

# Exercise: Adolescent Menstrual Dysfunction and Skeletal Problems

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## Abstract

Exercise is beneficial for adolescents since it increases bone mineral density (BMD) and fitness. Excessive exercise is associated with unique risk of menstrual dysfunction and skeletal problems in adolescent girls. Hypothalamic dysfunction has the key role in menstrual dysfunction and metabolic aberrations associated with nutritional insult may be the primary factor affecting low bone density in these adolescent girls. Proper physical examination and screening for eating disorder is required for the diagnosis. Treatment should be aimed at correcting metabolic abnormalities than correcting estrogen deficiency.

**Keywords:** Bone mineral density (BMD), menstrual dysfunction, osteopenia, osteoporosis, female athlete triad.

## INTRODUCTION

Adolescence is usually defined as young person between the ages of 12 and 19. This is the period during which many changes are taking place in their body. As their body develops and matures, it is important for adolescent to get a healthy amount of exercise. Unfortunately many adolescents do not.

Although the obesity is one of the rising problems, number of adolescents participating in sports and athletics has grown considerably over past several decades. Exercise has many beneficial effects but excessive exercise can have negative effects on reproduction and skeletal systems. Benefits of exercise, societal changes, new opportunities for young girls in sports, and media attention all have encouraged young girls to participate in athletics. Overuse injuries, overtraining and burnout among adolescent athletes are a growing problem. Overuse injury is microtraumatic damage to bone, muscles or tendons. Because of repetitive stress, there is insufficient time to heal or undergo the natural reparative process for these damages.

The incidence of menstrual dysfunction in athletes has been reported approximately up to 50%. Severe weight loss and dieting are particularly common in adolescents and put them at risk.

## FEMALE ATHLETE TRIAD

Sports and exercise are very important for balanced, healthy life. Exercise makes the heart and lungs strong, increases strength and endurance, and helps maintain a healthy weight. It changes

a person's body shape by building certain muscle groups. Exercise can also help alter body composition, increasing the ratio of muscle to fat. People who exercise regularly feel healthier and more alert. Adolescents who exercise score higher in positive personality traits and social acceptance than those who do not exercise. Thus exercise keeps adolescents healthy, helps get better grades and keeps them away from stress and depression. But girls who exercise intensely can have major consequences. They are at risk for a problem called female athlete triad, which refers to three interrelated conditions: disordered eating, amenorrhea and osteoporosis. Such girls can have one, two or all three parts of triad. Among all, disordered eating is the main culprit for all consequences. Girls who are more concerned about the size and shape of their bodies get athlete triad.

## NEGATIVE EFFECTS OF EXERCISE

Because of better nutrition and education young girls experience early menarche than their previous generation. Any delay in menarche beyond 16 years is defined as primary amenorrhea. Secondary amenorrhea is defined as absence of menses in postmenarcheal girls. Oligomenorrhea is affected by several factors including excessive strenuous exercise.

Exercise is normally the most important factor to increase bone mass but can have the opposite effect when carried out excessively. Normal bone mineral density (BMD) that is no more than 1 standard deviation (SD) below the mean of young adults. Osteopenia is BMD between 1 and 2.5 SD below the mean of young adults. Osteoporosis is BMD more than 2.5 SD below the mean of young adults.

Thus negative effects of exercise include:

- a. Menstrual dysfunction
  - Delayed menarche
  - Oligomenorrhea
  - Amenorrhea – primary/secondary.
- b. Skeletal problems
  - Osteopenia
  - Osteoporosis
  - Increase risk of fracture.

### MECHANISM OF MENSTRUAL DYSFUNCTION

Intense training of any kind places immense strains on many of the body's systems. Physical and mental processes that regulate human biological function can be disrupted and may then take the body on a journey it was never designed for. However, this problem is not an inevitable consequence of strenuous exercise.

Specific mechanism for menstrual dysfunction may vary across athletic disciplines but mainly it is due to hypothalamic dysfunction and disturbance of gonadotropin releasing hormone (GnRH) pulse generator. Reproductive abnormalities are mainly due to dysfunction at hypothalamic – pituitary – gonadal axis or hypothalamic – pituitary – adrenal axis.

Athletes engaged in sports, which emphasize on leanness have disruption of hypothalamus – pituitary – ovarian axis resulting in hypoestrogenism. While sports emphasize strength have activation of the hypothalamic – pituitary – adrenal axis resulting in hyperandrogens.

In fact, there seems to be a close relationship between the hypothalamic – pituitary – gonadal axis and hypothalamic – pituitary – adrenal axis.

