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Menstrual Dysfunction and the Female Athlete: A Review of Literature

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MENSTRUAL DYSFUNCTION AND THE FEMALE ATHLETE

A REVIEW OF LITERATURE

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CHAPTER 1

INTRODUCTION

From the inclusion of females in the Olympic Games to the development of women's professional sport teams comes evidence that the gender gap is closing. In fact, the last thirty years have been a monumental time in the increase of popularity in women's athletics. Not only has this increase in popularity changed the dimension of sport for females, but the interest continues to create a growing number of opportunities for female athletes. Often not recognized as an athlete, a person who possesses natural or acquired traits in strength, agility, and endurance necessary for physical exercise or sport, especially of a competitive nature, females are now enjoying elevated status in their role as female athletes. According to a recent National Collegiate Athletic Association's (NCAA) Sports Sponsorship and Participation Report, more than 160,000 females are competing in organized sport at the collegiate level (NCAA Report, 2003).

These new opportunities and increased interest are possible due to the introduction of Title IX. The passing of this act mandates equal opportunity for women in educational institutions receiving federal funding (NCAA

Report, 2003). The movement toward Title IX was sparked by the desire and interest of some women to change past image and limitation of opportunities to keep hope alive; "the passing in 1972 of Title IX of the Education Amendments Act has provided the final thrust to dramatically alter the history" of female athletes (Albohm, 1981, p. 3). Scuderi and McCann (2005) state, "Under Title IX, women receive a percentage of funding high enough to give them equivalent uniforms, playing fields, coaches, and budgets to that of their male counterparts" (p. 4). The acceptance of Title IX establishes the legal rights of women and provides the privilege of participation in sport to all individuals.

Statement of the Problem

Despite the fact that elite female athletes are categorized as being the model of optimal health, many are plagued with menstrual dysfunction. Menstrual dysfunction is a very personal, private condition that may show very few outward symptoms; however, with increasing numbers of competitive female athletes several trends have begun to emerge. Focusing specifically on the gynecologic perspective, the most significant problem has been the disruption of the normal menstrual cycle, resulting in

delayed puberty, oligomenorrhea, amenorrhea, and decreased bone density or osteoporosis.

Compounding the issues of the disruption of the normal menstrual cycle are the physical and psychological stresses placed upon female athletes. These stresses, when added to intense training, can disrupt the regularity of the menstrual cycle. Statistically, the prevalence of amenorrhea in the general population ranges from two percent to five percent (Pfeifer & Patrizio, 2002). Among athletes, amenorrhea is much more common, with some studies reporting prevalence of up to sixty-six percent (Pfeifer & Patrizio, 2002). Furthermore, Jennke states that some studies have determined a relationship between the female athlete and the delay of onset of menstrual function, finding that menarche in the general female population of the United States occurs at 12.6 years of age; competitive athletes and dancers have shown a clear delay in menarche of up to two or more years (as cited in Scuderi & McCann, 2005).

Specifically, the purpose of this study was to review the consequences of menstrual dysfunction in the female athlete. This review also examines the compounding factors of psychological stress of competition and the physical

stress of training on menstrual function. Infertility may not be more common among athletes than the general population; however, impairment of fertility is much more common in female athletes due to the higher rates of menstrual dysfunction.

Delimitations

This study was delimited to the review of published literature identified through Internet searches utilizing PubMed, LexisNexis, Medline, and Health Source databases. Searches were conducted for research published no earlier than 1981 and written in the English language. Search terms utilized included female athlete, amenorrhea, female athlete triad, decreased bone density, infertility, fertility problems, oligomenorrhea, anovulation, and osteoporosis. Excluded terms included pregnancy.

Limitations

The biggest limitation of the studies that were reviewed was the limited number of studies related specifically to infertility and female athletes. Although the subject of infertility and female athletes has become more prevalent since the mid-1970s when the awareness of potential for health conditions was first being recognized and studied, the subject has not been studied extensively.

A second limitation relating to menstrual dysfunction and female athletes was that the studies reviewed included very small samples. A third limitation included group selection bias. For example, subjects may have been chosen randomly or by their availability at a particular time for the interview. A fourth limitation involved methodological differences, which limit comparability between studies when the subject population includes young athletes. Finally, few of the studies were designed as prospective randomized control studies. However, the complexity of exercise-associated menstrual dysfunctions in the female athlete is becoming more defined, though not fully understood.

Definition of Terms and Common Abbreviations

For the purpose of this study, the following terms were defined (all definitions from *Merriam Webster's Medical Desk Dictionary*, 2002, unless otherwise noted):

Amenorrhea - The abnormal absence or suppression of menstruation, or absence of menses for six months, or menstrual cycle for three cycles.

Anorexia Nervosa - A serious eating disorder characterized by a refusal to maintain weight at or above a minimal normal weight for height and age, an intense fear of gaining weight or becoming fat, a disturbance in the

way in which one's body weight, size or shape is perceived by the individual and, in females, absence of at least three menstrual cycles when otherwise expected to occur.

Anovulation - A condition in which the ovary does not release a ripened egg each month as part of a woman's normal cycle in her reproductive years, naturally, with no egg available for sperm, a woman cannot become pregnant, thus, this condition is a prime factor in infertility (http://www.healthscout.com/ency/68/388/main.html#DefinitionofAnovulation).

Athlete - A person possessing the natural or acquired traits, such as strength, agility, and endurance that are necessary for physical exercise or sports, especially those performed in competitive contexts (http://www.thefreedictionary.com/athlete).

Bradycardia - A relatively slow heart action whether physiological or pathological, usually under sixty beats per minute in adults.

Bulimia Nervosa - A serious eating disorder characterized by recurrent episodes of binge eating, a feeling of lack of control over eating behavior, regularly

engaging in self-induced vomiting, strict fasting, use of laxatives, or excessive vigorous exercise, and a minimum average of two binge-eating episodes per week for at least three months.

Corpus Luteum - A yellowish mass of progesterone-secreting endocrine tissue that consists of pale secretory cells derived from granulose cells, that forms immediately after ovulation from the ruptured graafian follicle in the mammalian ovary, and that regresses rather quickly if the ovum is not fertilized but persists throughout the ensuing pregnancy if it is fertilized.

Disordered Eating - Any abnormal eating pattern, ranging from less extreme to extreme behaviors and it includes a collection of interrelated eating habits; weight management practices; attitudes about food, weight and body shape; and physiological imbalances. Disordered eating includes classic eating disorders (anorexia nervosa, bulimia nervosa, and binge eating disorder) as well as eating patterns of lesser severity (http://www.mch.dhs.ca.gov/documents/pdf/Body%20Image%20and%20Disordered%20Eating.pdf).

