Female Athlete Triad: Evaluation and Treatment Options

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Objectives

• Define Female Athlete Triad
• Discuss the medical evaluation of women with Female Athlete Triad
• Identify possible treatment strategies for women with Female Athlete Triad
• Identify resources to aid in treatment and identification of women with Female Athlete Triad
What is the Female Athlete Triad?

• First recognized in 1992 by American College of Sports Medicine
  – Combination and interplay of 3 factors seen in female athletes
    • Low energy availability
    • Menstrual disturbance
    • Low bone mineral density
Components of triad: Energy availability

- Low Energy Availability
  - Inadvertent failure to match calorie intake with expenditure
  - Purposeful weight loss for sport performance, health motivation
  - Disordered eating behaviors, eating disorders

Energy out = energy in
Weight maintenance

Energy out > Energy in
Weight maintenance

Energy out >> Energy in
Weight loss
Components of triad: Menstrual disturbance

- Menstrual disturbance
- Regular Monthly Periods
- Luteal Phase Defect
- Oligomenorrhea
- Amenorrhea

Elements:
- Menstrual Irregularity
  - Structural problem
  - Ovaries
  - Pituitary
  - Other

Sub-Elements:
- Thyroid
- Pregnancy
- Adrenal
- Hypothalamus
Components of triad: Bone health

- Optimal Bone Health
- Low Bone Density/Osteopenia
- Osteoporosis
Prevalence estimates

• Challenging to gather data
  – Definitions, self-report, measuring energy availability, sub-clinical v clinical diagnoses

• 2013 Review (Gibbs et al)
  – 3 components (0-15.9%)
  – 2 components (2.7%-27.0%)
  – 1 component (16.0%-60.0%)
Who is at risk?

- Any exercising female
- Sports where low body weight, lean physique emphasized for appearance or performance
- Sports that require weight checks
- Exercising more than needed for sport
- Controlling coaches, parents, teammates
- Social isolation due to sporting activities
- Pressure to “win at all costs”
Case #1

• Alise is a 20 year old junior who comes to student health for evaluation of amenorrhea.
  – No period in past 10 months (one day of spotting over summer break)
  – Varsity cross-country team
What additional information would you like?
Additional history

• Menstrual history
  – Menarche age 15
  – Never had regular periods

• Past Medical History
  – R ACL reconstruction 4 years ago
  – No other significant musculoskeletal injuries

• Medications
  – None

• Review of systems
  – No concerns, all negative
Additional history

- Social history
  - LOVES college
  - Living off campus with other members of the cross country team
  - Division II NCAA qualifier past year
    - Mileage during summer up to 80-90 miles per week
  - She and roommates cook most meals at home
    - Goal 1500-1800 kcal/day
    - Eliminated gluten last year
    - She feels low weight is very important for performance and has maintained same weight since entering college
  - Drinks alcohol only in the off-season
  - Not sexually active
Physical exam highlights

- Vitals
  - HR 52  BP 102/65
  - BMI  18.2
- CV: bradycardic, no murmurs
- Abd: soft, NT/ND
- GU: Normal female external genitalia
- Breasts: Tanner V
- Skin: no acne, no hirsuitism
Questions to consider

1. What do you think is causing Alise’s amenorrhea?
2. Would you order labs today?
Myth #1

• Not menstruating is “normal” for competitive female athletes
What do you think is causing Alise’s amenorrhea?
Brief Endocrine Review

Hypothalamus

+GnRH pulses

Pituitary

+LH
+FSH

Ovaries

+Progestrone
+Estrogen
Functional Hypothalamic Amenorrhea

- Hypothalamus
  - +GnRH pulses
  - +LH
  - +FSH
- Pituitary
  - +LH
  - +FSH
- Ovaries
  - +Progesterone
  - +Estrogen

Low Energy Availability

Physiologic & Neuroendocrine Response
(i.e., changes in leptin, cortisol, insulin, growth hormone, IGF-1, T3, glucose, fatty acids, ketones)
Would you order labs today?
Components of triad: Menstrual disturbance

- Menstrual disturbance
  - Regular Monthly Periods
  - Luteal Phase Defect
  - Oligomenorrhea
  - Amenorrhea

- Structural problem
  - Ovaries
    - Estradiol
  - Pituitary
    - Prolactin
  - Other
    - LH
    - FSH
    - Celiac ESR

- Thyroid
  - TSH Free-T4
  - B-hcg

- Adrenal
  - DHEA-S
  - Testosterone

- Hypothalamus
  - Prolactin
  - Other
  - LH
  - FSH

- Pregnancy
  - Adrenal
  - Thyroid
  - Hypothalamus
Why are we concerned?
Consequences of female athlete triad

