Female Athlete Triad

Dr. Tommie Berry, Jr.

Objectives

1. Explain the relationship between low energy availability, amenorrhea, and bone health.
2. Relate problems commonly associated with the female athlete: stress fractures, menstrual dysfunction, bone disorders, and eating disorders with the condition of Female Athlete Triad.
3. Know recommendations and guidelines concerning return to play for patients at risk for female athlete triad.

Definition

A condition of female athletes that refers to disordered eating, functional hypothalamic amenorrhea, and osteoporosis; this condition is a manifestation of the interrelationship of energy availability, menstrual function, and bone mineral density[1].

Relative Energy Deficiency in Sport

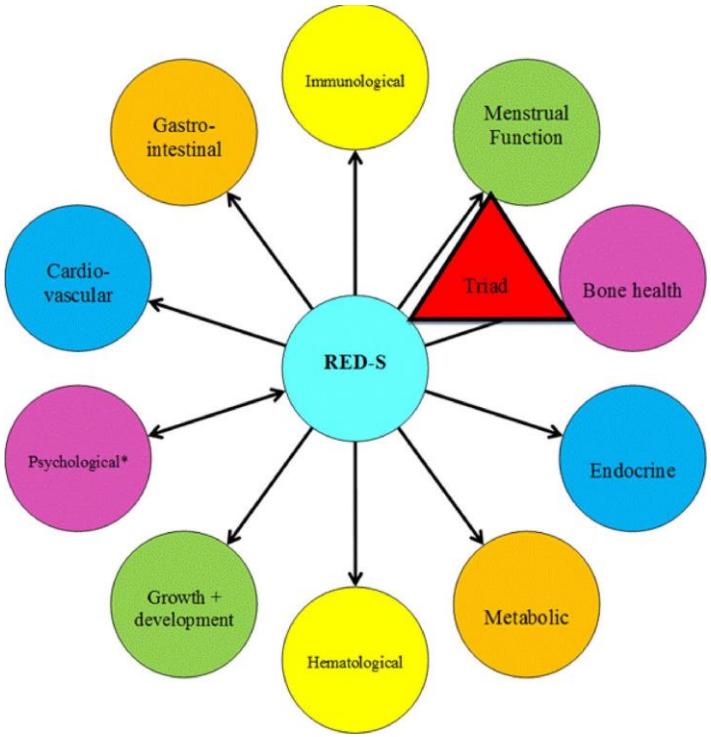
- In 2014, the International Olympic Committee published a consensus statement entitled ‘Beyond the Female Athlete Triad: Relative Energy Deficiency in Sport (RED-S)’

- RED-S is a syndrome of impaired physiologic dysfunction:
  - Metabolic Rate
  - Menstrual Function
  - Bone Health
  - Immunity
  - Protein Synthesis
  - Cardiovascular Health

- Underlying cause of conditions is relative energy deficiency

Relative Energy Deficiency in Sport

- Although there tends to be areas for overlap, this syndrome is not just a triad.

