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Manual of Sports Medicine

Editors
Marc R. Safran
Douglas B. McKeag
Steven P. Van Camp

Lippincott - Raven

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21. SPECIAL CONCERNS OF THE FEMALE ATHLETE

Aurelia Nattiv and Mary Lloyd Ireland

I. Introduction

A. History of women in sports

1. For centuries, women participated very little in sports and athletic competition. In fact, in the early 1900s women were excluded from the modern Olympic games because participation in sports was thought to be too stressful for them.
2. The adoption of Title IX to the Education Amendments Act in 1972 led to a dramatic increase in female sports participation and had a great impact on women in sport. Title IX states that men and women should have the same opportunities for participation in sports and exercise.

II. Physiologic Differences in Females and Males

A. Pre- and postpubertal differences

1. There is no significant difference in the physical capabilities of prepubertal boys and girls (controlling for body size and composition).
2. With puberty, girls show a relative increase in body fat and boys a relative increase in lean body mass (mostly due to hormonal influences). This inequality of muscle mass after puberty in women is reflected in their decreased muscle strength, power, and speed, as compared with that of men.

B. Muscle strength

1. Strength differences between women and men are more apparent in the upper extremity. Upper extremity strength in women averages 40% to 75% that of men, while lower extremity strength in women averages 60% to 80% that of men. However, women have the same capacity for strength gains as do men (controlling for body composition and size). This is because strength gains are the result of both neuromuscular recruitment and muscle hypertrophy. Women do not experience the same degree of increased muscle hypertrophy as men, primarily because their testosterone levels are lower.

C. Aerobic capacity: Maximum oxygen uptake ($\dot{V}_{O2MAX}$)

1. Women have a lower maximal level of aerobic capacity (after puberty) than men, due to several factors: lower oxygen-carrying capacity, lower hemoglobin content, lower blood volume (relative to lean body mass), smaller hearts (relative to lean body mass), lower stroke volume, higher percentage of body fat, and smaller muscle fiber area.
2. Athletic training programs produce similar increases in aerobic capacity in males and females (controlling for body composition and size).

D. Endurance performance

1. Endurance performance is 6% to 15% lower in women in most endurance events. This can be partially explained by the larger muscle fibers in men (both fast- and slow-twitch muscle fibers), although the actual muscle fiber composition is similar in men and women.
2. Athletic training programs (interval and continuous) produce similar improvements in endurance performance in men and women.

E. Menstrual cycle and performance

1. Although there is a lack of research regarding menstrual cycle and performance, most studies have shown no significant difference in athletic performance in females during the different phases of the cycle. Similarly, most studies report no significant benefit or detriment to athletic performance in women taking oral contraceptive pills.

III. Musculoskeletal Considerations

A. Common musculoskeletal problems

1. Injury rates
   a. Few true epidemiologic studies have compared male and female injury rates. The rates of injury documented by the military studies are about equal.
   b. Each year, the National Collegiate Athletic Association (NCAA) sends injury surveys to its member institutions. There are two true sex-comparable sports, basketball and soccer. The additional women's sports included in the injury surveys are gymnastics, volleyball, softball, lacrosse and field hockey. Men's sports included in the injury survey are ice hockey, wrestling, gymnastics, lacrosse, spring football, baseball and football.
      (1) A comparison of the rates of injury with number of injuries per 1,000 athletic contests, averaged over a 3-year period, demonstrated that there was no significant change in the rate of injuries in each sport in the 3 years.
   c. More studies comparing differences in injury patterns need to be conducted at many levels.
2. Specific sport demands
   a. In female sports, there are fewer traumatic collision mechanisms and more repetitive axial loading microtraumatic overuse problems.

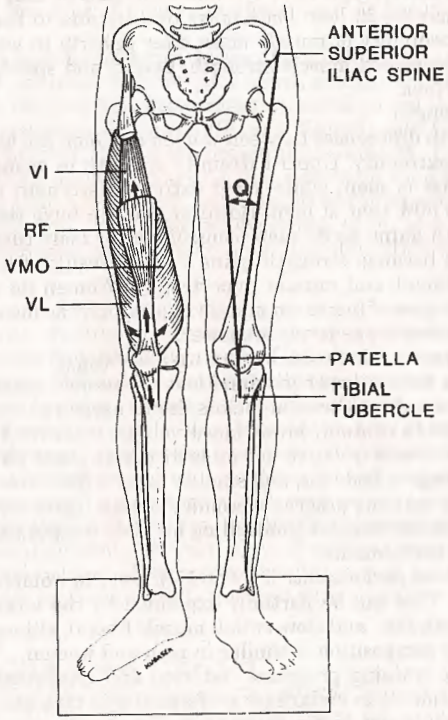

Fig. 21-1. Lower-extremity alignment: Q-angle is a measure of patellofemoral alignment. It is measured as the angle formed by the intersection of a line from the anterior superior iliac spine to the center of the patella and a line from the center of the patella to the tibial tubercle. Normal is less than 12 degrees. Quadriceps muscles are labeled with their force vectors (VI, vastus intermedius; RF, rectus femoris; VMO, vastus medialis obliqus; VL, vastus lateralis).

