial, are known to be at the highest risk (Burrows & Bird, 2000).

Amenorrhea is defined as the absence or cessation of three or more consecutive menstrual cycles (Prentice, 2011). There are three types of amenorrhea which include: primary amenorrhea, secondary amenorrhea, and oligomenorrhea. Research illustrates that the types of amenorrhea seen in athletic women develop because of the combined effects of low body fat, weight loss, insufficient calorie intake, and increased physical activity (Vinci, 1999). Amenorrhea has been previously thought of as the 'normal' response to intense physical training (Kleposki, 2002). Presently, health professionals are starting to recognize the severity of the health complications associated with menstrual dysfunction (Kleposki, 2002).

Disordered eating refers to the spectrum of harmful and irregular eating behaviors used in "a misguided effort to sustain or lose body weight for sport" or also to improve performance (Beals, Brey, & Gonyou, 1999). The spectrum of disordered eating ranges in severity, from mild to critical. Female athletes who develop disordered eating habits often show signs of perfectionism and feel a desire to excel in their sport (Kleposki, 2002). They may also believe a certain body physique is a necessity to succeed as an athlete (Kleposki, 2002).

Osteopenia is the third component of the triad and refers to premature bone loss or insufficient bone formation (Kleposki, 2002). This can increase skeletal fragility and vulnerability of stress fractures. A decrease in bone mineral density and an increase incidence of stress fractures occur from decreased estrogen levels connected with amenorrhea, along with the decreased calcium intake related to disordered eating behaviors (Kleposki, 2002). Amenorrhea, disordered eating, and osteopenia are all interrelated and can be very detrimental to a female athlete's health.

Alone or in combination, the disorders of the Female Athlete Triad can negatively affect the health of athletes and impair performance levels. Consequently, health professionals employed specifically for the care of athletes should be knowledgeable of signs and symptoms of the triad components in order to prevent this dangerous syndrome. Additionally, health professionals and coaches should educate their athletes on the dangers of the consequences of the triad by establishing awareness of the syndrome. If the syndrome remains undiagnosed, the future health complications can be severe and potentially life threatening (Beals, Brey, & Gonyou, 1999). Previous studies suggest what is currently known about the Female Athlete Triad and the prevalence within certain

sport population. The existence of disordered eating has been found to be between 15%-62% of female collegiate athletes in all the different sport populations (Smith, 1996) (Kreipe, 1995). Menstrual dysfunction has been reported to arise between 3%-66% in the intercollegiate athletic population (Smith, 1996) (Thompson, 2007) (Warren & Chua, 2008). Lastly, the frequency of low bone mineral density among the female athletic population is commonly unknown (Smith, 1996) (Nichols, Rauh, Lawson, Ji, & Barkai, 2006).

Purpose of the Study

The purpose of this study was to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among Eastern Illinois University female intercollegiate cross country runners.

Hypotheses

The study was designed to test the following hypotheses:

1. Between 0% - 2% of Eastern Illinois University cross country athletes would show risk factor criteria for all three components of the Female Athlete Triad.

2. Between 5% - 15% of Eastern Illinois University cross country athletes would show signs of risk factor criteria for two out of the three components of the triad.

3. Between 40% - 55% of Eastern Illinois University cross country athletes would show signs of risk factor criteria for one out of the three components of the triad.

Importance of the Study

The importance of this study was to further examine the occurrence of the Female Athlete Triad among Eastern Illinois University collegiate cross country runners. There is currently not a significant amount of research studies that focus on the prevalence of the risk factors associated with all three components of the triad. Furthermore, to the researcher's knowledge, a study regarding the Female Athlete Triad has never been conducted on the Eastern Illinois University's cross country team. This study was unique because of the selection of subjects and also how it studied the prevalence of the risk factor criteria of all three components. The results were beneficial because they lead to education for the female athletes on the cross country team at Eastern Illinois University.

Delimitations

The study was delimited to the following:

1. Subjects were 13 student-athletes enrolled at Eastern Illinois University from the Ohio Valley Conference during the 2011 - 2012 academic school year.

2. The study was delimited to only females in the sport of cross country.

3. Subjects were between the ages of 18 – 22.

Limitations

The study was limited to the following items:

1. Subjects used in this study were a small sample and not necessarily representative of the entire female collegiate cross country runner population.

2. Inaccurate responses could result in a misinterpretation of the overall findings.

Assumptions

The study was conducted with the following assumptions:

1. All student-athletes who participated answered the questions on the survey honestly and to the best of their capabilities.

2. All participants in this study recorded the occurrences of stress fractures truthfully.

3. Coaches permitted athletes to participate in the study.

Definition of Terms

The terms listed below have been defined for the purpose of this study:

Female Athlete Triad: A syndrome categorized by the relationship among three different medical conditions, which are disordered eating, amenorrhea, and osteoporosis (Prentice, 2011).

Amenorrhea: The absence of menstruation (Prentice, 2011).

Primary Amenorrhea: A condition where the female has not experienced any menstrual periods by the age of sixteen (Prentice, 2011).

Secondary Amenorrhea: A condition that occurs when a female was previously menstruating, but then the periods ceased (Prentice, 2011).

Oligomenorrhea: Menstrual cycles where the intervals are greater than 36 days, but less than 90 days; irregular menstrual cycles with less than 6 cycles occurring each year (Cuppett & Walsh, 2005).

Athletic Amenorrhea: An athlete experiencing amenorrhea due to intense physical training (Prentice, 2011).

Menstrual Dysfunction: Includes the irregular menstrual syndromes of: primary amenorrhea, secondary amenorrhea, or oligomenorrhea (Nichols, Rauh, Lawson, Ji, & Barkai, 2006).

Age at Menarche: The age of the female when the onset of menstruation begins (Prentice, 2011).

Disordered Eating: A variety of abnormal eating behaviors, which range from mild food restriction and irregular bingeing or purging to severe conditions of anorexia nervosa and bulimia nervosa (Prentice, 2011).

Anorexia Nervosa: Characterized by an inaccurate body image and a major concern about gaining weight (Prentice, 2011).

Bulimia Nervosa: An individual normally goes through a period of starvation and gorges of thousands of calories, later to purge with induced vomiting or use of laxatives or diuretics (Prentice, 2011).

Eating Disorders Not Otherwise Specified (EDNOS): An individual who does not meet the full diagnostic criteria for anorexia nervosa and bulimia nervosa, yet still exhibit signs of body image disturbances and weight control manners (Beals, Brey, & Gonyou, 1999).

Osteopenia: Bone mineral density (BMD) that is found to be lower than normal peak BMD, however it is not low enough to be classified as osteoporosis (Prentice, 2011).

Osteoporosis: Premature bone loss and low bone mineral density, which results in inadequate bone formation (Beals, Brey, & Gonyou, 1999).

Stress Fracture: An overuse injury that transpires when muscles become fatigued and are unable to absorb added stress. The fatigued muscle transfers the overload of stress to the bone causing a crack within the bone (Prentice, 2011).

CHAPTER II

REVIEW OF RELATED LITERATURE

The purpose of the study was to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among Eastern Illinois University female collegiate cross country runners.

The research literature that is relevant to this study is discussed in this chapter. Included are the following topics: 1) Description of the Female Athlete Triad; 2) Disordered eating in athletes; 3) Consequences of disordered eating; 4) Potential causes of athletic amenorrhea; 5) Detriments of athletic amenorrhea; 6) Osteopenia and osteoporosis in athletes; 7) Probable causes and health complications of osteoporosis; 8) Incidences of the Female Athlete Triad in cross country athletes; and 9) Management and treatment of the Female Athlete Triad.

Description of the Female Athlete Triad

In 1972, the United States passed a law that allowed an equal opportunity in athletics for school-age male and female students known as the Title IX of the Education Amendments Act (Warren & Chua, 2008). The amount of female participation amplified in high school athletics by almost 800% within the last forty years (Warren & Chua, 2008). In 1992, the Female Athlete Triad was defined by the American College of Sports Medicine as an association between the medical conditions of disordered eating, amenorrhea, and osteoporosis (Warren & Chua, 2008).

The Female Athlete Triad consists of three main components: disordered eating, amenorrhea, and low bone mineral density (BMD) or osteoporosis (Boston, 2010). There are numerous health complications this issue can cause if it is not diagnosed early. Most women consider sports participation as a positive experience by providing an enhancement in their health and physical fitness. For some female athletes, the desire to succeed along with the pressure to adhere to an ideal body weight can result in restrictive diets and weight reductions. This causes negative effects on performance level and the health of the athlete (Beals K. , 2000).

Disordered eating has been more prevalent in athletes than compared to the general population for those previous reasons (Putukian, 1994). Disordered eating can lead to an irregular heartbeat, fainting, muscle weakness, fatigue or even loss of concentration in athletic competition or in educational settings (Boston, 2010). Ensuring normal bone mass is extremely important to a female's long term health. Peak bone mass is normally achieved by the age of twenty-five, which after very little bone mass is added (West, 1998). If a female athlete is not developing adequate bone mass, they are at greater risk for a stress fracture (Boston, 2010). The athletes who are in jeopardy of the Female Athlete Triad are those with a low body weight, involved at the elite level, participate in endurance sports, or athletics that place an importance on appearance (Thompson, 2007).

Approximately twenty-one years has passed since the Female Athlete Triad was first acknowledged and described as a syndrome of three interrelated health issues (Nichols, Rauh, Lawson, Ji, & Barkai, 2006). Although there have been numerous reports on occurrence estimates of the individual components, only a few studies have

directly examined the interrelationships of the triad in its entirety (Thompson, 2007) (Nichols, Rauh, Lawson, Ji, Barkai, 2006) (Lauder, Williams, Campbell, Davis, Sherman, & Pulos, 1999) (Cobb, Bachrach, Greendale, & al., 2003).