Normally pulsatile release of GnRH occurs every 60-90 minutes, which is suppressed limiting pituitary secretion of leutinizing hormone (LH) and to some extent follicular stimulating hormone (FSH) which in turn limits ovarian stimulation and so estradiol production. Thus hypoestrogenism results in delayed menarche, primary or secondary amenorrhea or oligomenorrhea.

Some of the following factors are responsible for disturbance at hypothalamic level.

#### 1. Body Composition and Fat Mass

Menarche occurs in girls when body fat rises to 17% of body weight and menstrual function is lost when body fat decreases to less than 22% of body weight (Frisch and Mc Arthur 1974). Energy drains occur on preadolescent age in athletic girls whose energy expenditure exceeds dietary energy intake, which affects GnRH pulsatility and so delayed menarche.

#### 2. Exercise Stress

Intensive athletic training with caloric restriction disrupts GnRH pulsatility and so LH suppression.

### 3. Pathological Eating Disorder

Pathological eating disorder and negative energy balance is common in athlete girls especially who are engaged with sports which requires low body weight for esthetic appearance and enhanced performance. Athletes worry continuously about what they are going to eat, when and where they're going to eat, how much weight they'll put on if they go out for a meal with friends, how many hours they'll have to exercise to burn off those calories, how they can avoid eating 'banned' foods, and so on. Such an obsession with food and body weight is termed an eating disorder. Eating disorders appear to be on the increase in the population as a whole.

There is a wide spectrum of eating disorders among athletes, ranging from anorexia nervosa and bulimia, to restrictive eating behaviors, to poor nutritional habits.

Thus nutritional and the associated metabolic adaptation may be the important causal factor for menstrual dysfunction.

#### 4. Hormone Leptin

Leptin hormone is secreted by adipocyte and is regulator of metabolic rate (Zhang et al. 1994). Leptin levels fluctuate in response to fat stores and are disproportionately lowered in the presence of fasting. Its chronic low level in women leads to amenorrhea. Leptin receptors have been found on hypothalamic neurons involved in control of GnRH pulse generator (Cheung et al. 1997). Thus leptin may be a critical factor responsible for reproductive dysfunction.

#### 5. Hyperandrogenism

There is activation of hypothalamic – pituitary – adrenal axis in athletes engaged in sports of strength like swimming or rowing. Which results in high level of androgens particularly dehydroepiandrosterone sulfate (DHEA-5). This hyper androgenism along with decreased aromatization because of low fat may impair follicular development resulting in anovulation or amenorrhea.

#### 6. Hyperprolactinemia

Exercise also induces acute but transient hyperprolactinemia. Daily exposure to this can precipitate menstrual dysfunction.

#### 7. Increased Level of Beta Endorphins

Beta – endorphins are known to accumulate with exercise and suppress LH pulses.

### MECHANISM OF SKELETAL PROBLEMS

Bone is principally made of type I collagen and contains 99% of the total calcium and phosphate in the body. Bone also contains osteoblasts, osteoclasts and osteocytes. Osteoblasts take part in the formation and mineralization of bone matrix. Osteoclasts are multinucleated giant cells responsible for the resorption of bone.

Significance of weight bearing exercise for maintaining healthy skeleton has been widely appreciated. Reports have shown that estrogen may have a 'protective' effect on bone loss, and that this protective effect is lessened in females with menstrual cycle abnormalities (Constantini and Warren, 1994).

Bone remodeling occurs in response to mechanical stress, but low levels of estrogen have a negative effect on remodeling. Osteoporosis in young female athletes is sports specific. There is a higher incidence of stress fractures in amenorrheic athletes particularly those with a late menarche.

Osteoporosis is a systemic skeletal disease characterized by low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture.

Osteoporosis is recognized as the 'silent epidemic' (Rose, 1994) and it affects mostly women over the age of 40. However, osteoporosis is not exclusively disease of old age.

Exercise protects against osteoporosis but excessive exercise may cause osteoporosis.

There is GnRH suppression resulting in hypoestrogenism in athletes engaged in sports emphasizes on leanness. Such girls fail to attain peak bone mass because of nutritional deprivation and at the same time there is bone loss because of hypoestrogenic amenorrhea. These two are predisposing factors for osteopenia. Unfortunately this bone loss is irreversible. Athletes having low-density bone exposed to exercise can suffer from stress fractures, vertebral impression fractures, and femoral head collapse, particularly in overuse.

Exercise is normally the most important environment factor in the increase of bone mass, but can have the opposite effect when carried out vigorously.

Further more, nutritional deprivation and delayed sexual maturation results in delayed epiphyseal closure of long bones, which in turn leads to scoliosis (Warren lasa).