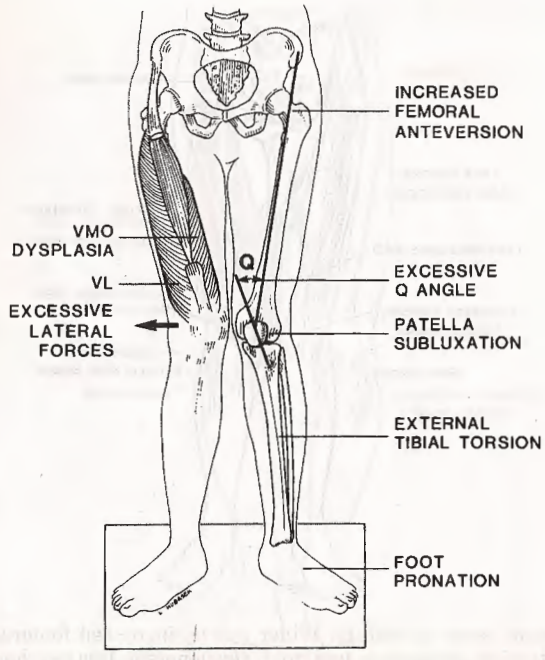

Fig. 21-2. Lower extremity alignment of miserable malalignment syndrome: Changes in patellar alignment and muscle force vectors are shown in miserable malalignment syndrome. Increased femoral anteversion, external tibial torsion, and foot pronation, along with the increased Q-angle and VMO hypoplasia/dysplasia, all create forces that laterally subluxate and tilt the patella (VL, vastus lateralis; VMO, vastus medialis obliqus).

   b. Lower extremity
      (1) In running and dance sports, lower-extremity tendinitis or stress fractures are most common. To prevent injury, three assessments must be made: the sport's biomechanics, footwear and orthotic equipment and duration of training.
   c. Upper extremity
      (1) Upper-extremity weakness and physiologic multidirectional laxity can result in shoulder overuse injury patterns. In the younger athlete, the primary problem is usually laxity or instability, rather than rotator cuff dysfunction. Repetitive overload results in entire upper-extremity dysfunction.
      (2) Sports can be divided into two types: axial loading (compression) and distraction (the glenohumeral joint and rotator cuff), or into a combination of both. Tennis and softball are distraction sports. Diving and cheerleading are more axial loading sports, whereas basketball and swimming are a combination of both types. Specific prevention programs for strengthening should be used in each case.
      (3) The pitcher in softball, fast-pitch underhand style, is more likely to be injured by contact with the ball than to develop an overuse shoulder problem or labral tear. Swimming rarely results in labral tears; more often, the laxity leads to rotator cuff dysfunction.

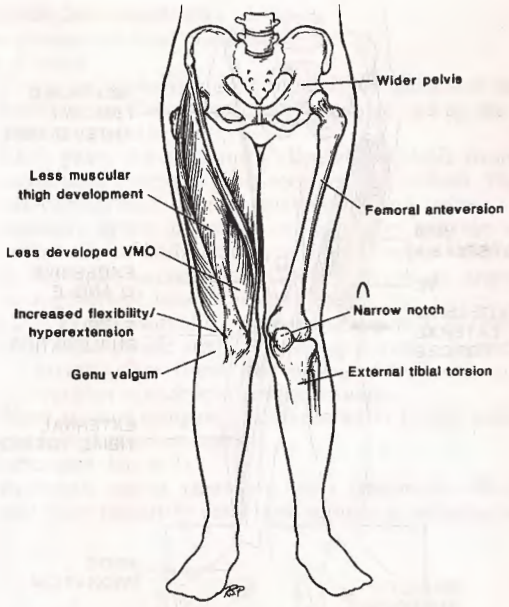

Fig. 21-3. Female lower extremity: Wider pelvis, increased femoral anteversion, external tibial torsion, pes planus, less thigh development, less developed VMO along with increased flexibility, range of motion, genu valgum, and narrow notch make women's knees more "ligament dominant." (VMO, vastus medialis obliqus)

d. Unique and female-only apparatuses are used in gymnastics: balance beam and uneven parallel bars. Varying injury patterns can occur when athletes perform on the unique equipment.

