Female Athlete Issues for the Team Physician: A Consensus Statement—2017 Update

Definition

Female athletes experience musculoskeletal injuries and medical problems, resulting from and/or impacting athletic activity. Team physicians must understand the gender-specific implications of the following issues:

- Anterior cruciate ligament (ACL) injuries
- Patellofemoral pain
- Shoulder injury
- Bone stress injuries
- Concussion
- Low bone mass and Osteoporosis
- Energy availability (EA) and disordered eating/eating disorders (DE/ED)
- Menstrual dysfunction
- Female Athlete Triad
- Pregnancy and contraception

Goal

The goal of this document is to help the team physician improve the care of the female athlete by understanding select injuries and illnesses in this population. To accomplish this goal, the team physician should have knowledge of and be involved with the following:

- Musculoskeletal conditions, including ACL injuries; patellofemoral injuries; shoulder injuries; and bone stress injuries.
- Medical conditions, including low energy availability (LEA)/DE/ED; menstrual dysfunction; bone health; and pregnancy/contraception.

Summary

This document provides an updated overview of select musculoskeletal and medical issues that are important to team physicians who are responsible for the medical care of female athletes. It is not intended as a standard of care and should not be interpreted as such. This document is only a guide and, as such, is of a general nature, consistent with the reasonable, objective practice of the health care professional. Individual treatment will turn on the specific facts and circumstances presented to the physician. Adequate insurance should be in place to help protect the physician, the athlete, and the sponsoring organization.

This statement was developed by a collaboration of six major professional associations concerned about clinical sports medicine issues; they have committed to forming an ongoing project-based alliance to bring together sports medicine organizations to best serve active people and athletes. The organizations are American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.

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The Female Athlete and Anterior Cruciate Ligament (ACL) Injuries

Epidemiology

- The noncontact ACL injury rate is two to six times higher in female athletes than in male athletes. In contrast, contact ACL injury rate is similar in both populations.
- Sports requiring pivoting, cutting, and twisting (*e.g.*, basketball, gymnastics, lacrosse, skiing, and soccer) place the athlete at highest risk of injury.
- Most ACL injuries occur in athletes in their late teens and early 20s.

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- Divergence in noncontact ACL injury rates is evident immediately after puberty, with a disproportionate increase in female athletes.
- The risk of subsequent contralateral ACL injury is higher in female athletes.

Physiology/Pathophysiology

- ACL injuries occur when an athlete stops suddenly or changes directions abruptly during cutting and landing maneuvers. At-risk positions during these maneuvers include knee extension, flat foot, and off-balance body position.
- Causes of noncontact ACL injuries may be multifactorial: proposed risks include environmental (*e.g.,* surface and shoes), anatomical (*e.g.,* increased Q angle, narrow intercondylar notch, increase in posterior tibial slope), and hormonal.
- Neuromuscular factors, such as poor core muscle control, greater quadriceps-to-hamstrings strength ratio, and gluteal muscle weakness result in altered biomechanics and contribute to an increased risk of noncontact ACL injuries.
- There is an increased incidence of knee osteoarthritis with or without surgery after ACL injury.

Evaluation and Treatment

- A description or history of feeling a "pop," giving way and immediate effusion represent a high likelihood of sustaining an ACL injury and indicates the need for early evaluation.
- Conduct a comprehensive physical examination of the knee acutely and when symptoms decrease.
- Utilize imaging as indicated as part of the evaluation.
- Immediate postinjury treatment and rehabilitation should address pain, swelling, range-of-motion deficit, strength loss, instability, and poor neuromuscular control and should be initiated regardless of nonoperative or surgical management.
- Surgical indications may vary depending on age, anticipated activities (pivoting/cutting sports), and associated injuries.

Prevention

- Tests that may assess neuromuscular factors include competence in landing and cutting positions (*e.g.,* box drop and landing error scoring system [LESS]) and hip and core strength (*e.g.,* single-leg squat).
- ACL injury prevention programs that address biomechanical and neuromuscular factors have been shown to decrease the rate of ACL injuries:
  - Program components include dynamic stretching, strengthening, functional balance, agility, and plyometric exercises.
  - Preseason protocol lasting more than 10 min, three times per week for at least 8 wk is most effective; this program should be continued in-season during warm-up and modified when needed.

