

The Implications of the Female Athlete Triad on the Development of Second Metatarsal Stress Fractures in Professional Classical Ballet Dancers

Shira Lanyi
Honors Rhetoric, Biology
Virginia Commonwealth University
Richmond, VA

Faculty Advisor: Faye Prichard

Abstract

The professional ballet world is plagued by high injury rates that negatively impact both the ballet company and its dancers. Female dancers between the ages of 18 and 30 are particularly prone to stress fractures of the lower extremities and of the medial forefoot. Current research suggests that the incidence of dance injuries in women correlates with the symptoms of the female athlete triad. This triad is characterized by disordered eating patterns, amenorrhea, and bone mineral loss. The aesthetic nature of ballet and the desire to remain thin, lead many dancers to display the symptoms of the triad, and ultimately make them more prone to injury. How do second metatarsal stress fractures in professional female ballet dancers correlate to the female athlete triad syndrome and in what way can education and therapy reduce the prevalence of this injury in dance companies? I viewed the triad from the perspective that bone density loss is a physiological response to menstrual dysfunction. I reviewed primary sources that suggest menstrual dysfunction is symptomatic of nutrient deficit in females. I also reviewed research from the perspective that caloric deficit often leads to a reduction of resting metabolic rate and bone mineral density. Studies I found indicated that disordered eating in professional dancers is primarily a psychological and sociological response related to the extreme pressure to maintain an ideal body shape. I also reviewed research from the perspective that injury is related to ballet footwear and faulty technique. Results of my research suggest that the female athlete triad is a process that begins with an unhealthy body image and disordered eating patterns. Providing dancers, teachers, and administrators with the resources to acknowledge and address the serious implication related to the female athlete triad can diminish the excessively high rate of injury observed, enhance overall performance, and lengthen a career in professional ballet.

Keywords: Amenorrhea, dance, osteopenia.

Dancers are instruments, like a piano the choreographer plays. – George Balanchine

1. Body of Paper

For ten years I danced as a professional ballerina. My career took me to dance on international stages in New York, Chicago, Virginia, Washington D.C., Tel-Aviv, London, and China. My life was devoted entirely to my art and my instrument. My dance training began when I was eight years old and rapidly progressed in intensity and frequency as I entered high school. The rigorous training and pursuit of perfection led to a successful career. I played the roles of a lifetime and grew into the sylphlike enigma that defines a ballerina. My body had transformed into the aesthetic figure that defines classical ballet.

From the start of my dance training, I stared critically in the mirror at my body against the shapes and lines of the other girls around me. I read books, watched films, and pasted posters of renowned professional ballet dancers on the walls of my bedroom. Determined to become a ballerina, I found ways to shape my body in a way that would gain attention from my ballet teachers. By the age of 18, I had never menstruated and found myself consumed by the desire

to achieve perfection in dance through the mistreatment of my body. I experienced repetitive injuries throughout my professional career and, most commonly towards the middle of the season. The fear and paranoia of losing an opportunity to dance and be on-stage often led to my dismissal of pain. While my career was marked by eating disorders, injury, and menstrual dysfunction, I was not the only one. Dance injuries are reported by Liederbach (2010), a physical therapist at Harkness Center for Dance Injuries to inflict up to 97% of all professional ballet dancers.

Professional ballet places huge emphasis on the archetypal ballerina body type. This aesthetic is notably depicted as a below average body mass index, slender legs and thighs, overly arched feet, a flat chest, and hypermobility of the joints and muscles. Dancers are selected based upon their aesthetic appearance and are often forced to adopt unhealthy eating patterns in order to maintain the below-average body weight desired by the dance industry. The habitual low energy availability observed in ballet dancers is associated with the absence of regular menstruation, or amenorrhea. Lucas (2010) states that caloric restriction is the leading cause of exercise-induced amenorrhea. Delayed puberty is observed in up to 44% of the female dancer population, with these dancers showing the highest rates of stress fracture (Molnar, 2010, p.7). Chronic amenorrhea is strongly associated with osteopenia, or below normal bone mineral density in ballet dancers. The association between disordered eating, amenorrhea, and osteopenia is termed the female athlete triad syndrome.