Estrogen - Any of various natural steroids that are formed from androgen precursors, that are secreted chiefly by

the ovaries, placenta, adipose tissue, and testes, and that stimulate the development of female secondary sex characteristics and promote the growth and maintenance of the female reproductive system.

Female Athlete Triad - The combination of three interrelated conditions that are associated with athletic training: disordered eating, amenorrhea and osteoporosis (http://www.aafp.org/afp/20000601/3357.html).

Infertility - The condition of being incapable of or unsuccessful in achieving pregnancy over a considerable period of time in spite of determined attempts by heterosexual intercourse without conception.

Luteal Phase - This relates to or is characterized as related to the corpus luteum.

Menarche - The beginning of the menstrual function or the first menstrual period of a female.

Menstrual Cycle - The whole cycle of physiologic changes from the beginning of one menstrual period to the beginning of the next.

Menstrual Dysfunction - The dysfunctional uterine bleeding (DUB) is defined as abnormal bleeding in the absence

of intracavitary or uterine pathology and most commonly is associated with anovulatory menstrual cycles and systemic or medical conditions, but may coexist with intrauterine pathology (http://www.clevelandclinicmeded.com/diseasemanagement/women/menstrual_dysfunction/menstrual_dysfunction1.htm).

Oligomenorrhea - A condition of abnormally infrequent or scant menstrual flow or a cycle length greater than thirty-five days.

Osteopenia - A reduction in bone volume to below normal levels especially due to inadequate replacement of bone lost to normal lysis.

Ovulation - The discharge of a mature ovum from the ovary.

Ovum - A mature egg that has undergone reduction, is ready for fertilization, and takes the form of a relatively large inactive gamete providing a comparatively great amount of reserve material and contributing most of the cytoplasm of the zygote.

Progesterone - A female steroid sex hormone that is secreted by the corpus luteum to prepare the endometrium for implantation and later by the placenta during pregnancy to prevent rejection of the

developing embryo or fetus and that is used in synthetic forms as a birth control pill, to treat menstrual disorders, and to alleviate some cases of infertility.

CHAPTER 2

REVIEW OF LITERATURE

Along with the opportunity for women to participate in organized sport at the collegiate level and the increased popularity of women's athletics comes a unique set of risks for the female athlete. Specifically, the stress of intense physical training and the psychological stress of competition are being linked to a number of exercise-associated abnormalities and dysfunctions of the reproductive system. These abnormalities and dysfunctions have manifested as amenorrhea, menstrual dysfunction, disordered eating, osteoporosis, anovulation, and infertility (Baker, 1981; Greenfield, 2001; Holschen, 2004; Lebrun, 2002; Pfeifer & Patrizio, 2002; Putukian, 1998; Van den Akker, 2002; Warren & Perlroth, 2003; Wilson, Braunwald, Isselbacher, et al., 1991).

Studies by these experts have identified various factors that are believed to be interrelated and detrimental to the reproductive system of female athletes. Although literature pertaining to these studies does not prove that infertility is more prevalent in female athletes than in the general female population, experts are finding evidence that female athletes do experience exercise-

associated conditions and pathologies specific to the psychological and physical stresses of participating in women's sport.

Baker (1981) has determined that increased involvement of more women in physical fitness and competitive endurance sport has also increased the occurrence of menstrual dysfunction in these women. Furthermore, Putukian's 1998 study compares the incidence of amenorrhea among female athletes and the general population, and the findings suggest that the prevalence of amenorrhea among female athletes is much higher. More recent research confirms these findings and has prompted further study into the interrelationships of conditions ranging from current health risks to future health issues such as osteoporosis and infertility (Lebrun, 2002). The review of this literature is presented in the following order: an examination of normal function of the menstrual cycle: ovulation; an overview of females involved in sport; fertility issues; amenorrhea; the female athlete triad: menstrual dysfunction, disordered eating, osteoporosis, and anovulation.

An Examination of Normal Function of the Menstrual Cycle: Ovulation

The normal functioning menstrual cycle, as identified by Pfeifer and Patrizio, requires an intact central nervous system and a properly functioning anatomy. Included in the central nervous system are the brain, spinal cord, and nerves. Included in the anatomy of the female gynecologic system are the vagina, uterus, and ovaries. When both the central nervous system and the gynecologic system are healthy, they produce a normal menstrual cycle of twenty-five to thirty-five days, which is made evident by predictable menstrual flow of three to seven days (Pfeifer & Patrizio, 2002).

Following a signal from the pituitary gland an egg is released from the ovaries, a pair of glands located in the pelvis that make the hormones estrogen and progesterone and carry eggs (Greenfield, 2001). The ovulation process continues as the egg travels down the fallopian tube to the uterus. If the egg (ovum) meets and is penetrated by a male sperm cell during the journey down the fallopian tube, the fertilized egg implants in the wall of the uterus where it grows and develops into a human embryo ("The Ovulation Process," 2004).

While the ovulation process appears to be quite simple, it is dependent upon other organs, processes, and systems being healthy and functioning normally. As noted, the ovulation process begins in the hypothalamus of the brain where the gonadotropin releasing hormone (GnRH) is produced, and the ovulation process prepares to enter the following three cycles:

Early Cycle. The GnRH communicates to the pituitary gland that it is time to begin the ovulation cycle. The pituitary gland then signals the ovaries to release an egg by sending out the follicle-stimulating hormone (FSH) to stimulate a few of the follicles to develop into mature eggs. As the follicles mature, one follicle becomes dominant. The other eggs die off, and the dominant follicle becomes the only one to mature. When the dominant follicle has matured, the follicle sends out a large amount of the estrogen hormone to tell the ovary that there is an egg; the estrogen also tells the pituitary that the ovary is ready to release its egg (Greenfield, 2001).

Mid-Cycle. When the pituitary gets the estrogen signal from the ovary, the pituitary releases luteinizing hormone (LH), which signals the follicle to go ahead and release the egg. Within twelve to twenty-four hours after

the release of the LH, ovulation occurs (Greenfield, 2001). Within this phase experts believe that physical stress becomes an important variable in a female athlete's menstrual cycle. Figure 1 illustrates the levels of release of both the luteinizing hormone (LH) and the follicle-stimulating hormone (FSH) during a normal menstrual cycle.

