

RELATIVE ENERGY DEFICIENCY IN SPORT

Robyn Knutson Bueling, MD, CAQ, MS

Primary Care Sports Medicine
Allina Sports and Orthopedics

Team Physician:

United States Figure Skating
Minnesota United Football Club
Macalester College

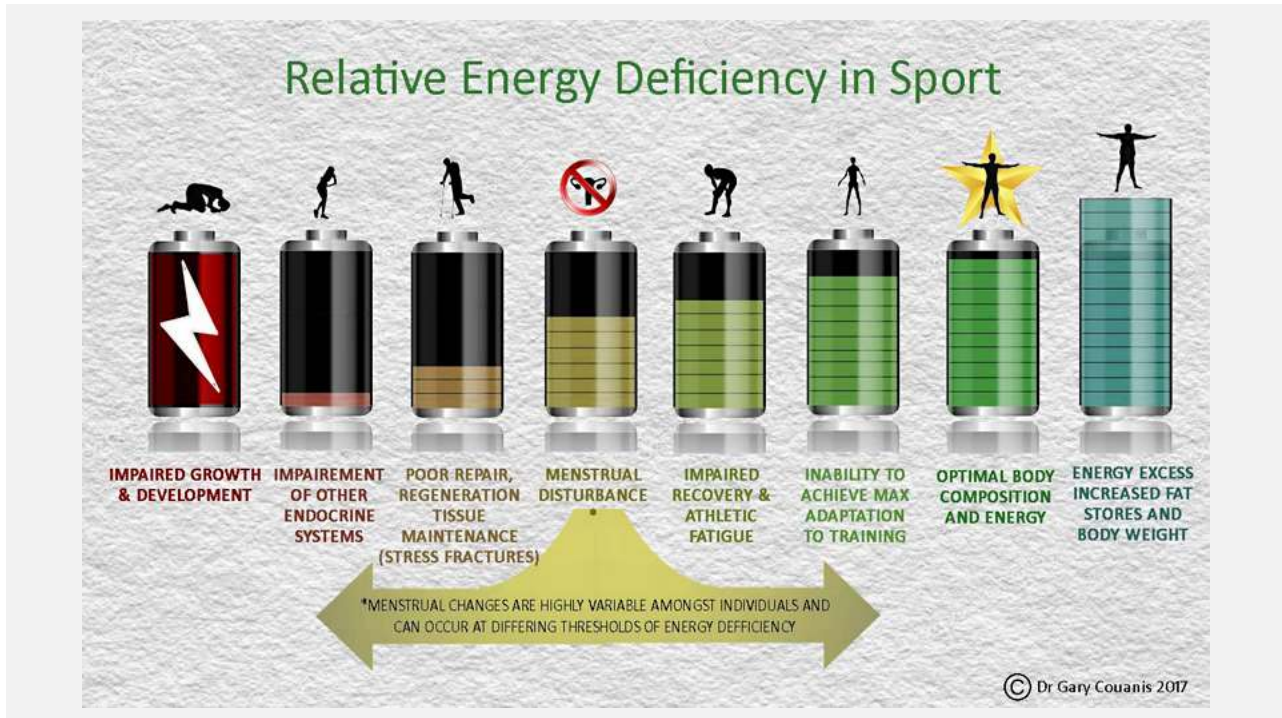


1

RED-S

- **Relative energy deficiency in sport**
- Result of insufficient caloric intake and/or excessive energy expenditure in relationship
- “Energy deficiency relative to the balance between dietary energy intake and energy expenditure required for health and activities of daily living, growth and sporting activities”

2



3

RED-S

- Low-energy condition that can alter many physiologic systems
 - Metabolism
 - Menstrual function
 - Bone health
 - Immunity
 - Protein synthesis
 - Cardiovascular function
 - Psychological health

4

WHAT WAS THE FEMALE ATHLETE TRIAD?

- Previously identified syndrome affecting women
 - ACSM published 1st position statement in **1997**
- Low energy availability → menstrual dysfunction → low BMD

- Parallel syndrome in males resulting in hypogonadal function

- **RED-S** is a comprehensive model of low-energy status in physically active people of any gender
 - ACSM and American Bone Health Alliance published consensus statement in **2014** RE: treatment, management and RTP

5

A WORD ABOUT DISORDERED EATING...

- “DE underpins a large proportion of cases of low EA, but other situations, such as a mismanaged programme to quickly reduce body mass/fat or an inability to track EI with an extreme exercise commitment, may occur without such a psychological overlay.”