3. Stress fractures (see Chapter 37)
   a. Overall rate: the military rates of stress fractures have equalized with changes in training during the last 10 years. Stress fractures appear to occur more often in the female athlete as compared to her male counterpart. The etiology of the stress fracture whether from insufficiency or over training, must be determined. One must suspect an underlying nutritional disorder or hormonal insufficiency: amenorrhea or oligomenorrhea.
   b. Factors contributing to stress fractures
      (1) Anatomic and biomechanical factors
         (a) Training errors
         (b) Biomechanics
         (c) Low bone density
         (d) Bone geometry
      (2) Hormonal influence
         (a) Hypoestrogenic amenorrhea
         (b) Oligomenorrhea
      (3) Nutritional factors
         (a) Inadequate calories
            i) Calcium
            ii) Mineral
         (b) Disordered eating
            i) Anorexia nervosa
            ii) Bulimia
            iii) Single or combined

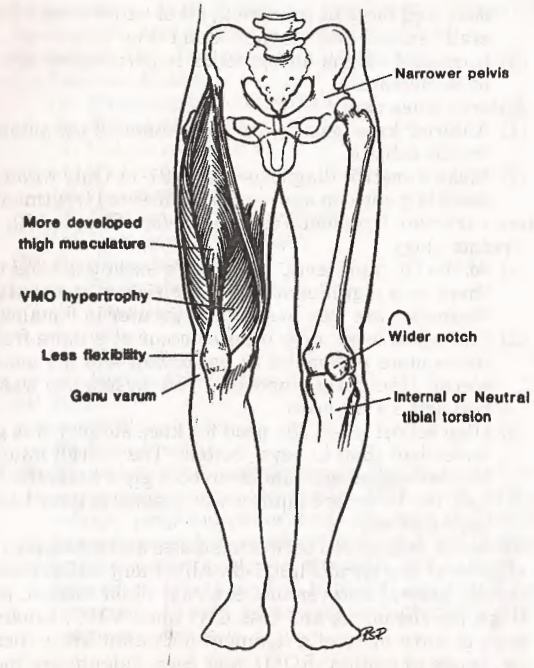

Fig. 21-4. Male lower extremity: More narrow pelvis, less femoral anteversion, wider femoral notch, neutral (to slight internal) tibial torsion, genu varum, more thigh musculature development, VMO hypertophy, and less flexibility result in a muscle dominant/less ligament-dominant knee. (VMO, vastus medialis obliqus).

   c. Assess level of risk of completion of fracture
      (1) Stress fracture at risk of progression
         (a) More aggressive treatment
         (b) *At-risk location*
            i) Hip–Distraction side superior femoral neck.
            ii) Tibia–Anterior tibial cortex–dreaded black line.
            iii) Tarsal navicular
            iv) Fifth metatarsal–Jones' type
            v) Proximal second metatarsal
            vi) Sesamoids–great toe
            vii) Intraarticular fracture—unusual
      (2) Not at risk of progression
         (a) Medial tibial
         (b) Fibular fracture
         (c) Metatarsal
            i) Non-Jones
            ii) Nonproximal second metatarsal
   d. After second stress fracture, bone density study should be considered.

4. Patellofemoral disorders (PF) (see Chapter 53)
   a. Anatomic alignment
      (1) The Q angle is measured by line from anterior superior iliac spine to patella and line from patella to tibial tubercle. The normal is less than 12 degrees (Fig. 21-1).
      (2) Miserable malalignment syndrome refers to lower-extremity alignment of increased femoral anteversion, vastus medialis obliquus (VMO) dysplasia, excessive Q angle, external tibial tor-

sion, and forefoot pronation, all of which create forces which laterally sublux and tilt the patella (Fig. 21-2).
(3) Increased valgus and patellar hypermobility are more common in the female.

b. Anterior knee pain
(1) Anterior knee pain is the most common complaint of the young female athlete.
(2) Make a specific diagnosis (Table 21-1). Only when a specific diagnosis is made can appropriately directed treatment be instituted.

