# Osteoporosis in Female Athletes

**Raja Habib[1], Irsa Sajjad[*2,3] ,Tehniat Asif [4]**

[1] Department of Computer Sciences - IBADAT International University Islamabad, 44000, Pakistan
[2] Department of Management Sciences - IBADAT International University Islamabad, 44000, Pakistan
[3]Department of Mathematics and Statistics, Central South University Changsha, Hunan, China
[4] Department of Diet and Nutritional Science, IBADAT International University Islamabad, 44000, Pakistan
Emails: raja.habib@se.iiui.edu.pk; irsasajjad@yahoo.com;tehniatasif9@gmail.com

**Abstract**

Osteoporosis affects millions of women around the world, but female athletes are atparticular risk. These female athletes are at a higher risk due to the stress of their intensive workouts than the overall female population. In female athletes, the absence or suppression of menstruation results in a low peak bone mass, which weakens their bones. Combined with their physical activity, this domino effect dramatically increases their risk of stress fractures. Increased understanding of the dangers of osteoporosis may help female athletes avoid or decrease the symptoms of the disease. The purpose of this study is to educate female athletes on the need for **s**reening the techniques for identifying and treating this disease.

**Keywords:** Osteoporosis; Female Athletes.

## 1. Introduction

Osteoporosis is a condition that affects nearly 10% of the global female population and is especially common among female athletes. This disease is distinguished by a decrease in bone mass and density, as well as an enlargement of bone spaces, which results in porosity and fragility. With an increasing number of women of all ages participating in physical activity, the link between osteoporosis and female athletes is becoming a growing concern. It is estimated that over 6 million women compete in strenuous exercise around the world. Despite the health benefits of exercise, excessive and strenuous physical activity can harm the reproductive and skeletal systems, leading to osteoporosis. In 1992, the phrase "female athlete triad" was coined in order to highlight the interrelationships that were discovered between disordered eating, amenorrhea, and osteoporosis in adolescent and young adult female athletes. The American College of Sports Medicine (ACSM), in accordance with their 2007 Position Stand, has updated their definition of the triad to describe it as a spectrum of interrelationships between energy availability, menstrual function, and bone mineral density. These interrelationships have the potential to translate into the following clinical manifestations: eating disorders, functional hypothalamic amenorrhea, and osteoporosis. For girls and women who are physically active, the presence of low energy availability (with or without eating disorders), amenorrhea, and osteoporosis, either on their own or in combination, poses significant negative health risks. Therefore, physicians and other health care workers need to have a strong awareness of the condition's prevalence as well as the interconnectedness of its components. The prevalence of eating disorders among female athletes is a major cause for concern because these behavioral syndromes are linked to a significant amount of morbidity, which can ultimately result in one of the highest fatality rates seen in patients suffering from mental illness. Regrettably, the engagement in sports by female athletes has become a potential risk factor for the development of an eating disorder. In the beginning stages, the



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symptoms of eating disorders including anorexia nervosa (AN) and bulimia nervosa (BN), among others, can be difficult to recognize. Anorexia nervosa is characterized by the following: restrictive eating by the self-conscious individual that considers herself as over-weight and is terrified of gaining weight despite having a weight that is 15 percent below what would be expected for their age and height. BN refers to a group of individuals who are within the normal weight range but have a pattern of engaging in binge eating followed by purging or other compensatory behaviors such as prolonged periods of not eating or engaging in excessive physical activity. Athletes who participate in physical exercise for extended periods of time while also controlling their meals in an effort to either maintain or reduce their body weight are among the women who have a greater likelihood of developing the Triad. The prevalence of the Triad is relatively low among high school female athletes, coming in at just over 1 percent; however, the prevalence of the Triad is relatively high among college female athletes, as nearly two-thirds of college female runners are affected with at least one component of the Triad. In particular, female collegiate cross-country runners have a higher prevalence of the Triad due to the tremendous volume of physical activity they engage in and the pressure they put on themselves to either maintain or reduce their body weight. A study conducted on female collegiate cross-country runners found that almost one-fifth of the participants had either experienced or were currently experiencing eating disorders; nearly one-quarter of the participants had irregular menstrual periods; and nearly a third had an insufficient amount of calcium in their diet. When compared to their male counterparts, female collegiate athletes have a higher risk of eating disorders such as anorexia nervosa and bulimia nervosa. In addition, research has shown that female collegiate cross-country runners lack the nutritional knowledge that is essential to the prevention of health issues that are related to these disorders. In addition, it has been demonstrated that the training of female collegiate cross-country runners actually lowers their BMD. Furthermore, female collegiate cross-country runners are at a larger risk than other athletes of having a lower bone mass, which raises their risk of osteoporosis.