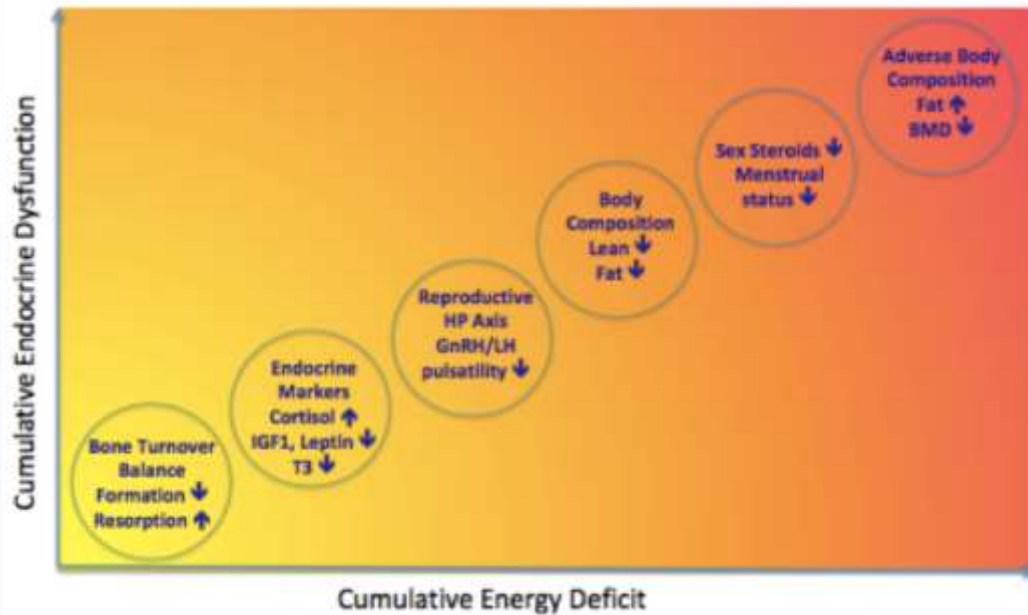
- In other words, an eating disorder is **NOT** required in order for RED-S to exist, nor is RED-S automatically a sign of an eating disorder.

- *It IS a sign of lack of fuel in comparison to amount of fuel burned.*

- (That’s all. This isn’t an eating disorders talk.)

6

Cumulative Energy Deficit and Endocrine Dysfunction



7

MENSTRUAL IRREGULARITIES

- **Eumenorrhea**--> regular menstrual cycles 21-35 days long
- **Primary amenorrhea** → no menarche by age 15
 - 7% overall
 - 22% cheer, diving, gymnastics
- **Secondary amenorrhea** → absence of 3 consecutive cycles post-menarche
 - 2-5% of collegiate women
 - 65% distance runners, 69% dancers
- **Oligomenorrhea**--> cycles longer than 45 days

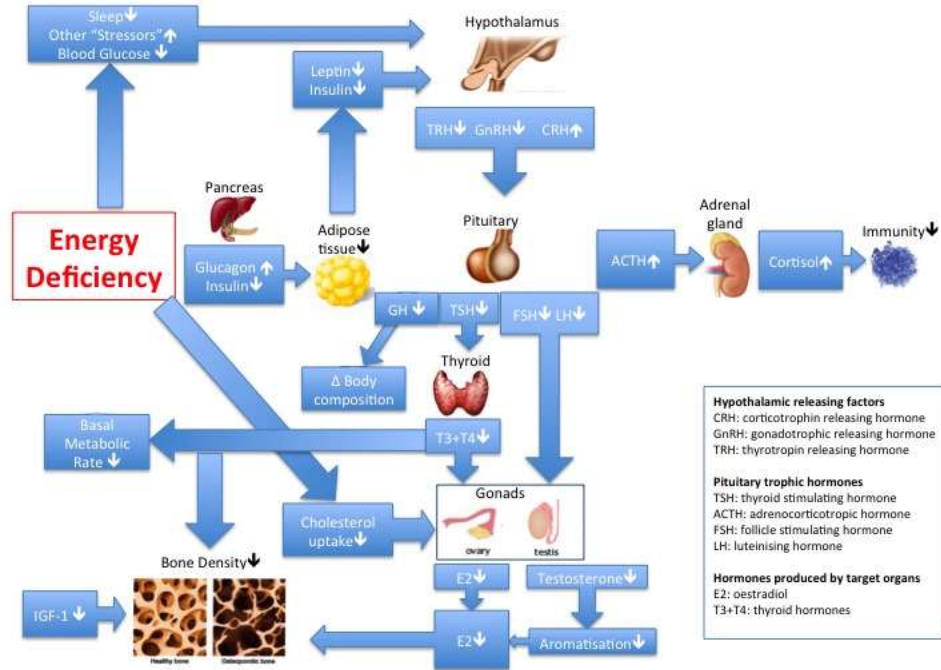
8

HEALTH CONSEQUENCES OF RED-S

- Nutrient deficiencies, anemia
- Chronic fatigue
- Increased infection, illness
- Decreased muscle protein synthesis
- Anxiety/altered perception of normalcy
- Confounded conception, infertility, unexpected pregnancy