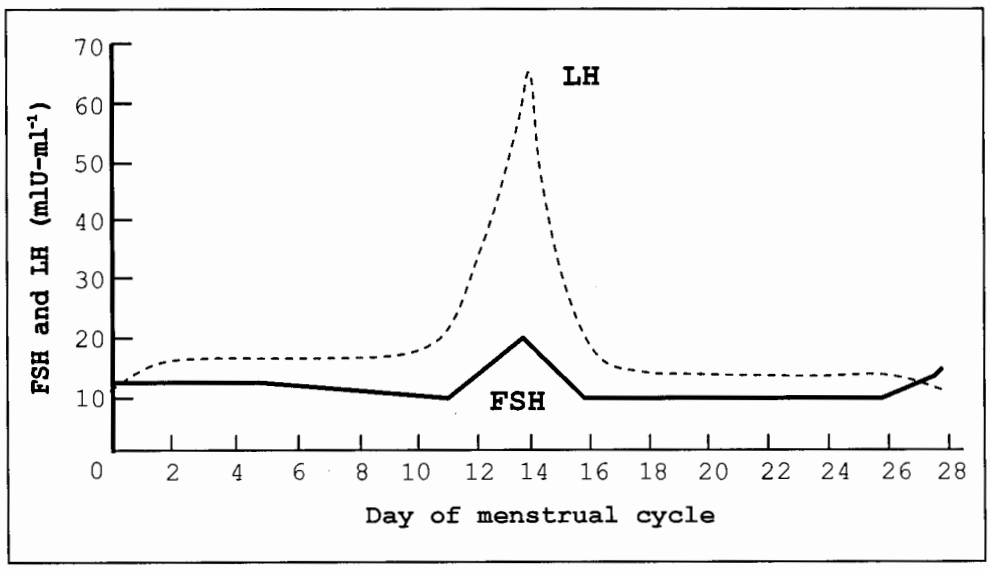

Figure 1.

Release of LH and FSH during normal menstrual function. Lebrun, 2002. Copyright 2002 by Lippincott, Williams and Wilkins. Adapted with permission from the author.

Late Cycle. The dominant follicle from which the egg is released forms a type of cyst called the corpus luteum. The corpus luteum will release progesterone for about

twelve to sixteen days (the luteal phase of the cycle) to help thicken and prepare the uterus lining for implantation. Once an egg is fertilized and implanted in the uterine wall, the egg begins to produce human Chorionic Gonadotropin (hCG). The presence of hCG tells the ovary to continue to produce progesterone until the placenta takes over (Greenfield, 2001). Figure 2 depicts the different amounts of estrogen and progesterone during the two phases of a normal cycle: follicular and luteal.

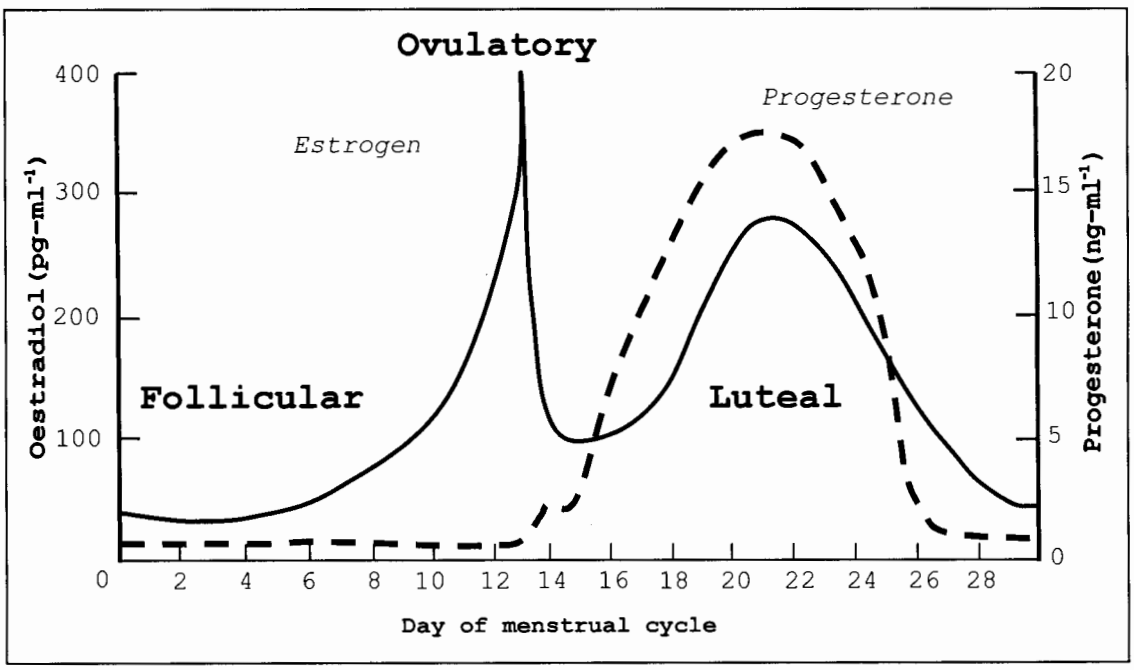

Figure 2.

The endocrine events of the menstrual cycle. Lebrun, 2002. Copyright 2002 by Lippincott, Williams and Wilkins. Adapted with permission from the author.

Any alteration of any of the endocrine events can interrupt ovulation and cause menstrual dysfunction. If at any point in the ovulation process the organs, processes, or systems do not function normally, any number of problems may arise. Furthermore, studies of female athletes who are active participants in competitive or physical activity show that the effect of physical training or competition can have a powerful influence on the physiological and emotional health of the athlete.

Overview of Females Involved in Sport

Following the adoption of Title IX, the female athlete was granted equal opportunities to participate in college athletics equivalent to her male counterpart. Physiologically the female athlete in the prepubertal stage is equal in strength, aerobic power, heart size, and weight to a male athlete. On the other hand, Holschen (2004) suggests that the female body undergoes physiologic changes with the onset of puberty and that the rise in levels of female sex hormones does affect bone mass, lean body mass, circulation, and metabolism. However, the equivalency recognized in Title IX stands, and female athletes have support and preventive techniques to keep them performing at their optimum. The research reflects that the disparity

in performance and injury patterns between males and females has become less pronounced even though women have become more active in sport at a younger age because training and conditioning techniques have appropriately been applied to the female athlete. However, research finds that female athletes have also acquired a unique set of risk factors associated with strenuous exercise relating to sport (Lebrun, 2002).