The female athlete triad is a cascade of events that strongly correlates to the high rate of stress-fractures observed throughout the professional ballet community. Ballet related injuries are often associated with the extrinsic factors related to dance; poorly sprung dance floors, faulty technique, and footwear. The symbol of a ballerina is her pointe shoes and footwear is often faulted for the high rate of second metatarsal stress fractures observed in young professional dancers. However, intrinsic factors associated with the psychological disruptions observed in ballet dancers, hints at a pattern of behavior that ultimately corresponds to increased rates of injury.

The 97% injury rate observed in professional dancers proves detrimental both for the health of the dancer and for the financial stability of the ballet company. The bulk of injuries observed occur towards the middle of the performance season when dancers are often fatigued and overworked. Professional dancers work according to a seasonal performance schedule. The summer months are reserved for lay-off and the performance months are densely packed with rehearsal hours. A typical dancer's work day lasts eight hours with a forty-five-minute lunch break. The day begins with an hour and a half technique class, a highly demanding warm-up for the various rehearsals scheduled for the remainder of the day. One day off is granted at the end of the week, although two or more days are granted depending upon upcoming performance and rehearsal demands. The bulk of the season is spent in rehearsal, preparing the repertoire for presentation on stage for an audience. Drive, dedication, and perfectionism are qualities required for a professional ballet dancer to succeed in a competitive environment.

The highly competitive nature of a career in ballet and the pressures to remain thin prevent many dancers from reporting injury until daily activity is compromised. O'Malley (1996), reports that 80% of the female dancers diagnosed with second metatarsal stress fractures experience delayed menarche (p.91). Second metatarsal stress fractures are the most common of all injuries and require an average of 6.2 weeks for recovery (O'Malley, 1996 p. 92). The female athlete triad and its implications on the development of second metatarsal stress fractures suggest the need for proper counseling and education in the dance community. The high rate of injury and time lost due to injury not only pose financial loss for professional ballet companies, but also sacrifices the health and well-being of young women. Dance is a gift, a career filled with gratifying moments of expression, emotion, and joy. The career span of a ballerina is short, often due to the injuries sustained as a result of chronic overuse and poor nutrition.

Although the dance community views ballet as an aesthetic art-form as opposed to an elite athletic profession, the high rate of injury observed in professional ballerinas underscores the interplay between art and sports medicine. The prevalence of second metatarsal stress fractures observed in ballerinas symptomatic of the female athlete triad suggests the need for intervention because preventative and therapeutic techniques can effectively mitigate the frequency of dance-related injury.

Ballet is a performance based art-form that requires an elite mastery of skill and technical prowess in order to appear effortless before an audience. Ballet dancers pursue a career in dance in order to convey dramatic expression through the extraordinary use of their bodies. The primary goal in training for a career in professional ballet is the vigilant pursuit of perfection. Classical ballet dancers require above average flexibility, coordination, determination, and strength in order to successfully achieve professional status within a ballet company. Classical ballet roots itself in tradition and therefore demands the rigorous maintenance of certain aesthetic qualities. The sylph-like ballerina is the desired body shape determined suitable for a career in professional ballet. The ideal female dancer's body is described by Warren (1989) as narrow hiped, small busted, and slender legged, displaying minimal muscular bulk (p.66).

Despite classical ballet's deep roots in traditions of the past, it is nonetheless an athletic endeavor that requires extensive physical training. Liederbach (2010) states that many professional ballet companies do not incorporate modern principles of training into the dancer's work-day and are therefore ill-prepared for the stresses associated with

physical injury. Dance injury results from the complex interplay between intrinsic and extrinsic factors. A broad definition of dance injury categories according to Liederbach (2010) are the occupational demands, movement demands, and training oversights.

The aesthetic nature of a career in professional ballet lends itself to a variety of psychosocial symptoms related to the extreme stresses related to the competitive environment. Most notably, the desire to maintain a thin physique, both from internal pressures as well as environmental influences, results in chronic nutritional deficiencies. According to Lucas (2010), ballet dancers consistently weigh 10% to 12% below ideal body weight (p.146). Disproportionately low body weight in professional ballet dancers is achieved through low energy consumption and extreme dieting behavior.