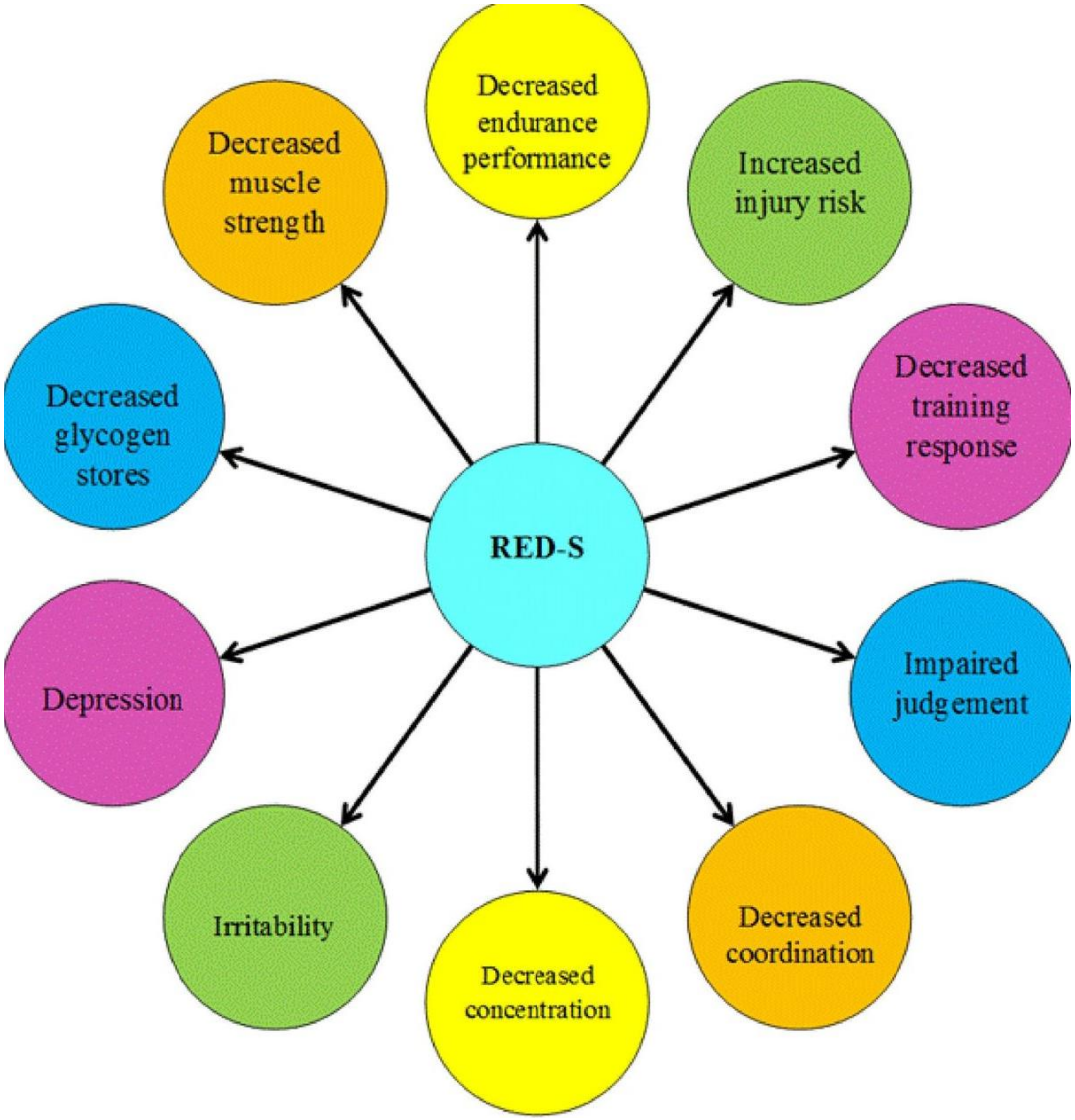


- It affects many aspects of physiological function, health and athletic performance (as previously listed).