5. Anterior cruciate ligament Tears (ACL) (see Chapter 50)
a. Epidemiology
(1) At the Olympic level, in women's basketball and team handball, there is a significantly greater risk of noncontact ACL tears. Estimates are four to six times greater in females.
(2) Collegiate level: ACL injuries occur at a more frequent rate: 4.1 times more in females in basketball and 2.4 more in women in soccer. Noncontact increased rate in females was 5.3 in basketball and 3.4 in soccer.
(3) High school level: The need for knee surgery was greater in girls' basketball than in boys' football. The overall injury rate per athlete per season was similar in both girls' basketball and boys' football, but for severe injuries was greater in girls' basketball than in boys' football.

b. Anatomic differences between females and males play a role. Female alignment is shown (Fig. 21-3). Alignment differences include wider pelvis, femoral anteversion, external tibial torsion, pes planus, less thigh development, and less developed VMO, causing female athletes to have more of a ligament-dominant knee; increased flexibility, range of motion (ROM), and genu valgum are more common in female athletes. In male athletes, alignment of a more narrow pelvis, less femoral anteversion, wider femoral notch, internal or neutral tibial torsion, and genu varum are common, as are a more muscle-dominant structure of more developed thigh musculature, VMO

Table 21-1. Differential diagnosis of anterior knee pain[a]

Mechanical	Inflammatory	Other
Patella	Bursitis	Reflex sympathetic dystrophy
Subluxation	Prepatellar	Tumor
Dislocation	Retropatellar	
Fracture	Semimembranosus	
Stress	Tendinitis	
Acute (transverse)	Patellar	
Bipartite	Pes anserinus	
Fibrous nonunion	Semimembranosus	
Acute fracture	Synovitis	
Quadriceps rupture	Arthritis	
Patella tendon rupture		
Inferior avulsion		
Interstitial		
Patellofemoral stress syndrome		
Pathologic plica		
Osteochondral fracture		
Trochlear groove		
Patella		
Loose bodies		
Osteochondritis dissecans		

[a] From Hutchinson MR, Ireland ML. Knee injuries in female athletes. *Sports Med* 1995; 19:288–302.

hypertrophy. Less flexibility results in a muscle-dominant, less ligament-dominant knee in males (Fig. 21-4).

c. Factors contributing to ACL injuries
(1) Intrinsic factors
(a) Physiologic rotatory laxity
(b) Size of ACL
(c) Valgus alignment
(d) Hyperextension
(e) Proprioception
(f) Neuromuscular firing order
(g) Hormonal influences
(2) Extrinsic factors
(a) Strength
(b) Conditioning
(c) Shoes
(d) Motivation
(e) Deceleration forces
(3) Both
(a) Skill
(b) Coordination
(4) The most important factors in the increased incidence of noncontact injuries in the female athlete are physiologic rotatory laxity, proprioception and neuromuscular firing patterns. Improvement is needed in the level of youth physical education and movement patterns, strength, and balance. Teaching a basketball athlete to land on both feet and to use posterior directed forces should help. Screening for high-risk factors should reduce incidence of injury.

IV. Female Athlete Triad: Disordered Eating, Amenorrhea, and Osteoporosis

A. Definition of the triad
1. The female athlete triad represents the interrelationship and often coexistence of disordered eating patterns, amenorrhea, and osteoporosis. These problems represent a growing concern in sports medicine. Each component of the triad is defined in sections V and VI. The constant focus on achieving and/or maintaining an "ideal" body weight and/or "optimal" body fat often is the underlying theme.

B. Prevalence of the triad in athletes
1. The true prevalence of the female athlete triad is unknown and difficult to determine, but a triad profile has become apparent. The female athlete triad appears to be more prevalent among athletes competing in appearance or endurance sports: gymnasts, figure skaters, dancers, runners (distance), and swimmers, although athletes of all sports are potentially at risk. It is also more common in adolescent and young adult age groups.
2. The prevalence of amenorrhea and disordered eating in athletes is noted in sections V. B. and VI. B. The prevalence of osteoporosis in young female athletes is unknown.

C. Health consequences of the female athlete triad
1. The potential exists for short- and long-term health consequences as well as psychological, medical, and orthopaedic repercussions of disordered eating, amenorrhea, and premature osteoporosis. (Refer to sections V. C and VI. D.)

