The Female Athlete Triad

Position Stand 2007

AMERICAN COLLEGE OF SPORTS MEDICINE

STRATEGIC HEALTH INITIATIVE FOR

WOMEN, SPORT & PHYSICAL ACTIVITY
Presentation Outline

- Importance of Exercise in Health
- Components of the Female Athlete Triad
- Prevalence
- Health Consequences
- Screening & Diagnosis
- Treatment & Prevention
Benefits of Physical Activity Outweigh Risks for Women & Girls

- Improved cardiovascular fitness
- Increased strength & power
- Decreased morbidity & mortality
- Decreased high-risk behavior
- Decreased risk of breast cancer

- Improved cognitive function
- Higher bone strength
- Higher self-esteem
- Healthy aging

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Exercise: Girls and Women

ACSM encourages all girls and women to participate in physical activities and sport.
The Female Athlete Triad

- Originally defined in 1992
- Initially recognized as three separate but interrelated entities of disordered eating, amenorrhea, and osteoporosis
- Most commonly observed in young female athletes in sports emphasizing a lean physique
- First ACSM Position Stand developed in 1997
The Female Athlete Triad

- Updated 2007 ACSM Position Stand (PS) now recognizes a spectrum of symptoms and conditions between health and disease
- The three spectrums include energy availability, menstrual function and bone mineral density

The updated PS also identifies that low energy availability may occur unintentionally in female athletes with or without disordered eating
The Female Athlete Triad

- Three distinct clinical entities
- *May occur alone or in combination*
- Often interrelated and coexist in physically active & athletic women
- Occurs across a spectrum of expression ranging from normal healthy condition to unhealthy or pathologic
Importance of the Triad

- Poses significant health risks
- Potentially irreversible consequences
- Dictates need for
  - Prevention
  - Early diagnosis and
  - Treatment
Spectrums of the Female Athlete Triad

OPTIMAL HEALTH

Reduced Energy Availability with or without Disordered Eating

Eumenorrhea

Optimal Bone Health

PATHOLOGY

Low Energy Availability with or without an Eating Disorder

Subclinical Menstrual Disorders

Low Bone Mineral Density

Movement along each spectrum between optimal health and pathology may occur at different rates according to diet and exercise habits
Female Athlete Triad Components

- Energy Availability
- Menstrual Function
- Bone Mineral Density

While energy availability may change daily, the effects on menstrual cycle may not occur for months, and an effect on bone mineral density may not be detectable for years.
Total daily energy expenditure (TEE) is equal to the amount of energy required for resting metabolic function \((RMR = \text{basal} + \text{thermic effect of food including digestion})\) plus the energy required for activities of daily living and physical activity (EEE).

\[
\text{RMR (Resting Metabolic Rate)} + \text{EEE (Exercise Energy Expenditure)} = \text{TEE (Total Daily Energy Expenditure)}
\]
Energy Balance & Body Weight

When TEE = calorie intake it is described as being in “energy balance”. When an athlete is eating enough calories to meet basic and athletic needs, balance is achieved and body weight should be stable.

However, it isn’t that simple….we know that when there is a calorie deficit, the brain and body try to help reestablish energy balance by decreasing RMR! The body conserves calories.

So, body weight may be stable BUT at a cost. Decreased calories available for important metabolic functions. It would be easy if we could use changes in or a stable body weight as a marker of calorie balance but we can’t. Determination of Energy balance requires accurate laboratory measurement of RMR, EEE and caloric intake.
Spectrum of the Female Athlete Triad: Energy Availability

**PATHOLOGY**
- Low Energy Availability with or without an Eating Disorder
- Functional Hypothalamic Amenorrhea
- Osteoporosis

**OPTIMAL HEALTH**
- Optimal Energy Availability
- Eumenorrhea

**Reduced Energy Availability with or without Disordered Eating**
- Subclinical Menstrual Disorders
- Low Bone Mineral Density
- Optimal Bone Health

**OPTIMAL HEALTH**
- Eumenorrhea
- Optimal Bone Health
Definition: Energy Availability

The amount of energy available for all body functions after accounting for energy expended from exercise & physical activity.