Dancers are often encouraged when they appear to lose weight. When a dancer's body weight fluctuates below a healthy level, artistic staff and coworkers positively reinforce the restrictive behavior, ultimately placing the dancer at increased risk for fatigue and injury. Glace (2008) states that dancers train from a young age with coaches and teachers who stress the connection between performance and low body weight. Between 1% and 25% of all dancers characterize the symptoms of extreme eating disorders like bulimia and anorexia (p.5). Liederbach (2010) states there is a far greater incidence of disordered eating amongst female dancers. Disordered eating, defined by the Women's Task Force of the American College of Sport's Medicine is chronic, often ritualistic, and compulsive eating patterns (p. 6).

A dancer's body is equivalent to a musician's instrument. The identity of a ballerina is bound to her body-image. Liederbach (2010) states that sense of self is often formed "as a result of the perception of how others see the dancer, wherein the dancer develops a role identity instead of a self-identity" (p. 7). The performance-oriented environment emphasizes the externalization of goals and vigilant self-surveillance. Daily body judgment is a threat to self-esteem and can lead to self-destructive behaviors. Turner (2003) found that the classical ballet environment often generates social pressures that regard the body as an aesthetic tool subject to the preferences of the community. Dancers adopt the attitudes, dispositions, and tastes of the ballet institution. These preferences are reflected in how dancers view and treat their bodies.

Female dancers consuming below adequate calorie levels does not always indicate the diagnosis of an eating disorder. A rigorous schedule will often not permit a dancer to balance intake with energy expenditure, leading to an overall deficit. Reduced caloric intake is one of the leading causes of menstrual irregularity observed in young females.

Menstrual irregularity is commonly understood as a consequence of low energy availability for the body to carry out normal physiological function. This includes endocrine function, thermoregulation, and cellular maintenance. Lucas (2010) suggests that these deficiencies in energy availability coupled with energy expenditure may lead to a decrease in resting metabolic rate. The suppression of these basic biological functions have adverse consequences on the female body as a unit. The suppression of normal reproductive function is most highly correlated with a reduced energy availability. Exercise-induced amenorrhea results in the lower than average bone-density levels recorded in female ballet dancers. An energy deficit of 30 kcal/kg of fat-free mass per day is associated with the development of the female athlete triad. Dancers historically report up to 80% below ideal caloric intake, creating a deficit compared with energy expenditure (p.149).

Secondary amenorrhea refers to the loss of menses while primary amenorrhea refers to the absence of an initial menstrual period all together. Glace (2008) states that female dancers have a 69% occurrence of secondary amenorrhea compared to only 5% found in the general public (p.4). Exercise alone is not a cause of amenorrhea. Caloric deficit displays the strongest correlation to menstrual dysfunction observed in elite female athletes. Burckhardt (2011) states that females accrue the bulk of their bone density during adolescence and into early adulthood. In normal growth, females experience an imbalance between growth in stature and bone mineral density. The mineralization of bone falls several years behind growth rate until menstruation occurs. This critical period is characterized by increased risk of stress fracture. Pubertal delay, in conjunction with amenorrhea, delays the maturation of the skeleton and consequently, the risk of fracture is maintained. Amenorrheic female dancers between the ages of 18 and 30 are at high risk for the development of osteopenia and bone mineralization deficits (p.52).

Restrictive eating patterns are associated with poor bone quality. Kaufman (2002) found that the long-term energy restriction observed in ballet dancers coupled with exercise-induced amenorrhea are strongly associated with low bone density and a depressed metabolic state (p.2779). While it has been previously suggested by Glace (2008) and Burckhardt (2011) that hypoestrogenism is the primary cause of osteopenia, studies by Kaufman (2002) and Lucas (2010) suggest leptin levels may also be operative in the development of osteopenia. Leptin is a hormone secreted by fat cells whose receptors have been found in bone tissue. The presence of these receptors in bone tissue is suggestive of leptin's role in laying down new bone growth and the regulation of metabolic rate. Kaufman (2002) states that depressed resting metabolic rate, bone density, and leptin levels are observed in female dancers with hypothalamic

amenorrhea (p.2780). These findings suggest a strong correlation between the long-term restrictive eating patterns observed in ballet dancers, amenorrhea, and bone density levels.