- Long-term bone health
- Hormonal disruption, reproductive dysfunction
- Endothelial dysfunction
Concern #1: Bone Health

• Adolescence/Young Adulthood
  – Critical time period for bone development
    • Bone mineral accrual
    • Peak of bone mass
  – Peak bone mineral density (BMD) predicts future osteoporosis risk
Importance of Peak Bone Mass

Figure 6–2. Bone Mass Versus Age With Optimal and Suboptimal Bone Acquisition

Source: Based on Heaney et al. 2000.
Determinants of peak bone mass

- **Extrinsic**
  - Diet
  - Body Mass
  - Hormonal milieu
  - Exercise
  - Lifestyle choices
  - Illnesses

- **Intrinsic**
  - Family history
  - Gender
  - Ethnicity

50-80%
Low BMD

↓ Weight
↓ Skeletal load

↓ Estrogen
↓ Androgen
↓ IGF-I
↑ Cortisol

↓ Ca++ & Vitamin D
Recommendations
Calcium and Vitamin D intake

**Calcium**
- RDA: 1200-1400mg/day
- Dietary sources
  - Flintstone complete = 100mg
  - Milk (8oz) = 300mg
  - Cheese (1oz) = 60-270mg
- Check level?

**Vitamin D**
- IOM: 600-800 IU/day
- Dietary sources
  - Cod Liver Oil (1T) = 1300 IU
  - Milk (8oz) = 100 IU
  - Salmon (3oz) = 800 IU
- Check level?
Measuring bone density

• DXA (Dual-energy X-ray Absorptiometry)
  – 2-dimentional image used to measure bone density, bone mineral content, body composition
  – Not the absolute predictor of bone strength

• Z-scores
  – -1.0 – -1.9: slightly low
  – -2.0 and below: low
    • Athletes may have slightly different standard
When to measure bone density?

• No consensus
  – Not 1:1 correlation with fracture risk
  – Some argue to optimize risk factors
• American College of Sports Medicine
  – Order DXA if any of the following conditions are met and repeat in 1 year if condition still exists
    • Oligo- or amenorrhea ≥ 6 months
    • Disordered eating or eating disorder ≥ 6 months
    • Stress fracture or other fracture from minor trauma
Concern #2: Fluctuating hormone levels

- Fluctuation in hormone levels can lead to menstrual irregularity and fertility problems.
- Hormones affected include:
  - FSH
  - LH
  - Leptin
  - IGF-1
  - T3
  - GH
  - Cortisol
  - Estrogen
  - Progesterone
Concern #3: Endothelial dysfunction

• New emerging data
  – Low estrogen levels lead to endothelial disruption
    • Mediated via NO
  – Long-term cardiovascular consequences?
Back to Alise...

1. Is this female athlete triad?
2. How would you start management of Alise?
3. Can she continue to run?
Is this female athlete triad?
How about management?
First steps in treatment

• Increase energy availability
  – Increase intake, decrease consumption, both
  – Goal 30-45 kcal/kg of fat free mass
    • Example: 110 lb female runner with 15% body fat needs approx 1900 kcal/day when NOT running
      – Add 100kcal/mile when training

• Role of multidisciplinary team
  – Medical provider, sports dietician, athletic trainer, coach, +/- mental health provider

• Realistic and tangible goals
Can Alise continue to run?
Case #2

• Carol is an 18 year old freshman who comes to student health for evaluation of amenorrhea
  – No period in past 6 months (one day of spotting over winter break)
  – Club soccer team, now indoor season
More history

• Menstrual history
  – Menarche age 13
  – 1 year of regular periods in high school, but otherwise fairly unpredictable
  – Typically no cramps

• Past Medical History
  – Exercise-induced asthma
  – No significant musculoskeletal injuries

• Medications
  – Albuterol

• Review of systems
  – No concerns, all negative
More history

• Social history
  – LOVES college
  – Living in freshman dorm
  – High school athlete, now even more active
    • Club soccer, thinking about trying out for walk-on spot next year on varsity team
    • Practice 5x/week
    • On “off” days runs and lifts
  – Meals in freshman dining hall, tries to average 1500-1800kcal/day, vegetarian diet
    • Thinks she has lost about 5 pounds during freshman year
    • Happy with current weight
  – Occasional alcohol, no cigarettes or illicit substances
  – Not sexually active
Physical Exam highlights

- Vitals
  - HR 54  BP 102/65
  - BMI  21.3
- CV: bradycardic, no murmurs
- Abd: soft, NT/ND
- GU: Normal female external genitalia
- Breasts: Tanner V
- Skin: mild acne over forehead, darker hair noted on sides of face and lower abdomen (though she notes her sister and mother have the same)
Questions to consider

1. What are your top 3 etiologies for Carol’s amenorrhea?
2. Would you order labs today?
3. DXA scan?
Possible etiologies for amenorrhea