The risk factors for poor reproductive health that are closely associated with the female athlete in sport are such things as significant weight loss, decreased body fat, excessive strenuous exercise, the physical stress of training, and the emotional stress of training or competing. In addition, certain risk factors are presenting themselves that are detrimental to the menstrual cycle of women, thus affecting fertility; research experts are also finding a greater correlation in infertility and the female athlete (Warren & Perlroth, 2001).

Fertility Issues

Infertility is defined as the "inability to conceive a pregnancy after one year of unprotected intercourse or the inability to carry a pregnancy to term" (Harkness, 1992, p. 368). Female infertility issues may stem from a long list

of different causal factors of which some may not be at all obvious or may not even seem likely. Anxiety, fear, and other psychological effects are examples of emotions that have not been thought to affect fertility in the past. For example, only recently Van den Akker (2002) states that anxiety can adversely affect blood pressure, hormonal function, and other biochemical and neuroendocrine activities. For an athlete, anxiety can be a common feeling experienced before, during, and after every practice, contest, or performance. If female athletes are exposed to a constant increase in their level of anxiety, anxiety can be detrimental to their hormone levels, thus affecting their menstrual cycle.

On the other hand, research also states that infertility is not more prevalent among athletes than for the general population (Birrer, 1994). Still, although there is not a reported increase in incidence in infertility in non-athletes as compared to infertility in female athletes, experts suggest that athletes are exposed to many risk factors that make them more susceptible to dysfunctional menstrual cycles. The spectrum of the problem of infertility in female athletes compared to their counterparts is the impairment of fertility due to these

higher rates of menstrual dysfunction, which include such conditions as amenorrhea, oligomenorrhea, the female athlete triad, anovulation, and the luteal phase deficiency.

According to Baker (1981), the increased involvement of women in physical fitness and competitive endurance sport has increased the likelihood of menstrual dysfunction. As a result of the increase in menstrual dysfunction in female athletes, much attention has been paid to the relationship between sport participation and the female reproductive system. In addition, participation in sport may lead to alterations in gonadotropins, androgens, estrogens, progesterone, or prolactin, which in some women may directly or indirectly result in amenorrhea or infertility.

When females experience a normal menstrual period, the hormones released from the hypothalamus, pituitary gland, and ovaries work together in a functional manner to maintain a normal menstrual cycle which usually lasts twenty-five to thirty-five days and will occur ten to thirteen times per year. In the course of a menstrual cycle the gonadotropin releasing hormone must be produced by the hypothalamus in sufficient quantity where it is

released to the portal vessel and travels down the pituitary stalk to the cells in the pituitary gland. The pituitary gland in turn produces the luteinizing hormone and follicle-stimulating hormone (Drinkwater, 2000). On approximately the fourteenth day a burst of LH from the pituitary gland causes the ovarian follicle to rupture and release an egg. Any disruption in this balance can lead to menstrual dysfunction and amenorrhea or olgiomenorrhea (Wilson, et al., 1991).

The reproductive system of the female athlete is a mechanism that is highly sensitive to physiological stress, and reproductive abnormalities may result. Examples of such abnormalities are delayed menarche, primary and secondary amenorrhea, and oligomenorrhea. Other observed irregularities and abnormalities vary with athletic discipline and level of competition. Experts have also determined the predisposition for menstrual irregularities through studies of the hormonal profiles of women engaged in sport which emphasize low body weight. M. P. Warren and Perlroth (2001) state that women who engage in sport emphasizing leanness may experience suppression of reproductive function, a neuroendocrine adaptation to caloric deficit.

As shown in Table 1, the investigators discovered that six to seventy-nine percent of women engaged in athletic activity are susceptible to menstrual irregularities. The first number listed in the table signifies the percentage of individuals who reported oligomenorrhea. The number listed second signifies the percentage of individuals who reported amenorrhea.

Table 1. The prevalence in different athletic disciplines of menstrual irregularities (oligomenorrhea and amenorrhea).

	Study	Number of subjects	Percentage with irregularities
General population	Petterson et al. (1973)	1,862	1-8
	Singh (1981)	900	5-0
Weight-bearing sports			
Ballet	Abraham et al. (1982)	29	79-0
	Brooks-Gunn et al. (1987)	53	59-0
	Feicht et al. (1978)	128	6-43
	Glass et al. (1987)	67	34-0
Running	Shangold & Levine (1982)	394	24-0
	Sanborn et al. (1987)	237	26-0
Non-weight-bearing sports			
Cycling	Sanborn et al. (1987)	33	12-0
Swimming	Sanborn et al. (1987)	197	12-0

Warren and Perlroth, 2001. Adapted with permission from the author.

Amenorrhea

Scuderi and McCann (2005) define amenorrhea as the absence of three or more consecutive menstrual cycles in a female who has had at least one previous menstrual cycle. Drinkwater (2000) defines oligomenorrhea as fewer than eight menses per year with menstrual cycles longer than thirty-five days; oligomenorrhea is typically associated with anovulation. Authors Schwartz, Shangold, Levine, Sanborn, and others agree that the prevalence of menstrual irregularity and amenorrhea is higher among women athletes than the general female population and is more prevalent among runners than among cyclists or swimmers (as cited in *Women in Sport*, 2000). C. A. Dueck, Manore, and Matt (1996) state that the bias in group selection, the inconsistency in the definition of amenorrhea, and the lack of reporting have led to the wide variance of reported incidences of amenorrhea among female athletes. However, Putukian (1998) concludes that the prevalence of amenorrhea is much higher in female athletes, compared with the general population: the range within athletes is from 3.4 percent to 66 percent, compared with two percent to five percent in the general population.

Also to be considered is hypothalamic amenorrhea, which experts recognize as the equivalent of exercise-associated amenorrhea or secondary amenorrhea (Lebrun, 2002). In hypothalamic amenorrhea the gonadotropin releasing hormone is deficient, inappropriately secreted, or absent completely in the hypothalamus, and thus is not released. Another observation may be that the female athlete with exercise-associated amenorrhea often has an inadequate nutritional status in which case she is likely to weigh less and to have lost more weight after the onset of vigorous physical activity (Schwartz, Cumming, Riordan, Selye, et al., 1981). Therefore, if a female athlete makes extreme changes in her workout regime and training, a menstrual dysfunction can result. Athletes who suffer from hypothalamic amenorrhea can experience a significant change in weight loss, fat loss, nutritional inadequacy, and/or hormone alterations which, when teamed with physical stress or emotional stress, can all trigger abnormal menstruation.