One of the largest factors associated with the chronic dieting behavior and menstrual irregularity observed in professional female dancers, is the body's adaptation to malnutrition. Studies by Lucas (2010) indicate that the resting metabolic rate of irregularly menstruating dancers is significantly lower compared to pair matched non dancers of similar height and weight. Despite higher composition of lean body mass and active life-style, amenorrheic dancers consistently display depressed metabolic activity. These findings were also supported by Kaufman (2002). Lower bone density is associated with both lower hormonal leptin levels and a decline in resting metabolic rate in women currently or previously experiencing menstrual irregularity. Poor bone turnover and low bone density are often the result of a slowed metabolism due to consistent calorie deprivation. These studies indicate the strong correlation between osteopenia, depressed metabolic rate, and the physiological adaptation to low energy intake. The chronic restriction of caloric intake, prolific in professional ballet dancers, is often manifested in the form of stress fractures.

Stress fractures are overuse injuries commonly observed in elite athletes during periods of fatigue and overtraining. A stress fracture is a process rather than an event and develops over the course of several weeks due to repetitive strain in a localized area. O'Malley (1996) states that injury to the base of the second metatarsal is the most common injury cited in professional ballet dancers. Delayed menarche, or late puberty, is reported in up to 80% of female dancers treated for second metatarsal stress fractures (p.89). O'Malley (1996) found that the incidence of secondary amenorrhea was twice as high in females diagnosed with stress fractures than those with normal menses. Delayed menarche is also a significant factor in the development of second metatarsal stress fractures. The later the age of initial menses, the higher the likelihood of stress fracture development. While menstrual dysfunction and amenorrhea are strong factors in the development of a stress fracture, the etiology of the injury is multifaceted.

A heavy schedule during performance season increases the incidence rate of injury. Molnar (2008) states that the most probable cause of stress fractures observed in the lower extremities is muscle fatigue. While muscle fatigue is cited as a significant factor on stress fracture development, the findings of Lucas (2010) or Kaufman (2002) are not unsupported by these claims. Fatigue and limitations in energy consumption either due to aesthetic concerns or a busy schedule, lead to an energy deficit. This deficit will manifest itself in women as menstrual abnormality and likely bone tissue loss. The highest incidences of the stress fractures are viewed in 18 to 25 year olds. This age range correlates with the younger, less experienced dancers. These dancers are typically rehearsed longer hours with fewer rest periods, and also pressured to maintain the aesthetic look required in ballet. Fatigue, poor technique, and psychological stress are all factors that contribute to the rate and severity of stress fracture occurrence.

Bone mineral density is typically accrued during the time of menstrual onset until age thirty in females. Warren (2008) suggests that cortical bone mass may increase with increased physical activity as measured by dual-photon absorptiometry in adolescent boys and girls. Due to the caloric restrictions often noted in female dancers with hypothalamic amenorrhea, bone mineral density levels are often depleted despite weight-bearing exercise. This suggests a strong correlation between decreased bone mineral density, delayed menarche, and stress fracture frequency. A delay in sexual development may adversely affect bone accrual despite the positive affects weight-bearing exercise has on bone density levels. Insufficient energy consumption correlates with the development of exercise-related amenorrhea and may be an adaptive response to chronic low energy intake. Warren (2008) also suggests that hormonal levels of leptin found in bone tissue may signal the regulation of bone mass and may account for the high rates of stress fractures reported in amenorrheic young women.

Many dancers fail to report injuries at the onset of symptoms due to the competitive environment and short career span in professional ballet. This under-reporting lead the authors to suggest that the incidence of injury is higher than recorded. The etiology of stress fractures at the base of the second metatarsal is multifaceted. Risk factors primarily include amenorrhea, anorexia nervosa, and structural problems of the foot. The incidence of stress fractures in females is twice as high in dancers with stress fractures than those without (p.92).