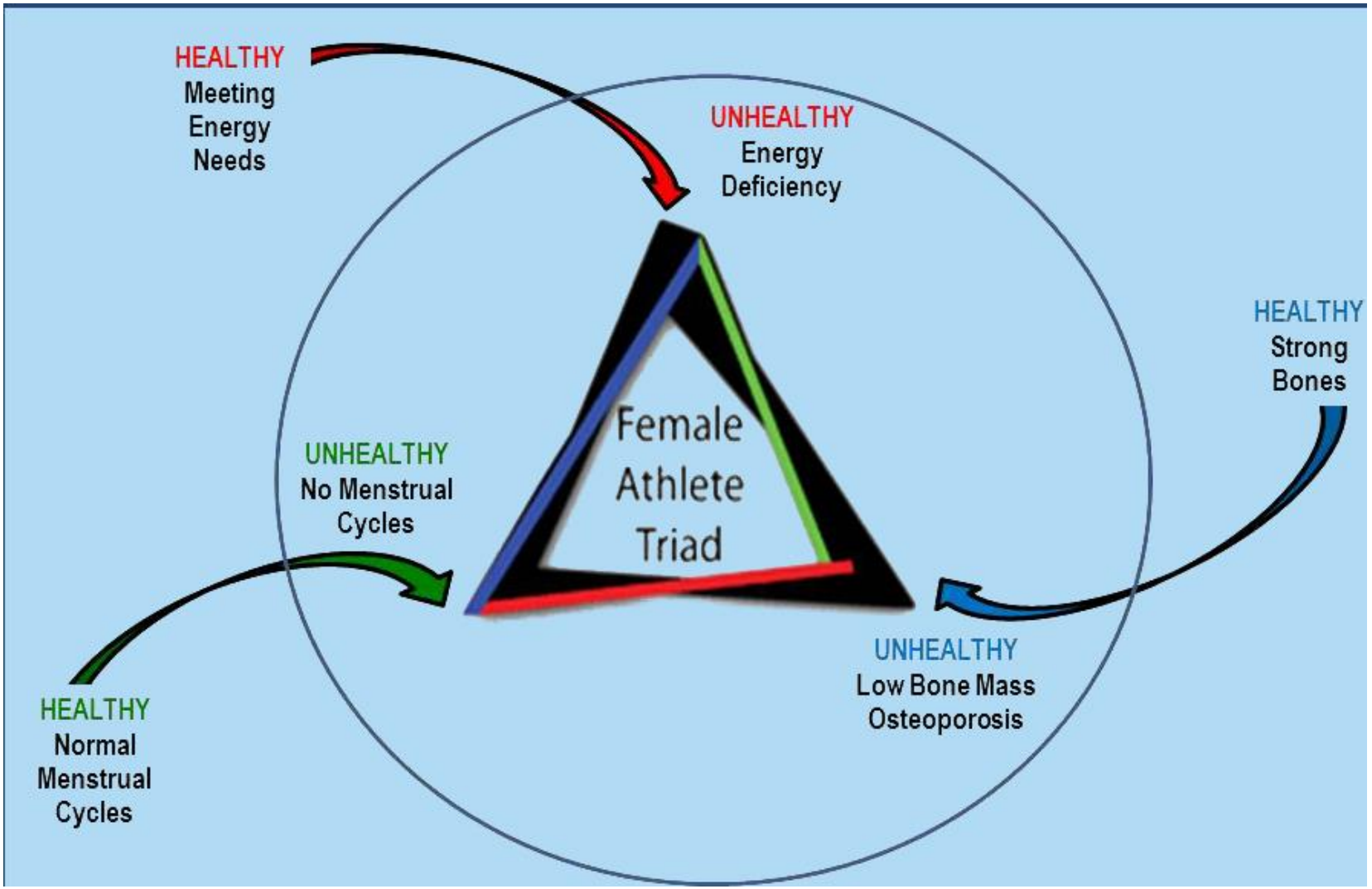
- Additionally, males are included

Summa Health

Potential Performance Consequences

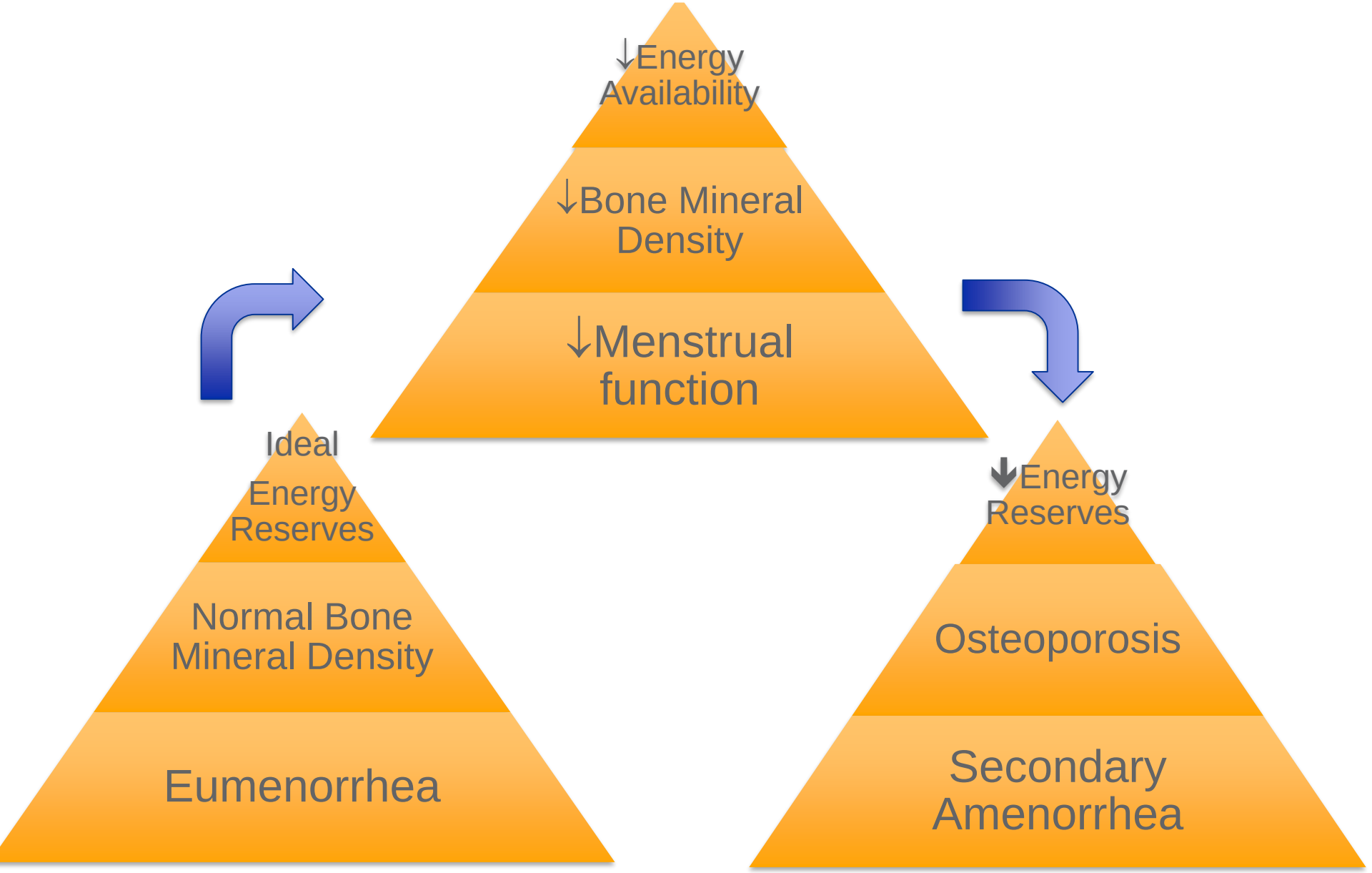


Female Athlete Triad Model



Summa Health

Female Athlete Triad Definition revisited on a continuum



Summa Health

Clinical Significance

- It is important to recognize the triad to prevent potentially irreversible consequences.
- On average, BMD is lower in amenorrheic than in eumenorrheic athletes.
- Menstrual irregularities and low BMD increase stress fracture risk.

Summa Health

LEAF Screening Tool

- Low Energy Availability in Females-Questionnaire (LEAF-Q):
  - Brief and easy to administer
  - 25 item validated screening tool to detect persistent low energy availability (EA) and Triad conditions, with or without eating disorder or disordered behavior
  - Identifies female athletes at risk for the Triad
  - Sensitivity 78% & Specificity 90% for correctly classifying current energy availability and/or reproductive function and/or bone health.