## 2. Related Work

[9] suggested that premenopausal osteoporosis is a common reason for younger women to see a doctor. Unexpected low-trauma fractures commonly occur in patients. Further testing includes bone density and basic laboratory tests. The female athlete triad is increasingly recognized as a cause of bone loss in younger women who participate in intense athletic activity, mainly while still in school or at university, but also after university in women in their third decade who continue to pursue intense physical exercise. Dancers, marathon runners, and other athletes who restrict calorie intake to improve performance may show the triad. Restrictive diet, amenorrhea, and osteoporosis are the traditional female athlete triads. Restrictive food and rigorous physical activity during training or competition both deplete energy. Low energy availability is sometimes linked to disordered eating, although not always.

The triad patients have a low BMI (BMI). This can cause delayed menarche, oligomenorrhea or amenorrhea, and low serum estradiol and gonadotropins, which causes accelerated bone turnover and fast bone loss. Low bone mineral density (BMD) causes stress reaction or fracture, most commonly in the lower limbs.The Female Athlete Triad Coalition lists the following “high risk” triad risk factors: Menarche at 16 years; present or prior history of 6 menses over 12 months; two or more stress responses or fractures, one high-risk stress reaction/fracture, or a low-energy non-traumatic fracture; or a bone density Zscore of 2.0. It can also be diagnosed with two “moderate risk” triad risk factors: 6– 8 menses over 12 months; one past stress reaction/fracture; or a BMD Z-score between 1.0 and 2.0. It may also be diagnosed with 1 or 2 peripheral long-bone traumatic fractures if 1 or more of the triad risk factors are present.

In its 2014 article, the Coalition proposed a Cumulative Risk Assessment for the Female Athlete Triad, which uses risk stratification and evidence-based risk indicators to assess an athlete's risk. Secondary causes of bone loss in premenopausal women must be recognized in order to prevent bone loss before the late third or early fourth decade. Unlike many other secondary causes, the female athlete triad can be totally avoided or treated with non-pharmacological measures such as reduced physical activity and proper diet. These therapies may help reach peak bone density and avoid osteoporosis and fractures. Weight regain or increased caloric intake may be resistant to physiological hormone treatment.

A less common pharmaceutical therapy may be used to treat female athletes if these interventions do not work. Early pharmacologic therapy may expose patients to longer exposure to medications designed only for postmenopausal women, with associated dangers. [4] suggested that the female athlete triad includes three interrelated conditions: disordered eating, amenorrhea, and osteoporosis. Patients with anorexia nervosa may restrict their food intake or binge and purge to lose weight or maintain a slim physique. Changes in the hypothalamus produce amenorrhea associated to physical training and weight fluctuation. Estrogen levels fall



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due to these changes. Primary or secondary amenorrhea in female athletes. In primary amenorrhea, there is no spontaneous uterine bleeding by the age of 14 without secondary sexual characteristics, or by the age of 16 with otherwise normal development. Secondary amenorrhea is described as a six-month or 12-month absence of menstrual bleeding in women with primary regular menses. Osteoporosis is the decrease of bone mineral density and inadequate bone growth, leading to increased bone fragility and fracture risk. Premature osteoporosis puts athletes at risk for stress fractures and more serious hip or vertebral fractures. In osteoporosis, reduced bone density may be irreversible. Studies have found that between 15% and 62% of female collegiate athletes have an eating disorder. Amenorrhea affects 3.4- 66 percent of female athletes, compared to 2-5 percent of women in general. 2–7.