\[
\text{Energy Availability} = \text{EI (Energy Intake)} - \text{EEE (Exercise Energy Expenditure)}
\]

**KEY CONCEPT:** Energy available must meet energy needs for basic physiological processes (RMR).
Low Energy Availability

- Occurs with or without an eating disorder when:
  - dietary intake is intentionally or inadvertently restricted
  - energy expenditure is very high and intake does not match expenditure i.e. calorie imbalance or deficit

- May be due to *inadequate education* regarding energy requirements

Regardless of the cause, a cascade of physiologic & neuroendocrine adaptations occur
Behaviors Contributing to Low Energy Availability

- Some athletes practice abnormal eating behaviors e.g. dietary restraint, binge eating, eating in secret
- Some athletes inadvertently fail to increase intake to meet training needs
- Others have a DSM-IV clinical eating disorder
  - Anorexia Nervosa (AN)
  - Bulimia Nervosa (BN)
  - Eating Disorders Not Otherwise Specified (EDNOS)
Outcomes of Low Energy Availability

Low energy availability results in physiological adaptations that alter the levels of several metabolic, growth, and reproductive hormones.

- Leads to:
  - reduced metabolic rate/energy conservation (to restore energy balance)
  - menstrual disturbances
  - disrupted bone metabolism

This concept links dietary energy intake to physiologic changes that may affect health and athletic performance.
Spectrum of the Female Athlete Triad: Menstrual Function

**Optimal Health**

- Optimal Energy Availability

**Pathology**

- Low Energy Availability with or without Disordered Eating
- Subclinical Menstrual Disorders
- Functional Hypothalamic Amenorrhea
- Osteoporosis
- Low Bone Mineral Density

Eumenorrhea

Optimal Bone Health
Hypothalamus is the regulatory center that releases pulses of gonadotropin-releasing hormone (GnRH).

- Pulse size and frequency are critical for normal pituitary gland stimulation.

- GnRH pulses signal pituitary release of luteinizing hormone (LH) & follicle stimulating hormone (FSH).

- LH & FSH act at the ovaries to produce estrogen and progesterone, hormones necessary for normal menstrual function.
Endocrine Review Continued

Reproductive hormone concentrations vary monthly during the menstrual cycle.

Luteinizing hormone (LH)
Follicle-stimulating hormone (FSH)
Estrogen
Progesterone
GnRH stimulates FSH & LH pulsatile-release which is critical for a normal menstrual cycle.

Alterations in the amplitude or frequency of LH pulses can change the menstrual cycle.

Definition of Menstrual Irregularity

Eumenorrhea:
Menstrual cycles that occur at a median interval of 28 days (plus or minus 7 days)

Primary Amenorrhea:
Onset of menses $> \text{age 15 years}$

Secondary Amenorrhea:
Absence of menstrual cycles for 3 or more consecutive months or $<3$ cycles per year
Functional Hypothalamic Amenorrhea in the Female Athlete Triad

Low Energy Availability

Physiological & Neuroendocrine Response

(i.e. changes in leptin, cortisol, insulin, growth hormone, IGF-I, T3, glucose, fatty acids & ketones etc)

Negative or inhibitory input

Hypothalamus

GnRH pulses

Pituitary Gland

LH pulses

FSH pulses

Ovaries

Progesterone

Estrogen

ABNORMAL MENSES
Critical Concept

Exercise in and of itself does not induce functional hypothalamic amenorrhea

Rather, exercise may contribute to sustained low energy availability in the presence of inadequate dietary & nutritional intake
Summary of Mechanisms Resulting in Amenorrhea in the Female Athlete

- Low energy availability disrupts GnRH pulse generator in the hypothalamus
- May be caused by one or more of many possible neuroendocrine or metabolic signals (for example: cortisol, leptin, insulin, IGF-I, glucose, grehlin, ketones etc.)
- May occur in the absence of either an eating disorder or disordered eating
- Altered hypothalamic hormone output alters menstrual cycle

"Functional Hypothalamic Amenorrhea" is a diagnosis of exclusion by ruling out other causative mechanisms
Spectrum of the Female Athlete Triad: Bone Mineral Density

**OPTIMAL HEALTH**
- Optimal Energy Availability

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- Reduced Energy Availability with or without Disordered Eating
- Low Bone Mineral Density
Bone mineral density (BMD) exhibits a spectrum ranging from optimal bone health to osteoporosis.