It is essential the team physician understand:

- The female athlete is at increased risk of noncontact ACL injury in multiple sports and activities.
- The anatomy, biomechanics, and mechanisms of ACL injury.
- Evaluation and treatment strategies, including history, examination, imaging studies, and surgical indications.
- Immediate treatment and rehabilitation addresses pain, swelling, range-of-motion deficit, strength loss, instability, and poor neuromuscular control.
- Injury-prevention programs decrease the risk of ACL injury.

It is desirable the team physician:

- Identify risk factors during the PPE.
- Review imaging studies.
- Understand the principles of nonoperative and surgical management of the ACL injury.
- Understand the potential long-term sequelae of ACL injury.
- Understand and coordinate the components of an ACL injury prevention program.
- Develop criteria and a protocol for RTP.
- Educate the athletic care network, including information about at-risk positions and game situations that are associated with ACL injury.

The Female Athlete and Patellofemoral Pain

Epidemiology

- Patellofemoral pain occurs frequently in female athletes and significantly more than in male athletes.
- Patellofemoral pain and dysfunction may result from structural problems (*e.g.,* anatomic, alignment), macrotrauma, and microtrauma.

Physiology/Pathophysiology

- Normal patellofemoral mechanics involve a balance between bone alignment, articular cartilage, soft tissue (ligaments, muscles, tendons, fascia), and coordinated neuromuscular activation.
- The causes of patellofemoral pain and dysfunction are multifactorial, including anatomic (*e.g.,* patella alta, trochlear dysplasia), static and/or dynamic malalignment, articular cartilage lesions, instability, soft tissue factors (*e.g.,* increased flexibility, hypermobility, poor neuromuscular control), and physiologic (hormonal).
- Patellofemoral pain may occur in what appears to be a structurally normal knee joint.
- Clinical or radiographic findings in athletes with patellofemoral pain may include:
  - Static and/or dynamic malalignment of the pelvis, hip, knee, ankle, and foot
  - Muscle weakness and/or imbalance and inflexibility in the pelvifemoral region and around the knee
  - Altered patellofemoral alignment and/or morphology
  - Trauma, overuse, and/or training errors (*e.g.,* volume, intensity, and early specialization)

Evaluation and Treatment

- Obtain a comprehensive history and perform an assessment of the kinetic chain, pelvifemoral region, flexibility and posture, and a detailed knee examination, including the patellofemoral joint.
- Utilize imaging as indicated as part of the evaluation.
- Nonoperative management:
  - Patient education and activity modification
  - Rehabilitation to address poor neuromuscular control, muscle strength imbalance, and inflexibility
  - Taping, bracing, foot orthotics, and medications
- Surgical management when indicated.

Prevention

- Clinical or radiographic findings in athletes with patellofemoral pain may not be risk factors for development of patellofemoral pain in asymptomatic athletes.
- Risk factors that have been found to predict the development of patellofemoral pain in asymptomatic female adolescent athletes include:
  - Knee valgus displacement as assessed by the box-drop test (1)
  - Early sport-specialization

It is essential the team physician understand:

- The female athlete is at increased risk of developing patellofemoral pain.
- The anatomy, biomechanics, and clinical and radiographic findings of patellofemoral pain.
- Principles of evaluation and treatment

It is desirable the team physician:

- Utilize the PPE to identify and address known risk factors for the development of patellofemoral pain.
- Identify musculoskeletal deficits as the basis for a conditioning program.
- Coordinate a network to identify risk factors and implement rehabilitation interventions.
- Coordinate the evaluation and treatment of athletes with patellofemoral pain.
- Review the imaging studies.
- Understand comprehensive nonoperative and surgical management.
- Coordinate a comprehensive prevention program that includes neuromuscular education.
- Develop criteria and a protocol for return to play after rest/recovery and injury.
- Educate the athletic care network, including information about risk factors including early sport-specialization as associated with patellofemoral pain.

The Female Athlete and Shoulder Injury

Epidemiology

- Shoulder injuries are common in female athletes in all overhead sports at all skill levels.
  - Softball and swimming: most commonly injured joint
  - Tennis and volleyball: third-most commonly injured joint
- Shoulder injuries result from macrotrauma and microtrauma.
- Injury incidence is increasing over the last 10 yr.
- Most common injuries are impingement/rotator cuff, labral tears, and glenohumeral (GH) instability.