The secrecy of disordered eating habits and the widespread idea that amenorrhea is a typical side effect of training keep some aspects of the female athlete triad hidden. [8] proposed that as a serious condition, osteoporosis decreases both quality and quantity of life. The illness is marked by decreasing bone strength, increasing fracture risk, and a BMD 2.5 standard deviations below the adult peak mean. The disease raises mortality and affects hundreds of millions of people globally. Women, especially Caucasian and Asian women, have greater incidences of osteoporosis than men, and some women may be at even higher risk due to the female athlete triad. The female athlete triad is a syndrome including low energy, irregular menstrual periods, and osteoporosis. Eating disorders like anorexia nervosa and bulimia nervosa can cause low energy availability. Amenorrhea is the lack of menstruation for three months due to irregular menstrual cycles. Eating disorders and/or amenorrhea can cause low BMD, which affects bone health and strength, increasing the risk of osteoporosis. Women who exercise for lengthy periods of time while controlling their meals are more prone to the Triad.

The Triad affects less than 1% of high school female athletes, but nearly two-thirds of college female runners. The Triad is more common in female collegiate cross-country runners due to their high level of physical exercise and need to maintain or lose weight. Women's cross-country runners reported roughly one-fifth eating problems, one-quarter irregular menstrual cycles, and one-third low calcium consumption. Female collegiate athletes are more prone to eating disorders including anorexia nervosa and bulimia nervosa than male athletes, and lack nutritional understanding is linked to these concerns. Furthermore, female collegiate crosscountry runners have been reported to have lower BMD than other athletes, increasing their risk of osteoporosis. The Triad increases the risk of osteoporosis in female collegiate cross-country runners, although their awareness of the illness is unknown. The perceived susceptibility to osteoporosis and the perceived severity of osteoporosis were examined and analyzed to assess their possible worry for osteoporosis. Women's Sports Medical Centre,Hospital of Medical Surgery., [2] suggested that our bones expand with our bodies. We build bone during periods of rapid growth and development, such adolescence, and continue until about age 25-35. Then bone loss begins. Women's bone loss accelerates after menopause (around 50). To avoid osteoporosis, we need to have plenty of bone throughout our mature years.

Osteoporosis is a condition that causes bone loss and weakens bones. We normally associate osteoporosis with the elderly. Imagine an elderly woman with a humpback spine. But osteoporosis is a silent bone degradation that only manifests as a fracture, a deformed spine, or pain. Female Athlete Triad patients have bone density equal to women in their 50s or 60s. They might have had stress fractures. It may not be able to rebuild lost bone during our growing years, thus maintaining excellent habits is crucial. [3] suggested that the female athlete triad puts some young women at risk of developing poor bone health and accompanying issues. Low energy availability (with or without disordered eating), menstrual dysfunction, and low bone mineral density are all connected (BMD). Athletes in lean sports are most commonly affected.

The female athlete triad may increase the chance of bone fracture, particularly in athletes at high risk for stress fractures, such endurance runners and dancers. The incidence of bone stress injury in a sample of 259 female teenage and early adult athletes was 11% overall, but increased to 50% in those with 3 significant female athlete triad risk factor factors. 3 The triad components individually raised the chance of stress fracture, although not as much as the combined risks. [5] suggested that the association between menstrual status, fracture risk, and BMD was also studied in 175 young women, including 100 oligoamenorrheic athletes (no menarche by age 15, or no menses for at least 3 out of 6 months, with a cycle length exceeding 6 weeks), 35 amenorrheic athletes (at least 9 menses per year without using oral contraceptives in the 3 months prior to enrollment), and 40 non-athletes. The lifetime risk of fracture was higher in oligoamenorrheic athletes than amenorrheic athletes (47 percent vs 26 percent; adjusted P =.0004). This was due to oligo-amenorrheic athletes (32%) having more stress fractures than eumenorrheic athletes (6%), and nonathletes (0%).

BMD was lower in oligo-amenorrheic athletes than eumenorrheic athletes, but equivalent in nonathletes. 4 The effect of weight-bearing exercise on bone mineral density is reduced in athletes with menstrual disorder,



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according to Alaine Joffe, MD, MPH, FAAP. There was a significant difference in average BMI between oligoamenorrheic athletes (20 kg/m2) and amenorrheic athletes (22 kg/m2). These athletes were also more likely to have an eating disorder history than amenorrheic athletes or nonathletes (26 percent, 6 percent, and 0%, respectively; P =.0001). 4 After adjusting for eating problem history, the fracture risk inequalities across the groups remained.[1] proposed that stress fractures affect many female athletes. In a poll of collegiate cross-country runners, 44% had one or more stress fractures. According to several research, stress fractures among female athletes are linked to oestrogen shortage and menstrual irregularity. Two studies linked menstrual irregularity to stress fractures. Risk of stress fractures was 2–4 times higher in amenorrheic/oligomenorrheic athletes than in males. Less research has been done on athletes with irregular periods and low bone density.