Summa Health

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 (oestrogen, progesterone, birth control pills)?
-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 (osteopenia or osteoporosis)?

*The Triad Consensus Panel recommends asking these screening questions at the time of the sport preparticipation evaluation.

Annual Pre-participation Exam History Questions

Ohio High School Athletic Association PPE Form 2018-2019 (page 1)

HEART HEALTH QUESTIONS ABOUT YOUR FAMILY		Yes	No
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, arryhthmogenic right ventricular cardiomyopathy, long QT syndrome, short QT syndrome, Brugada syndrome, or catecholaminergic polymorphic ventricular tachycardia?		
15.	Does anyone in your family have a heart problem, pacemaker, or implanted defibrillator?		
16.	Has anyone in your family had unexplained fainting, unexplained seizures, or near drowning?		
BONE AND JOINT QUESTIONS		**Yes**	**No**
17.	Have you ever had an injury to a bone, muscle, ligament, or tendon that caused you to miss a practice or game?		
18.	Have you ever had any broken or fractured bones or dislocated joints?		
19.	Have you ever had an injury that required x-rays, MRI, CT scan, injections, therapy, a brace, a cast, or crutches?		
20.	Have you ever had a stress fracture?		
21.	Have you ever been told that you have or have you had an x-ray for neck instability or atlantoaxial instability? (Down syndrome or dwarfism)		

42.	Do you or someone in your family have sickle cell trait or disease?		
43.	Have you had any problems with your eyes or vision?		
44.	Have you had an eye injury?		
45.	Do you wear glasses or contact lenses?		
46.	Do you wear protective eyewear, such as goggles or a face shield?		
47.	Do you worry about your weight?		
48.	Are you trying to gain or lose weight? Has anyone recommended that you do?		
49.	Are you on a special diet or do you avoid certain types of foods?		
50.	Have you ever had an eating disorder?		
51.	Do you have any concerns that you would like to discuss with a doctor?		
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 "yes" answers here

_____

_____

_____

_____

_____

I hereby state that, to the best of my knowledge, my answers to the above questions are complete and correct.

Signature of Student_____ Signature of parent/guardian_____ Date: _____

The student has family insurance ☐ Yes ☐ No If yes, family insurance company name and policy number: _____

Summa Health

Annual Pre-participation Exam History Questions

Ohio High School Athletic Association PPE Form 2018-2019 (page 2)

Please indicate if you have ever had any of the following.

	Yes	No
Atlantoaxial instability		
X-ray evaluation for atlantoaxial instability		
Dislocated joints (more than one)		
Easy bleeding		
Enlarged spleen		
Hepatitis		
Osteopenia or osteoporosis		
Difficulty controlling bowel		
Difficulty controlling bladder		
Numbness or tingling in arms or hands		
Numbness or tingling in legs or feet		
Weakness in arms or hands		
Weakness in legs or feet		
Recent change in coordination		
Recent change in ability to walk		
Spina bifida		
Latex allergy		

Explain "yes" answers here

Summa Health

Physical Exam

- Exam:
  -Russell sign: calluses on the knuckles or back of the hand
  -Bradycardia or dysrhythmia
  -Underweight (BMI<18.5 kg/m^2)
  -Orthostatic hypotension
  -Lanugo (soft, downy, fine white/light hair)
  -Parotid or Thyroid Gland hypertrophy
  -Lingual enamel erosion
  -Cool/Discolored Hands/Feet
  -Brittle nails
  -Insidious or vague musculoskeletal pain

Low Energy Availability

- Energy Availability (EA) = Energy Intake (EI) – Energy Out (EEE/FFM)
  - EI (Dietary Calories) in kcal
  - Exercise & Energy Expenditure in kcal / Free Fat Mass (kg)

- Low Energy Availability (LEA) may be shown via:
  - BMI <17.5
  - ↓T3 levels
  - ↓Resting Metabolic Rate (< 90% = measured RMR/predicted RMR)

  EA > 45 kcal/kg FFM/day = Weight Gain

  EA = 45 kcal/kg FFM/day = Weight Maintenance

  EA = 30 kcal/kg FFM/day = Minimum EA for optimal reproductive and bone health

  EA = 20 kcal/kg FFM/day = Moderate Energy Deficiency

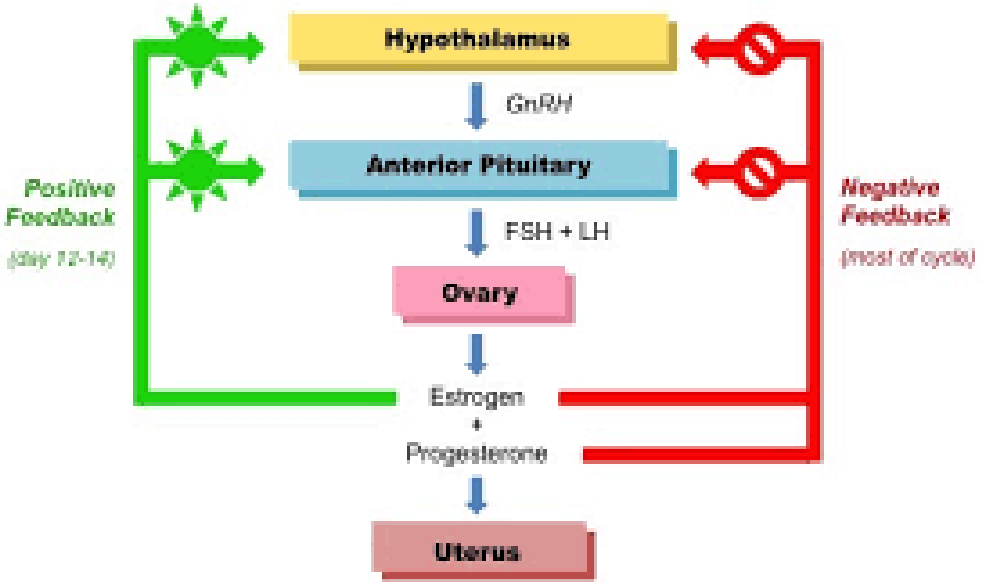
  EA = 10 kcal/kg FFM/day = Severe Energy Deficiency