According to Schwartz, Cumming, Riordan, Selye et al. (1981), the condition athletic amenorrhea is common among women who participate in athletics. This exercise-related amenorrhea is thought to be so athlete specific that amenorrhea is part of the female athlete triad; the other

two parts of the triad are disordered eating and osteoporosis. Schwartz et al. (1981) find that the athlete with exercise-associated amenorrhea often has an inadequate nutritional status; however, female athletes who suffer from amenorrhea do not necessarily suffer from an eating disorder. In contrast, research suggests that athletic participation in sport, particularly those that emphasize leanness, increases the risk for disordered eating (Scuderi & McCann, 2005). In a study by Warren and Goodman (2003), they find that physical exercise alone does not cause menstrual irregularities. Rather, they conclude that chronic inadequate or restrictive caloric intake that does not compensate for the expended energy in physical activity is a more likely cause of menstrual irregularities.

Fortunately, amenorrhea as an exercise-induced condition can be treated through an increase in nutritional intake and decrease in exercise. Most frequently amenorrhea is associated with those aerobic-type activities associated with lower bodyweight and fat percentages including such athletes as gymnasts, ballet dancers, fencers, rowers, and long-distance runners. Athletes who increase aerobic-type activities are particularly at risk because the percentage of body fat to support the minimum

ratio of fat to lean mass that is normally necessary for menarche is approximately seventeen percent, and the maintenance of female reproductive ability is approximately twenty-two percent (Frisch, 1987). The high percentage of body fat in women may influence reproductive ability directly, and evidence is presented that the high percentage of body fat, between twenty-six to twenty-eight percent, in mature women is necessary for regular ovulatory cycles. Consequently, to reverse amenorrhea and to return to a regular menstrual cycle athletes can gain weight, decrease exercise, or both gain weight and decrease exercise.

Female Athlete Triad: Menstrual Dysfunction

Menstrual dysfunction (amenorrhea), disordered eating, and low bone density, the female athlete triad, have been recognized as major health issues for the past fifteen years (Bradley, 2004). Individually each of these entities can cause negative changes in an athlete, but together they are significantly detrimental. Consequently, the triad can begin with disordered eating patterns, unintentional or intentional, which can then lead to menstrual disorders and finally to the decrease in bone density and osteoporosis. The triad should be a topic of concern for all female

athletes, but extenuating factors must also be addressed, for psychological and physical stresses such as competition, leaving home for the first time, and numerous lifestyle changes can also lead to menstrual changes. Birrer (1994) suggests that a normal menstrual function can tolerate a single alteration, but the combination of two or more factors will increase the possibility of menstrual abnormalities. Examples of these alterations include exercise to the point of exceeding energy supplies from a nutritional standpoint, altering body weight or percent body fat, and dieting in an obsessive fashion to the point of physical stress or emotional distress.

Female Athlete Triad: Disordered Eating

Typically, female athletes initiate a workout routine from their desire to lose weight through dieting. To some extent, all athletes are concerned with diet and body image, but in susceptible individuals, this preoccupation with their bodies can become obsessive. Disordered eating patterns cover a broad range of behaviors from simple food restriction to full blown anorexia and bulimia nervosa. Any sign or symptom of abnormal eating habits or preoccupations with food should be well noted since they

all can have significant implications for the female athlete.

A review of the literature finds that the symptoms of eating disorders and true eating disorders among female athletes range from less than one percent to as high as seventy-five percent (Gadpalle, Sandborn, & Wagner, 1987; Sundgot-Borgen, 1994; Warren, Stanton, & Blessing, 1990). Smolack, Murnen, and Rubie (2000) conducted a study that suggests that athletes, as a subgroup, have an even higher incidence of disordered eating than the non-athletic population. Compared to non-athletes, elite athletes seem to be at an increased risk for eating disorders (Sundgot-Borgen, 1999), especially in sports promoting leanness (Nielsen, 2001) and in weight-class sports. Eating disorders are prevalent among this population and symptoms may to go unnoticed until a problem occurs.

Various factors have been hypothesized to be causal in the development of eating disorders; however, every situation is very individually based. According to a study of young elite swimmers as reported by Dummer et al. (1987), 60.5 percent of average-weight girls and 17.9 percent of underweight girls were trying to lose weight. A study conducted in 1999 by the NCAA concludes that

incidence of eating disorders among student athletes is more conservative than in similar studies, yet female athletes continue to report more disordered eating habits than their male counterparts (Johnson, Powers, & Dick, 1999).

Factors that may push a young athlete into feeling the pressures of disordered eating behaviors are included in the psychosomatic model, which comprises predisposing, precipitating, and sustaining factors (Powers, 1996). These factors are easier to understand with examples of each type of stress an athlete may undergo when facing different situations. Predisposing factors include the following: cultures idealizing the thin body, families who have poor problem solving skills, and obsessive-compulsive personality disorders. Precipitating factors include restrictive eating, a family death, being ridiculed about shape or size, and the onset of a developmental stage for which the athlete is unprepared. Sustaining factors are the emergence of the actual physiologic consequences of disordered eating habits or development of other psychiatric disorders. The stress that accompanies the athlete to compete at an elite level motivates her to

strive to be leaner in order to be faster, to have more endurance, and to maintain her ideal body image.

Researchers have found that body image for the female athlete is a highly sensitive yet critical aspect pertaining to the introduction of an eating disorder (Scuderi & McCann, 2005). The sensitivity of the female athlete toward how others perceive her body image has the potential to boost confidence in one athlete, but in another athlete sensitivity may lead to destructive behaviors if perceived negatively or less than perfect. An athlete's view of herself can often lead to a distorted self-portrait. Additionally, there is constant outside pressure for female athletes to possess the slender athletic body that is still viewed as feminine. Attaining this perfect figure only adds to the additional stressors placed upon the athlete. The very personality traits that push an athlete to strive to be the best and to reach the top of her game are also risk factors for the development of eating disorders (Scuderi & McCann, 2005) such as anorexia nervosa and bulimia nervosa.