Three studies found that amenorreic athletes who gained weight, reduced exercise, and restarted menses (with increasing oestrogen levels) had bone density increments of 3 to 9% in the first year. However, compared to controls, formerly amenorrheic athletes had considerably reduced bone density, showing that late intervention may permanently damage bone health. Ex-amenorrheic/oligomenorrheic athletes were studied for eight years. Despite having regular menstrual periods for several years, formerly amenorrheic/oligomenorrheic athletes' bone density was 15% lower than that of nonamenorrheic athletes. This shows that early intervention is critical to reversing some bone loss. Several studies suggest that the longer an athlete's menstrual irregularity persists, the larger the bone losses. These findings point to a direct link between low oestrogen and bone loss. In theory, normalizing oestrogen levels should stop or reverse bone loss. Oral contraceptives give oestrogen and regulate the menstrual cycle, therefore they may be utilized to strengthen the bones of female athletes.

Oral contraceptives may also help prevent stress fractures. Four studies indicated that oral contraceptive users had 2–4 times fewer stress fractures than non-users. Oral contraceptive use appears to lower stress fracture incidence. These research cannot prove causation and effect. For example, women who used oral contraceptives may have had more bone mass before using them. The Bone Health in Female Runners Intervention Trial (B-FIT) at Stanford School of Medicine is testing these concepts. This is a multi-site randomised trial with female long distance runners. During the trial, treatment athletes are given oral contraception; control athletes are not. These athletes are tracked for two years, with three bone density measurements and sixmonthly training and nutritional assessments. [6] suggested that,It has been more than three decades since the number of women who participate in organised sports has climbed considerably. Women who participate in sports are more likely to suffer from the female athlete triad, which is defined by the triad of amenorrhea, disordered diet, and osteoporosis. An imbalance between energy intake and expenditure causes the triad, which has been linked to severe medical morbidity and mortality in the past. It is most typically seen in sports where the emphasis is on having a lean appearance. It is critical to recognise and intervene as soon as possible. Rather than being dismissed as a normal side effect of training, amenorrhea in adolescents should be taken seriously as an indication of a more serious problem.

The athlete should be assessed for an underlying eating disorder and should be checked for osteoporosis, if necessary. Reducing the intensity of training until menstruation returns, boosting caloric intake, ensuring proper calcium and vitamin D consumption, encouraging weight-bearing exercise where suitable, and considering hormone replacement medication are all principles of treatment to consider. Young female athletes' health and safety will be improved if they are educated about the importance of prevention. 7]suggested that the number of female athletes has expanded dramatically in recent years. Organized sports have become more accessible to girls and young women, allowing them to benefit from the mental and physical health benefits of participating. The female athlete triad, a potentially deadly but underdiagnosed sports-related disease, has seen a rapid rise in recent years, coinciding with greater engagement. The presence of disordered eating (DE), amenorrhea, and osteoporosis was once considered to be the triad's definition. Further study, however, indicated that these diagnostic criteria were too restrictive in scope, and the current diagnosis is that of a dynamic interaction between decreased energy availability (EA), menstrual dysfunction, and low bone mineral density (BMD) (BMD). The long-term effects of untreated osteoporosis include irreversible declines in bone mineral density (BMD) as well as a tendency to potentially devastating musculoskeletal injuries. First-line treatment is typically non-pharmacological, with interventions targeted at modifying dietary and physical activity habits as the primary goal. A number of pharmacological treatments may be used in the case of behaviour change failure, however this practise is still contentious. While there is currently no recommendation for a pharmacological approach to treatment, a new clinical trial provides convincing data, and the implications of the findings demand further exploration.



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## 3. Research Methodology

Table 1: related research

| Country | Study | Year |
|---|---|---|
| **New York, US** | Srinivas Pentyala.et.al | 2013 |
| **Texas, US** | J.J Robert. McComb.et.al | 2014 |
| **Naples, Italy** | Angela Lucariello.et.al | 2019 |
| **Oslo, Norway** | Monica klungland torstveit.et.al | 2005 |
| **Turkey** | Selma Arzu Vardar | 2005 |
| **Columbia , US** | Vu H.Nguyen.et.al | 2014 |

A meta-analysis of different studies was done regarding etiology of osteoporosis in which articles from six different region worldwide were included i.e Texas, New York, Italy, Norway, Turkey and Columbia.