Though the exact prevalence is unknown, past data has shown the existence of disordered eating to be between 15%-62% of female collegiate athletes (Smith, 1996) (Kreipe, 1995). Amenorrhea has been reported to arise between 3%-66% in this population (Smith, 1996) (Thompson, 2007). Although it is unfortunate that the frequency of osteoporosis among the female athletic population is commonly unknown (Smith, 1996), the severity of menstrual dysfunction seems to be linear with decreased bone mineral density (Joy, Clark, Ireland, Matire, Nattiv, & Varechok, 1997).

A past study conducted in 2006 on high school varsity sports, reported estimates of 18.2% for disordered eating, 23.5% for menstrual dysfunction, and 21.8% for low bone mass, respectively. Although the findings were only 1.2% (two of one hundred and seventy) of the athletes had the full triad simultaneously, 5.9% (ten of one hundred and seventy) met criteria for two components of the triad, and 48.2% met criteria for at least one triad component (Nichols, Rauh, Lawson, Ji, & Barkai, 2006). This study indicates that these three medical conditions can occur as early as adolescence.

Disordered Eating in Athletes

Katz (1986) suggested that intense exercise, such as endurance running, can trigger anorexia nervosa in individuals who are at risk biologically and psychologically for developing disordered eating. The spectrum of behaviors associated with disordered eating range in severity. Behaviors can be reported from moderate food restriction,

consuming diet and/or laxative pills, having intermittent periods of bingeing and purging, to actually meeting the criteria for bulimia nervosa and anorexia nervosa established by *The Diagnostic and Statistical Manual, Fourth Edition (DSM IV)* of the American Psychological Association (Beals, Brey, & Gonyou, 1999) (Smith, 1996). Fortunately, a majority of female athletes do not meet the full diagnostic criteria for anorexia nervosa or bulimia nervosa because the criteria are very strict (Kleposki, 2002). The criteria for anorexia nervosa and bulimia nervosa are illustrated in Table 1 (Kleposki, 2002).

Previous researchers have reported that 15-65% of women who participate in sports with a normal characteristic of a thin build have pathogenic eating behaviors (Thompson, 2007) (Macleod, 1998) (Warren & Shantha, 2000). Rosen at el, found that 32% of a female collegiate athletic population exercised pathogenic weight-control behaviors, and 70% of those athletes felt their practices were harmless to their health and athletic performance (Rosen L. , McKeag, Hough, & Curley, 1986).

Anorexia and bulimia are not the only types of disordered eating athletes can encounter. Eating Disorders Not Otherwise Specified (EDNOS) can account for almost 50% of disordered eating cases (Thompson, 2007). EDNOS can also be known as subclinical eating disorders. EDNOS occurs when a patient suffers from only some symptoms of anorexia or bulimia, so the full criteria for the disorders are not completely met (Thompson, 2007). The main characteristics of a patient suffering from EDNOS are: engaged in excessive exercise, preoccupied with eating, experiences low self-esteem, distorted body image, and depression (Thompson, 2007).

The disordered eating component of the triad creates an imbalance between energy intake and energy the athlete expends through daily exercise (Rangarajan, 2009). In the past, one research study proposed the occurrence can be as high as 62%, depending on the sport (West, 1998). Athletes who suffer from disordered eating may attempt to conceal their symptoms or behavior from friends, family, athletic trainers, or coaches. This is the primary reason why diagnosis can be so complicated (Gottschlich, 2008). The majority of cases are identified only after advanced symptoms become apparent in the athlete (Gottschlich, 2008). Ensuring proper nutrition has been perceived as a key component in preventing many female specific health complications.

Table 1: Criteria for Disordered Eating (American Psychiatric Association)

Bulimia Nervosa

1) Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
    a. Lack of control over eating during the episode. They have a feeling as if they cannot control how much food they consume or they cannot stop eating.
    b. Eating in a short period of time (within a 2 or 3 hour period) the amount of food that is significantly larger than any other person would consume in the same circumstance.
2) Recurrent unsuitable behavior in order to prevent weight gain, such as the misuse of diuretics, laxative, self-induced vomiting, fasting, excessive exercise, enemas, or other forms of medications.

3) Self-evaluation is excessively influenced by body shape and weight.
4) The binge eating and unsuitable behaviors both occur, on average, at least twice a week for three months.
5) The disturbance does not occur exclusively during periods of anorexia nervosa.

Specify Type:

- Non-purging type: during the current episode of bulimia nervosa, the person has not engaged in self-induced vomiting or the misuse of any medication, but they have used other unsuitable behaviors such as fasting or excessive exercise.
- Purging type: the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or any other types of medication.

Anorexia Nervosa

1) The person has the intense fear of gaining weight or becoming fat, even though they are typically underweight.
2) Refusal to maintain body weight at or above minimally normal weight for height and age (Weight loss that leads to less than 85% of the body weight expected or failure to make expected weight gain during stages of growth that leads to less than 85% of body weight expected).
3) Disturbance in the ways that one's body weight or shape is experienced.
4) In post-menarche females, amenorrhea (the absence of at least three consecutive menstrual cycles)

Specify Type:

- Restricting type: during the current episode, the person has not regularly engaged in binge-eating or purging behavior.
- Binge-eating/purging type: during the current episode, the person has regularly engaged in binge-eating or purging behavior.

Eating Disorders Not Otherwise Specified (EDNOS)

The disordered eating behaviors do not meet all of the criteria for anorexia nervosa or bulimia nervosa.

(Diagnostic and Statistical Manual of Mental Disorders, 4th ed., 1994)

Consequences of Disordered Eating

There are known to be certain personality traits countless successful athletes have in conjunction with sports that are also risk factors for disordered eating (Macleod, 1998). Those personality characteristics are: persistence, perfectionism, high self-expectation, and independence (Macleod, 1998). Disordered eating with excessive exercise or over-training is a dangerous mixture (Zeigler, 2011). Health complications associated with disordered eating include, but are not strictly limited to, decreased lean body mass, chronic fatigue, dehydration, anemia, micronutrient deficiencies, decreased bone density, gastrointestinal disorders, and electrolyte imbalances (Beals, Brey, & Gonyou, 1999). Additionally, psychological issues are often correlated with disordered eating such as, anxiety, low self-esteem, depression, and death due to suicide (Beals & Manore, 1994).

When athletes are training intensely, yet restricting their caloric intake, hormonal changes occur in a woman's body (Thompson, 2007). This affects the reproductive system and causes menstrual dysfunction, such as amenorrhea or oligomenorrhea (Thompson, 2007). Consequently, amenorrhea is an energy-conserving mechanism by the body in order to protect more significant reproductive and biological processes (Raymond-Barker, Petroczi, & Quested, 2007). The absence of menstruation cycles removes the protective effects the hormone estrogen has on the skeletal system (Miller, 2003). This results with the female becoming more susceptible to calcium loss and decreases of bone mineral density (Miller, 2003).

Diets low in protein and/or amount of calories and intense exercise have been found to be associated to menstrual dysfunction in the female athlete population (Gordon, 2000). Physically active females with subclinical disordered eating tend to fear the addition of body fat and as an outcome consume inadequate dietary fat (Beals K., 2000). Athletes should be encouraged to consume ample dietary fat, which is at least 10% of energy intake (Beals K. , 2000). It is essential to consume lean meats, monounsaturated fats, and dairy products daily (Beals K., 2000).

Potential Causes of Athletic Amenorrhea

Menstrual dysfunction is the simplest of the three components to recognize and diagnose of the Female Athlete Triad. Amenorrhea is categorized as two types: primary and secondary (Cuppett & Walsh, 2005). Primary amenorrhea is the absence of menstruation prior to the age of sixteen (West, 1998). In contrast, secondary amenorrhea is when a female experiences regular menstruation but then it ceases for at least a three

month time period (Cuppett & Walsh, 2005). The other type is of menstrual dysfunction is oligomenorrhea, and is defined as menstrual cycles occurring at intervals longer than 35 days (Rauh, Nichols, & Barrack, 2010). Athletes, who begin to compete in athletics before the age of menarche, tend to have a higher frequency of amenorrhea (West, 1998). The most extreme forms of menstrual dysfunction are primary and secondary amenorrhea; they have been linked to an increased injury risk and reductions in bone mineral density in the vertebral column (Fruth & Worrell, 1995).

The cause of amenorrhea is the disruptions in the normal signaling processes between the hypothalamus and the pituitary gland (Warren & Chua, 2008). Many contributing factors have been suggested in the etiology of athletic amenorrhea. Contributing factors most frequently cited are a decrease in body fat, weight fluctuations, restricted diet, and stress associated with high or intense training volumes (Warren & Chua, 2008) (Thompson, 2007). Researchers have studied and investigated the processes through which endurance training affects regular menstrual function (Warren & Chua, 2008).

Many competitive collegiate female athletes participate in extensive training sessions and frequently twice a day. During these circumstances athletes can expend over 1,000 kcal, in exercise alone (Block, 1999). Prevalence estimates of menstrual dysfunction among athletes have ranged from 3.4% to 66.0% (Torstveit & Sundgot-Borgen, 2005) (Loucks, 1990). The wide range in percentages may be a result of varying criteria used to define amenorrhea and specific sport populations that were sampled.

A previous study conducted revealed that exercise duration is highly linked with types of menstrual dysfunction (Drinkwater, Nilson, Chesnut, Bremmer, Shainholtz, & Southworth, 1984). This study focused on the number of miles each athlete ran per week. It was discovered that of the athletes who ran less than 10 miles per week, only 6% experienced amenorrhea. Conversely, 43% of the athletes who ran more than 70 miles each week were found to have experienced amenorrhea (Drinkwater, Nilson, Chesnut, Bremmer, Shainholtz, & Southworth, 1984).