Summa Health

Menstrual irregularity

- Amenorrhea
  - 1°: no menarche by age 15
  - 2°: no menses > 3 months; functional hypothalamic amenorrhea

- Normal Physiologic Feedback Loop (GnRH pulse every 1-2 hours)



- LEA→ Negative Feedback to Hypothalamus→ Abnormal Menses
  - Due to pituitary secreting LH pulses at incorrect frequency

Summa Health

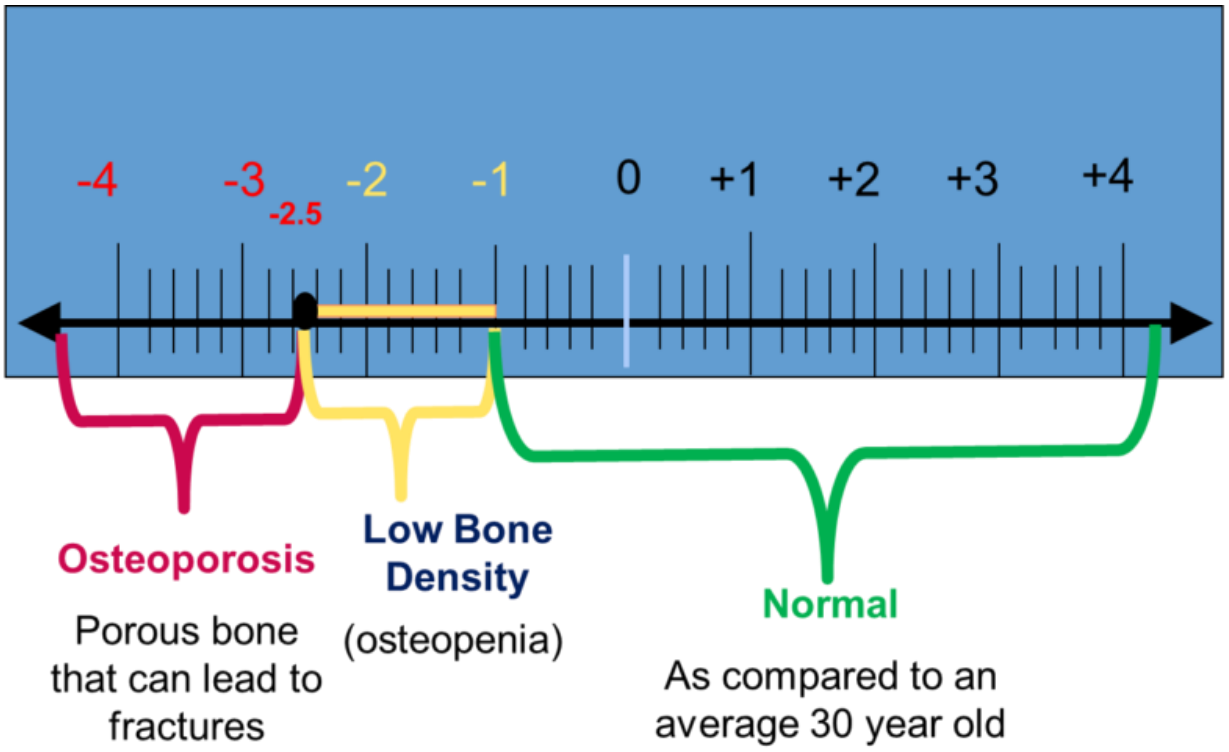
Functional Hypothalamic Amenorrhea

- Diagnosis of Exclusion

- Evaluation should 1st rule out:
  -Pregnancy
  -Pituitary Disorder
  -Thyroid dysfunction (Hyper/Hypothyroidsm)
  -Adrenal Dysfunction (tumors, PCOS, Cushing's Disease)
  -Hypogonadism
  -Autoimmune Disease
  -Exogenous steroid use
  -Malabsorption