❖ Table 2: Main Symptoms:

| Country | Main symptoms | Prevalence |
|---|---|---|
| **US New York** | Menstrual Dysfunction | 66% |
| **Italy, Naples** | Anorexia | 83% |
| **Columbia** | Calcium deficiency | 15.9% |
| **Turkey** | Amenorrhea | 16.8% |



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| | | |
|---|---|---|
| **Norway** | Low fat levels | 39.8 |
| **Texas** | Low estrogen | 38% |

There was 83% prevalence of osteoporosis in patients with anorexia, 66% had menstrual dysfunction, 39% had low fat levels, 38% had low estrogen levels and16% patients had amenorrhea. These are the main symptoms of osteoporosis in these regions.

**Menstrual dysfunction**: Menstrual dysfunction or abnormal uterine bleeding isclassified as either an-ovulatory or ovulatory abnormal uterine bleeding (AUB). An-ovulatory AUB is caused by the corpus luteum's inability to support the developing endometrium.

**Anorexia:** It is a psychological condition characterised by an obsessive desire tolose weight by refusing to eat.

**Calcium deficiency:** Hypocalcemia, commonly known as calcium deficiency disease, occurs when calcium levels in the blood are too low. Long-term calcium insufficiency can cause dental problems, cataracts, brain abnormalities, andosteoporosis, which causes bones to become brittle.

**Amenorrhea:** The absence of menstruation, often known as amenorrhea, is described as missing one or more menstrual periods. The absence of menstruationin someone who has not had a period by the age of 15 is known as primary amenorrhea.

**Low-fat levels:** Anything under 19 percent is considered low for women aged 19 to 20. Women in their 30s and 40s should have a body fat percentage of less than 21%, while women in their 40s should have a body fat percentage of less than 24%. Low body fat women are those who are 50 years old or older and have lessthan 28 percent body fat.

**Low estrogen levels:** It's not the same as having persistently low estrogen levels.Low estrogen levels over time could indicate that you're going through a natural transition, such as menopause. Low estrogen can be an indication of a disorder that affects your sexual development, making it more difficult to conceive.



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Table 3: Main causes of osteoporosis and prevalence:

| Causes | Prevalence |
|---|---|
| **Excess weight** | 68.75% |
| **Eating disorder** | 30% |
| **Use of laxatives** | 11.25% |
| **Irregular menstrual cycle** | 88.75% |
| **Stress fracture** | 20% |
| **Being eating** | 31.25% |

In this table there are some causes that increase the risk of osteoporosis in female athletes. Their high prevalence makes athletes more susceptible to osteoporosis. Aworldwide data collection revels the results that suggest irregular menstrual cycle is the most common causative factor in osteoporosis with highest prevalence 88.75% and with 11.25% use of laxatives become the least common causative factor in development of osteoporosis.

**Excess weight:** Excess pounds increase your chance of significant health problemsin addition to increasing your weight. Obese people are more likely to suffer from heart disease, strokes, diabetes, cancer, and depression. Losing weight, fortunately,can lower your risk of having some of these issues.

**Eating disorders:** Any of a number of psychological disorders marked by abnormal or disturbed eating patterns is known as anorexia nervosa (such as anorexia nervosa).

**Use of laxatives:** Laxatives are drugs that aid in the stimulation of bowel motions or the loosening of feces to make it easier to pass. Constipation is a condition marked by infrequent, unpleasant, or difficult bowel motions, and they are frequently used to treat it. They've also become a popular weight-loss strategy.

**Irregular menstrual cycle:** Periods that are irregular and fluctuations in cycle duration are common. However, something may be impacting a person's menstrualcycle if they have very short or long cycles on a regular basis. Stress, normal hormonal changes, and starting or stopping birth control are all temporary reasons of irregularity.

**Stress fracture:** Stress fractures are small fissures in a bone that most usually affect the lower leg and foot, which carry the brunt of the body's weight. A stressfracture is a small crack in the bone. They're created by repetitive force, which iscommonly caused by misuse, such as leaping up and down repeatedly or running large distances.

**Being eating:** Binge eating disorder is characterized by consuming a large amountof food in a short period of time till you feel uncomfortable. Binges are frequentlyplanned ahead of time, are usually performed alone, and may include "special" binge meals.