V. Menstrual Dysfunction and Bone Concerns in the Female Athlete

A. Introduction
1. Hormonal status has a significant effect on bone in young as well as in older persons who exercise. The various types of menstrual dysfunction most common in premenopausal female athletes and their effects on bone are summarized below:
a. Luteal phase dysfunction: Inadequate levels of progesterone; normal or shortened cycle length; may be an adaptive response to exercise. Effect on bone mass is still controversial.

b. Oligomenorrhea: Menstrual cycle greater than 36 days; may be anovulatory; associated with bone loss due to low estrogen (primarily) and progesterone.
c. Primary amenorrhea: The lack of menarche by 16 years of age; may be associated with significant decrease in bone density and skeletal development if due to low estrogen state; may contribute to an increased incidence of stress fractures and scoliosis.
d. Secondary amenorrhea: Absence of three to six consecutive menstrual cycles or less than three cycles per year in a woman who has previously had her menarche. Significant negative effect on bone mineral density can be seen in axial and appendicular skeletal sites.

2. Definition of osteoporosis: Premature bone loss and inadequate bone formation, resulting in low bone mass, microarchitectural deterioration of bone tissue, and increased bone fragility, resulting in an increased risk of fracture.

B. Prevalence of menstrual dysfunction and bone concerns
1. The prevalence of menstrual dysfunction in the female athlete varies among sports and intensity of training, although other factors are involved. In general, there is an increased prevalence of oligomenorrhea and amenorrhea among athletic women, with prevalence rates of secondary amenorrhea between 3.4 and 66% (as compared with the rates of amenorrhea in the general female population of 2% to 5%).
2. The prevalence of premature osteoporosis in the premenopausal female athlete is uncertain, but is a significant medical concern in athletic women with a history of oligomenorrhea, amenorrhea and/or disorders of eating.

C. Potential complications of menstrual dysfunction in athletes
1. There are a number of potential complications of menstrual dysfunction in the athletic setting. Problems of some concern that may develop in this setting are those of premature osteoporosis and an increased prevalence of stress fractures and pathologic fractures (due to a hypoestrogenic state). Infertility is a potential complication if the athlete is anovulatory, but this is believed to be reversible if it is exercise related.
2. There are other theoretical risks of menstrual dysfunction in the athletic woman which include an increased risk of cardiovascular disease and a negative effect on lipid profiles (possibly due to low estrogen). Other possible risks include endometrial hyperplasia with an increased risk of adenocarcinoma of the uterus (if a woman is anovulatory and there is an unopposed estrogen state). Future research is needed to assess these potential risk factors in women with athletic-associated menstrual dysfunction who exercise.

D. Contributory variables associated with menstrual dysfunction in athletes
1. Although the etiology and pathophysiology of menstrual dysfunction in athletes is not known, several contributory variables appear to be associated with menstrual dysfunction. These include previous menstrual history (delayed menarche, irregular menses, nulliparity), increased exercise intensity, dietary factors, disordered eating patterns, abrupt changes in body composition, stress (psychological and physical), and certain high-risk sports (gymnastics, distance running, ballet, figure skating, swimming).

E. Proposed mechanisms of athletic amenorrhea
1. There are many theories relating to the mechanisms involved in athletic amenorrhea. The most popular current theories involve an inhibition of the hypothalamic gonadotropin-releasing hormone (GnRH) pulse and reduction in lutenizing hormone (LH) pulse frequency. Low energy availability may disrupt the GnRH pulse. Caloric intake may not be sufficient for the amount of energy being expended in exercise training. A state of negative energy balance exists, resulting in an energy drain manifested by amenorrhea.

F. Decreased bone mineral content in amenorrheic athletes
1. Although exercise can increase bone mineral density in healthy, normally menstruating, women, there appears to be a point of diminishing return

in women who overtrain and develop athletic-associated amenorrhea and oligomenorrhea. Multiple studies have shown that decreased bone mineral density often is a consequence of amenorrhea and oligomenorrhea in athletes. This decrease in bone mineral density is generalized throughout the skeleton and can be quite severe. The majority of studies have not shown gain in bone density in the premenopausal female athlete, despite estrogen replacement and calcium. Therefore, prevention is important.
2. Low bone density can predispose athletes to stress fractures and potentially devastating osteoporotic fractures later in life. When assessing risk factors for stress fractures, researchers have shown that athletes with stress fractures have lower bone mineral density, calcium intake, and menstrual irregularity, and use fewer oral contraceptives.

