Disclosure

Relevant Financial Relationships
None

Off-Label/Investigational Uses
None
Objectives

• Define the classic and updated components of the female athlete triad.

• Recognize that low energy availability is the cornerstone of the triad.

• Identify red flags of the triad in order to introduce early multidisciplinary intervention and treatment.

• Discuss newer Return to Play (RTP) recommendations based on the 2014 ACSM Position Stand.
Benefits of Athletics

• Improved physical fitness
• Enhanced self-esteem
• Improved physical and emotional health
• Promotion of peak bone mass
• Team building & leadership skills
• More likely to obtain advanced degrees
• Less likely for high risk behaviors (substance use, teen pregnancy)
Female Athlete Participation Continues to Rise!

- Since Title IX in 1972, more than 10 fold increase in HS girls sports >3 million female student athletes
Classic Triad

Eating Disorder

Amenorrhea

Osteoporosis
Female Athlete Triad Timeline

• 1992- ACSM Task Force on Women's Issues
  • Identified 3 interrelated disorders

• 1997- ACSM Position Statement
  • Classic definition
  • Defined prevalence & consequences
  • Call for research

• 2007- ACSM Position Statement - revised
  • Low energy availability is key disorder
  • Athletes can exist along a spectrum

• 2014- Female Athlete Triad Coalition Consensus Stmt
  • Confirmed spectrum of disorder
  • Discussed treatment & RTP models
Updated Triad

Energy Availability

Menstrual Function

Bone Health
Energy Availability

↓ Stress

Δ Hypothal GnRH

↓ LH pulse

↑ Risk of amenorrhea

Δ Menstrual Function

↓ Estrogen

↑ Bone resorption

↓ Bone formation

Δ Metabolic mediators of bone formation

↓ ↓ Bone Mineral Density

IRREVERSIBLE LOSS OF BMD...

↑ Risk of Stress Fractures

Δ Metabolic mediators of bone formation
Red Flags/ Risk Factors

- Sports that emphasize appearance/aesthetics
  - Ballet, figure skating, gymnastics, cheerleading
- Pressure to maintain low body mass for optimal performance
  - Cross country, swimming
- Overtraining
  - Practice outside scheduled times or until exhaustion
  - Training despite illness or injury
- Traumatic event
  - Injury, Poor Performance, Coach/Parent pressure
Disordered Eating Prevalence

• More prevalent in athletes than non-athletes
• Higher in sports with weight classes (rowing, wrestling)
• Higher in aesthetic sports (gymnastics, figure skating, ballet)
• Higher in sports where lower weight may be advantageous (cross country, track, cycling)
• 2004 US study (Sundgot-Borgen)
  • Aesthetic sports 42%, endurance 24%, ball sports 16%
• 2015 German study of professional athletes (Theimann)
  • Aesthetic sports 17%, ball sports 2%, non-athletes 2%
Energy Availability

• Energy input – Energy Output = Energy Availability
• Normal caloric intake 30kcal/kg/day
• After 5 days of restriction <30kcal/kg/day
  - LH pulse frequency → estradiol
  - Bone formation
  - Bone resorption
• Severe under-nutrition impairs reproductive and skeletal health (ACSM Rec Stmt- Evidence A)
Disordered Eating VS Eating Disorders

• Athletes may be unaware of nutritional needs
  • Intake inadvertently restricted
  • Intake does not match expenditure
  • Inadequate EDUCATION regarding energy requirements

• Eating Disorders
  • Anorexia nervosa
  • Bulimia nervosa
  • Eating disorder NOS
Anorexia nervosa (DSM V)

- Restrictive eating
- Distorted view that pt is overweight
  - No longer need to endorse “fear”, may be inferred from behaviors
- Less than minimally normal weight/expected weight (kids)
  - No longer <85% of normal or BMI <18
- *Removed amenorrhea from dx criteria
  - Decrease NOS category, include those on OCPs, delayed menarche, (and men)
Anorexia nervosa