Physiology/Pathophysiology

- The integration of coordinated neuromuscular activation, capsular/ligament stiffness, and GH and scapulothoracic positioning is key to shoulder function.
- The shoulder joint is subjected to frequently applied high loads and large ranges of motion in normal sport activities.
- Risk factors identified in athletes with shoulder injuries include:
  - Overload/overuse is a consistently demonstrated risk factor (*e.g.,* multiple games/matches/teams, increased training volume, and decreased rest intervals)
  - Musculoskeletal risk factors (*e.g.,* muscle fatigue and imbalance, hip and core weakness, shoulder rotation deficits, and scapular dyskinesis)
  - Alterations in technique (*e.g.,* dropped elbow in throwing and tennis, altered hand entry position in swimming)
  - Hyperlaxity has not been proven to be an independent risk factor

Evaluation and Treatment

- Investigate overhead activity exposure (*e.g.,* practice, competitions, teams, exposure per week and per year, rest, and recovery times).
- Conduct a comprehensive examination for the shoulder condition, including assessment of range of motion, strength, stability, biceps, acromioclavicular (AC) joint and rotator cuff integrity, and scapular function.
- Conduct a comprehensive examination for the kinetic chain, including hip and core strength, flexibility, and posture.
- Utilize imaging as indicated as part of the evaluation.
- Modify overhead exposure and improve overhead mechanics.
- Implement a comprehensive rehabilitation program, including kinetic chain, core, scapula, and shoulder.
- Implement specific return-to-play programs and criteria.
- Surgical treatment may be indicated when rehabilitation fails to change symptoms and improve function.

Prevention

- Manage overhead activity exposure (*e.g.,* periodization and rest/recovery) (2)
- Training to optimize sport- and activity-specific biomechanical techniques
- A dedicated off-season conditioning program (6–9 wk, including whole-body training and a variety of resistance methods) has been shown to increase performance and decrease injury risk.

It is essential the team physician understand:

- There is a high incidence of shoulder injuries in female athletes participating in overhead sports.
- Training and competition volume (the total overload exposure) is the most consistent etiologic risk factor for overuse shoulder injuries.
- The anatomy, biomechanics, and mechanisms of shoulder injury, including importance of the kinetic chain.
- A comprehensive process is necessary for evaluation of these injuries.

It is desirable the team physician:

- Understand the sport- and activity-specific biomechanics and musculoskeletal demands of each sport.
- Understand alterations in overhead motion biomechanics and technique are common risk factors.
- Understand musculoskeletal strength and flexibility deficits around the shoulder and in the kinetic chain are commonly associated with injury.
- Evaluate the training and competition volume profile of the athlete.
- Perform a comprehensive musculoskeletal kinetic chain evaluation of the athlete.
- Assist in the periodization plan for conditioning and competition of the athlete, including rest/recovery time.
- Know the indications and guidelines for surgical treatment.
- Develop criteria and a protocol for RTP.
- Educate the athletic care network.

The Female Athlete and Bone Stress Injuries (BSI)

Epidemiology

- Bone stress injuries (BSI) occur frequently in female athletes.
- Studies suggest a higher incidence of BSI in female athletes as compared to male athletes.
- Common anatomical areas include the foot, tibia, fibula, femur, pelvis, and sacrum.

Physiology/Pathophysiology

- BSI occurs when bone is subjected to repetitive loads that exceed its capacity to repair itself.
- If bone formation is inadequate, alone, or in combination with increased bone resorption, the bone may not withstand continued repetitive loads.
- BSI occurs on a spectrum, ranging from stress reaction to stress fracture to complete fracture.
- BSI risk factors include:
  - Extrinsic: exercise volume, intensity, and type; surface and footwear
  - Intrinsic: biomechanics, muscle strength and balance, and limb alignment
  - Medical and psychological: previous BSI, low energy availability, poor nutrition, menstrual dysfunction, low and/or poor bone mineral density, low body mass index (BMI), low body weight (adolescents) and DE/ED

Evaluation and Treatment

- Perform a comprehensive history and physical examination, including assessment for extrinsic, intrinsic, and medical and psychological risk factors.
- Evaluate for focal bony tenderness and pain with loading.
- Utilize imaging as indicated as part of the evaluation.
- BSI in trabecular bone (*e.g.,* femoral neck, sacral, calcaneal) and multiple BSI should trigger an evaluation for underlying medical abnormalities (*e.g.,* low energy availability, poor nutrition, low bone mass/osteoporosis, menstrual dysfunction).
- Identify BSI at high-risk of complication and long-term sequelae (*e.g.,* fifth metatarsal [Jones], tarsal navicular, tension-side, or significant compression-side femoral neck, anterior tibial cortex).
- Implement comprehensive management and rehabilitation, including nonoperative and surgical intervention when indicated. Activity modification is central to a treatment plan.
- Recognize some BSI require management by a multidisciplinary team.