G. Stress fractures (See Chapter 37)

H. Clinical evaluation of menstrual dysfunction
1. A detailed history is important to identify potential risk factors for athletic-associated amenorrhea and to differentiate athletic-associated amenorrhea from amenorrhea due to other causes. Risk factors for athletic-associated menstrual dysfunction include a previous history of delayed menarche and irregular menses, excessive training, disordered eating behaviors, abrupt changes in body composition, and stressors. It is important to assess for other apparent etiologies of menstrual dysfunction. Medication history and history of possible associated symptoms (i.e., galactorrhea) are important, as are family history of endocrine disorders or other medical problems.
2. The diagnosis of athletic-associated amenorrhea is a diagnosis of exclusion. A thorough physical examination and pelvic examination are indicated in most instances. A work up for delayed menarche is indicated if menstruation has not begun by age 16 (or by age 14 if there are no secondary sexual characteristics) For females less than 18 years of age, a pelvic examination may be deferred if not sexually active. Vital signs, physical examination, and assessment of development of secondary sexual characteristics are important. An increase in weight or development of hirsutism, and/or acne may suggest polycystic ovarian syndrome.
3. Laboratory testing may be important to establish the diagnosis of athletic-associated menstrual dysfunction and to rule out other causes. A pregnancy test is essential in sexually active individuals. A thyroid-stimulating hormone (TSH) test to assess for underlying thyroid disease, a follicle-stimulating hormone (FSH) test to assess hormonal function, and a prolactin level to assess for a pituitary adenoma, are important screening tests. If individuals complain of hirsutism and acne, or if these findings are noted on examination, assessment of LH and FSH, dihydroandosterone sulfate (DHEA-S), and free testosterone may help in establishing whether polycystic ovarian syndrome exists or androgen-excess due to ovarin or adrenal tumors. Indirect testing includes a progesterone challenge with medroxy-progesterone acetate (Provera) 10 mg/day for 7 to 10 days. Lack of vaginal bleeding suggests a hypoestrogenic state, an obstructed outflow tract, or pregnancy.

I. Treatment and prevention of menstrual dysfunction in athletes
1. The treatment of menstrual dysfunction in female athletes varies somewhat based on the degree of menstrual dysfunction (see section V.A.). Adequate caloric intake and avoidance of disorders in eating patterns are often key components in the prevention and treatment of menstrual dysfunction. Adequate calcium intake and healthy eating patterns can help prevent the potential negative effects of athletic amenorrhea and oligomenorrhea on bone health. Specific preventive and treatment strategies are outlined, based on the hormonal milieu and type of problem. It must be remembered that the same individual may experience significant hormonal changes throughout her exercising and athletic career and treatment may vary during these times. Luteal-phase dysfunction, oligomenorrhea and amenorrhea in the athletic setting may

occur on a spectrum (see section V.I. for definitions of menstrual dysfunction common in athletes).

2. For luteal-phase dysfunction, an effect on bone is not certain. Treatment includes assessment of energy needs and optimal nutrition, calories and calcium intake. Hormonal therapy may be beneficial.
3. Treatment of oligomenorrhea may vary depending on the person's estrogen status. If the athlete is euestrogenic, oral contraceptives may be used if she is sexually active or monthly progestin may be used to protect the endometrium (medroxyprogesterone acetate 10 mg/day for seven to 10 days). Optimal nutrition and calcium intake—1,200 to 1,500 mg/day calcium—is recommended.
4. The hypoestrogenic amenorrheic woman presents the greatest challenge. A multidisciplinary approach is needed to address the many issues that may be contributory: Use of oral contraceptives or cyclic estrogen/progestin are recommended to prevent further bone loss and possibly to reduce the risk for stress injury. Decreasing exercise training intensity and/or duration should be considered. To optimize nutrition, calories and/or weight can be increased if indicated, and calcium intake can be increase to 1,500 mg/day (supplement if indicated). Disordered eating patterns can be treated by considering psychological and nutritional counseling and stress reduction techniques. Bone density testing should be considered if amenorrhea has been manifest for more than 6 months. The importance of education, counseling, and a multidisciplinary team approach must be emphasized and is essential.

VI. Disordered Eating

A. Definition of terms
   1. In the athletic setting, a spectrum of eating patterns exists: from normal eating habits to disordered eating, and to development of an eating disorder. Disordered eating represents abnormal eating behaviors in persons who do not necessarily fit the psychiatric criteria for anorexia or bulimia nervosa. At the extremes of the disordered eating spectrum lie the frank eating disorders of anorexia and bulimia nervosa, which have strict (DSM IV) psychiatric criteria. Many athletes who have poor nutritional habits are at an intermediate point on the spectrum of disordered eating. These athletes are still at risk for developing serious endocrine, skeletal, and psychiatric disorders.
   2. Features of anorexia nervosa include weight 15% below expected weight, feeling fat when really thin, an intense fear of becoming overweight, and amenorrhea. Features of bulimia nervosa include secretive binges two times a week for more than three months, lack of control over eating, purging behavior (laxative use, diuretic use, self-induced vomiting, overexercising), and overriding concern with body shape.
   3. Anorexia (restrictive eating) and bulimia (binge/purge behaviors) often coexist. Many athletes exhibiting these behavior patterns do not fit the DSM IV criteria for an eating disorder, but may have some of the features of anorexia and bulimia and are still at risk for significant health problems. The DSM IV classification of Eating Disorders Not Otherwise Specified is sometimes used in these situations.