## TREATMENT IN FEMALE ATHLETES:

Athletes with amenorrhea and a history of fractures should be screened forosteoporosis.

Treatments include:

- Calcium supplementation, salmon calcitonin, estrogen, vitamin D, anabolic steroids, diphosphonates, fluoride, and coherence therapy.
- The National Institutes of Health Consensus Conference recommended 1.5 g of elemental calcium with vitamin D for all postmenopausal women (400 IUper day).
- Women over 65 should consume 1.5g of elemental calcium per day, along with 800-g of vitamin D. The FDA has approved salmon calcitonin nasal spray. The daily dose is 200-IU administered



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through one nostril. It has beenreported that calcitonin increases bone mass by 5% to 20%. It should be used for postmenopausal women with low bone density who refuse to take estrogen.

- Estrogen replacement therapy reduces bone turnover while also preventing bone resorption. When used correctly, many female athletes will benefit fromthe use of estrogen.
- Raloxifene was approved by the FDA as a selective estrogen receptor modulator. Raloxifene acts as an estrogen agonist in some tissues and as anestrogen antagonist in others. BMD was increased in postmenopausal women after two years of raloxifene treatment at a dose of 60 mg per day.
- Clinical studies show that estrogen and estrogen-androgen re-placement therapies both prevent the development of osteoporosis, as measured by bonemineral density and bone marker analyses. By combining androgen with hormone replacement therapy, bone loss can be avoided, and bone formation stimulated; bisphosphonates can also be used. Bi-phosphonates are pyrophosphate analogs in which the oxygen in P-O-P is replaced by carbon, resulting in the P-C-P structure. These are very effective bone resorption inhibitors. Bisphosphonates increase osteoblast outperforming activity while inhibiting osteoclast absorption. Bisphosphonates promote a positive balance in the remodeling cycle and increase bone mass density, which reduces the risk of bone fractures.
- Alendronate is the only FDA-approved bisphosphonate that can reduce the occurrence of fractures. To prevent osteoporosis, alendronate 5-mg should betaken, and alendronate 10-mg should be taken to treat it. Over a three-year period, alendronate at 10 mg per day increased BMD at the spine by 6 percent-8 percent and at the hip by 4 percent -6 percent in postmenopausal women. Bone formation stimulants include sodium fluoride, calcitriol, PTH, growth hormone, growth factors, prostaglandin, strontium salts, and anabolic steroids. PTH prevents bone loss from the proximal femur and the entire body in young women with GnRH-induced oestrogen deficiency and increases lumbar spinal BMD. In the United States, alendronate is approved for the treatment of secondary forms of osteoporosis, such as steroid-induced osteoporosis, and etidronate is approved in the United Kingdom and Canada.

- Exercise is another effective treatment, and several studies with postmenopausal women have revealed modest increases in bone mineral in response to training. Training has been proposed as a means of improving BMD effects in postmenopausal women.

- Training or hormone replacement therapy can change bone geometry and mass distribution, increasing bone strength and decreasing fracture risk.Training promotes bone diameter increases throughout one's life. These typesof exercise increase bone porosity and promote bone diameter growth. They also reduce fracture risk by mechanically counteracting bone thinning.
  - There is, however, no agreement on the amount, frequency, or type of exercise. Weight-bearing exercise for one and a half hours three times per week is advised. It should be noted that in order to maintain previously obtained BMD, the patient must commit to the exercise.

## 4. Conclusion

It is critical that women participate in sports and develop skills that will allow themto participate in sports for the rest of their lives. When one engages in strenuous exercise, however, serious complications can arise. Female athletes are susceptible to complications such as amenorrhea, eating disorders, and osteoporosis. To promotea healthy lifestyle, proper screening, diagnosis, and treatment should be provided. More research on female athletes and osteoporosis is required. Along with this research, physicians, coaches, trainers, female athletes, and parents must be educatedabout the athlete-athlete triad, which includes osteoporosis as a critical component. A thorough history and physical examination provide an excellent opportunity to detect triad disorders and educate female athletes on the importance of healthy nutrition, normal menstrual function, and osteoporosis-related exercise. Delays or failure to recognise and manage these patients may result in the emergence of athletic triad, which may have serious consequences such as increased stress fractures, scoliosis, and thin body mass.

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