Anorexia nervosa and bulimia nervosa are the two most prevalent eating disorders among athletes. Anorexia nervosa is characterized by self-starvation (Otis,

Drinkwater, Johnson, et al., 1997). The condition typically involves dramatic weight loss, restricted dietary intake, dramatic mood swings, and extremely controlled exercise regimes. The hallmark characteristic associated with anorexia is a distorted body image. The clinical signs include amenorrhea, minimal subcutaneous fat, muscle loss, dry hair and skin, bradycardia, and lanugo hair (Wiggins & Wiggins, 1997; Lebrun, 1994). The lanugo reaction is performed as a defense mechanism to keep heat within the body. Menstrual dysfunction, heart problems, and the development of lanugo hair are all the body's response to starvation. Experts Brownell and Rodin (1992) suggested that deaths associated with anorexia are usually attributed to fluid and electrolyte abnormalities or suicide.

In addition, Powers (1996) states that the most common cause of weight loss in adolescent girls in the United States is attributed to anorexia nervosa. Drinkwater (2000) reveals that symptoms of both disordered eating and eating disorders are more prevalent among female athletes than non-athletes. In addition, certain sport settings are more likely for the development of an eating disorder. Anorexics have an intense fear of gaining weight or

becoming fat even though they are typically underweight. Most individuals with anorexia nervosa do not recognize that they have a problem and, therefore, do not seek treatment. Only if these athletes see that their performance is suffering, might they consider seeking help.

Putukian (1998) and Dueck, Manore, & Matt (1996) suggest that bulimia nervosa and anorexia nervosa are similar in appearance: a distorted body image and a desire for thinness. Yet in bulimia nervosa, the body weight throughout the illness is generally above normal. The signature of the bulimic is that of a cry for help. Often, the person is aware of her disordered eating and is reaching out for assistance. Bulimia is characterized by binge eating, followed by some type of purging behavior; factors leading to binge eating may include inappropriate food restriction, overt hunger, and stress (Powers, 1996).

Research has no precise estimates of incidence of bulimia nervosa due to the secretiveness of patients, diverse study designs, and short diagnostic history (Nielsen, 2001). Regardless, the numbers are thought to be on the rise. According to Putukian (1998), the clinical signs of bulimia include changes in weight, facial swelling, decay of tooth enamel from multiple episodes of

vomiting, esophagitis, calluses on the dorsum of the hand, and enlargement of the parotid glands and cervical lymph nodes, causing menstrual irregularity. A number of other noteworthy warning signs include numerous visits to the bathroom, not wanting to eat with others, and an obsession with quantities of calories or food. Athletes suffering from bulimia are more difficult to identify because they are near, or at, normal weight and the condition could be disguised in an overweight athlete as well.

Another contrast between anorexia nervosa and bulimia nervosa is the sub-classification of the two divisions of bulimia nervosa into purging and non-purging. Purging involves such methods as laxatives, diuretics, vomiting, or enemas to counteract binge eating (Scuderi & McCann, 2005); whereas, non-purging types use other methods to compensate, such as fasting or excessive exercise (Scuderi & McCann, 2005). Disordered eating habits as a component of the female athlete triad parallel the notion that the cause for these conditions are a result of the stress and anxiety of competing in sport and not a direct cause of infertility. Of the three components of the female athlete triad: menstrual dysfunction, disordered eating, and bone density loss, disordered eating has the potential to turn deadly in

the short term and bone density loss can be deadly in the long run if not brought under control. Therefore, disordered eating habits when diagnosed as severe eating disorders, anorexia nervosa and bulimia nervosa, have been determined as critical and must be addressed.

Female Athlete Triad: Osteoporosis

In addition to amenorrhea and disordered eating practices, female athlete triad victims have a final concern to consider: osteoporosis. Directly correlated with the duration and severity of menstrual dysfunction, bone mineral density (BMD) is a major concern for female athletes (Drinkwater, Bruemner, & Chesnut, 1990; Voss, Fadale, & Hulstyn, 1998). Loss of bone density, or osteoporosis, is the third component to the female athlete triad.

As Warren and Goodman (2003) attest, the ramifications from bone loss density are many, but the most dangerous risk with amenorrhea for the female athlete is the impact on the skeleton. The ravaging effects on bone are due to estrogen deficiency, and a decrease in estrogen levels, common to amenorrhea, can affect bone density as well as the reproductive system. Consequently, when a young athlete suffers from amenorrhea, she may lose bone mass

that she has already built up, or she may have compromised the normal amount of bone that is typically gained during those crucial years. Young women with low estrogen amenorrhea before peak bone mass is obtained lose two percent of bone mass per year instead of gaining 2.4 percent per year. Although this disease begins in adolescence, it may not be expressed until late adulthood (Otis & Lynch, 1994). Warren and Perlroth (2001) report that low BMD in athletes is often associated with decreased levels of estrogen or hypoestrogenic amenorrhea.

Although estrogen status is thought to be a major factor in the development of osteoporosis and stress fractures, this is not the only factor. Manore (1999) suggests that factors which affect athletic amenorrhea include age of menarche, onset and duration of amenorrhea, total caloric intake, and type of physical activity. Treasure and Serpell (2001) report that both the degree of weight loss and the duration of amenorrhea or eating disorder are directly correlated to BMD determination.

Warren and Goodman (2003) establish that the complications associated with amenorrhea include compromised bone density, failure to attain peak bone mass in adolescence and increased risk of stress fractures.

Forty-eight percent of skeletal mass is attained during adolescence, and accumulation continues into the thirties (Benson, Gillien, & Bourdet, 1985). To be sure, the consequences of decreased BMD are not favorable. For example, even after the athlete re-establishes menses, she will still retain an increased risk of fracture after the competitive years are over (Glover, Maron, & Matheson, 1999). Prevention of substantial loss of bone mineral is therefore of utmost importance, and the simplified or natural way of fulfilling this goal is the resumption of normal menstruation. Research suggests that normal menstruation may be accomplished by weight gain and increased caloric intake (Lebrun, 2002). Intervention is suggested if menstrual disturbance lasts longer than six months as there are negative associated outcomes involved.

One of these outcomes is increased risk of osteoporosis, which is responsible for over 1,300,000 fractures per year in the United States (Putukian, 1998). Osteopenia, the least severe form of bone density loss, is believed to affect twenty-five million people in the United States alone and is the cause of 1.5 million fractures per year (Wiggins & Wiggins, 1997). One of the early warning signs of decreased BMD is a stress fracture. Stress

fractures occur in both male and female athletes and are the result of an imbalance between bone resorption and remodeling. Studies support that female athletes sustain more stress fractures than males (Scuderi & McCann, 2005). In relation to the female athlete, there is a set list of predictive risk factors for the occurrence of stress fractures. These factors are lower bone density, history of menstrual abnormalities, less lean mass in the lower limb, and diet lower in fat (Bennell, White, & Crossley, 1999). These predictors support the findings that nutritional and hormonal factors combine and directly affect overall bone quality, and the complications associated with suppression of specific hormones, such as GnRH and estrogen, validate the findings that the loss of a menstrual cycle is directly correlated to loss of bone density (Warren & Perlroth, 2001).