B. Prevalence of disordered eating in female athletes
   1. The true prevalance of disordered eating in athletes is unknown. Based on a series of small studies there is a reported 15% to 62% prevalence in female athletes. A higher prevalence of disordered eating is often noted among participants in certain sports; sports in which subjective judging and aesthetics are important (gymnastics, dance, figure skating, diving), sports in which peak performance is associated with low body fat (running—especially distance running— and swimming).
   2. The prevalence of anorexia and bulimia in the general female population is an estimated 3% to 5% for bulimia, and 1% to 3% for anorexia.

C. Contributory factors for disordered eating in athletes
   1. Although the etiology and pathophysiology of disordered eating is not known, there are some known contributory factors, including the desire

to achieve or maintain an ideal body weight and/or optimal body fat, extreme pressure to excel in sport, pressure from coaches (weight standards, unrealistic expectations), pressure from parents, school, organization, society, self, low self-esteem, and poor body image. Athletes in sports in which appearance or endurance is important are often at higher risk. A family history of disordered eating or substance abuse and family dysfunction may also be an underlying factor, as might a history of sexual abuse. Puberty, adolescence, and young adulthood are vulnerable stages of development and it is in these periods of time when most disordered eating problems manifest.

D. Health consequences
   1. The health consequences of disordered eating are often lifelong. Psychological health consequences include the potential for significant morbidity and even mortality with anorexia and bulemia, as well as with disordered eating. Endocrine problems may involve menstrual dysfunction, premature osteoporosis, and growth and development effects. Nutritional problems often include pathologic weight-control techniques, malnutrition, and a starvation state, which can lead to a multitude of problems. Multiorgan problems of the cardiovascular and gastrointestinal (GI) systems can occur and in the more severe cases these can have a potential negative effect on every organ system.

E. Clinical evaluation
   1. History. One must maintain increased awareness of the female athlete triad and potential high-risk groups when screening for these important and often secretive problems. The preparticipation physical examination (PPE) is often an ideal time to screen and intervene for health issues of concern. Questions assessing nutritional history, menstrual history and exercise training are important. A 24-hour diet recall, highest and lowest weight in the past 12 months, a list of forbidden foods, and assessment of the athlete's sense of body satisfaction are important. A past or present history should be obtained of laxative use, use of diet pills or of self-induced vomiting. If a problem is identified, the athlete should be referred for a more detailed assessment and a physical examination can be scheduled at another office visit.
   2. Physical examination. A complete physical examination and pelvic examination (if there is menstrual dysfunction) is warranted if there is concern about disordered eating. Some signs/symptoms on physical examination that may be helpful are decreased body temperature, bradycardia, orthostatic hypotension, lanugo development (anorexia), decreased concentration, swollen parotid glands (bulimia), erosion of tooth enamel (bulimia), face and extremity edema, esophageal tears (bulimia), cardiac arrhythmias, abdominal pain, and delayed gastric emptying, in addition to other problems.
   3. Laboratory testing may be helpful in some instances. Tests obtained depend on clinical assessment of risk. Patterns that may be seen with disordered eating patterns include a complete blood count with a low white blood cell (WBC) count, low platelets; a chemistry panel with elevated LFTs (liver function tests), elevated cholesterol level; thyroid function tests with a low T3 and normal TSH; and electrolytes with low K, Na, Cl, Mg, PO4, Ca; and urine analysis to assess for ketonuria, pyuria, and hematuria. A ferritin level may be helpful to assess for iron deficiency.
   4. An electrocardiogram (ECG) should be obtained in athletes with more significant restrictive eating (anorexia) prior to clearing for sport participation. Assess for prolonged QT interval or other abnormalities if disordered eating is significant or if clinically indicated. (Prolonged QT interval and other ventricular arrhythmias have been noted as causes of death in severely ill patients with anorexia nervosa.)