Exercise-induced amenorrhea is considered to be a form of hypothalamic amenorrhea (Rust, 2002). Hypothalamic amenorrhea is distinguished by a decreased amount of secretion of the hormone known as 'gonadotropin releasing hormone' (GnRH) from the brain's hypothalamus (Rust, 2002). The important function of the hormone is to stimulate the pituitary gland, which then transmits signals to the ovaries to begin menstruation (Rust, 2002). A reduction in the amount of secretion levels of GnRH are discovered in patients with amenorrhea (Rust, 2002). Previous researchers hypothesized that hypothalamic amenorrhea is not caused by low body fat, or weight, but is more influenced by energy drain from intense training (Otis, 1992).

The prevalence of amenorrhea has been stated as high as 66% in certain athletic sports populations, to as low as 3.4% in others; this is a concern because the general population range is between 2% - 5% (Otis, 1992). The difference in percentages between some athletic and non-athletic population cases may be significant (West, 1998). A former study performed on collegiate cross country runners reported the mean age of menarche to be 13.5 years and the percentages of menstrual dysfunction to be, 5.3% amenorrhea and 17.7% oligomenorrhea (Thompson, 2007).

Detriments of Athletic Amenorrhea

Out of the three components, types of amenorrhea have revealed the strongest relationship to injury and illustrate positive correlations with increased risk of stress fractures in collegiate athletes (Barrow & Saha, 1988) (Nattiv, Puffer, & Green, 1997). One major medical concern of menstrual dysfunction in female athletes is a decrease in bone mineral density and premature osteopenia; however, it can also affect the overall productivity and health of the athlete (Nattiv & Armsey, 1997). The etiology of amenorrhea can depend on several factors which include: age, sport, level of activity, and the nutritional habits (Block, 1999).

Athletes who suffer from amenorrhea typically have a low estrogen level, which is known to be linked to a reduction in bone mass (West, 1998). Estrogen, a hormone associated with menstruation, supports the development of bone mineral density (West, 1998). If estrogen levels are low, this can cause calcium homeostasis to become less effective (West, 1998). Female athletes need to increase their calcium intake to sustain the balance needed (West, 1998).

In recent years, the hormone leptin has been revealed to be an important mediator between reproduction and nutritional status in females (Warren & Chua, 2008). The hormone leptin is secreted by adipose tissue, and the physiological levels of leptin are known to be related to the amount of fat mass (Warren & Chua, 2008). Leptin responds to any changes in caloric intake (Warren & Chua, 2008). Studies conducted have revealed when energy availability is limited, physiological mechanisms decrease the energy used for many bodily processes including reproduction, in order to compensate

for the low amount to energy availability (Wade, Schneider, & Li, 1996). No matter the cause of amenorrhea, health complications are the outcome.

Osteopenia and Osteoporosis in Athletes

The third component of the Female Athlete Triad is low bone mineral density, which can lead to osteopenia or osteoporosis. Osteopenia is a condition where an athlete's bone mineral density is lower than normal; however it is not depleted enough to be classified as osteoporosis (Osteopenia - Overview, 2011). Osteopenia is observed more in the younger population (Gottschlich, 2008). The incidence of osteopenia has been reported as high as 50% and as low as 22% for athletes compared to 12% in the non-athlete population (Gottschlich, 2008).

Osteoporosis is thought to be a condition in the elderly population; however, the amount of bone mineral loss in young female athletes can range from 2% to 6% per year (Yurth, 1995). A possible total loss of almost 25% can occur over four years if an athlete does not have adequate calcium consumption (Yurth, 1995). Also, women have been estimated to be eight times more likely to have osteoporosis during their lives than men, which illustrates that women are already at an increased risk (Prentice, 2011).

Probable Causes and Health Complications of Osteoporosis

Low body weight and amenorrhea are two significant factors that are predictors of osteoporosis (Baker, Roberts, & Towell, 2000). The combination of poor nutrition and menstrual dysfunction harmfully affect an athlete's skeletal system (Thompson, 2007). The combination of a low calcium intake from disordered eating patterns and the decline

in estrogen level associated with amenorrhea, lead to decreased bone mineral density and a rise in occurrence of stress fractures (Kleposki, 2002).

There is evidence that the preadolescent and adolescent years provide a female with the best opportunity to maximize bone strength and mass (Greene & Naughton, 2006). Weight-bearing activity during the growth years can enhance bone mineralization and can lead to a higher peak bone mass in adulthood (Zanker, Osborne, & Cooke, 2004). One reason bone mineral loss is associated with the Female Athlete Triad is because athletes who do not consume enough calories may also not consume adequate calcium to strengthen their bones (Zeigler, 2011).

Calcium is critical for bones, as well as muscle contraction and transmission of nerve impulses. If the calcium intake of the athlete is depleted, then the body will remove calcium from the bones to maintain blood calcium levels (Prentice, 2011). The average daily consumption of calcium should be 1,000 mg; however, approximately 25% of all females in the United States consume only 300 mg of calcium daily (Prentice, 2011). Even when normal menstruation resumes, bone loss is not completely reversible; therefore, low energy availability, menstrual dysfunction, intense exercise training and lack of calcium may lead to premature osteoporosis (Furth & Worrell, 1995).

Previous research studies propose that the bone mineral density lost as an outcome of amenorrhea may be completely, or at least partially irreversible, even with the assistance of estrogen replacement therapy, calcium supplementation, and a continuation of normal menstrual cycles (Drinkwater, Nilsion, Orr, & Chesnut, 1986) (Beals, Brey, & Gonyou, 1999). The bones most commonly affected from osteopenia

and osteoporosis are stress fractures of the lower extremities, pelvis, and vertebrae (Gottschlich, 2008).

Incidences of the Female Athlete Triad in Cross Country Athletes

A former study conducted in 2007, examined athlete's calcium consumption and observed the prevalence of the components, disordered eating and menstrual dysfunction of the Female Athlete Triad in Division I, II, and III NCAA female cross country runners (Thompson, 2007). There were a total of 300 participants from 44 different states and 1 foreign country (Thompson, 2007).

To summarize the results Thompson established, 19.4% reported a previous eating disorder or a current eating disorder, 23% had irregular menstrual cycles, and approximately 29.1% had inadequate calcium intake levels (Thompson, 2007). It was observed that only 50.7% of the athletes who reported amenorrhea or oligomenorrhea consumed the recommended amount of calcium (Thompson, 2007). In all three areas, the cross country athlete population had higher percentages than the general population of women. This can be significant since the syndrome could possibly evolve into something dangerous later in a female's life. The current researcher could not locate a vast amount of former research studies that individually focused on the entire Female Athlete Triad strictly with collegiate cross country athletes, which was the reason this study was inspired.

Management and Treatment of the Female Athlete Triad

Currently, the best treatment for the Female Athlete Triad is prevention. There are two different types of prevention known as primary and secondary prevention (Rust,

2002). Primary prevention is simply preventing the occurrence of the triad, while secondary prevention promotes early detection and prompt treatment of any of the triad components (Rust, 2002). This will increase the chances of a quick and healthy recovery. An effective prevention program should potentially involve the following individuals: the athlete, the athletic trainer, the coaches, and the athlete's parents if they are minors.

The main goal of primary prevention is to educate athletes on the factors that may predispose them to developing the medical disorders of the triad (Beals, Brey, & Gonyou, 1999). For example, athletic trainers can annually promote primary prevention through communicating common body fat myths, providing reliable nutrition education, and discussing ways to overcome stress. In the area of osteoporosis prevention, information on wise food choices, vitamins and minerals proven to build bone, avoiding alcohol and tobacco usage, and the importance of weight-bearing activity are all critical aspects to educate athletes. Many concerns with body weight, appearance, dieting habits, and disordered eating tend to develop in junior high or high school age female athletes (Neumark-Sztainier, 1996). Because of this, primary prevention should be aimed to begin at this age level, and become a part of regular educational health programs (Neumark-Sztainier, 1996).

The goal of secondary prevention is to limit the progression and shorten the recovery time and duration of the medical conditions of the triad (Beals, Brey, & Gonyou, 1999). For secondary prevention to be successful, health professionals and personnel should be familiar with the signs and symptoms. The National Collegiate Athletic Association (NCAA) published a list of traditional warning signs and symptoms associated with the Female Athlete Triad (Table 2) (Beals, Brey, & Gonyou, 1999).

The two most important pharmacological interventions for the Female Athlete Triad are calcium supplementation and estrogen replacement (Smith, 1996). A frequently used treatment for hypothalamic amenorrhea is hormone replacement therapy (Warren & Chua, 2008). The best treatment is restoration in weight, a decrease in exercise intensity, and an associated increase in caloric intake (Dominguez, Goodman, & Sen, 2007). With the return of normal menstrual function, there are very substantial increases in bone mineral density of 6-20%, which are much more significant than achieved by pharmacological agents alone (Dominguez, Goodman, & Sen, 2007). However, complete bone mineral density will not be able to be fully recovered (Dominguez, Goodman, & Sen, 2007).

One of the most significant and effective methods for early identification of the Female Athlete Triad is to screen the athletes during their annual pre-participation physical exam. This provides the best opportunity because during the exam, athletic trainers and clinicians can ask specific questions regarding menstrual irregularities, weight loss attempts, eating behaviors, and history of musculoskeletal injury. Other issues can also be addressed such as, life stressors, depression symptoms, training frequency and intensity, and displeasure with weight and body appearance.

Athletic trainers and physicians must recognize the varied health care needs of female athletes to ensure safe and healthy participation of women sports. These sports medicine health care providers see athletes on a frequent basis and must be aware of this health issue. They should also be involved in annual education programs that promote healthy eating and training methods to all female athletes.