- 90-95% Females, age 12-30s
- Caucasian, middle, to upper-class
- Mortality 9-12%
  - Risk of premature death 6-12 times higher
  - Cardiac arrhythmia, electrolyte disturbances, diminished heart muscle mass
- Suicide rate accounts for 20% deaths of those with AN
Bulimia nervosa (DSM V)

- Normal weight range
- Sense of lack of control during binging
- Purging - vomiting, laxatives, enemas
- Binge → purge >ONE time/week average over 3 months
  - (decreased from twice/week)

- Eating disorders NOS
  - All others…
Anorexia Athletica (not DSM)

- Distinctly associated with sports training
  - Perfectionism
  - Compulsiveness
  - Competitiveness
  - High self motivation
  - Menstrual disturbances
  - Unhealthy weight control (at least ONE)
    - Fasting, vomiting, diet pills, laxatives, diuretics
    - Intentional OVER TRAINING
Normal Menstrual Function
Menstrual Dysfunction

- **Caloric deficit** → decreased release of hormones from hypothalamus (GnRH) & pituitary (LH & FSH)
- LH & FSH signal ovaries to produce Estrogen & progesterone for menses to occur
- Estrogen essential for bone health
  - Inhibits osteoclasts
  - Increases mineralization
  - Enhances Ca absorption from gut
  - Protects bones from resorption effect of PTH
Menstrual Function
Eumenorrhea ↔ Amenorrhea

• **Oligomenorrhea**: menses occurring >35 day cycles

• **Amenorrhea**: menses occurring >90 day cycles
  • **Primary**:
    • Delay in age of menarche >15 yo WITH secondary sexual characteristics
    • Lack of secondary sexual characteristics by age 14
      • More common in sports started at younger ages (gymnastics, skating, cheer)

• **Secondary**: Cessation of menses after menarche
  • Most common for Athletic amenorrhea
Menstrual Function
Eumenorrhea ↔ Amenorrhea

• Prevalence of menstrual dysfunction
  • General population 2-10%
  • Female athletes 6-79%

• Mechanism: ENERGY DEFICIT →

Functional hypothalamic amenorrhea
• Hypothalamic-pituitary-ovarian axis
• Suppression of GnRH
• Decreased LH pulse frequency
• Decreased circulating estrogen
Amenorrhea Algorithm (DeSouza Coalition Stmt 2014)

**History and Examination**
- Uterine pathology or outflow tract disorder
- Disorders of sexual differentiation
- **Rule out Pregnancy**

**Initial Investigation (based on H&P)**
- LH, FSH, hCG
- Prolactin
- TSH, free T4
- Estradiol, testosterone (total and free), DHEAS ± 8AM 17(OH) progesterone
- Progesterone challenge test
- ± Pelvic ultrasound

**FINDINGS**
- Low to normal gonadotropins
  - Negative progesterone challenge test
  - Possibly ↑ prolactin

- Normal gonadotropins
  - Possibly ↑ LH/FSH
  - ↑ Total/free testosterone
  - Positive progesterone challenge test

- ↑ Gonadotropins
  - Negative progesterone challenge test

- Abnormal TSH, prolactin, DHEA/S or 8 AM 17(OH) progesterone

**DIAGNOSIS**
- Hypothalamic-pituitary etiology
  - Rule out outflow tract obstruction if not done so previously
  - Consider FHA (prolactin typically not elevated)*
- Chronic anovulation/PCOS
- Primary ovarian insufficiency
- Specific investigation of endocrine disorder

* If energy deficiency-related amenorrhea, including exercise, weight loss, or disordered eating related, consult with sports dietitian and obtain a bone mineral density test (site of testing should be based on the age of the patient: spine and whole body for growing children and adolescents, spine and hip for adult women); Refer or consult with endocrinologist if not experienced in treatment.
Bone Mineral Density

- Peak Bone Mass is achieved between 18-25 yrs
Bone Mineral Density Optimal ↔ Osteoporosis

• **Post-menopausal Adults:**
  • Accelerated bone mineral loss
  • Hypoestrogen state