F. Treatment and prevention
   1. The treatment for disordered eating should emphasize prevention. A multidisciplinary team (psychologist, nutritionist, physician, others) is essential in both preventive and treatment efforts. Medication may be

indicated in some cases (SSRIs are promising) along with individual and group therapy. A support network is important. Increasing self-esteem often is the focus of therapy sessions. The physician should emphasize optimal health, not disease. Follow/treat the patient if there is menstrual dysfunction [e.g., with ERT, calcium, etc.] for prevention of osteoporosis (dietary approaches, appropriate exercise, possible ERT, or other intervention).

2. Redefining athletic goals is important if appropriate and removal of an at-risk athlete from competition can be considered if medically indicated. Hospitalization may be indicated in some cases.

VII. Nutritional Concerns in the Female Athlete

A. Nutrient requirements
   1. Female athletes have nutrient requirements similar to those of male athletes, with two exceptions: calcium and iron.

B. Calcium
   1. For hypoestrogenic amenorrheic women, calcium 1,500 mg/day is needed to maintain calcium balance. For euestrogenic women, calcium 1,200 to 1,500 mg/day is needed. Dietary calcium is preferred to supplements.

C. Iron
   1. Approximately 20% to 30% of female adolescent and young adults (athletes and nonathletes) may be iron deficient. It is important to differentiate iron deficiency anemia from pseudoanemia, which occurs in some athletes (see Chapter 28). Sources of iron loss include menstruation, diet, GI blood loss, sweat, urine and foot strike hemolysis.
   2. It is not cost-effective to screen all female athletes for iron deficiency. Screening high-risk athletes (endurance athletes and others, based on clinical assessment) or those with a previous history of iron deficiency, may be beneficial. Serum ferritin is the most sensitive diagnostic test (more than 12 mg/dL is diagnostic). Because ferritin is an acute-phase reactant, obtaining serum iron studies may be helpful. Iron level is decreased and TIBC level is increased in iron deficiency. Decreased hemoglobin and hematocrit levels may be deceiving and can also be a finding with pseudoanemia of athletes (a physiologic dilutional effect).
   3. The effect of anemia on athlete performance is controversial. Mild anemia decreases performance, whereas low ferritin without anemia probably does not.
   4. The treatment of iron-deficiency anemia includes iron supplementation (varying dose depending on severity) and dietary counseling. In iron deficiency without anemia, iron supplementation is controversial. Prevention of anemia through dietary counseling is recommended and following the athlete to detect development of anemia is suggested. In athletes with normal iron stores, routine iron supplementation is not warranted. Prevention through dietary counseling is recommended.

VIII. Stress Urinary Incontinence in the Female Athlete

A. Stress urinary incontinence is experienced as involuntary loss of urine during physical exertion by some athletes.

B. The mechanism involves increased intraabdominal pressure during exercise.

C. At risk are athletes in running and jumping sports (gymnasts, runners, jumpers), hypoestrogenic amenorrheic/oligomenorrheic females, multiparous females, and those with anatomic defects.

D. Treatment includes avoiding excessive fluid ingestion for 2 to 3 hours before an event (tailored to sport and weather conditions to avoid dehydration) and use of a tampon or small sanitary napkin during an event and/or kegel exercises to strengthen muscles of the pelvic floor. Biofeedback, and other forms of behavioral therapy may prove beneficial. Physicians should assess such problems and correct menstrual dysfunction if it exists, especially hypoestrogenic state, which may contribute to stress urinary incontinence (e.g., hormone replacement may beneficial). Assess and correct for anatomic defects, such as in the posterior urethrovesical angle.

IX. Prevention of Medical and Orthopaedic Problems in the Female Athlete

A. Screening
   1. The PPE is required for many athletes before they participate in organized sports and provides an ideal opportunity to screen athletes and to educate and counsel them. A thorough history is important—be specific in questions and maintain a high index of suspicion for the special concerns of the female athlete. A physical examination should be tailored to the needs of female athletes.
   2. Physician office visits should be used to follow individuals when necessary for identified problems or to provide athletic training room opportunities for the physician who is also following an athletic team in a high school, college, or professional setting.

B. Education and counseling
   1. Medical concerns, including endocrine, nutritional, and psychological problems, must be monitored if the athlete is to exercise in a safe and healthy manner.
   2. Orthopaedic concerns include injury prevention—strength and flexibility, correction of biomechanical imbalances, appropriate footwear, and year-round training.

C. Multidisciplinary team
   1. The importance of a multidisciplinary team approach cannot be overemphasized. The primary care physicians ideally should have consultants available in the areas of nutrition, psychology, orthopaedics, and physical therapy/athletic training to assist in medical care of the female athlete when needed.

Suggested Readings

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