The disorders of the triad are serious and are linked to numerous health complications; because of this, prevention and early identification are vital (Beals, Brey, & Gonyou, 1999). The treatment advised by health professionals involves programs specific for psychological counseling, medical and nutrition support, and in certain cases medication prescriptions (Beals, Brey, & Gonyou, 1999). Although the Female Athlete Triad is potentially life-threatening, it is a preventable disorder (Otis C. , 1998). By establishing an awareness of this medical condition, the prevention team can make it promising for female athletes to enjoy the numerous benefits that competitive and recreational sports has to offer.

Table 2. NCAA Warning Signs and Symptoms of the Female Athlete Triad

Behavioral

- Mood Swings
- Excessive criticism of one's body weight or shape
- Compulsive, and/or excessive exercise
- Noticeable weight gain or loss
- Bathroom visits after eating
- Secretly eating or stealing food
- Preoccupation with food, calories, and/or weight
- Depression
- Avoiding food-related social activities
- Consumption of large amounts of food not consistent with the athlete's weight
- Excessive laxative, diuretic, and/or diet pill use

Physical

- Anemia
- Cold intolerance
- Chronic fatigue
- Callused fingers
- Frequent gastrointestinal problems, such as excessive gas, abdominal bloating, constipation, ulcers
- Lanugo
- Tooth erosion, excessive dental caries
- Irregular or absent menstrual cycles
- Delayed/prolonged wound and/or injury healing
- Frequent musculoskeletal injuries, particularly stress fractures

NCAA Warning Signs and Symptoms of the Female Athlete Triad (Beals, Brey, & Gonyou, 1999)

CHAPTER III

METHODOLOGY

The purpose of the study was to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among Eastern Illinois University female cross country runners. The methodology of the study included the following steps: 1) Selection of the subjects; 2) Identification of the questionnaire instrument; 3) Administration of the questionnaire; 4) Analysis of data.

Selection of Subjects

The subjects for this study were thirteen collegiate student-athletes from the Eastern Illinois University female cross country team. This sport was chosen because cross country has been associated with a higher prevalence of the Female Athlete Triad among athletes (Prentice, 2011). The student-athletes voluntarily participated in this study approved by the Institutional Review Board at Eastern Illinois University. After giving their informed consent, the subjects completed a questionnaire designed to determine whether they met any risk factors associated with each of the three components of the Female Athlete Triad.

Identification of the Questionnaire Instrument

The instrument developed for this study was an adaptation of two previously-designed questionnaires. The questionnaire was composed of five different sections. The sections included were: demographic information, exercise history, dietary habits, history of menstruation, and a skeletal health risk screening. Several questions from the exercise

history, dietary habits, and history of menstruation sections were based on the instrument utilized by Block (1999). Her study explored the comparison of nutritional knowledge, eating attitudes, training regimens, and body composition between normal and abnormal menstruating female adolescent cross country athletes (Block, 1999). The skeletal health risk screening section was the form developed by The Ageless Foundation (Osteoporosis Screening Form, 2009).

The demographic information section included age, date of birth, year in school, ethnic background, height, weight, and body mass index (BMI). Height and weight were used to calculate BMI for each subject, a standard acceptable measure of body size (BMI = weight (kg) ÷ height (m^2)). The second portion of the questionnaire contained the athlete's exercise history and consisted of questions to determine the training regimen of the athlete. Exercise can be a key factor in the presence of amenorrhea (Prentice, 2011).

Subjects were asked to report information that concerned their current and past exercise routines. They were asked their age when they first became competitive in sports. The subjects recorded their average weekly mileage during the cross country in-season and off-season, and additionally the number of days and minutes per week they participated in vigorous exercise. The subjects were then asked if they had ever experienced weight loss due to a training program. If the subjects experienced weight loss, they were asked to indicate approximately how much weight was lost. In the situation an athlete had lost weight multiple times, she recorded the most recent weight loss. The subjects were also asked if they have ever experienced a stress fracture and to

what bone. These questions were significant to assess their level of training and if over-training was a concern in the subject population.

The third section of the questionnaire regarded their dietary habits. This segment consisted of eighteen questions. The questions were aimed to obtain information regarding what foods they consumed daily, what foods they considered 'bad' for them, vitamin and supplement intake, and personal decisions about nutrition. These questions were structured as open ended questions and selecting from a list of foods. The fourth section examined their menstrual history. There were a total of nine questions that were utilized to assess whether any athlete was categorized as having any of the following conditions: primary amenorrhea, secondary amenorrhea, or oligomenorrhea.

The fifth section of the questionnaire was a skeletal health risk screening tool that contained forty questions created by The Ageless Foundation (Osteoporosis Screening Form, 2009). This form included 'yes' and 'no' responses to the sections of non-modifiable risks, modifiable risks, patient and medical history, and medication history (Osteoporosis Screening Form, 2009). This was used to establish if an athlete was considered 'low risk', 'moderate risk', or 'high risk' for a possible fracture or decrease in bone mineral density (Osteoporosis Screening Form, 2009). A subject was classified as 'low risk' if they responded 'yes' to ten questions or fewer. 'Moderate risk' was categorized between ten and seventeen 'yes' responses, while 'high risk' was twenty-five or more 'yes; responses.

Administration of the Questionnaire

Data collection occurred at Eastern Illinois University's pond pavilion on campus. The subjects were asked to sign an informed consent (Appendix B) if they wished to participate in the research study. The questionnaires and forms were distributed before practice by the researcher with permission from the cross country head coach. The questionnaire explained to the subjects that their participation was completely voluntarily and their anonymity was guaranteed. The subjects were instructed to circle or fill in the appropriate answer for each question honestly and to the best of their ability.

The researcher remained inside the testing area while the subjects completed the informed consent to answer any questions they had. Once informed consents were completed, the researcher remained outside the immediate testing area while the subjects completed the questionnaires. Once a subject finished, she placed the forms in two separate envelopes labeled 'Inform Consent' and 'Questionnaire' located at the front of the pavilion. This helped to ensure anonymity and confidentiality; after all thirteen participants departed, the researcher retrieved the envelopes. Subjects were not required to provide their names or any other identifying information numbers on the questionnaires. The researcher was the only individual with access to their responses throughout the entire study.

Analysis of Data

The data analysis was completed in the following manner. The results of the study were compared with the hypotheses using descriptive analysis. Mean, standard deviation, and percentages were computed for all variables within the demographic,

exercise history, dietary habits, menstruation history, and skeletal health risk sections of the questionnaire. If the data was in the form of a nominal or categorical statistical variable, the percentages were calculated. If the data was a ratio statistical variable, the mean and standard deviation were calculated. In regard to the results of the skeletal health risk screening, those participants who were found to be 'moderate risk' or 'high risk' were considered to be at significant risk for osteopenia. On the other hand, those athletes which were 'low risk' were not classified as being at risk for osteopenia.

CHAPTER IV

RESULTS & DISCUSSION

Results

Introduction

The purpose of the study was to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among the Eastern Illinois University female collegiate cross country team. The presentation of results were organized as follows: 1) description of subjects, 2) explanation of exercise history, 3) account of dietary habits, 4) evaluation of menstrual history and, 5) description of skeletal health risk level.

The data were analyzed using descriptive statistics including mean, standard deviation, and percentages. The physical characteristics of the subjects are shown in Table 3.

Table 3: Physical Characteristics of Subjects (n=13)

Variable	Mean ± SD	Range
Age (yr)	20.54 ± 1.2	18 - 22
Height (cm)	66.13 ± 3.1	59 - 71
Weight (kg)	56.47 ± 5.4	43 - 64
BMI	19.95 ± 1.4	17.7 - 22.1

Age and Year in School

All thirteen participants were members of the Eastern Illinois University cross country team. Fifteen percent of the subjects were freshman, 0% sophomores, 54% juniors, 23% seniors, and 8% were graduate level students.

Exercise History

The age the subjects began to participate at the competitive level is shown in Figure 1. The subjects were questioned about how many miles they ran during the on and off cross country season. The subject's weekly mileage ranged between 35 – 65 miles per week during the off-season and 50 – 65 miles per week while in-season. The mean mileage per week in season was 59.64 ± 4.1.

Subjects were asked if they ever experienced any weight loss as a result of their training. Thirty-eight percent (5 of 13) of the subjects reported weight loss of a mean of 7.3 ± 2.3 lbs. Subjects were also asked if they ever suffered a stress fracture throughout their training. Twenty-three percent (3 of 13) of the subjects reported a stress fracture. Finally, some questions involved overtraining behaviors and characteristics. One hundred percent (13 of 13) of the subjects reported behaviors considered to be associated with overtraining. A few of those behaviors were the following: continued to exercise if they were sick or injured, felt guilty if they missed a workout, missed spending time with friends or family in order to workout.