The en pointe position, unique to ballet dancers, is also cause for the prevalence of second metatarsal fracture. The biomechanics of the foot in the en pointe position places stress at the tarso-metatarsal junction. This is the region where stress fracture most often occurs.

Although research has shown that weight-bearing exercise increases bone density accrual in women with hypothalamic amenorrhea during adolescence, however, prolonged menstrual dysfunction in exercising young-women indicates lower bone mineral density because menstrual dysfunction is known to be linked to higher frequencies of stress fractures within this population due to compromised reproductive and nutritional health.

The development of eating disorders, the first sign of the female athlete triad, has been tied to psychological and social pressures associated with a career in professional ballet. Turner (2003), claims that although ballet injuries are accepted as a sign of occupational loyalty, injury destroys the dancer's identity because the ballet environment generates social pressures that regard the body as an aesthetic tool subject to the preferences of the group. Ballet

dancers adopt a self-image that is considered ideal by the ballet institution and their peers. The acceptance of pain is a requirement for a career in professional ballet. As a result, many dancers show high levels of pain threshold compared to non-dancers. The psychological pressures to remain on stage and not lose time from work often leads dancers to ignore the signs of injury. Liederbach (2008) agrees with the previous arguments and also states that many dancers continue to dance on an injury because of anxiety related to loss of performance opportunities and peer judgment. The psychological stress associated with a career in professional ballet shows a strong correlation to the time spent from injury to recovery. O'Malley (1996) finds that many dancers fail to report injuries due to the competitive environment and short career span in professional ballet.

A ballerina's body is her identity and therefore an injury becomes a crisis of self. Dancers often overlook pain and "work through" physiological symptoms of injury in order to continue performing. Liederbach (2008) states that due to the brevity of the career, the extreme competition, and low income associated with professional dancers, only 20% of injured dancers receive medical attention (p.7). It is also suggested that 47% of professional dancers continue to dance on an injury because they fear the loss of performance opportunities as well as peer judgement. Within this same statistical group, 35% show signs of clinical depression through the Hamilton Depression Rating Scale with 100% admitting to suicidal thoughts (p.13).

Psychological distress is often a symptom related to the development of eating disorders. Liederbach (2008) claims that dancers receive positive reinforcement when they appear to lose weight and often gain recognition from administrators and fellow dancers. Glace (2008) also claims that dancers train from a young age with coaches and teachers who stress the connection between performance and low body weight. The emotional, hormonal, and psychological health of the whole dancer are of importance in the healing process from injury.

A skewed sense of self is amongst many of the occupational demands placed on professional dancers. Liederbach (2008) states that up to 40% of ballet dancers experience performance anxiety which has been linked to injury due to the heightened levels of muscular tension and anxiety. The externalized nature of a performance based career has been shown to heighten negative personality traits including depression, fear of failure, and extremely low self-esteem. The psychological stresses associated with a career in professional ballet shows a strong correlation to the time spent from injury to recovery. Liederbach (2008) found that 78% of ballet dancers report experiencing feelings of stress and negativity in the work place on a day to day basis.

The most conditioned and psychologically stable dancers will also become injured due to the intensity and nature of the extreme movements in classical ballet. Every ballet dancer's body differs in joint structure and flexibility and therefore requires varying levels of conditioning in order to enhance technique and reduce the incidence of injury. The female dancers are particularly susceptible to injuries of the foot and ankle due to the demands placed on the lower extremities coupled with complications related to the female athlete triad.

The female athlete triad plays a major role in the development of second metatarsal stress fractures in female classical ballet dancers. Caloric deficit is a primary factor in the development of many of the injuries reported in professional ballet dancers. The desire to remain thin, little rest time, and the pressure to maintain a desired aesthetic lead many females to adopt unhealthy eating rituals. This is not to say that all caloric deficiency is the result of anorexia or bulimia, but many dancers also report a high rate of these disorders.