• **Adolescent Athletes:**
  • Failure to accumulate optimal BMD
  • Hypoestrogen, but also decreased growth factors (GH, insulin, cortisol, leptin, TSH)

• Athletes in weight bearing sports should have 5-15% HIGHER BMD than non-weight bearing sports…

• **Bone loss may occur rapidly in the first 2-3 years after menstrual disturbance ~ 4% per year**
# Bone Mineral Density

Optimal Bone health $\iff$ Osteoporosis

<table>
<thead>
<tr>
<th></th>
<th>Osteoporosis</th>
<th>Osteopenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postmenopausal</td>
<td>T-score $&lt;-2.5$ SD</td>
<td>$-1.0 &gt;$ T-score $&gt;-2.5$ SD</td>
</tr>
<tr>
<td>(WHO recs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premenopausal Athletes</td>
<td>Z-score $&lt;-2.0$ PLUS</td>
<td>“Low BMD for age” $-1.0 &gt;$ Z-score $&gt;-2.0$ PLUS</td>
</tr>
<tr>
<td>(ACSM recs)</td>
<td>Risk Factors</td>
<td>Risk Factors</td>
</tr>
</tbody>
</table>

- **Risk factors:**
  - Nutritional deficits
  - Hypoestrogen
  - Stress fractures

- **T-score:** mean of zero, compares to peak BMD of healthy young women

- **Z-score:** relative to age, better correlation for young females
Bone Mineral Density Stress Fractures

- Overuse injuries where resorption outpaces formation
- Exacerbated in athletes with poor bone quality or poor nutritional intake.
- Direct correlation between number of months of amenorrhea and number or stress fractures
- *Menstrual irregularities and low BMD increases stress fracture risk (RR 2-4 fold)*
  - ACSM Rec Stmt Evidence A

“Dreaded black line”
Anterior cortex of tibia
## Bone Mineral Density Stress Fractures

<table>
<thead>
<tr>
<th>Stress Fx Location</th>
<th>Associated Sport or Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia</td>
<td>Running, ballet, track, XC</td>
</tr>
<tr>
<td>Metatarsals</td>
<td>Running, marching, ballet, tennis</td>
</tr>
<tr>
<td>Tarsal navicular</td>
<td>Sprinting, jumping, football, running</td>
</tr>
<tr>
<td>Fibula</td>
<td>Running, aerobics, race-walking, ballet</td>
</tr>
<tr>
<td>Femur</td>
<td>Distance running, jumping, ballet</td>
</tr>
<tr>
<td>Pelvis</td>
<td>Distance running, ballet</td>
</tr>
<tr>
<td>Pars interarticularis (Spondylolysis)</td>
<td>Gymnastics, ballet, volleyball, diving</td>
</tr>
</tbody>
</table>
Bone Mineral Density
Stress Fractures

• Imaging
  • Xray- depends on acuity
  • Bone scan- nonspecific
    • DDx tumor, infection
  • MRI-
    • Periosteal and marrow edema = stress reaction
    • Fracture line = stress fracture
Female Athlete Triad Detection

• Screening is continuous…
  • (PPE is great time for questions)

• Detection of 1 component should trigger investigation

• Screening questions (see next slide)

• Lab testing (if indicated)
  • *hcg, TSH, LF/FSH, Chem7, prolactin, ferritin

• Imaging (if indicated)
  • DXA
  • Xray vs bone scan vs MR (if suspicious of stress injury)
Triad Consensus Panel Screening Questions

- Have you ever had a menstrual period?
- How old were you when you had your first menstrual period?
- When was your most recent menstrual period?
- How many periods have you had in the past 12 months?
- Are you presently taking any female hormones (OCPs)
- Do you worry about your weight?
- Are you trying to or has anyone recommended that you gain or lose weight?
- Are you on a special diet or do you avoid certain types of foods or food groups?
- Have you ever had an eating disorder?
- Have you ever had a stress fracture?
- Have you ever been told you have low bone density?