Prevention

- Multiple risk factors exist for BSI and should be identified and addressed during the PPE.
- Screening for risk factors should be continued during routine health care visits.
- Manage the overload activity exposure.

It is essential the team physician understand:

- A BSI can be an isolated injury or may indicate underlying medical and psychological issues.
- Certain BSI may be high-risk in terms of delayed healing, progression to complete fracture, and long-term sequelae.
- Imaging is important in the confirmation of the diagnosis.

It is desirable the team physician:

- Coordinate and manage multidisciplinary evaluation and treatment, including addressing risk factors.
- Review imaging studies.
- Develop criteria and a protocol for RTP.
- Educate the athletic care network.

The Female Athlete and Concussion

Concussions are an important injury in the female athlete. There is a published Team Physician Consensus Statement on concussion (3), as well as other recent reviews (4). These recent works delineate some issues related to concussion in female athletes, about which the team physician should be aware.

It is essential the team physician understand:

- In sports with the same rules, the reported rate of concussions is higher in female athletes than male athletes.
- While female athletes often report more symptoms at baseline and after concussion than male athletes; it

remains unclear if female athletes actually have worse initial outcomes or slower recovery.

It is desirable the team physician:

- Understand male/female differences in sports concussion reporting rates and clinical course are multifactorial, and include reporting bias, cultural and/or linguistic factors, hormonal differences, biomechanical mechanisms, cervical spine muscle strength, and stiffness.
- Understand there may be male/female differences in mechanisms of injury (*e.g.,* male—more likely to have player-to-player contact; female—more likely to have contact with stick or ball)
- Coordinate and manage multidisciplinary evaluation and treatment, including addressing risk factors.
- Develop criteria and a protocol for return-to-learn and RTP.
- Educate the athletic care network.

The Female Athlete and Low Bone Mass and Osteoporosis

In this section, bone mass is the mineral content of bone as measured by DXA and is reported as bone mineral content (BMC, g) or areal bone mineral density (BMD, $g \cdot cm^{-2}$). BMD corrects for the area of bone studied.

Epidemiology

- The incidence of low bone mass and osteoporosis in the female athlete is unknown.
- Several studies have demonstrated low bone mass and osteoporosis in female athletes with low energy availability (LEA), DE/ED, and/or menstrual dysfunction.

Physiology/Pathophysiology

- Osteoporosis is a disease of the bone characterized by decreased bone mass or the presence of a fragility fracture. Low bone mass is the preferred term to osteopenia in children and adolescence.
- Bone mass is determined by the balance between bone resorption and formation. LEA from decreased energy intake and/or excessive exercise energy expenditure causes suppressed reproductive and metabolic hormones and alterations in bone metabolism.
- The major determinant of adult bone mineral density (BMD) is bone mass achieved during adolescence and young adulthood. Peak bone mass is attained between ages 20 and 30; 90% of which is accrued by the end of adolescence, creating a window of opportunity to maximize bone mass.
- Osteoporosis-related fractures in later life are associated with significant morbidity and mortality.
- Peak bone mass is largely (60% to 80%) dependent on genetic factors, with weight bearing/loading exercise, lean body mass, reproductive hormone status, adequate energy intake nutrition, and bone-building nutrients (*e.g.,* calcium/vitamins D, K) also contributing to optimal peak bone mass.
- Bone mass is decreased by tobacco use, excessive alcohol consumption, certain medical conditions (*e.g.,* renal disease, hyperparathyroidism, DE/ED), medications (*e.g.,* Medroxyprogesterone Acetate, Selective Serotonin Reuptake Inhibitors, corticosteroids), and inadequate bone-building nutrients.
- Athletes who engage in impact activities and/or strength training have higher site-specific BMD than athletes in low-/nonimpact sports or nonathletes. The effect of impact activities and/or strength training is most pronounced during puberty and dependent upon intensity and volume of conditioning.