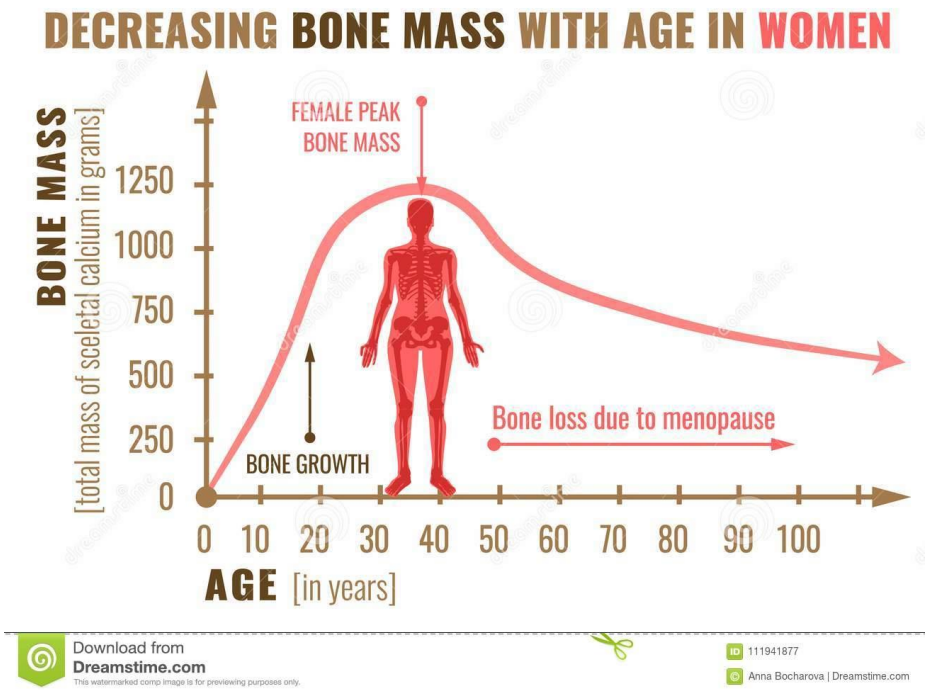
Low Bone Mineral Density

- Z-score compares our bone mineral density (BMD) to what is normal in someone your age and body size.
- Z-score from -1 to -2 with 2° risk factors= osteopenia
- Z-score less than -2.0 with 2° risk factors = osteoporosis
- 2° risk factors = prior fracture, glucocorticoid exposure, malnutrition, eating disorder, hypoestrogenism



Low Bone Mineral Density

- Peak BMD at age 30, remains stable until post-menopausal
- Bone resorption rate ↑ while bone formation rate ↓within 5 days after energy availability was ↓to <30 kcal/kgFFM/day in exercising women.[9]
- Late menarche (>15 y.o.) with stress fracture among H.S. runners.[10]



Low Bone Mineral Density: DEXA

- Children & adolescent patients (< age 20 y.o.), obtain PA lumbar spine bone mineral content (BMC) and areal BMD

- DEXA Indications:

≥1 "High Risk" Triad Factors	≥2 "Moderate Risk" Triad Factors	Hx of Non-stress fractures with 1 or more Moderate or High Risk Factors
Hx of DSM-5 ED	Current or hx of DE for 6 months or greater	Hx of ≥1 non-peripheral long bone traumatic fractures (non-stress)
BMI ≤17.5, <85% estimated weight, OR recent weight loss of ≥10% in 1 month	BMI between 17.5 and 18.5, <90% estimated weight, OR recent weight loss of 5-10% in 1 month	Hx of ≥2 peripheral long bone traumatic fractures (non-stress)
Menarche ≥16 yo	Menarche between ages 15 and 16 years	
Current or Hx of <6 menses over 12 months	Current or hx of 6-8 menses over 12 months	
2 prior stress rxns/fxs, one high-risk stress rxn/fx or a low energy nontraumatic fx	One prior stress rxn/fx	
Prior Z-score of <-2.0 (after at least 1 year from baseline DXA)	Prior Z-score between -1.0 and -2.0 (after at least 1 year from baseline DXA)	