- Menstrual Irregularity
  - Structural problem
  - Ovaries
  - Pituitary
  - Hypothalamus
  - Thyroid
  - Pregnancy
  - Adrenal
  - Other
Lab Results

- HCG negative
- TSH 2.68 ng/dL, Free T4 1.19 uU/mL
- DHEAS 183 mcg/dL (nrml 45-380)
- LH 3.2 IU/L, FSH 4.5 IU/L
- Prolactin 12.42 ng/mL
- Total Testosterone 20 ng/dL (nrml 9-58)
- Free Testosterone 4.3 pg/mL (nrml 1.2-9.9)
DXA

- Total Left Hip: Z-score +0.6 SD
- L1-L4 PA Spine: Z-score -0.1 SD
Additional questions

1. Is this female athlete triad?
2. What treatment options might you consider?
3. Can Carol continue to play soccer?
Myth #2

• The female athlete triad affects only women participating in sports emphasizing leanness.
Myth #3

• Only very thin female athletes and exercising women lose their regular menstrual periods.
Treatment options

1. Increase energy availability
2. Hormone replacement therapy?
How about hormone replacement?

• Does HRT alone restore/prevent bone loss?
  – Studies in patients with anorexia nervosa
  – 2005 meta-analysis shows very limited evidence for positive effects on BMD
  – 2006 RCT in adolescents showed same

• Conclusion: *Oral* Estrogen-containing HRT alone does **not** increase BMD
  – Non-physiologic dosing?
  – IGF-1 resistance?
Transdermal estrogen? (Misra, 2011)

- Enrolled 110 adolescents with AN
  - Patients randomized (Transdermal 17-B-estradiol 100 mcg patch vs Placebo)
  - 18-month trial
- Impaired BMD at baseline compared to controls
- Patients receiving estradiol patch had increased BMD at spine compared to patients receiving placebo
- Idea behind transdermal: physiologic dosing, may mitigate IGF-1 resistance
- Take Home
Case #3

• Susan is a 19 year old sophomore who presents to college health for evaluation of foot pain
  – Avid athlete
  – Recently increased mileage to prepare for Chicago marathon in October
  – Pain has become progressively worse over past 4 weeks, primarily at end of runs
More history

• Menstrual history
  – Menarche age 16
  – Periods have never been regular

• Past Medical History
  – Stress fracture in hip, 12th grade

• Medications
  – Multivitamin

• Review of systems
  – No concerns, all negative
More history

• Social history
  – LOVES college
  – Living in sorority house
  – High school multi-sport athlete
    • Now runs for fun with sorority sisters
  – Eats in sorority house, most meals “healthy”; typically skips lunch
    • Weight has always been a concern
  – Regular alcohol, +cigarettes (1/2 ppd)
  – Sexually active, using condoms
Physical exam highlights

• Vitals: HR 65 BP 99/52 BMI 20.8
• Gen: appears anxious
• MSK:
Questions to consider

1. What are your top 3 possible etiologies of Susan’s foot pain?
2. Does Susan need a DXA?
Myth #4

• Female athlete triad affects only elite athletes.
Differential Diagnosis
(Chronic foot pain in young athlete)

- Fractures (including stress fractures)
- Morton’s neuroma
- Pes planus/pes cavus
- Tendonitis
- Nerve entrapment
- Tarsal coalition
What is a stress fracture?

• Partial or complete fracture due to repetitive loading and consequent microtraumas

• Fracture results if traumas accumulate faster than they can heal
Typical history and physical: stress fracture

• History
  – Insidious onset of pain
  – Pain worsens after or at end of activity
  – Recent increase in intensity
  – Pain progresses as injury progresses

• Physical
  – Localized tenderness
  – +/- swelling
Does Susan need a DXA?
What would you do now?

A. Refer to orthopaedics
B. Refer to sports medicine
C. Send for X-ray
D. Send for MRI
E. Recommend decreased mileage and return in 2 weeks
F. Recommend cessation of sports and return in 2 weeks
Algorithm for Diagnosis/Treatment of Stress Fractures (Patel, 2011)

Pain with activity, recent increase in training, edema, or bone tenderness

Plain radiography

Positive

Urgent diagnosis required?

No

Avoid stress, repeat radiography in two to three weeks

Positive

Clinical suspicion persists?

No

Stress fracture likely ruled out; proceed with treatment

Treatment (Table 4): rest (stress avoidance), activity modification, analgesics

Negative

MRI or bone scintigraphy

Positive

High-risk fracture?