Evaluation and Treatment

- All female athletes should be screened for LEA, DE/ED, menstrual dysfunction, and low bone mass/osteoporosis.
- Female athletes with amenorrhea, prolonged oligomenorrhea, or a history of BSI are at high risk.
- Evaluation of BMD is by Dual Energy X-ray Absorptiometry (DXA). Interpretation is based on normal distribution of BMD of adolescents and premenopausal females compared to average females of their own age (Z-score) as opposed to using criteria for postmenopausal women (T-score) to determine osteoporosis risk.
- Evaluation also includes laboratory assessment for oligo/amenorrhea and DE/ED, as well as further metabolic work up for those with low bone mass and/or recurrent BSI.
- In the presence of oligo/amenorrhea, the American College of Sports Medicine recommends the presence of Z-scores between −1.0 standard deviation (SD) and −2.0 defined as low bone mass. Z-scores of −2.0 and below may be indicative of osteoporosis.
- In children, an osteoporosis diagnosis is made by Z-score along with clinical risk factors (5).
- All athletes with Z-scores of less than −1.0 should be referred to a registered dietitian. In addition, all athletes with scores less than −2.0 should be referred for more comprehensive medical evaluation and treatment. BMD should be monitored.
- It is advantageous to identify athletes during the first year of amenorrhea as bone loss is most active at this time. Initial intervention should be counseling to change nutritional and exercise habits to decrease incidence of BSI.
- Pharmacological interventions for increasing bone mineral density and reducing fracture risk should be implemented only if nonpharmacologic measures are not successful after at least one year, and may include transdermal estrogen or oral contraceptives in the amenorrheic or oligomenorrheic athlete (if bone loss occurs after at least one year of nonpharmacologic management), along with calcium and vitamin D.
- Bisphosphonates, teriparatide, selective estrogen receptor modulators, and denosumab should be avoided due to effects on pregnancy in premenopausal women and lack of safety data in the premenopausal female.

- Multidisciplinary treatment may include restoration of normal menstrual cycles, optimization of physical activity and nutrition, psychological therapy, and pharmacological intervention.

Prevention

- Adequate nutrition, weight bearing/loading exercise, and physiologic estrogen levels may help prevent low bone mass.
- Bone mass preservation is especially important in adolescence and young adulthood when bone mass is accruing.
- Coordinate a screening evaluation process, during the PPE and routine visits, to identify at-risk female athletes.
- Avoid factors that negatively affect BMD and maximize management of medical conditions that have a risk for low bone mass/osteoporosis.
- Educate the athletic care network on the identification and prevention of low bone mass/osteoporosis and its effect on injury risk and long-term consequences on the athlete's health.

It is essential the team physician understand:

- Low bone mass and osteoporosis can exist in the young female athlete.
- The majority of peak bone mass is accrued by the end of adolescence.
- The most common risk factors for low bone mass are LEA, DE/ED, and menstrual dysfunction.

It is desirable the team physician:

- Coordinate a screening process to identify at-risk athletes.
- Understand indications and interpretations for the utility of imaging techniques (DXA) and laboratory assessment for low BMD.
- Coordinate a comprehensive evaluation including assessment of menstrual status and nutritional intake, measurement of BMD, and laboratory testing as necessary.
- Facilitate comprehensive treatment for low bone mass and osteoporosis.
- Understand that the diagnostic criteria for osteoporosis in children is determined by Z-score along with clinical risk factors.
- Educate the athletic care network.

The Female Athlete and Energy Availability (EA) and Disordered Eating/Eating Disorders (DE/ED)

- Energy availability (EA) is defined as the amount of energy available for physiological processes and activities of daily living after subtracting out the energy used for exercise training (dietary energy intake – energy expenditure/kg fat-free mass [FFM]).

Epidemiology

- Low EA and disordered eating/eating disorders (DE/ED) occur on a spectrum. This ranges from unintentional inadequate EA (inadvertent undereating), to calorie, protein and/or fat restriction and pathogenic weight control measures (*e.g.* diet pills, laxatives, excessive exercise, self-induced vomiting) to classic eating disorders (ED), such as anorexia nervosa, bulimia nervosa, binge eating disorder, and other specified eating or feeding disorders (6).
- DE/ED can occur in any athlete in any sport. Athletes in sports involving aesthetics, endurance, and weight classifications are at particular risk.
- DE/ED are psychiatric disorders with distortion of body image and significant nutritional and medical complications, including increased risk of death from suicide or metabolic disturbances.
- Female athletes are at higher risk for developing DE/ED than the general population.