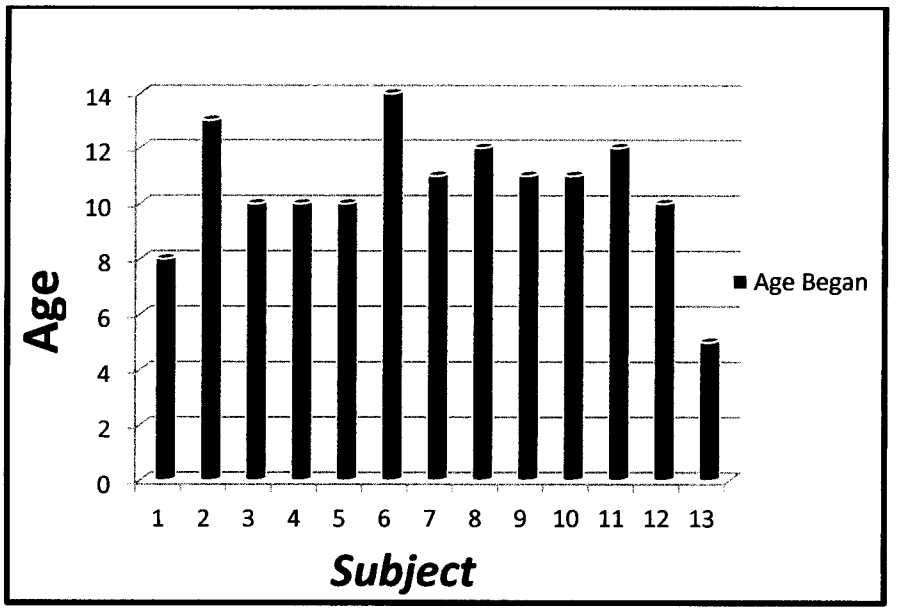

Figure 1: Age the athletes began to be competitively involved in athletics

Dietary Habits

Subjects were asked to rate their current diet, based upon whether or not they felt their intake was balanced between the major food groups. The major food groups considered were: grains, vegetables, fruits, meat and beans, and dairy. Thirty-eight percent (5 of 13) of the subjects rated their diet as excellent and 62% (8 of 13) of the subjects rated their diet as average. The questionnaire instructed the participants to check all possible sources of food they consume daily from a list developed by the researcher (Table 4). Additionally, the subjects indicated which, if any foods they believed to be harmful to their health (Table 5). Subjects were additionally instructed to approximate how many calories they consumed daily. The estimated mean of daily caloric intake was 2,500 ± 549.2 kcal/day. The percentage distribution for daily caloric consumption is shown in Table 6.

Table 4: The Food the Participants Consumed Daily (n=13)

Food	# of Subjects	Percentage
Breads	13	100%
Pasta	10	77%
Fruit	13	100%
Vegetables	12	92%
Dairy	11	85%
Poultry	8	62%
Sweets	10	77%
Nuts	6	46%
Dark Chocolate	5	38%
Tea/Coffee	5	38%
Cheese	9	69%
Red Meat	5	38%
Fish	1	8%
Eggs	3	23%

Table 5: Food Choices Rated as "Bad" By Participants (n=13)

Food	# of Subjects	Percentage
Butter	8	62%
Tea/Coffee	4	31%
Dark Chocolate	3	23%
Fried Foods	13	100%
Sugar	6	46%
Eggs	1	8%
Red Meat	2	15%
Cheese	1	8%
Milk	1	8%

Table 6: Estimated Amount of Calories Consumed Daily (n=13)

Calorie Range	# of Subjects	Percentage
1800 – 2000	4	31%
2001 - 2500	5	38%
2501 - 3000	3	25%
3001 - 3500	1	8%

The participants were asked if they had ever felt guilty after consuming added calories not in their normal diet. Sixty-two percent (8 of 13) of the participants responded yes, they felt guilty, and 38% (5 of 13) replied no. Subjects were asked if they purchased nutritional supplements and if so, what type. Ninety-two percent (12 of 13) of the participants replied yes, they did purchase supplements and 8% (1 of 13) of the participants respond no. A summary of the nutritional supplements subjects purchased are displayed in Table 7.

Table 7: Nutritional Supplements Purchased By Participants (n=13)

Supplement	# of Subjects	Percentage
Multi-Vitamin	9	75%
Iron	11	92%
Calcium	5	42%
Vitamin C	6	50%
B-12	2	17%
Omega 3	1	8%
Echinacea	1	8%

Finally, the subjects were questioned in regard to possible disordered eating habits. The results are displayed in Figure 2.

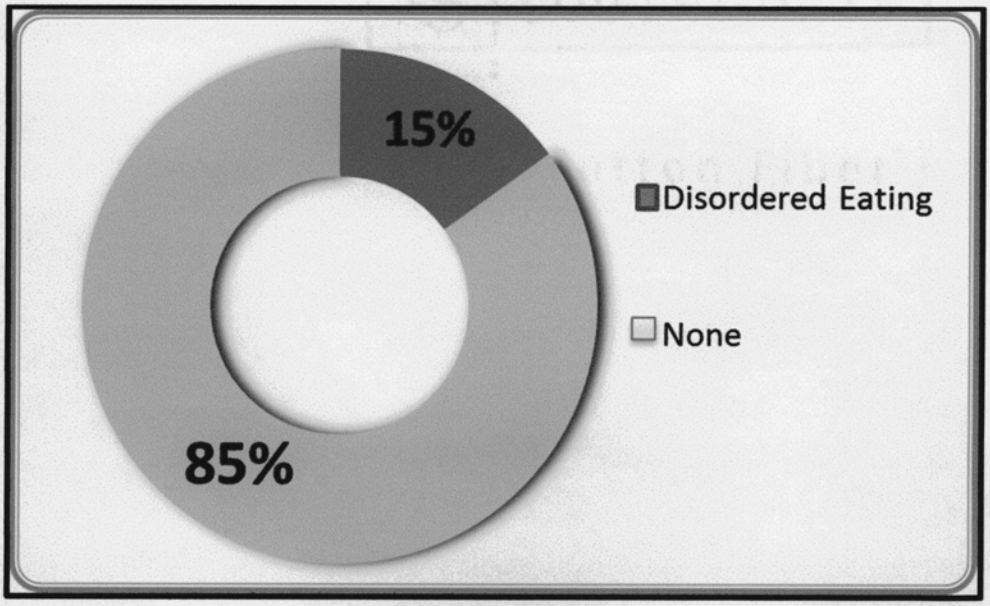

Figure 2: Percentage of subjects characterized with disordered eating

Menstrual History

Subjects were instructed to answer questions related to their menstrual history. The mean age for menarche was 13.7 ± 1.7 years. The participants were asked how many menstrual cycles they experienced in the past year. The mean was 10.5 ± 1.9 cycles. Subjects reported the mean number of days between each menstrual cycle to be 31.7 ± 5.7 days. Then, subjects stated if their menstrual cycle has ever ceased for longer than 3 months. Thirty-one percent (4 of 13) reported that their menstrual cycle has ceased for longer than three months at one time. Of these four subjects, the number of occurrences of cessation was requested. These results are shown in Figure 3.

Additionally, the researcher separated the subjects into three categories of menstrual dysfunction which were: primary amenorrhea, secondary amenorrhea, and oligomenorrhea. Those results are presented in Figure 4. Finally, the participants

indicated if they were currently taking oral contraceptives. Twenty-three percent responded yes, they were currently taking oral contraceptives and 77% answered no.

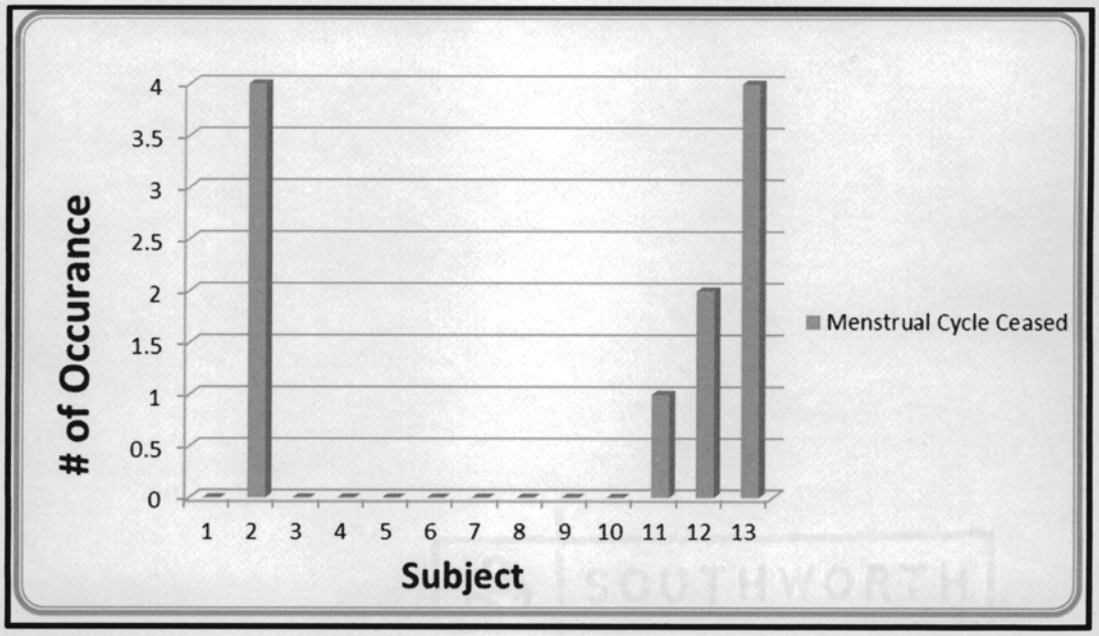

Figure 3: Number of occurrences of menstrual cycle cessation of three months or more