Bone strength and risk of fracture depends upon the bone mineral density, content, internal structure and quality of bone.

BMD is most commonly measured by dual energy X-ray absorptiometry (DXA).
Bone is a dynamic tissue

- Constant remodeling
- Dynamic balance between two opposing signals
- Osteoblasts stimulate bone formation
- Osteoclasts stimulate bone resorption
Determinants of Bone Mineral Density

- Genetics (60-80%)
- Nutrition
- Smoking
- Drugs
- Alcohol
- Exercise
- Physical Activity
- Hormones
Wolfe’s Law

- Osteoblastic activity is proportional to the forces on bone.

- Forces include: pulling forces at tendon interface, compression forces from gravity and loads placed upon the bone with activity.

- Exercise and physical activity should positively influence BMD.

- Eumenorrheic, healthy athletes have higher BMD (5-15%) than sedentary controls.
Stages of Bone Growth & Loss

- Peak (genetically set)
- Adolescent/pubertal growth determines whether BMD reaches genetic potential (peak)
- Adolescent bone mineral gains are modified by lifestyle, nutrition, environment & physical activity
Osteoporosis in Post-Menopausal Women

- Low bone mass and micro-architectural deterioration of bone tissue leading to enhanced skeletal fragility and increased risk of fracture.

- May result from failure to achieve PEAK BMD or from accelerated bone loss.

- T-scores from DXA are used to diagnose osteoporosis only in postmenopausal women.
Osteoporosis in **Pre**-menopausal Women & Children/Adolescents

International Society of Clinical Densitometry (ISCD) recommends use of Z-scores to determine low bone mineral density.

Z-scores compare an individual to age & sex-matched controls.

In children/adolescents between age 5-19y, **low bone mass AND a clinically significant fracture history** are needed to diagnose osteoporosis.
Osteoporosis in Pre-menopausal Women & Children/Adolescents

- ACSM defines “Low BMD” in premenopausal women and girls as a history of nutritional deficiencies, hypoestrogenism, stress fractures, and/or other secondary clinical risk factors for fracture together with a BMD Z-score between -1 and -2.0.

- ACSM defines “Osteoporosis” in premenopausal women and girls as a history of nutritional deficiencies, hypoestrogenism, stress fractures, and/or other secondary clinical risk factors for fracture together with a BMD Z-score of ≤ -2.0.
Spectrum of Low Bone Mass: Link to Female Athlete Triad

- Low bone mass may be caused by accelerated bone loss or failure to accrue optimal bone mineral (the latter is likely the cause of low BMD in otherwise healthy young athletes)

- BMD declines as the number of missed menstrual cycles accumulate

- Stress fractures occur more commonly in physically active women with menstrual irregularities

- Severe undernutrition (low energy availability) impairs reproductive health (low estrogen and progesterone) and skeletal health (low BMD)
How Prevalent is the Triad?

- In athletes, prevalence of disordered eating, menstrual disorders, low BMD and stress fractures varies widely.

- In the literature to date: assessment criteria have varied; often lack a control group; great heterogeneity of athletic populations studied, often didn’t directly measure hormone levels and widely varying methodology.
How Prevalent is the Triad?

- **ANSWER:** not sure….

Disordered eating, eating disorders, amenorrhea and low bone mass occur more frequently in sports that emphasize leanness.

Hopeful that prevalence is decreasing

Studying a moving target ….. contributes to variability in results
Prevalence: Low Energy Availability

- The prevalence of inadvertent low energy availability with or without eating disorders is unknown.

- **Disordered Eating**: 28-62% prevalence of dietary restriction, binge eating and/or purging behaviors among thin-build athletes.