The rigorous training required to pursue a career in professional ballet begins at a very young age. Young girls are encouraged to maintain a shape desirable by their teachers and coaches in order to maintain a competitive edge against other dancers. Ballet training does not include meaningful education in the field of nutrition. There is a mismatch between what is nutritionally sound advice and what is expected of professional ballet dancers. This will translate into enhanced performance levels and a lower risk for chronic injury. A reduced injury rate is beneficial for the overall health of the dancer and also for the continued success of the ballet company.

The restrictive eating behavior characterized by many female ballet dancers, is profoundly detrimental and counterintuitive. Caloric restriction translates to a decrease in resting metabolic rate, hypoestrogenism, and bone density loss. The consequences of chronic energy deficiency pose a threat to the overall health and wellness of a woman as she progresses through life after a career in professional ballet. The symptoms corresponding to the female athlete triad are not easily reversed, and may impact a woman's bone health into adulthood. One of the largest factors associated with chronic dieting behavior and a history of amenorrhea, is the body's adaptation to malnutrition. Studies by Kaufman (2002) indicate that the resting metabolic rate in an experimental group of dancers with a history of amenorrhea remains suppressed despite return to normal menarche. Bone mineral density is also diminished within this group, leading often to the side-effect, osteopenia, or softening of bone mass. Kaufman (2002) states that these findings are indicative of a causal relationship between chronic restrictive eating behavior and a metabolic suppression that persists beyond the resumption of menarche.

Fatigue plays a substantial role in the development of the second metatarsal stress fractures observed in ballet dancers. Higher rates of injury occur towards the middle of the performance season and are observed in the less senior

dancers who have more hours of rehearsal and fewer breaks. Many professional ballet companies control the hours of the dancers through worker's unions, however, this is not universal. In order for the dancers and the company to avoid high rates of injury, a modified structure of the dancer's work day should be evaluated. Many professional dance companies provide only one day of rest a week. In many cases, during the weeks of performance, dancers receive fewer hours of rest and increased rehearsal and performance hours. This schedule coupled with the risks associated with the female athlete triad, drastically increase the chances of injury in professional ballet dancers.

In 2005, the Dance USA Task Force implemented an annual dancer screening process to create a standardized method for evaluating the psychological, physical, and emotional health of professional dancers. The Pre-Season Post-Hire Health Care Screen for Professional Dancers is a two component survey that consists of a health history questionnaire and a physical assessment performed by a licensed health care professional. The Dance USA Task Force created this wellness screening in order to improve the health and wellness of professional dancers in a meaningful and personalized manner. While this standardized assessment is exemplary in terms of format and composition, it is not implemented throughout all professional ballet companies. Very few professional dancers receive a follow-up session and therefore are left with little benefit from the assessment.

Liederbach suggests that the future effectiveness of dance injury prevention will rely upon a standardized screening and injury reporting method. These studies must measure the intrinsic factors of the dancer as well as the external and environmental factors that may have attributed to the onset of the issue. In time, these studies will produce a means to understand the mechanisms related to the onset of certain injuries and illnesses. On-site physical therapy clinics and nutritional counseling services that incorporate a biopsychosocial perspective are suggested to reduce the overall injury rates by providing easily accessible and free care for professional dancers. The most important step in providing the most effective treatment options for dancers is to gain a data base from clinical research to understand how reduction of injury will work over time. Analysis of a variety of treatment options geared toward common injuries will provide dancers and health care professionals with more standardized treatment options.

The most effective dancer screening programs will provide an understanding of the relationship between the intrinsic and extrinsic factors that impact a dancer's health and wellness. Clark (2014) found that standardized screening programs promoted a discussion of how artists are trained and supported in a professional environment. The availability of nutritional counseling, supplemental strength training, and mental health programs will help ensure the overall fitness of professional ballet dancers. Combining the knowledge of sports medicine with the artistic athleticism and prowess of professional ballet, an effective screening program may effectively promote the health and wellness of the whole dancer. Regular assessments will ensure dancers receive the quality of care and emotional support necessary in order to mitigate the consequences of the female athlete triad. A standardized screening process along with regular follow-up meetings with the necessary professionals will provide dancers with a complete wellness program necessary to promote a successful career and a healthy body for life.

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