*The Triad Consensus Panel recommends asking these screening questions at the time of the sport pre-participation evaluation.*
Female Athlete Triad
Treatment is Multidisciplinary
Treatment

• Overall increase in **ENERGY AVAILABILITY**
  • ↑Energy Intake  ↓Energy expenditure

• Disordered eating:
  • Refer to mental health practitioner (outpt vs inpt as needed)
  • Supplements: Ca, Vit D, Vit B12, iron, protein
  • Meds: SSRIs PLUS cognitive behavioral therapy
    • NOT Buproprion! (Seizure risk)
Typical recovery trajectory

Recovery of Bone Mineral Density

Recovery of Menstrual Status

Recovery of Energy Status

**PROCESS:** Days or Weeks

**OUTCOMES:**
- Energy status will stimulate anabolic hormones (IGF-1) and bone formation
- Energy status will reverse energy conservation adaptations

**PROCESS:** Months

**OUTCOMES:**
- Reproductive hormones
- Estrogen exerts an anti-resorptive effect on bone

**PROCESS:** Years

**OUTCOMES:**
- Estrogen continues to inhibit bone resorption
- Energy status will stimulate anabolic hormones (IGF-1) and bone formation
Female Athlete Triad
Treatment

• **Functional Hypothalamic Amenorrhea**
  • Weight gain is key to normalize menses and increase BMD.
  • OCPs - delay and reduce likelihood of restoring regular menstrual cycle
  • OCPs will not normalize metabolic factors that impair bone formation.
  • If BMD declines in athlete >16yo w persistent FHA, despite adequate nutrition and body weight
    • OK to consider OCP to minimize further bone loss
  • No guidelines for OCPs in athletes <16yo
Female Athlete Triad

Treatment

• **Stress Fracture treatment**
  • **REST** until pain free
  • Restoration of adequate nutrition & menstrual cycle → GRADUAL return to play
  • Few surgical indx (poor vascular supply)
    • Femoral neck, base 5th MT, tarsal navicular, ant tib

• **Low Bone Mineral Density**
  • *Bisphosphonates should NOT be used*
    • Unproven efficacy in women of child-bearing age
    • Bisphosphonates may reside in bone for years → potential harm to developing fetus
  • DEXA screening recommendations unclear
**Bone re-mineralization Treatment**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Increase in BMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt gain &amp; resume menses</td>
<td>6-20%</td>
</tr>
<tr>
<td>HRT</td>
<td>1.5-5.4%</td>
</tr>
<tr>
<td>Bisphosphonates</td>
<td>4.1-4.9%</td>
</tr>
</tbody>
</table>

* In FHA, increases in BMD are more closely associated with increases in weight than with OCP/HRT.

*ACSM Evidence Statement, Category C
# Risk Stratification for RTP recommendations

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Low Risk = 0 points each</th>
<th>Moderate Risk = 1 point each</th>
<th>High Risk = 2 points each</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low EA with or without DE/ED</td>
<td>□ No dietary restriction</td>
<td>□ Some dietary restriction;</td>
<td>□ Meets DSM-V criteria for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>current/past history of DE;</td>
<td>ED*</td>
</tr>
<tr>
<td>Low BMI</td>
<td>□ BMI ≥ 18.5 or</td>
<td>□ BMI 17.5 &lt; 18.5 or</td>
<td>□ BMI ≤ 17.5 or &lt; 85% EW or</td>
</tr>
<tr>
<td></td>
<td>≥ 90% EW** or</td>
<td>&lt; 90% EW or</td>
<td>≥ 10% weight loss/month</td>
</tr>
<tr>
<td></td>
<td>weight stable</td>
<td>5 to &lt; 10% weight loss/month</td>
<td></td>
</tr>
<tr>
<td>Delayed Menarche</td>
<td>□ Menarche &lt; 15 years</td>
<td>□ Menarche 15 to &lt; 16 years</td>
<td>□ Menarche ≥16 years</td>
</tr>
<tr>
<td>Oligomenorrhea and/or Amenorrhea</td>
<td>□ &gt; 9 menses in 12 months*</td>
<td>□ 6-9 menses in 12 months*</td>
<td>□ &lt; 6 menses in 12 months*</td>
</tr>
<tr>
<td>Low BMD</td>
<td>□ Z-score ≥ -1.0</td>
<td>□ Z-score -1.0*** ≤ -2.0</td>
<td>□ Z-score ≤ -2.0</td>
</tr>
<tr>
<td>Stress Reaction/Fracture</td>
<td>□ None</td>
<td>□ 1</td>
<td>□ ≥ 2; ≥ 1 high risk or of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>trabecular bone sites†</td>
</tr>
</tbody>
</table>