The triad is especially detrimental to the health of the female athlete when all three factors are allowed to progress without the proper care and attention, for each of the triad factors can be correlated to another. For example, research states that restrictive eating habits have been positively correlated with the incidence of stress fractures among dancers (Warren & Perlroth, 2001).

Similarly, the prevalence of stress fractures and multiple stress fractures has been associated with incidence of menstrual irregularities in runners (Barrow & Saha, 1988).

Anovulation

Stanton and Dunkel-Schetter (1991) deduce that in some ten to fifteen percent of women, infertility is due to failure of ovulation. A menstrual cycle that takes place without ovulation at all is termed as an anovulatory cycle. Anovulatory women have unopposed estrogen stimulation of the endometrium without the final addition of progesterone; having an anovulatory cycle means that the individual did not ovulate, in which case an egg was not released. Research reports that anovulatory women still more than likely shed the endometrial lining because the corpus luteum fails to release progesterone, the hormone that normally is released during the second phase of the menstrual cycle by the ovaries (Greenfield, 2001). Progesterone is necessary to get the uterine lining ready for implantation of the early fertilized egg. Since the ovaries release this hormone after an egg has been released, a common blood test can be performed to check for evidence of progesterone.

Chronic stress may produce an effect upon the body that results in anovulation. This type of stress-related anovulatory amenorrhea is seen in athletes and is hypothesized to be caused by excessive exercise itself, the physical stress of training, the emotional stress of competing, or a combination of these (Haycock, 1980). Failure of the normal function of the hypothalamus, the pituitary gland, the ovaries, and/or the corpus luteum or other body systems to secrete their hormones in proper sequence and in sufficient quantity can all result in anovulation (Greenfield, 2001).

CHAPTER 3

SUMMARY AND DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Summary and Discussion

Only a short time ago, infertility was more accepted than treated. Today infertility is a clinical problem that can be extensively evaluated and often successfully treated. The deep rooted explanations of the issue of menstrual dysfunction leading to infertility among female athletes can stem from the high demands placed on the elite athlete, or they can be explained by the physiological stresses from strenuous physical training or competition to which all female athletes are subjected and place her at risk. While experts and studies can point out possible causes and solutions, the female athlete's responsibility is to recognize and seek treatment for menstrual irregularities, which often can have successful results.

Many young females engaged in sport have high demands that include performance anxiety and pressure from many sources placed upon them. These female athletes are more vulnerable physically to the stresses because they are also in their reproductive years. The review of literature reveals a correlation in the ways that anxiety, fear and other psychological effects influence physiological

functioning. For example, anxiety has been shown to negatively affect blood pressure, hormonal and other biochemical and neuroendocrine functions (Van den Akker, 2002). Furthermore, athletes can be subjected to these highly stressful situations from grade school through college.

The alterations in the concentrations of reproductive hormones that have been shown in association with exercise might represent the potential causes of infertility for these female athletes. Exercise produces hormonal changes and in moderation does not affect the menstrual cycle, but excessive exercise may result in an anovulatory cycle. The more intensive and prolonged the exercise is the more pronounced the changes. The hormonal changes in younger athletes produced by prolonged and strenuous exercise, specifically when intense competition is involved, require careful monitoring for potential effects on the delay of menarche and the onset of puberty since the changes have proven to be detrimental to both. Stress, anxiety, a recurrent increase in body core temperature produced by strenuous physical activity, and an inadequate diet are among the most important factors that can affect these hormonal alterations (Arena & Maffulli, 2002). Yet again,

physical exercise has definite positive effects on overall health, but once the regime combines intense competitive physical exercise and decreased caloric intake, there poses a potential for negative effects.

This literature review examined the available body of published research pertaining to the incidence of menstrual dysfunction in the female athlete. Specifically, the purpose of this study was to (1) review the consequences of menstrual dysfunction in the female athlete, (2) examine the compounding factors of psychological stress of competition and the physical stress of training on menstrual function, and (3) investigate the negative long term effects of the female athlete triad on the reproductive system.

Holschen (2004), examined female athletes and found that irregular menses and anovulation more frequently occur in athletes (up to sixty percent) compared with non-athletes (approximately five percent) with the percentage of those affected being sport dependent. Irregular menses are reported in up to twenty percent of casual runners and fifty percent of elite runners and professional dancers.

The incidence of infertility may be greater than expected (Warren & Perlroth, 2001) in reporting that the

incidence of inadequate luteal phase, anovulation, and oligomenorrhea are considerably greater in athletes than non-athletes. The exact incidence of these abnormalities is unknown; however, many athletes are actually suffering from hidden menstrual irregularities such as inadequate hormones during the luteal phase or anovulatory cycles, which cannot be determined without a blood test to check the levels of progesterone in the body. An athlete may appear to be perfectly normal in her menstrual cycles but may not be producing enough progesterone to release an egg. Therefore, if the athlete is trying unsuccessfully to obtain a planned pregnancy, she will need to have a progesterone test to determine whether or not she has ovulated.

Furthermore, a relationship to eating disorders and college athletics has been determined. College gymnasts with eating disorders reported that sixty-seven percent of these female athletes were told by their coaches that they were too heavy, and seventy-five percent admitted to use of vomiting, laxatives, or diuretics to maintain weight (West, 1998). Prior & Vigna (1985) and Drinkwater, Nilson, Ott, and Chesnut (1986) concluded that often a weight gain of one to two kilograms or a ten percent decrease in exercise

load, either in duration, or intensity, is sufficient to reverse reproductive dysfunction. Unfortunately for these highly trained athletes many will resist this solution, fearing that the decrease in training or increase in weight will compromise their performance.

Additionally, osteoporosis is a large concern for female athletes. Barrow and Saha (1998) found that the prevalence of stress fractures and multiple stress fractures has been associated with incidence of menstrual irregularities in runners. Those athletes suffering from menstrual dysfunction typically do not attain peak bone mass and may enter menopause with significantly lower bone density than normal women (Warren and Perlroth, 2001). The negative implication for a female who has not reached her maximum bone density as she ages is mainly susceptibility to fractures.