No

Consider referral to orthopedist or sports medicine subspecialist

Yes

Negative

Reconsider differential diagnosis
Low Risk sites

High Risk Sites

- 23.6%
- 17.6%
- 16.2%

Phalanges

Metatarsals

Cuneiforms

Cuboid

Navicular

Transverse tarsal joint

Talus

Talar articular surface for tibia

Calcaneus

Skull

Mandible

Cervical vertebrae

Thoracic vertebrae

Lumbar vertebrae

Pelvis

Sacrum

Coccyx

Clavicle

Scapula

Sternum

Ribs

Humerus

Radius

Ulna

Carpals

Metacarpals

Phalanges

Femur

Patella

Tibia

Fibula

Calcaneus

Tarsals

Metatarsals
General approach to Treatment
(for low-risk sites)

• Step 1
  – Pain control
    • Ice massage, physical therapy modalities (such as therapeutic ultrasound), oral analgesia, overall activity reduction, cessation of sports

• Step 2 (starts after pain free for 10-14 days)
  – Gradual return to activity, start 1 week after resolution of bony tenderness
  – Full return to pre-injury activity level no faster than 3-6 weeks
When is referral needed?

- Patients with stress fracture at high-risk fracture site
- Patients who cannot tolerate lengthy rehab process
- Failure of conservative management
- Extension of fracture
- Repeat fractures
- Patient/family preference or if need buy-in
When stress fracture is suspected or confirmed...

• **Must look at risk factors!**
  – Role of primary care/college health provider
• Training schedule, recent changes
• Dietary intake
  – Ca/Vit D
  – Relative energy deficit?
• Menstrual history
• Family history
• Personal medical and fracture history
Screening for Female Athlete Triad
Recommended Screening Questions
(Female Athlete Triad Coalition)

- Do you worry about your weight?
- Do you limit the foods you eat?
- Do you lose weight to meet image requirements for your sport?
- Does your weight affect the way you feel about yourself?
- Do you feel you have lost control over what you eat?
- Do you make yourself vomit; use diuretics or laxatives after you eat?
- Have you ever suffered from an eating disorder?
- Do you ever eat in secret?
- What age was your first menstrual period?
- Do you have monthly menstrual cycles?
- How many menstrual cycles have you had in the last year?
- Have you ever had a stress fracture?
## Preparticipation Physical Evaluation History Form

(Note: This form is to be filled out by the patient and parent prior to seeing the physician. The physician should keep this form in the chart.)

**Date of Exam**

<table>
<thead>
<tr>
<th>Name</th>
<th>Date of birth</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Grade</th>
<th>School</th>
<th>Sports(s)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>6. Have you ever had discomfort, pain, tightness, or pressure in your chest during exercise?</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Does your heart ever race or skip beats (irregular beats) during exercise?</td>
</tr>
<tr>
<td>8. Has a doctor ever told you that you have any heart problems? If so, check all that apply:</td>
</tr>
</tbody>
</table>
| □ High blood pressure
| □ A heart murmur
| □ High cholesterol
| □ A heart infection
| □ Kawasaki disease
| □ Other |
| 9. Has a doctor ever ordered a test for your heart? (For example, ECG/EKG, echocardiogram) |
| 10. Do you get lightheaded or feel more short of breath than expected during exercise? |
| 11. Have you ever had an unexplained seizure? |
| 12. Do you get more tired or short of breath more quickly than your friends during exercise? |

### Heart Health Questions About Your Family

| 13. Has any family member or relative died of heart problems or had an unexpected or unexplained sudden death before age 50 (including drowning, unexplained car accident, or sudden infant death syndrome)? |
| 14. Does anyone in your family have hypertrophic cardiomyopathy, Marfan syndrome, aortitis, or other familial diseases? |
| 15. Does anyone in your family have a heart problem, pacemaker, or implanted defibrillator? |

### Bone and Joint Questions

| 17. Have you ever had an injury to a bone, muscle, ligament, or tendon that caused you to miss a practice or a game? |
| 18. Have you ever had any broken or fractured bones or displaced joints? |
| 19. Have you ever had an injury that required x-rays, MRI, CT scan, injections, therapy, a brace, a cast, or crutches? |

### Females Only

| 52. Have you ever had a menstrual period? |
| 53. How old were you when you had your first menstrual period? |
| 54. How many periods have you had in the last 12 months? |

**Explain your answers here**
Managing the Female Athlete Triad

Good Nutrition Promotes Health Enhances Performance
Managing the Female Athlete Triad
Welcome to the Female Athlete Triad Coalition!
Summary

• Combination of low energy availability, menstrual disturbance, low bone mineral density present in some combination in up to 60% of females who exercise regularly
• Early identification and treatment important to minimize long-term health consequences
• Screening may be done at any time, in any visit and may be only opportunity
• Many resources available to aid in diagnosis and treatment
References

- Female Athlete Triad Coalition; [http://www.femaleathletetriad.org](http://www.femaleathletetriad.org)
References