| Cumulative Risk (total each column, then add for total score) | _____ points | + | _____ points | + | _____ points = _____ Total Score |
RTP Levels of Clearance:

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Risk Score*</th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Clearance</strong></td>
<td>0 – 1 point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Provisional/Limited Clearance</strong></td>
<td>2 – 5 points</td>
<td></td>
<td>□ Provisional Clearance</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted from Training and Competition</strong></td>
<td>≥ 6 points</td>
<td></td>
<td>□ Restricted from Training/Competition-Provisional</td>
<td>□ Disqualified</td>
</tr>
</tbody>
</table>

- It is the recommendation of the Consensus Panel that athletes diagnosed with anorexia nervosa who have a body mass index (BMI) <16 kg/m² or with moderate-to-severe bulimia nervosa (purging >4 times/week) should be categorically restricted from training and competition. Future participation is dependent on treatment of their eating disorder, including ascertainment of BMI >18.5 kg/m², cessation of bingeing and purging and close interval follow-up with the multidisciplinary team.
Step 1: Evaluation of Health Status

Medical Factors

- Patient Demographics (age, ethnicity)
- Symptoms (fatigue, lightheadedness, skeletal pain, weight loss/fluctuations)
- Personal Medical History (Triad risk factors - severity/chronicity, adolescent growth phase, hospitalizations, other medical factors)
- Family History/Genetics (eating disorders, other psychiatric illnesses, menstrual dysfunction, osteoporosis, fracture history)
- Signs (Physical Exam) (bradycardia, low BP/orthostatic, low BMI <17.5, low % body fat, lanugo, Russell’s sign)
- Lab Tests/ECG/DXA (metabolic panel, CBC, hormonal work up if oligomenorrhea and/or amenorrhea, 25(OH) Vit D if low BMD or bone stress injury, TSH and TFTs; ECG if ED; DXA if indicated; X-ray and imaging if suspect bone stress injury)
- Psychological State (depression, anxiety, OCD co-morbidities; severity of illness; athlete’s willingness to participate in treatment; psych testing if indicated)
- Potential Seriousness (ED, other psych hospitalization, chronicity of each Triad spectrum, co-morbidities, bone health evaluation/DXA)

Step 2: Evaluation of Participation Risk

Sport Risk Modifiers

- Cumulative Risk Assessment Score (based on cumulative Triad risk stratification)
- Type of Sport (leanness vs non leaness sport, sport with subjective judging, thin physique felt advantageous, endurance sport, weight class, impact nature/bone loading)
- Position Played (perceived advantage if lean)
- Competitive Level (competitive vs non-competitive, high school, club, college/intercollegiate/division rank, elite, professional, Olympic)
- Timing & Season (in season vs off season, early in season or late)
- Pressure from Athlete (desire to compete and excel)
- External Pressure (cooch, family, friends, administration, society)
- Masking the Injury (analgiesia, ignoring symptoms)
- Conflict of Interest (scholarship athlete, professional, Olympic athlete)

Step 3: Decision Modification

*Return-to-Play Decision

DeSouza, 2014
Female Athlete Triad

Take Home Messages

• Female participation in sports is expanding with a multitude of benefits
• Recognition of red flags and energy deficit is key for dx
• Treatment is multifactorial & multidisciplinary
• Early clinical suspicion is important
• Newer risk stratification from the Female Athlete Coalition can help with RTP decisions.
References


Questions & Discussion