Physiology/Pathophysiology

- Nutritional and medical consequences of the spectrum of DE/ED include:
  - Nutritional deficiencies and electrolyte disturbances
  - Decreased BMD
  - Metabolic disturbances (*e.g.,* low BMD, suppression of metabolic and reproductive hormones)
  - Gastrointestinal problems (*e.g.,* dental, gingival, bleeding, ulceration, bloating, constipation)
  - Cardiovascular abnormalities (*e.g.,* arrhythmias, heart block, endothelial dysfunction)
  - Psychiatric problems (*e.g.,* depression, anxiety, suicide)
- Risk factors include:
  - Pressure to optimize performance and/or modify appearance
  - Psychological factors, such as low self-esteem, poor coping skills, perceived loss of control, perfectionism, obsessive compulsive traits, depression, anxiety, and history of sexual/physical abuse and family dysfunction
  - Underlying chronic diseases related to caloric utilization (*e.g.,* diabetes, thyroid)

Evaluation and Treatment

- Screen for risk factors associated with the spectrum of DE/ED.
- Risk factors may be identified during the PPE. Assessment tools that can be used to help detect DE/ED include the "SCOFF" questionnaire, the Eating Disorder Inventory (EDI) and the Low Energy Availability in Females Questionnaire (LEAF-Q) (7–9).
- Early identification and early intervention have been shown to shorten the recovery from DE/ED.
- Utilize a multidisciplinary health care team, including primary care providers, mental health providers, and RDs.
- A comprehensive evaluation includes assessment of nutrition, exercise behaviors, pathogenic weight control measures, and psychosocial factors, as well as laboratory and diagnostic testing.
- A written contract with an athlete that delineates goals of treatment and specifies criteria necessary for ongoing or future clearance and RTP is recommended.

- Make RTP and clearance decisions in consultation with members of the multidisciplinary health care team.

Prevention

- Primary prevention is the ultimate goal. Strategies include:
  - Promoting healthy body image
  - Providing information on nutrition
  - Dispelling misconceptions about body weight and body composition as it relates to athletic performance
  - Providing information on healthy weight control, especially for weight-class sports and sports emphasizing leanness

It is essential the team physician understand:

- The spectrum of DE/ED and how it affects the female athlete.
- DE/ED can occur in any sport.
- The importance of prevention and early detection of the spectrum of DE/ED.

It is desirable the team physician:

- Understand the evaluation and treatment of the athlete with DE/ED.
- Encourage and facilitate referral to the multidisciplinary health care team.
- Identify and address risk factors during the PPE and subsequent clinical encounters, including specific survey tools (*e.g.,* SCOFF, EDI, LEAF-Q).
- Assess athletes with BSI or menstrual dysfunction for DE/ED.
- Understand screening programs for risk factors, including information to dispel misconceptions about body weight, body composition, and athletic performance.
- Educate athletes and coaches on the signs and symptoms of DE/ED and the role team culture may play (*e.g.,* linking performance to weight and emphasizing physical appearance).
- Educate the athletic care network.

The Female Athlete and Menstrual Dysfunction

- Menstrual dysfunction occurs in different forms:
  - Primary amenorrhea/delayed menarche (onset of menstrual cycles by 15 yr of age)
  - Secondary amenorrhea (absence of menses for three or more months after menarche)
  - Functional hypothalamic amenorrhea (FHA) is the absence of menses due to suppression of the hypothalamic–pituitary–ovarian axis, without an identifiable anatomic or organic cause (exercise-associated menstrual dysfunction)
  - Oligomenorrhea (six to nine cycles per year; cycle length greater than 35 days or less than three months)
  - Anovulation (absence of ovulation; "regular" menstrual bleeding still takes place but the normal fluctuations of ovarian hormones estrogen and progesterone are altered or missing; may have regular menstrual bleeding)
  - Luteal phase deficiency (cycle length may be normal, but there are decreased progesterone levels)

Epidemiology

- Menarche normally occurs at age 11 to 14.
- Female athletes are at risk for primary and secondary amenorrhea.
- In the athlete, menstrual dysfunction is at least two to three times more common than in the nonathlete.