The female athlete remains less understood and less well studied compared with her male counterparts, especially in the areas of performance factors and repetitive stress. One of the potential reasons for this gap in research is the limited number of the high profile female athlete. The introduction of the female athlete onto the playing field has only spanned two generations.

Another aspect of the infertility debate is that there are fewer females involved in sport medicine, coaching, and research, but with the discovery of these areas of concern and the popularity of females in sport, the number of women in the sport field has increased. Given the significance of implications of menstrual dysfunction in the female athlete; specifically amenorrhea, disordered eating, and osteoporosis, the need for further examination of how to prevent disorders so that the needs and concerns of the female athlete can be addressed without compromising her ability to compete at the highest level seems highly reasonable.

Conclusions

Within the limits of this research paper, the following conclusions were made.

1. The consequences of athletic amenorrhea are secondary to the loss of estrogen. These consequences include decreased bone density, related body fat changes, and infertility.
2. Intensity of training, psychological and physical stress, inappropriate dieting, and decreased body fat are factors that contribute significantly to

menstrual dysfunction in competitive female athletes.

3. Disordered eating patterns can potentially impact overall health and have long-term consequences. These health problems include possible infertility, cardiac abnormalities, and osteoporosis.

Recommendations

The increase in popularity and opportunities afforded female athletes within the past thirty years have brought with them potential health, menstrual cycle, and fertility issues. For the female athlete who is trying to conceive, infertility is an issue that clearly has negative implications. In addition, the unfortunate side of infertility is that in a number of cases "menstrual dysfunction" has become an accepted explanation for a number of relationships between sport participation and the female reproductive system. Moreover, the fact that no single test can determine whether a woman is fertile or infertile leads to frustration when the athlete desires a planned pregnancy. Finally, the long term effects of the physical and emotional stress on the female athlete are inconclusive. Lebrun (2002) concluded that no evidence for

long-term harmful effects on the reproductive system can be found.

Still, evidence does suggest that in the studies of young athletes the threat of bias must be considered. Specifically, the number of studies performed on this topic is quite small, and data are based on a relatively small population of subjects. There is no way to determine how many, if any, studies were conducted and not published due to the lack of information relating to menstrual dysfunction. Since menstrual dysfunction is such a private issue and may only be brought to attention when a problem occurs, menstrual history may be overlooked. From the studies that have been conducted, experts concluded that the benefits of exercise outweigh the possibility of being negatively affected by infertility. The introduction of women onto the sport scene has been growing but is relatively new; thus, the compilation of the appropriate amount of information gathered from research in menstrual dysfunction and the female athlete may take years.

Currently, the need for more standardized screening, prevention, and treatment programs for menstrual dysfunction and eating disorders in schools is urgent. These educational institutions, which range from elementary

through college or university level, should at the minimum implement mandatory education in these serious medical conditions for all athletic personnel and athletes. The percentage of fat in the female is an important factor to consider in coaching, teaching, and in implementing a sport-specific conditioning program.

Female athletes frequently experience a variety of menstrual-related irregularities, including amenorrhea, anovulation, oligomenorrhea, irregular menses, and menstrual-related mood changes. These problems deserve careful evaluation as they may reflect normal ovulatory menstrual symptoms or be suggestive of significant pathological issues that could have a major impact on future reproduction and overall health. The menstrual cycle is a vital sign in which being regular suggests overall good health, and in such case an abnormality requires close evaluation.

To aid in the detection of menstrual disturbances, one instrument that can be utilized by health professionals, athletic trainers, and medical personnel is a supplemental health history questionnaire. This group of questions can be administered to female athletes in a very private manner, which may be the avenue to acknowledge a need for

intervention. Maintaining each individual's privacy is crucial, and the questions relate specifically to diagnosing menstrual dysfunction and the female athlete triad.

Supplemental Health History Questionnaire
for the Female Athlete

1. How old were you when you had your first menstrual period?
   _____
2. How many periods have you had in the last 12 months?
   _____
3. Have you ever gone for more than 2 months without having a menstrual period?
   Yes No
4. How long do your periods last?
   _____
5. When was your last menstrual period?
   _____
6. Do you take birth control pills or hormones?
   Yes No
7. Have you ever been treated for anemia?
   Yes No
8. What have you eaten in the last 24 hours?
   _____
9. a. Are there certain food groups that you refuse to eat (i.e. meats, breads)?
      _____
   b. Are you happy with your present weight?
      Yes No
   c. If not, what would you like to weigh?
      _____
   d. Have you ever tried to control your weight with
      ____fasting? ____vomiting? ____using laxatives?
      ____diuretics? ____diet pills?
10. Do you have questions about healthy ways to control weight?
    _____

Figure 3. Supplemental health history questionnaire for the female athlete. Lebrun, 2002. Copyright 2002 by Lippincott, Williams and Wilkins. Adapted with permission from the author.

Severe and prolonged disordered eating can negatively affect every organ system in the body, resulting in significant morbidity and even mortality. For athletes, even the relatively mild health effects of disordered eating can have a devastating impact on performance. For example, dehydration is common in individuals who restrict food intake, self-induce vomiting, and/or use large amounts of diuretics or laxatives. Attempting to train and compete in a chronically dehydrated state will decrease performance and may lead to acute complications, such as heat exhaustion or heat stroke.

Further, female athletes with disordered eating patterns are particularly prone to the development of menstrual dysfunction and subsequent premature osteoporosis. Currently, multiple efforts are underway to educate athletes about the effects that disordered eating patterns have on menstrual function and to develop prevention and treatment guidelines for the female athlete triad.

Because female athletes are at an increased risk of eating disorders, those associated with athletes must be cognizant of the expectations, performance demands, and other factors that may place them at risk. This awareness

can facilitate both early identification and treatment. Coaches and parents need to understand that their opinions and remarks about body weight can strongly influence an athlete's eating behaviors. To comment on a female athlete's body size or need for weight loss without measuring actual percentage of body fat or without offering guidance on how to healthfully meet desired goals may trigger the development of an eating problem in certain athletes who are eating-disorder prone. The coach should never punish an athlete or dismiss her from the team for an eating disorder or abandon the athlete after she agrees to seek treatment. Performance will most likely decrease during treatment, and expectations should be adjusted accordingly.

Finally, the importance of the need for responsibility within the sport community about the demand placed on female athletes to achieve unrealistic weight and body shape goals needs to be recognized. The athlete also must recognize the importance of accepting the responsibility to understand her body and its limitations. When body composition standards for a sport seriously compromise the health of the majority of athletes, the health of athletes becomes a grave concern for all of those involved.

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