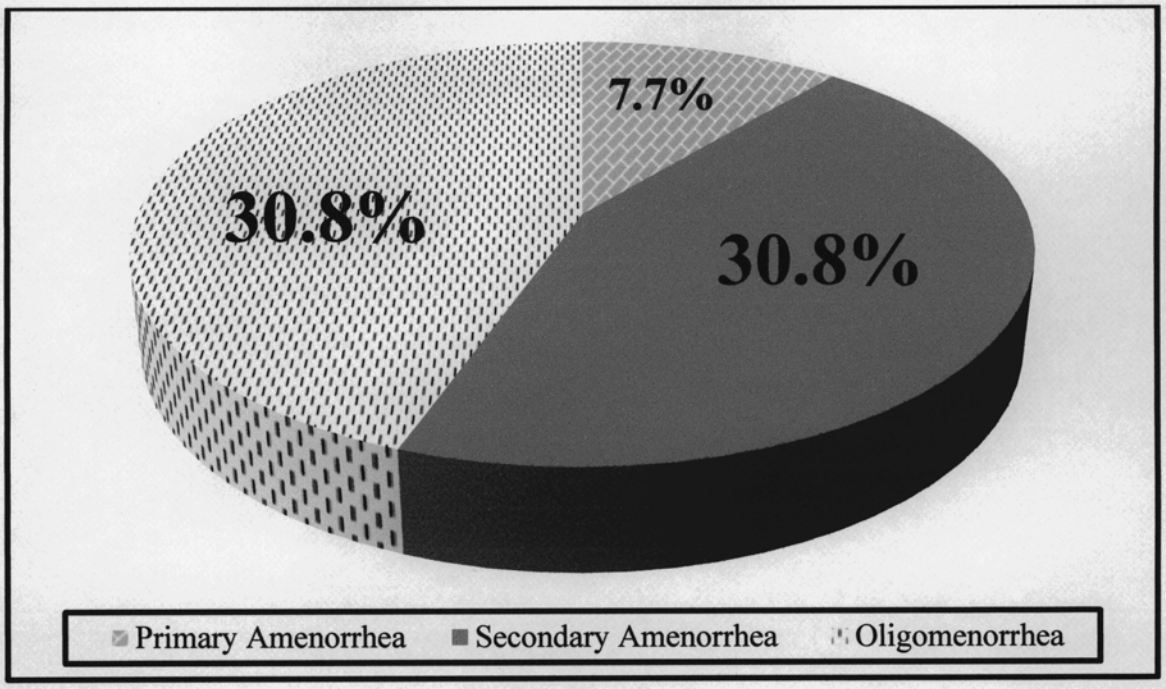

Figure 4: Distribution of menstrual dysfunction types observed in the sample (n=7)

Skeletal Health

The subjects were asked a series of questions that examined their skeletal health and the potential risks for developing low bone mineral density or osteopenia in the future. One-hundred percent (13 of 13) of the subjects were considered 'low risk' with their reported answers.

Discussion

Physical Characteristics

The results of the present study were similar to those from a study conducted by Thompson in 2007 that consisted of three hundred female collegiate cross country runners from all over the United States. In Thompson's study, the collegiate athletes had a mean body weight of 56.80 ± 6.2 kg, compared to the mean of the participants in the present study 56.47 ± 5.4 kg. Also, the subjects had a mean height of 65.40 ± 2.3 cm compared to the mean of subjects in the present study 66.13 ± 3.1 cm. Finally, the body mass index (BMI) measurement was similar among these two studies. In the present study, the mean BMI was 19.95 ± 1.4, compared to Thompson's study which the mean was 20.58 ± 2.0. The mean BMI results of both studies were within the normal and healthy range. Thompson's study was very diverse in the subject population. The reason these measurements were so close was possibly because these are normal characteristics that female cross country runners who compete at the collegiate level; many have similar body physiques and physical characteristics.

Exercise History

Training Volume

Distance and intensity are two significant training factors in the sport of cross country. The relationships between these variables and irregular menstrual cycles have been evaluated in the past (Thompson, 2007) (Block, 1999). Too much intense exercise has been known to cause a negative effect on a female's menstrual cycle (Thompson, 2007). A common assumption of the successful cross country athlete's physique is

usually one that is thin and lean. In many situations, that physique was a result of intense training. In the current study, subjects reported their average weekly mileage as fifty to sixty-five miles per week with a mean mileage of 59.46 ± 4.1 miles/week and one hundred percent (13 of 13) trained seven days per week. The women reported a mean total training time in minutes each week of 586.95 ± 92.8 minutes.

A previous study revealed that exercise duration is highly linked with types of menstrual dysfunction (Drinkwater, Nilson, Chesnut, Bremmer, Shainholtz, & Southworth, 1984). This study focused on the number of miles each athlete ran per week. It was discovered that of the athletes who ran less than 10 miles per week, only 6% experienced amenorrhea. Conversely, 43% of the athletes who ran more than 70 miles were found to have a type of menstrual dysfunction (Drinkwater, Nilson, Chesnut, Bremmer, Shainholtz, & Southworth, 1984). In both the current study and this study from 1984, the occurrence of a high percentage of athletes with menstrual dysfunction correlated with the amount of mileage each week. In both studies, the participants ran between 60 and 70 miles each week.

In a study which concentrated on high school cross country athletes, completed in 1999 by Block, the subjects reported running between twenty-one and sixty miles per week; the mean mileage of that study was not stated. In the present study, the subjects' mileage range per week was higher and more consistent than the high school athletes. In the current study, the subjects were asked a series of questions that were related to the identification of overtraining behaviors. One-hundred percent (13 of 13) of the subjects were found to meet the criteria for overtraining. The reason for the disparity in mileage between the high school and collegiate groups and the overtraining behaviors may be in

part due to the different levels of competition. At the collegiate level there most likely is a greater demand for longer, more intense training sessions with increased total mileage. Many collegiate competitive athletes participate in two training sessions per day, easily expending over 1,000 kcal/day in exercise alone (Block, 1999).

Another reason for an NCAA Division I program's higher mileage could have been a result of their successful past. The team has a history of conference championship titles. The drive, passion, and determination to continue to win and be successful could be a key factor in the intense training habits instilled in these young women. However, this could imply the population was at higher risk for menstrual dysfunction because of additional strain and pressure on their bodies to improve performance year after year.

Training Habits and Menstrual Dysfunction

For a female athlete, competing prior to menarche may have a negative effect on their menstrual cycle (Thompson, 2007). It has been shown that the younger a female athlete begins competing, the greater risk they incur for the development of menstrual dysfunction (Thompson, 2007). In the current study, the mean age at which the subjects began competing was 10.53 ± 2.3 years and the percentage of subjects with menstrual dysfunction was 54% (7 of 13). These subjects began competing at a relatively young age, which may in part explain the incidence of menstrual dysfunction observed in this group. In comparison, Thompson's study found that 23% of participants reported menstrual dysfunction. The mean age the subjects began competing was 11.37 ± 3.2 years (Thompson, 2007).

Training Habits and Stress Fractures

In a study conducted in 2010, it was shown that female athletes who participated in endurance sports experienced more musculoskeletal injuries compared to contact sports, such as basketball (Rauh, Nichols, & Barrack, 2010). The study consisted of 163 high school female athletes and each participant was analyzed for one sport season to track individual injuries. The purpose of the study was to find the relationship between injuries and disordered eating, menstrual dysfunction, and low bone mineral density among high school athletes (Rauh, Nichols, & Barrack, 2010).

Rauh, Nichols, and Barrack (2010) found 16.5% (27 of 163) sustained a musculoskeletal injury during the individual's sport season. In the present study, it was found that 23.1% (3 of 13) of the subjects suffered a stress fracture throughout their training. These percentages were comparable considering the difference in the population. The reason the present study had 3 out of 13 subjects (23.1%) could have been because of higher training volumes and in some individual cases, fairly low caloric intake. Stress fractures are caused by repeated over use and stress placed on a particular area (Prentice, 2011).

When the three individuals reporting stress fractures were evaluated in greater detail, factors were discovered that may have contributed to a stress fracture injury, such as intense training, over usage, and decreased calorie intake. The first subject ran an average of sixty-six miles per week during the off-season and sixty miles per week in-season. The second subject ran fifty miles per week in the off-season and sixty miles per week in-season. The third subject ran fifty-five miles per week during the off-season and

sixty-three miles per week in-season. The repeated training seven days per week, could have caused their stress fractures.

The first athlete estimated that she consumed approximately 2,000 kcal/day and was a vegetarian. The second athlete consumed approximately 2,400 kcal/day. With their estimated caloric intake, the athletes may not have consumed an adequate amount for their body's nutrient needs; from that nutritional behavior, their calcium intake levels could have been too low. With the training volume these athletes participate in daily, they expend approximately 1,000 kcal per day. These athletes may require a greater caloric intake to support their daily training regimen.

The third athlete experienced oligomenorrhea during the study period. Menstrual dysfunction has been shown to exhibit the strongest relationship to an increase risk of stress fractures (Rauh, Nichols, & Barrack, 2010). Furthermore, menstrual dysfunction has been associated with extensive recovery time due to musculoskeletal injuries (Rauh, Nichols, & Barrack, 2010). Given the third subject consumed approximately 3,500 kcal/day, her menstrual history or overuse most likely was the reason she experienced a stress fracture throughout her training.

Dietary Habits

Calorie and Daily Consumption

In the present study, the approximate mean reported daily caloric intake was 2,500 ± 549.3. Sixty-nine percent (9 of 13) of the subjects consumed approximately 2,500 kcal/day or less. This caloric intake may not have been sufficient for the training these athletes participate in. The reason the percentage of menstrual dysfunction was

elevated may be because the athletes were not consuming enough calories for the amount energy they were expending. Foods consumed daily were evaluated and it was found that only 85% (11 of 13) of the subjects consumed dairy products each day. This may suggest the possibility that these athletes had insufficient calcium consumption. One positive nutritional habit of this 15% is that the two individuals who reported not consuming dairy products both have purchased a calcium supplement in the past. Another reason for a portion of the menstrual dysfunction percentage in this population, may be because athletes who train intensely and restrict their caloric intake, hormonal changes occur affecting the reproductive system, causing different types of menstrual dysfunctions (Thompson, 2007).

Supplement Consumption

Ninety-two percent (12 of 13) of the subjects in the current study purchased and consumed a variety of supplements. Eight percent (1 of 13) of the subjects did not take any type of vitamin or supplement. In the study conducted in 1999 the author also assessed her subject's vitamin and supplement consumption (Block, 1999). Block found that 58% (21 of 36) of the subjects took vitamins or supplements. When compared with the current study, the amount of high school cross country athletes who consumed supplements were 34% less than the collegiate level athletes.