Summa Health

Treatment

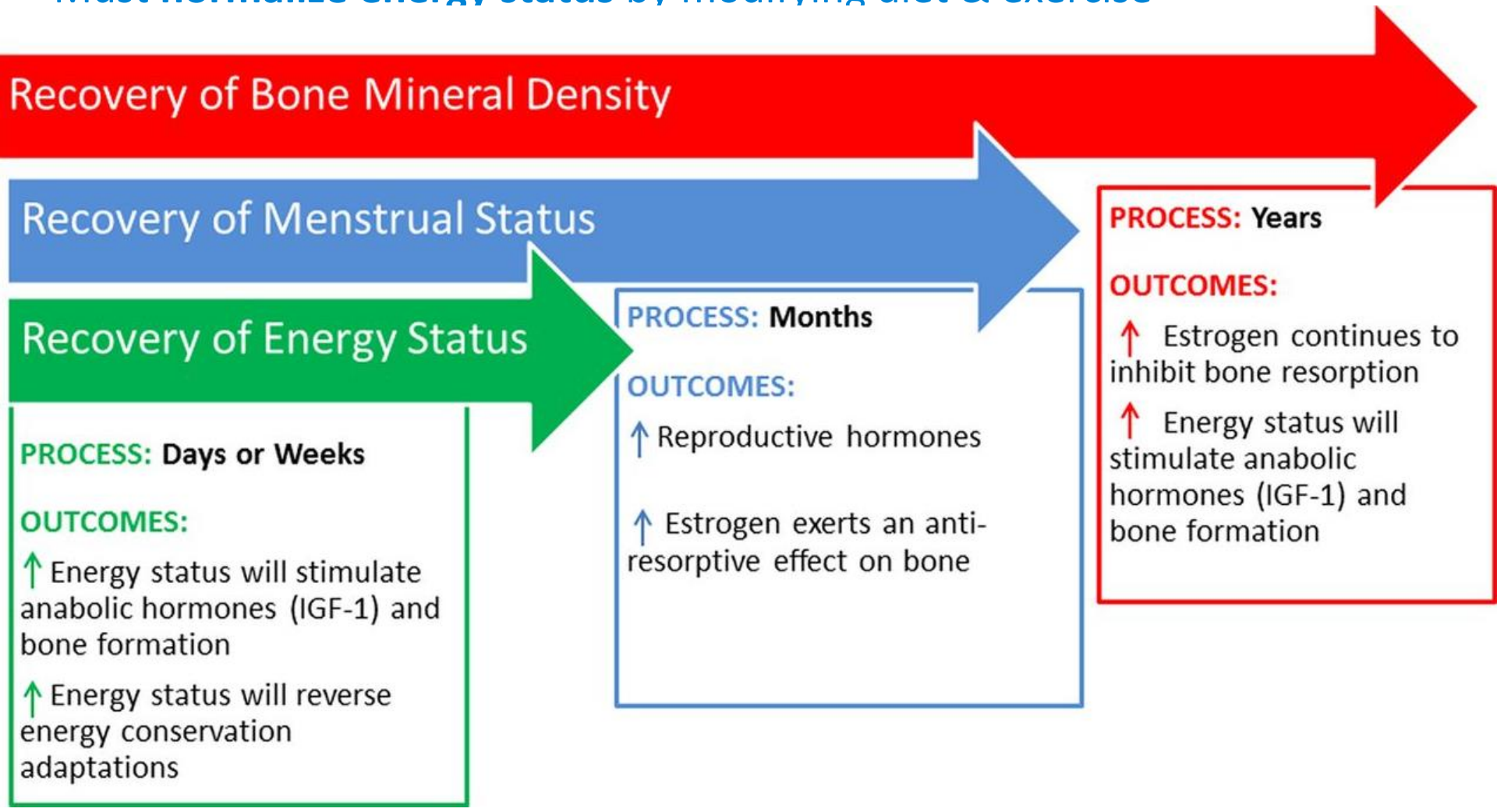
- Must **normalize energy status** by modifying diet & exercise
  - Diet: may require ↑caloric intake
  - Exercise: may require ↓ frequency

- Restoring body weight is the best way to resume normal menses and improved bone health [9]
- Psychology referral for CBT and family therapy
- Weight gain to achieve a BMI of ≥18.5 kg/m2 or ≥90% of predicted weight.

- Energy intake should be set at a minimum of 2000 kcal/d, or more likely, a greater energy intake will be required, depending on exercise energy expenditure.[10]
- Do not rely on OCP's to restore normal menses or bisphosphonates to restore normal bone health.
- Calcium supplementation 1000-1500mg/day & Vit-D 400-800 I.U. daily