Physiology/Pathophysiology

- Normal menstrual cycle depends on intact hypothalamic-pituitary–ovarian (HPO) axis and normal pelvic organ function.
- The etiology of menstrual dysfunction is multifactorial. Risk factors include body weight and body composition, LEA, nutrition, training, previous menstrual function, and psychosocial factors.
- Intense exercise alone does not necessarily cause menstrual dysfunction, provided there is adequate EA.
- Consequences of menstrual dysfunction include suppression of reproductive hormones and infertility, low BMD, higher incidence of BSI, and altered cardiovascular risk factors (*e.g.,* lipid profile, endothelial function).
- Effects of menstrual dysfunction on BMD may not be completely reversible; early detection and treatment is important.

Evaluation and Treatment

- Menstrual dysfunction evaluation should include assessment of nutrition and EA, exclusion of other causes (*e.g.,* pregnancy, thyroid disorder, prolactinoma, polycystic ovarian disease).
- If menstrual dysfunction is prolonged, consider evaluation of bone health.
- Treatment is dependent on the etiology and frequently involves a multidisciplinary approach.
- Initial treatment should include increasing EA and/or decreasing energy expenditure and optimizing intake of bone-building nutrients (*e.g.,* vitamin D and calcium).
- Hormonal therapy is rarely indicated for initial treatment.

Prevention

- Identify risk factors during the PPE and subsequent clinical encounters.
- Provide adequate EA to maintain normal ovulatory function.
- Educate the athletic care network.

It is essential the team physician understand:

- Menstrual dysfunction in athletes, while common, is not normal.
- FHA is a result of LEA, not excessive exercise alone.
- The consequences of menstrual dysfunction on bone health and BSI.

It is desirable the team physician:

- Understand the evaluation and treatment of the athlete with menstrual dysfunction.
- Encourage and facilitate referral to the multidisciplinary health care team.
- Identify multifactorial risk factors during the PPE and subsequent clinical encounters.
- Coordinate the evaluation and treatment of the athlete with menstrual dysfunction.
- Understand the value of prevention and early detection of menstrual dysfunction.
- Treatment should be focused on restoring normal ovulatory function by addressing adequate EA.
- Educate the athletic care network on the importance of normal ovulatory function and the link to bone health.

The Female Athlete Triad

The Female Athlete Triad (Triad) is a medical condition often observed in physically active girls and women. It involves any one or more of the following three components that are often interrelated (each addressed individually in this document): LEA, with or without DE/ED, menstrual dysfunction and BMD.

The components of the Triad each present along a physiological spectrum:

- EA ranges from optimal to LEA to eating disorder
- Menstrual function ranges from eumenorrhea to oligomenorrhea to amenorrhea
- Bone mineral density ranges from normal to low BMD to osteoporosis

The Female Athlete Triad Consensus Panel Cumulative Risk Assessment tool provides an objective method of determining an athlete's risk using risk stratification and evidence-based risk factors (10).

Relative Energy Deficiency in Sports (RED-S) is a broader, more comprehensive term defining a syndrome that occurs in both female and male athletes, where LEA may lead to altered reproductive hormones (including menstrual dysfunction) and/or low BMD; but also abnormalities in other systems (*e.g.,* metabolic, cardiovascular, gastrointestinal immunologic) that may have both health and performance consequences.

It is essential the team physician understand:

- The definition and recognize components of the Triad.
- Components of the Triad are interrelated; if one is identified, others should be evaluated.

It is desirable the team physician:

- Coordinate a multidisciplinary health care team capable of addressing the medical, nutritional, psychological, and sports-participation-related issues. This team should include the primary care provider, RD, and licensed mental health professionals, preferably with experience with female athletes.
- Develop criteria and a protocol for RTP.
- Educate the athletic care network.

The Female Athlete and Pregnancy/Contraception

The majority of team physicians do not provide obstetrical care or family planning for female athletes, although they may collaborate with members of the athlete's medical home including their health care provider for the management of sports-related injuries and illnesses for determination of participation status.