A few reasons for this result could have been because the collegiate athletes perform at a higher level, and they might have strength and conditioning coaches or athletic trainers who have advised them to consume certain vitamins or supplements to improve their health and performance. Furthermore, since athletes at the collegiate level

are adults, their personal physicians could have recommended certain supplements be added in their daily routine. For example, the physicians of the two athletes who did not consume dairy products daily might have advised them to purchase a calcium supplement. One other cause could have been that the collegiate athletes were more conscious about their health. They may have been more concerned about their improvements on performance and if they remained healthy.

Potential Disordered Eating

In the current study it was found that 15% (2 of 13) of the participants showed signs of disordered eating. Those questions were numbered 36-40 in the questionnaire shown in Appendix A. One cause for this result could have been that these individual athletes were very self-conscious about their weight or appearance. In the sport of cross country, the uniforms are small and reveal a good deal of skin. That thought could have been in those female's minds. They might have a fear that any weight gained could negatively affect their time and athletic performance. Lastly, they could have perceived themselves differently than others, or were their own hardest critic; in certain cases, that mindset can take a toll on a person's body, mental health, self-confidence, and stress level.

Menstrual History

Age of Menarche

The mean age of menarche in the present study was 13.69 ± 1.7 years. A similar mean age was found in a study completed in 2007 by Thompson. That researcher found the mean age of her population to be 13.46 ± 1.7 years (Thompson, 2007). This result

concluded that competitive female cross country runners normally begin menarche around the age of 13 or 14 years. The reason for this deduction was because the study by Thompson consisted of a wide range of diverse subjects, yet the mean age was extremely close to the current study. A probable explanation for the proximity of these two studies was the mean age the subjects became involved in competitive athletics were also very similar. In Thompson's study, the mean age the athletes became involved in athletics competitively was 11.37 ± 3.2 and the present study was 10.58 ± 2.6. It has been stated that athletes who begin training for competitive athletics prior to menarche are at greater risk for a type of menstrual dysfunction in the future and also to reach menarche at an older age (Thompson, 2007). In both studies the majority of the participants began training before menarche, which could be why they reached menarche later in adolescence.

Menstrual Cycles per Year

Subjects were asked how many menstrual cycles they experienced in the past year along with the interval of those cycles. In the present study, the mean for the amount of menstrual cycles for subjects who were considered to have oligomenorrhea (4 of 13) was 8.25 ± 1.5. The mean for the subjects without oligomenorrhea was 11.4 ± 0.8. Compared to the study conducted on high school athletes by Block, her means were 5.64 ± 2.8 and 11.8 ± 3.9. The subjects in both normal menstrual cycle groups were very similar and this was simply because each of the females experienced between 10 – 12 cycles in the past year. However, there was a slight difference with the oligomenorrhea groups within the two studies. This result was most likely due to the fact the subjects in the present study were older or have taken oral contraceptives that had attempted to

regulate cycles. The older a female, the more regular her menstrual cycles typically are; once a female has reached the age of menarche, it can take her body awhile to regulate her cycles normally (Vinci, 1999). This could have been the reason behind the different means.

Occurrences of Menstrual Dysfunction

The occurrence of menstrual dysfunction in the present study was higher than most studies related to this issue. Fifty-four percent (7 of 13) of the subjects were found to have menstrual dysfunction. This percentage was significantly higher when compared to the results stated by Thompson. It was found that only 23% (90 of 300) of that population reported a menstrual dysfunction (Thompson, 2007). One cause for the disparity in percentages could have been the dissimilarity of personal habits of the athletes, such as past diet and training intensity. Additionally, another factor could have been the difference in the mean age the subjects in the present study became competitively active. In the present study, the athletes were almost a whole year younger than in Thompson's study.

Skeletal Health

Level of Skeletal Health Risk

The participants in the present study were asked a series of questions that regarded their skeletal health and the potential risks for developing low bone mineral density, osteopenia, or osteoporosis. One-hundred percent (13 of 13) of the subjects were considered 'low risk' with their reported answers. This study had limited time and resources to actually assess bone density level, so the researcher focused on risk factors

associated with low bone mineral density. The majority of published studies similar had more time and financial availability to assess with bone mineral density scans, making it difficult to compare results. The reason these subjects were all considered 'low risk' could have been because the format was a questionnaire. It focused on potential skeletal health risk factors and concentrated more toward the older woman population.

Additionally, the questions were in a 'yes' and 'no', or closed format. Some questions could have caused confusion because of the use of medical terminology; some subjects might not have fully comprehended. This could have resulted in the subject circling 'no' because they were not positive on the actual meaning behind the question. Nevertheless, women have been estimated to be eight times more likely to have osteoporosis during their lives than men (Prentice, 2011). This illustrates that women are already at an increased risk, even though these athletes are considered 'low risk' at the present time (Prentice, 2011).

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSION, AND FUTURE RECOMMENDATIONS

Summary of Findings

The purpose of the study was to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among Eastern Illinois University female cross country runners. Thirteen subjects were recruited to discover the occurrence within this population. All subjects completed a self-report questionnaire with the following sections: demographic information, exercise history, dietary habits, history of menstruation, and a skeletal health risk screening.

In summary, 15% of the women were found to exhibit disordered eating, 54% reported irregular menstrual cycles, and the entire population was categorized as 'low risk' for the skeletal health risk screening. There were three stated hypotheses for this study. The first hypothesis was that less than 2% of the population would show risk factor criteria associated with all three components of the Female Athlete Triad. The hypothesis was supported as none of the subjects met risk factors for all three components of the triad.

The second hypothesis stated that between 5-15% of the subjects would show risk factor criteria related to two out of the three components of the triad. This hypothesis was also supported as 8% of the population met risk factors for two of the triad components. Finally, the third hypothesis stated that between 40-55% of the population

would show risk factor criteria for one of the three components of the triad. The hypothesis was rejected because the prevalence was even greater than expected with 61.5% of the subjects having risk factors associated with at least one component.

It appears that young female cross country athletes are at risk for behaviors associated with the Female Athlete Triad: intense training, negative attitudes towards some foods, and irregular menstrual cycles. This indicates additional education would be beneficial at the preadolescent, adolescent, and young adult female athlete age groups. The reason to begin at a young age is because that is when female athletes become involved in athletics competitively with intense training regimens. Screening for disordered eating, menstrual dysfunction and additional education at a younger age could be one of the first steps in preventing the level of health risks associated with the Female Athlete Triad.

Conclusion

In conclusion, the study revealed the results of the subject's approximate level of risk among all three triad components. None of the subjects met risk factor criteria for all three components of the Female Athlete Triad. One subject met risk factor criteria for two triad components. Eight of the subjects met risk factor criteria for one component of the triad; low caloric and calcium intake have been associated with amenorrhea, which could have been the case in this population. The number of subjects who met risk factor criteria for one or two components, illustrates a substantial number of these female athletes could be at an increased risk for the full Female Athlete Triad in the future.

Future Recommendations

Without further investigation and evaluation, the researcher cannot fully conclude if individual participants of this study had the full Female Athlete Triad; although, some of them may be at an increased risk. Calculating the percentages of those who suffer from osteopenia or osteoporosis is beyond the scope and financial funds of the present study; it is recommended for a future study with financial resources to assess bone mineral density utilizing a DEXA scan. Future studies could assess a larger number of Division I collegiate cross country athletes, or possibly athletes in different sports. This would help to determine if the results from the current study are comparable throughout the collegiate cross country population in the entire country.

It is recommended, however, that athletes with one component need to be screened for the remaining triad components. Since some of these female athletes exhibited at least one component, they may be at risk for others. It is thought that the Female Athlete Triad is underreported due to the fact that the symptoms are frequently overlooked and denied (Otis, Drinkwater, Johnson, Loucks, & Wilmore, 1997). Educating young female athletes about the dangers and long-term consequences of these three interrelated health issues is at the upmost importance in the prevention of the Female Athlete Triad. Since there is a deficit in knowledge and understanding about the prevalence and prevention of the Female Athlete Triad, especially osteopenia, further research should be conducted and highlighted in this area.

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APPENDICES

A. Questionnaire

COLLEGIATE FEMALE ATHLETE CROSS COUNTRY RUNNERS: NUTRITIONAL, TRAINING, & HEALTH QUESTIONNAIRE

Please take the time to fill out the following questionnaire. There are no right or wrong answers. Try not to answer as you WANT to, but instead, answer based on your ACTUAL BEHAVIORS and THOUGHTS. The information contained within this questionnaire is confidential and will not be shown by name to anyone other than the researcher. Thank you very much for taking part in this study. Rachel Snow, ATC

SECTION A: Demographic Information.

Fill in the blank for each of the following items or circle the correct response.

1. How old are you? _____

2. Date of Birth? _____/_____/_____

3. What year in college are you currently in?

Freshman Sophomore Junior Senior Super Senior Graduate

4. What is your racial or ethnic background?

Caucasian African American Hispanic Asian American Indian

Pacific Islander Other _____

5. What is your current height? _____

6. What is your current weight? _____

SECTION B: Exercise History

7. How old were you when you first became active in competitive sports?

_____

8. How many times a week do you engage in vigorous physical activity long enough to work up a sweat? _____ days/week

9. How many minutes a day do you usually exercise? _____ minutes

10. What is your average weekly mileage during the cross country "off season"?

_____

11. What is your average weekly mileage during the cross country "in season"?

_____

12. During the time frame when you are in the "off season" in cross country would you rate yourself as physically more active, less active, or about the same as another person your age?