Treatment

- Must **normalize energy status** by modifying diet & exercise



Summa Health

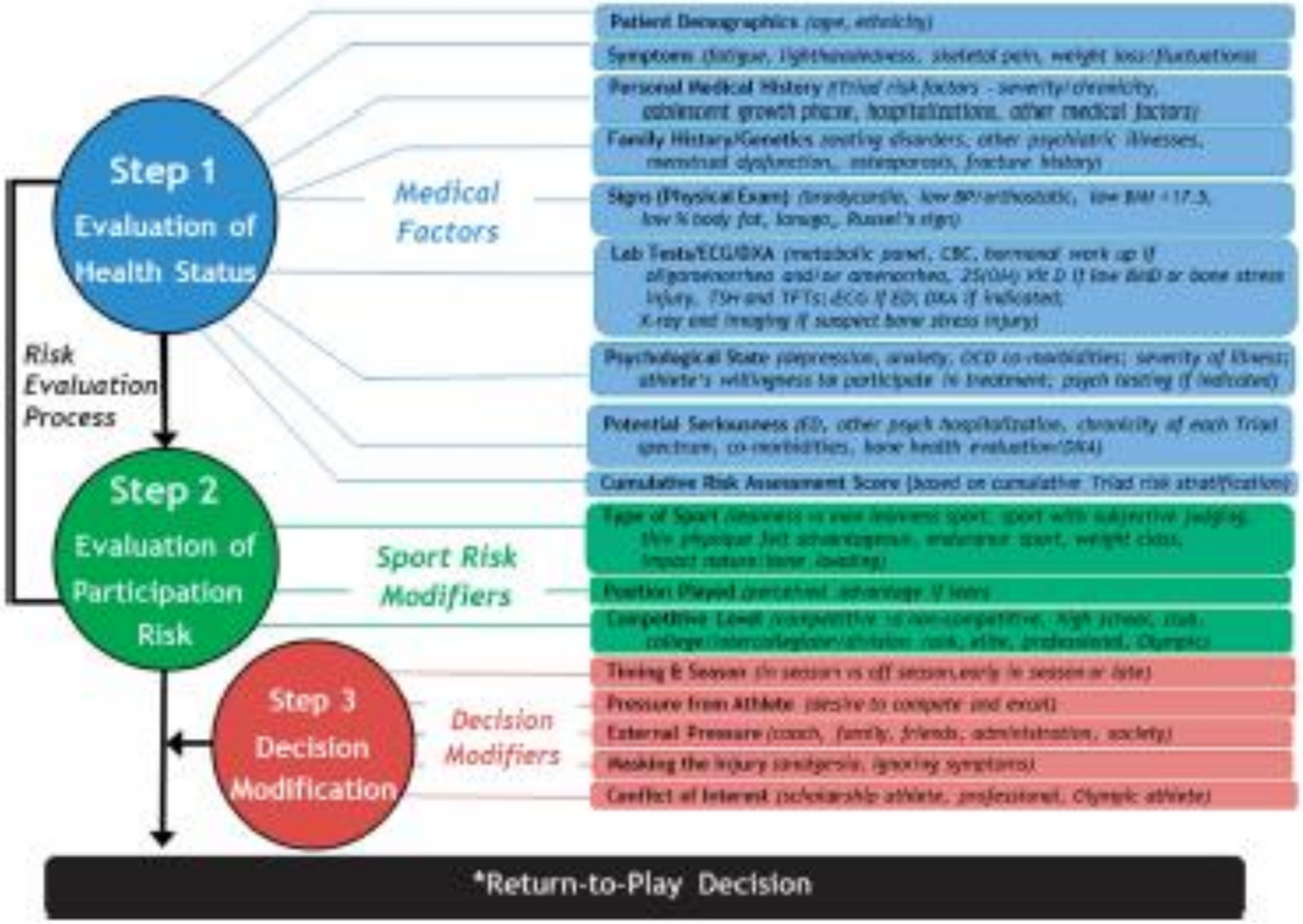
Return To Play

Risk Factors	Magnitude of Risk		
	Low Risk = 0 points each	Moderate Risk = 1 point each	High Risk = 2 points each
Low EA with or without DE/ED	☐ No dietary restriction	☐ Some dietary restriction‡; current/past history of DE;	☐ Meets DSM-V criteria for ED*
Low BMI	☐ BMI ≥ 18.5 **or** ≥ 90% EW** or weight stable	☐ BMI 17.5 < 18.5 **or** < 90% EW **or** 5 to < 10% weight loss/month	☐ BMI ≤17.5 **or** < 85% EW **or** ≥ 10% weight loss/month
Delayed Menarche	☐ Menarche < 15 years	☐ Menarche 15 to < 16 years	☐ Menarche ≥16 years
Oligomenorrhea and/or Amenorrhea	☐ > 9 menses in 12 months*	☐ 6-9 menses in 12 months*	☐ < 6 menses in 12 months*
Low BMD	☐ Z-score ≥ -1.0	☐ Z-score -1.0*** < - 2.0	☐ Z-score ≤ -2.0
Stress Reaction/Fracture	☐ None	☐ 1	☐ ≥ 2; ≥ 1 high risk or of trabecular bone sites†
Cumulative Risk (total each column, then add for total score)	**_____ points +**	**_____ points +**	**_____ points = _____Total Score**

	Cumulative Risk Score*	Low Risk	Moderate Risk	High Risk
Full Clearance	0 – 1 point	☐		
Provisional/Limited Clearance	2 – 5 points		☐ Provisional Clearance ☐ Limited Clearance	
Restricted from Training and Competition	≥ 6 points			☐ Restricted from Training/ Competition-Provisional ☐ Disqualified

Summa Health

Return To Play



Summa Health

Questions

- Questions

References

Logan, Kelsey. Female Athlete Triad. Five Minute Sports Medicine Consult, 2nd Edition. 2011; 158-159.

The IOC consensus statement: beyond the Female Athlete Triad- Relative Energy Deficiency in Sport (RED-S). 2014.

DeSouza, MJ et al. Misunderstanding the Female Athlete Triad: Refuting the IOC Consensus Statement on Relative Energy Deficiency in Sport (RED-S). British Journal of Sports Medicine.

Yeager KK, Agostini R, Nattiv A, et al. The female athlete triad: disordered eating, amenorrhea, osteoporosis. Med Sci Sports Exerc 1993;25:775–7.

Melin, A. The LEAF questionnaire: a screening tool for the identification of female athletes at risk for the female athlete triad. British Journal of Sports Medicine. 2014 April; 48 (7): 540-545

Loucks AB, Thuma JR, et al. J. Clin. Endocrinol. Metab. 2003

https://americanbonehealth.org/about-bone-density/understanding-the-bone-density-t-score-and-z-score/

https://www.dreamstime.com/decreasing-bone-mass-age-men-women-detailed-infographic-beige-pink-blue-colors-vector-illustration-healthcare-medicine-image108727224

Ihle R et al. Journal of Bone Mineral. 2004

Tenforde AS, Sayers LC, McCurdy ML, et al. Identifying sex-specific risk factors for stress fractures in adolescent runners. Med Sci Sports Exerc. 2013; 45 (10): 1843-1851.

DeSouza et al. 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad. British Journal of Sports Med 2014;48:289.

Summa Health