General Principles

- Exercise throughout pregnancy is generally safe but should be monitored.
- Benefits of exercise throughout pregnancy include:
  - Avoidance of excessive weight gain, improved balance, and decreased back pain.
  - Improved well-being, energy levels, and sleep patterns.
  - Improved labor symptoms and facilitation of postpartum recovery.
  - Lower risk of caesarean section.
  - Reduced risk of having a large- or small-for-gestational age infant.
- No evidence exists that elite athletes or physically active women have higher rates of pre-term labor, prolonged labor, or deliveries that require induction or episiotomy.
- No evidence of a negative effect on Apgar scores.
- Risks include environmental exposure, dehydration, hypoxia, and uterine trauma:
  - High impact or high strain physical activity during the fetal implantation phase may lead to slightly higher risk of miscarriage.
  - Sports with high risk of trauma late in pregnancy could result in placental abruption.
  - Scuba diving is contraindicated because the fetus is not protected from decompression problems.
- Female athletes may have impaired fertility secondary to persistent LEA.
- Travel to areas with endemic infectious disease (*e.g.,* Zika) may require enhanced precaution and consultation regarding risks related to pregnancy.

Physiology/Pathophysiology

- Physiological changes that may affect exercise throughout pregnancy include:
  - Musculoskeletal changes including ligamentous laxity, displacement of the center of gravity, changes in spinal posture, anterior rotation of the pelvis on the femur and abduction of the shoulders, which may all affect performance in certain sports.
  - Medical changes including weight gain, increased heart rate, stroke volume, cardiac output, blood volume and respiratory rate, decreased residual volume and expiratory resolve volume, and improved thermoregulation.
- The goals of exercise throughout pregnancy are to maintain or improve pre-existing levels of maternal fitness without undue risk to the mother or the developing fetus.
- Pregnancy increases nutritional needs (*e.g.,* calories, iron, calcium, and folic acid).

- Exercising in pregnancy at 60% to 70% $\dot{V}O_{2max}$ does not raise core temperature greater than 38°C; it is unclear if prolonged exercise at greater than 90% $\dot{V}O_{2max}$ is safe.
- Moderate to high level of exercise during pregnancy increases $\dot{V}O_{2max}$ after pregnancy.
- Exercise in the supine position may decrease venous return and causes hypotension in some pregnant women. There is no absolute contraindication to supine exercise; however women should avoid the supine position if symptomatic.
- Moderate strength training during pregnancy is effective for improving strength and muscular endurance.

Evaluation and Treatment

- An evaluation includes facilitating or performing a medical examination, nutritional assessment, and ongoing assessment of absolute and relative contraindications to exercise throughout pregnancy and the postpartum period.
- Treatment may include the limitation of physical activity as pregnancy progresses. Discussion with others (*e.g.,* health care providers, parents, coaches, and certified athletic trainers) may be necessary.
- Medications for the treatment of symptoms of pregnancy, such as nausea, vomiting, depression or anxiety, are safe to use and/or are on banned substance lists.
- Intrauterine devices may lead to amenorrhea but are generally considered safe in athletes.
- Combined oral contraceptive therapy is not consistently associated with improved BMD in amenorrheic athletes and may further compromise bone health (11).

Prevention

- Provide or facilitate information related to safe training and competition practices during pregnancy and the postpartum period.
- Implement a screening and education program for at-risk athletes for pregnancy, including information regarding safe sexual practices, family planning, and contraceptive options.
- Educate the athletic care network as to the benefits and risks of exercise throughout pregnancy and the postpartum period.

It is essential the team physician understand:

- Pregnancy may affect sports training and participation.
- Absolute and relative contraindications to certain forms of exercise during pregnancy exist.

It is desirable the team physician understand:

- The importance of family planning and contraception.
- Basic physiologic changes associated with pregnancy and the postpartum period.
- Sport-specific risks and benefits of exercise in pregnancy and exercise prescription.
- The effects of certain medications on maternal and fetal health.
- Medical and obstetrical conditions affecting participation and performance.
- Specific considerations in the pregnant athlete, including nutritional needs, environmental risks, appropriate use of imaging, and contraindications for rehabilitation modalities.
- The pregnant athlete with a past or current LEA, DE/ED is at higher risk of pregnancy complications and requires close monitoring.
- Contraceptive methods and alternatives, and their effects on menstruation, and bone mineral density.
- Risks related to pregnancy and travel to areas with endemic infectious disease (*e.g.,* Zika) is possible.

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