- **Eating disorders**: 25-31% prevalence among athletes in thin-build sports compared to 5-9% in the general population.
Prevalence: Menstrual Disorders

- **Secondary Amenorrhea:**
  - up to 65-69% prevalence among competitive dancers and endurance runners compared to 2-5% in the general population, higher among runners with a lower gynecologic age

- **Subclinical Disorders:**
  - 78% prevalence of anovulation or luteal deficiency in ≥ 1/3 cycles among both highly trained and recreational eumenorrheic athletes
Prevalence: Low BMD

- Higher prevalence reported among athletes with disordered eating and/or amenorrhea

- **T-score between -1 and -2.5***:
  - 22-50% prevalence among female athletes

- **T-score less than -2.5***:
  - 0-13% prevalence reported among female athletes

- These are higher than the 12% and 2.3% prevalence estimates, respectively, expected in a normal population distribution

* T-scores were reported in studies conducted prior to ISCD’s recommendation to use Z-score in premenopausal women
Prevalence of the Triad

Elite athletes \( N=938 \), Phase I; \( N=186 \), Phase II, Norwegian national team athletes age 13-39. **Full Triad: 4.3%**
(Torstveit & Sundgot-Borgen, MSSE, 2005)

Collegiate athletes \( N=112 \) athletes representing 7 sports. **Full Triad: 2.7%** (Beals & Hill, Int J Sport Nutr Exerc Metab, 2006)

High-School athletes \( N=170 \) athletes representing 8 sports. **Full Triad: 1.2%** (Nichols et al., Arch Pediatr Adolesc Med, 2006)

**KEY CONCEPT:**
*It is not necessary to have all 3 components of the Triad simultaneously for resultant negative effects on bone!*
The Female Athlete Triad can be seen in all sports, not just those traditionally associated with low body weight.
Health Consequences: Female Athlete Triad & Components

- Possible cardiovascular consequences (lack of estrogen)
- Potential for negative consequences to current and future bone health
- Increased risk of future osteoporosis and fractures
- Stress fractures
- Reproductive dysfunction
- Metabolic consequences
Health Consequences

- Impaired vascular endothelial function
- Psychological consequences
  - Low self-esteem; disordered eating/eating disorders; depression; anxiety disorder
- Gastrointestinal disorders
- Nutrient deficiencies
- Increased risk of heat-related injuries (cramping, heat stroke etc)
Consequence of the Triad: PERFORMANCE

Excessive Fatigue
Increased Recovery Time (slow to heal)
Decreased Training Responses or Adaptations (train but less gain)
Decreased or Impaired Performance
Screening & Diagnosis
Screening & Diagnosis

Screening can occur during pre-participation exam, annual check up, or any time an athlete is evaluated for a related problem, recurrent injury, stress fractures or illness.

- **Diagnosis only requires one of the three components of the Triad**

Athletes with one component should be assessed for the others.
Screening and Diagnosis

*Low Energy Availability*

Screen for risks of low energy availability:

- Disordered eating (DE), particularly high dietary restraint or a high drive for thinness
- Excessive or compulsive exercise
- Restriction of specific foods or food groups
- Repeated dieting
- Eating disorders (ED)
Screening and Diagnosis

Low Energy Availability

Screening Tools for Disordered Eating/Eating Disorders:

- EAT-26, EDE-Q, EDI, Three-factor Eating Inventory
- Screen for risks of low energy availability
- 3- or 7-day food record
- Exercise energy expenditure
Screening and Diagnosis

Menstrual Dysfunction

Screen for menstrual dysfunction:

- Administer detailed menstrual history questionnaire inquiring about:
  - Age at menarche
  - Number of periods in last 12 months
  - Loss of $\geq 3$ consecutive periods

- If menstrual abnormalities are present, rule out other causes of amenorrhea
Screening and Diagnosis

Low Bone Mineral Density

1. Consider BMD if history of stress or low impact fracture(s) and/or a history of ≥ 6 months of amenorrhea, oligomenorrhea, disordered eating or eating disorder
2. Perform DXA scan of spine and hip
3. Whole body and spine preferred site when evaluating pediatric population
4. DXA can also be helpful in tracking body fat and lean mass changes following intervention
Risk Factors and Warning Signs