## **SCREENING AND DIAGNOSIS**

Screening for the Triad can be challenging because its health consequences are not always readily apparent. Although affected athletes are usually involved in sports where thinness is believed to be advantageous, one or more clinical consequences of the Triad can occur in individuals participating in any sport or habitual, strenuous physical activity. Screening for the Triad requires an understanding of the relationships among its components, the spectrum within each component, and rates of movement along each spectrum. Optimal screening times occur at the preparticipation physical exam and annual health check ups. A menstrual irregularity is one of the common problems in adolescents. To decrease its prevalence clinician must understand the causes and profiles of it

### **Proper History Taking**

Information on energy intake, dietary practices, weight fluctuations, eating behaviors, and exercise energy expenditure should be obtained. Disturbed body image, fear of weight gain

and menstrual dysfunction are common in athletes with disordered eating or eating disorders.

Proper history taking is very important for differentiation between hypoestrogenism and hyperandrogenism. If girl has primary or secondary amenorrhea, evaluate her fully to rule out pregnancy and underlying pathologic conditions. This includes complete physical examination and pelvic examination when required.

### **Physical Examination**

An athlete with a history suggestive of one or more components of the triad should have a physical exam. The health-care provider should be alert for signs and symptoms of an eating disorder. Height, weight, and vital signs should be obtained. Bradycardia is commonly seen as well as orthostatic hypotension. Other findings include cold/discolored hands and feet, hypercarotenemia, lanugo hair, and parotid gland enlargement.

### **Laboratory Test**

You must ask for blood test to check for anemia, which is other problem associated with this. Assessment should include electrolytes, a chemistry profile, a complete blood count with differential, erythrocyte sedimentation rate, etc.

### **Hormonal Evaluation**

To evaluate amenorrhea, ask for pregnancy test, hormonal assays like TSH, prolactin, FSH, LH, testosterone DHEA-S, etc. Rule out prolactin secreting pituitary tumor.

### **Careful Screening for Nutritional Insult**

Measurement of bone mineral density to rule out osteopenia:

## **TREATMENT**

Osteopenia is the most serious complication of reproductive dysfunction associated with exercise in adolescence. Prevention and treatment are of the most importance.

### **1. Restoration of Menstruation**

Bone loss is directly related to duration of amenorrhea and bone loss is irreplaceable. Therefore it is crucial for such athletes to restore menses as soon as possible to minimize bone loss and resulting bone complications. Significant advancement can occur during times of rest especially girls of lower body weight and body fat.

Weight gain of 1-2 kg or 10% decrease in exercise load – in either duration or intensity for two to three months is sufficient to reverse reproductive function. Menstruation will spontaneously occur when physical activity is reduced.

### **2. Correction of Nutritional Deprivation**

The body needs enough calories to function properly. Adolescents often have growth spurts, and may need even

more calories. Adolescents are still growing and will continue to do so throughout the teen years and they need extra energy to fuel the growth.

Nutrition insult can be corrected by proper diet for positive energy balance. Treat underlying nutritional deprivation not only to restore menses but also to stimulate bone accretion.

Ask them to eat healthy foods, following the *Food Guide Pyramid*, get enough *protein* in the diet and get enough sleep and rest so the body has time to rest and recover between workouts

### 3. Bone Preservation

Prevention of osteoporosis starts at an early age. A good balanced diet with adequate proportions of carbohydrates, fats, proteins and minerals is essential for bone formation.

Stimulation of osteoblast activity is more effective than retardation of osteoclast activity.

*The healthy bone triad:* Diet and exercise and maintain normal hormone levels Advise diet rich in protein, calcium and vitamin D, which is very important.

#### Calcium

Calcium is essential for good bone health, muscle strength and normal cell function. Calcium helps build bone mass. You can give calcium 1500 mg and vitamin D 400 mg as daily supplement.

#### Protein, Fruits and Vegetables and Body Composition

At least 1,000 milligrams of calcium per day and eating an adequate amount of protein—at least 0.8-1.5 grams per kilogram of body weight per day—will increase calcium absorption. A healthy diet containing plenty of fruits and vegetables is important for bone health.

#### Vitamin D, Vitamin K

In studies, women who took vitamin K and D supplements showed increased bone density after two years.

Bank Bone When You're Young, then Maintain it.

### 4. Hormone Replacement Therapy (HRT)

Give HRT in the form of estrogen and progesterone to regulate menses in amenorrhea and to prevent bone loss. Higher dose of oral contraceptives is required to prevent bone loss but this will not replace the bone already lost. HRT should be administered only after bone growth is complete.