Less Active About the same More active

13. While in training have you experienced any weight loss?

Yes No

14. If yes to #11, what is the number of pounds lost (in total) (the most recent incidence you lost weight)? _____

a. In how much time? (# of days, weeks, or months?) _____

15. Have you ever experienced a stress fracture?

Yes No

16. If yes to #13, which bone(s) (or body part) was your fracture in?

_____

a. Was it diagnosed by a Bone Scan? Yes No

b. Was it diagnosed by an X-Ray? Yes No

17. Is your coach a good role model by providing you with accurate nutritional information and safe training programs? Yes No

18. Do you feel guilty if you miss your workout? Yes No

19. Do you still exercise when you are sick or hurt? Yes No

20. Would you miss going out with friends or spending time with family, just to ensure you got your workout in? Yes No

21. Do you freak out if you miss a workout? Yes No

22. Do you calculate how much to exercise based on how much you eat?

Yes No

23. Do you have trouble sitting still because you're not burning calories?

Yes No

24. If you're unable to exercise, do you feel compelled to cut back what you eat that day?

Yes No

SECTION C: Dietary Habits

25. How would you rate your diet? (In terms of your diet being balanced between the major food groups)

Excellent Average Below Average Poor

26. Which of the following foods/drinks do you think are bad for you? (Circle all that apply)

Eggs Red Meat Milk Butter Sugar Bread

Pasta Eggs Cheese Tea/Coffee Dark Chocolate Fried Foods

27. Which of the following foods do you consume daily? (Circle all that apply)

Breads/Cereals/Oatmeal Pasta Fruit Vegetables Dairy Products

Red Meat Fish Poultry Fast Food Sweets Nuts

Beans Eggs Dark Chocolate Tea/Coffee Fried Foods

Cheese

28. Are there any foods that you completely cut out of your diet? Please list all (if any):

_____

29. Do you follow a restrictive diet? Yes No

30. Are you a vegetarian? Yes No

31. If yes, do you eat adequate amounts of protein? Yes No

32. Approximately how many calories do you think you consume daily?

_____

33. Do you ever feel guilty after consuming added calories not in your normal diet?

Yes No

34. If you don't eat healthy, what is your biggest barrier to eating healthy?

Not enough time to eat Inconvenience Expense

Confused about what foods are healthy Don't enjoy healthy foods

Other: _____

35. Do you make yourself sick because you feel uncomfortably full? Yes No

36. Do you worry you have lost control over how much you eat? Yes No

37. Have you recently lost more than 15 pounds in a three-month period? Yes No

38. Do you believe yourself to be fat when others say you are too thin? Yes No

49. Would you say that food dominates your life? Yes No

40. Have you felt depressed in the past 3 months? Yes No

41. Do you buy nutritional supplements? (Including Multi-Vitamins, Calcium, Vitamin D, etc.) Yes No

42. If yes, what do you purchase?

_____

_____

SECTION D: Menstrual History

43. At what age did you begin to have your period? _____ years old

44. Approximate month and year you began your period.

_____/_____

a. What grade were you in school? _____

45. In the PAST 3 MONTHS have you had a period? Yes No

46. In the PAST 12 MONTHS how many times have you had a period?

_____

47. How many menstrual cycles do you have each year?

_____

48. On average, how many DAYS between each of your periods?

_____

49. On average, how many DAYS do your periods last?

_____

50. How many times has your period ceased for longer than 3 months?

_____

51. Are you currently taking birth control pills? Yes No

a. If yes, how long have you been taking them? _____

SECTION E: Skeletal Health Screening

Non Modifiable Risks

52. Are you female? Yes No

53. Are you Asian? Yes No

54. Are you Caucasian or have a fair complexion? Yes No

55. Do you have a small boned frame? Yes No

56. Do you have a family history of osteoporosis? Yes No

57. Have relatives lost height as they aged? Yes No

58. Have any of your relatives had a wrist, vertebral, or hip fracture? Yes No

Modifiable Risks (Behavioral/Lifestyle/Diet, Medical Conditions, Medications)

59. Do you smoke cigarettes, 1 - 10 (½ pack) a day? Yes No

60. ½ pack - one pack a day? Yes No

61. More than a pack a day? Yes No

62. Do you drink alcoholic beverages? Yes No

(2 oz. liquor = one mixed drink = one glass of wine = one 12 oz. beer)

63. Up to 2 oz. or one beer a week? Yes No

64. 2 - 12 oz. a day or two - six beers a week? Yes No

65. One mixed drink or beer a day or more? (7 drinks a week or more)

Yes No

66. Are you a vegetarian or have a diet heavily weighted to vegetables?

Yes No

67. Is your diet high in red meat or animal protein? Yes No

68. Do you consume less than one portion of dairy products a day?

Yes No

69. Do you drink 3 or more cups of coffee or caffeinated beverages like soda / tea a day?

Yes No

70. Do you exercise infrequently or not at all? Yes No

Patient and Medical History

71. Have you had a fracture? Any fracture wrist, spine or hip? Yes No

72. Do you have an eating disorder like Anorexia or Bulimia? Yes No

73. Do you have hyperthyroidism? Yes No

74. Do you have hyper para thyroidism? Yes No

75. Do you have an inflammatory bowel disease like Chron's Disease or Ulcerative Colitis?

Yes No

76. Do you have inflammatory arthritis like Rheumatoid arthritis or Gout?

Yes No

77. Do you have Diabetes? Yes No

78. Have you had your stomach removed? (a gastrectomy) Yes No

79. Do you have liver disease? Yes No

80. Do you have kidney disease? Yes No

81. Do you have Asthma that requires any steroids, even inhaled steroids?

Yes No

82. Have you ever missed a period or had amenorrhea? Yes No

83. Have you breast fed at least one child? Yes No

84. Have you given birth to a child? Yes No

Medication

85. Do you take or have you ever taken: Prednisone? Yes No

- For up to a cumulative total of six months during your life time?

  Yes No

- Commutative total of up to one year during your life time?

  Yes No

- Commutative total of one to five years during your life time?

  Yes No

- More than 5 years during your life time? Yes No

86. Have you ever taken Lupron or GNRH agonists? Yes No

87. Do you take thyroid medication? Yes No

88. Have you ever received chemotherapy Yes No

89. Have you ever used anti-convulsants like Dilantin? Yes No

90. Have you ever taken diuretics like Lasix? Yes No

91. Have you ever used Lithium? Yes No

92. Have you ever taken Heparin? Yes No

B. Informed Consent

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

THE PREVALENCE OF RISK FACTORS ASSOCIATED WITH THE FEMALE ATHLETE TRIAD AMONG EASTERN ILLINOIS UNIVERSITY FEMALE CROSS COUNTRY RUNNERS

You are invited to participate in a research study conducted by *Rachel Snow and Dr. John Storsved II*, from the *Kinesiology and Sports Studies Department* at Eastern Illinois University. Your participation in this study is entirely voluntary. Please ask questions about anything you do not understand, before deciding whether or not to participate.

- **PURPOSE OF THE STUDY**

The purpose of the study is to investigate the prevalence of the risk factors associated with all three components of the Female Athlete Triad among Eastern Illinois University female cross country runners.

- **PROCEDURES**

If you volunteer to participate in this study, you will be asked to:

1. Sign an informed consent and fill out a questionnaire.
    a. The questionnaires and forms will be distributed before practice with permission from the head coach. The questionnaire and informed consent

will explain to you that your participation is completely voluntarily and your anonymity is guaranteed.

2. Circle or fill in the appropriate answer for each question honestly and to the best of your ability.

b. The time length of the questionnaire will take approximately ten to fifteen minutes to complete. The sources of research material to be obtained from you that will be used for research purposes include: the questionnaire and informed consent.

- **POTENTIAL RISKS AND DISCOMFORTS**

There are no potential risks or discomforts associated with this research study.

- **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

The benefit you may receive as a result from participating in the research study is education in the form of prevention of this medical condition. Currently, the best overall treatment for the Female Athlete Triad is prevention. The main goal of prevention is to educate female athletes on the factors that may predispose them to developing the medical disorders of the Triad. If the researcher obtains significant results, then she plans on organizing an educational session and distributing pamphlets on The Female Athlete Triad for the female cross country athletes and coaching staff.

The potential benefits to society that may be expected from this research are the women involved in the study, including you, may have a chance of learning the warning signs and dangers of The Female Athlete Triad. You may become a coach someday and can educate your own athletes. This could potentially aid in the prevention of this

harmful medical condition and save many female athletes some future health complications.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. You will not be required to provide your name or student identification numbers on the questionnaires. The researcher will be the only individual with access to your responses throughout the entire study. Your records will be stored and secured in a locked filing cabinet. Records will be destroyed after three years of the completed study or if you withdraw from participation.

- **PARTICIPATION AND WITHDRAWAL**

Participation in this research study is voluntary and not a requirement or a condition for being the recipient of benefits or services from Eastern Illinois University. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits or services to which you are otherwise entitled. There is no penalty if you withdraw from the study.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about this research, please contact:

Principal Investigator: *Rachel Snow*

(618) 263-7895

rrsnow@eiu.edu

Faculty Sponsor (if student is the P.I.): *Dr. John Storsved II*

(217)581-2690

jrstorsved@eiu.edu

- **RIGHTS OF RESEARCH SUBJECTS**

If you have any questions or concerns about the treatment of human participants in this study, you may call or write:

Institutional Review Board

Eastern Illinois University

600 Lincoln Ave.

Charleston, IL 61920

Telephone: (217) 581-8576

E-mail: eiuirb@www.eiu.edu

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with EIU. The IRB has reviewed and approved this study.

I voluntarily agree to participate in this study. I understand that I am free to withdraw my consent and discontinue my participation at any time. I have been given a copy of this form.

_____

Printed Name of Participant

_____

Signature of Participant Date

I, the undersigned, have defined and fully explained the investigation to the above subject.

_____

Signature of Investigator Date