- Preoccupation with food, calories, and body weight
- Frequent dieting
- Restriction of dietary/energy intake, including vegetarians
- Training: Excessive exercise, repetitive overuse injuries, repetitive stress fractures
- Other: Loss of menstrual cycle, rapid changes in weight
Risk Factors and Warning Signs

- Psychological: low self-esteem, family dysfunction, abuse, depressive moods, excessive concern about weight
- Weight class sports or disciplines that favor leanness or involve subjective judging
- Elite youth sports or early sport specific training
- Inability or unwillingness to rest and recover
Treatment & Prevention
Treatment

- Multidisciplinary team approach should include physician (or other health care professional), registered dietitian, and a mental health professional if disordered eating/eating disorder present.

- Additional valuable team members: certified athletic trainer, physical therapist, exercise physiologist, coach and parent.
Treatment Goals: Nonpharmacological Therapy

**Primary Objective**

Increase Energy Availability by:

- Increasing energy intake and/or reducing energy expenditure (or combination)
- Structured behavior change plan to optimize nutritional status
- Athletes practicing restrictive eating behaviors should receive nutritional counseling and psychotherapy
- Behavioral contract or restriction from training/competition may be needed if non-compliant
Nonpharmacologic Therapy

- Increase energy availability in effort to restore menstrual cycles
- Optimize BMD
- Adequate amounts of bone-building nutrients:
  - Calcium (1200-1500 mg/day)
  - Vitamin D (400-800 IU/day)
  - As well as Vitamin K and other essential nutrients
- Adequate protein intake
Treatment: *Pharmacologic*

★★No pharmacologic agent approved for use has been shown to fully restore BMD★★

- Pharmacological restoration of regular menstrual cycles with oral contraceptives will *NOT* normalize metabolic factors that impair bone formation.

- Oral contraceptive medications may be considered to prevent further loss of BMD in an athlete with *functional hypothalamic amenorrhea (FHA)* > 16 years of age *IF* BMD is decreasing despite adequate nutrition and body weight.

- Bisphosphonates approved for post-menopausal women *should not* be used in young athletes with FHA.
Prevention by:

**Optimizing Energy Availability**

Educate, Educate and Educate some more!

Educate the athlete, physician, coach, parent, athletic trainer, other allied health professionals, athletic program administrators

**Policy Change**

National and international governing bodies for sports need to develop policies and procedures to eliminate potentially harmful weight loss practices
Prevention: Change The Mindset

- Food is needed to meet the energy availability needs for basic cell function (growth, cellular activity, healing) *in addition to calories* or energy need for activity & performance

Food is not the enemy…
Conclusion

Low energy availability (with or without eating disorders), amenorrhea, and osteoporosis, pose significant health risks to physically active girls & women.

PATHOLOGY
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OPTIMAL HEALTH
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Bone Health

Functional
Hypothalamic
Amenorrhea

Osteoporosis
Conclusion

Female Athlete Triad is *NOT* an inevitable consequence of training nor of being an athlete.

Rather, it mandates a call to educate women athletes and those involved in their training and medical care about the requirement for optimal energy intake, energy balance and fuel.
Prevention, recognition, and treatment of the Female Athlete Triad must be a priority to ensure that female athletes maximize the benefits of regular exercise and achieve optimal health as well as optimal performance.
Female Athlete Triad Resources

1. American College of Sports Medicine  www.acsm.org
2. ACSM Female Athlete Triad Position Stand, 2007  
3. American Dietetic Association Sports, Cardiovascular, and Wellness Nutritionists (SCAN) Dietetic Practice Group  www.scandpg.org
4. Female Athlete Triad Coalition  www.femaleathletetriad.org/
5. International Olympic Committee NCAA Coaches Handbook, Managing the Female Athlete Triad  
   http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2231403/
7. Nutrition and Athletic Performance Joint Position Paper  
   http://www.eatright.org/About/Content.aspx?id=8365
8. Women’s Sports Foundation  www.womenssportsfoundation.org/

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Female Athlete Triad Presentation

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