### 5. Bromocriptine or Cabergoline

To correct hyperprolactinemia.

## RECOMMENDATIONS

The clinician plays an important role in monitoring the adolescent health. Clinician must do extensive physical

examination to diagnose the female athlete triad. He must ask questions about her periods, her nutrition and exercise habits, any medication she is taking and her feelings about her body.

- Exercise and sports participation should be promoted in girls and adolescents for health benefits and enjoyment. Reduce injuries through strength training. If female athletes want to achieve elite performances they must ensure that comprehensive strength training is fully covered in their training schedules.
- Dietary practice; exercise intensity, duration and frequency and menstrual history need to be reviewed during evaluation that precede participation in sports or other medical encounters in which related problems may present.
- An athlete with a history suggestive of one or more components of the triad should have a physical examination. If a girl has one component of triad, screen for the other components. The best time of screening for triad is at the time of the preparticipation examination.
- Be alert for possible burn out if adolescent who exercise intensely complains of nonspecific muscle or joint problems, fatigue or poor academic performance. Recommend resistance training as a means of boosting muscle strength and aiding in bone mineralization.
- Ask adolescents to keep track of their periods, not to skip meals or snacks and seek advice from dietitian or nutritionist whenever required.
- Amenorrhea should not be considered a normal response to exercise. Exercise-associated amenorrhea or amenorrhea attributable to decreased energy availability should be considered a diagnosis of exclusion. A complete medical evaluation is required for any adolescent with primary or secondary amenorrhea or persistent oligomenorrhea.
- An adolescent with menstrual dysfunction attributed to exercise should be encouraged to increase her energy (caloric) intake and modify excessive exercise activity. If an athlete's weight is low, she may be required to gain weight before resuming athletic activity.
- Estrogen-progesterone supplementation may be considered in the mature amenorrheic athlete.
- Measurement of BMD may be considered as a tool when making treatment decisions for the amenorrheic athlete.
- Focus on normalizing weight, body composition, menstrual cycle, modify unhealthy thoughts process that maintain the disorder and deal with emotional issues.
- Emphasize that adolescents should focus on nutrition, fun, education and safety of their body apart from sports. Explains which minerals are essential for female athletes. Increased mineral needs of female athletes are due to several factors.
- Female athletes in general are likely to have a higher rate of iron loss than men, and also a higher daily requirement, largely because of blood loss through menstruation. Dietary factors that tend to limit iron intake include: *Low total energy intakes, Vegetarian diets, Natural food diets, Fad diets, etc.*

40 to 50% of adolescent female athletes demonstrate some degree of iron depletion or decreased iron stores without overt anemia.

Provide sound nutritional advice with a particular emphasis on enhancing iron status, taking into account the two forms of iron found in foods. Hem iron – present in animal food and nonhem iron – present in plant food.

- Disordered eating should be considered in adolescents with amenorrhea. Treatment often requires a team of health care professionals, including a physician, nutritionist, and mental health professional, all experienced in the treatment of eating disorders, in addition to cooperation by coaches, parents, and teammates.
- Encourage athletes to have at least 1 or 2 days off per week from sports specific training, not to increase numbers of repetitions by more than 10% each week and take at least 2-3 months away from a specific sport during the year.
- Education and counseling should be provided to athletes, parents, and coaches regarding disordered eating, menstrual dysfunction, decreased bone mineralization, and adequate energy (calorie) and nutrient intake to meet energy expenditure and maintain normal growth and development.
- Give appropriate information to adolescents, parents and coaches about proper nutrition and fluids, sport safety and avoidance of excessive exercise or sport training.
- When athletes and coaches want to know what weight and amount of body fat are best for a given athlete, it is preferable to establish a range of values rather than specific values. It is difficult and potentially dangerous to define an ideal level of weight and/or body fat for each sport or individual participant. Weight is not an accurate estimate of fitness or fatness, and when weight is lost, muscle and fat are lost.

## CONCLUSION

Exercise, like most things in life, is best done in moderation. Exercise is an important part of keeping adolescents healthy. Encouraging healthy lifestyles in adolescents is important for when they grow older.

On the whole, exercise is extremely beneficial for young girls since it increase cardiovascular fitness and reduce

adiposity. Too much, too soon, can lead to injuries or cross the line to compulsive exercise.

Excessive exercise and caloric deficit results into reproductive dysfunction and serious consequences such as osteopenia and osteoporosis. This phenomenon has been demonstrated in Indian girls also. A gynecologist should be aware of this fact when evaluating and adolescent with delayed menarche, oligomenorrhea or primary or secondary amenorrhea.

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