9

Simplified endocrine response in Relative Energy Deficiency in sport (REDs)



10

BONE HEALTH CONSEQUENCES OF RED-S

- Peak BMD at 19 in women, 20.5 in men
- Reduced energy availability suppresses the hypothalamic-pituitary axis
- Estrogen increases Ca uptake into blood and deposition into bone
- Progesterone facilitates estrogen actions
- Testosterone is anabolic, stimulates osteoclasts and increases bone formation & Ca absorption
- Reduced bone mass and abnormal bone microarchitecture = increased stress fracture

11

BONE HEALTH MONITORING

- Athletes with low energy availability, eating disorder or amenorrhea > 6mo should have BMD measured via whole body DEXA (minus head)
- **Z-score** → comparison with average of same age and sex
 - Athletes in WB sports should be 5-15% higher than non-athletes
 - Exercise is generally **osteogenic**
 - BMD Z-score -1.0 - -2.0 = osteopenia
 - BMD Z-score <-2.0 = osteoporosis

12

RED-S TREATMENT STRATEGIES

- Increased energy intake
- Reduce energy output (exercise)
- Or both
- Practically, increase current intake by ~300-600 kcal/day and address suboptimal training practices
 - 1 apple or banana with 2 tbsp peanut butter
 - Plain bagel and 2 tbsp cream cheese
 - 6oz sweetened yogurt with 1/2c granola
 - 1/2c rice or noodles with 1 tbsp butter or olive oil with 1 tbsp parm cheese
 - “half a sandwich and a glass of milk”
- OCPs can help restart menstrual cycle but mask energy deficiency

13

ADDITIONAL RED-S TREATMENT STRATEGIES

- We aren't going to discuss...
 - 1500mg Ca + Vit D (above 32-50ng blood level)
 - OCP for menstruation versus possible detrimental effects on bones??
 - Bisphosphonates not recommended in reproductive age women, ?in men?
 - Teriperatide (forteo), calcitonin, PTH off-label
 - IGF, leptin as appetite stimulant off-label
 - ED/psych treatment if unable to increase energy availability as recommended

14

RETURN TO SPORT RECOMMENDATIONS

- Education about RED-S, nutrition, energy availability, and affects on performance and health
- Reduce emphasis on weight, increase emphasis on nutrition and health to enhance performance
- Realistic and health-promoting goals related to weight/body composition
- Use reputable sources of information
- Promote awareness that good performance does not always mean the athlete is healthy
- Support appropriate, timely, effective treatment
- Identify multidisciplinary team for treatment

15

RELATIVE ENERGY DEFICIENCY IN SPORT RISK ASSESSMENT MODEL FOR SPORT PARTICIPATION

• (modified from Skårderud et al)

High risk: no start red light	Moderate risk: caution yellow light	Low risk: green light
<ul style="list-style-type: none"> • Anorexia nervosa and other serious eating disorders • Other serious medical (psychological and physiological) conditions related to low energy availability • Extreme weight loss techniques leading to dehydration induced haemodynamic instability and other life-threatening conditions 	<ul style="list-style-type: none"> • Prolonged abnormally low % body fat measured by DXA or anthropometry using The International Society for the Advancement of Kinanthropometry (IAK14) or non-IAK approaches (42) • Substantial weight loss (5-10% body mass in 1 month) • Attenuation of expected growth and development in adolescent athlete 	<ul style="list-style-type: none"> • Healthy eating habits with appropriate energy availability
	<ul style="list-style-type: none"> • Abnormal menstrual cycle: FHA amenorrhoea >6 months • Menarche >16 years • Abnormal hormonal profile in men 	<ul style="list-style-type: none"> • Normal hormonal and metabolic function
	<ul style="list-style-type: none"> • Reduced BMD (either from last measurement or Z-score < -1 SD) • History of 1 or more stress fractures associated with hormonal/menstrual dysfunction and/or low EA 	<ul style="list-style-type: none"> • Healthy BMD as expected for sport, age and ethnicity • Healthy musculoskeletal system
	<ul style="list-style-type: none"> • Athletes with physical/psychological complications related to low EA/disordered eating - ECG abnormalities- Laboratory abnormalities 	
	<ul style="list-style-type: none"> • Prolonged relative energy deficiency • Disordered eating behaviour negatively affecting other team members • Lack of progress in treatment and/or non-compliance 	

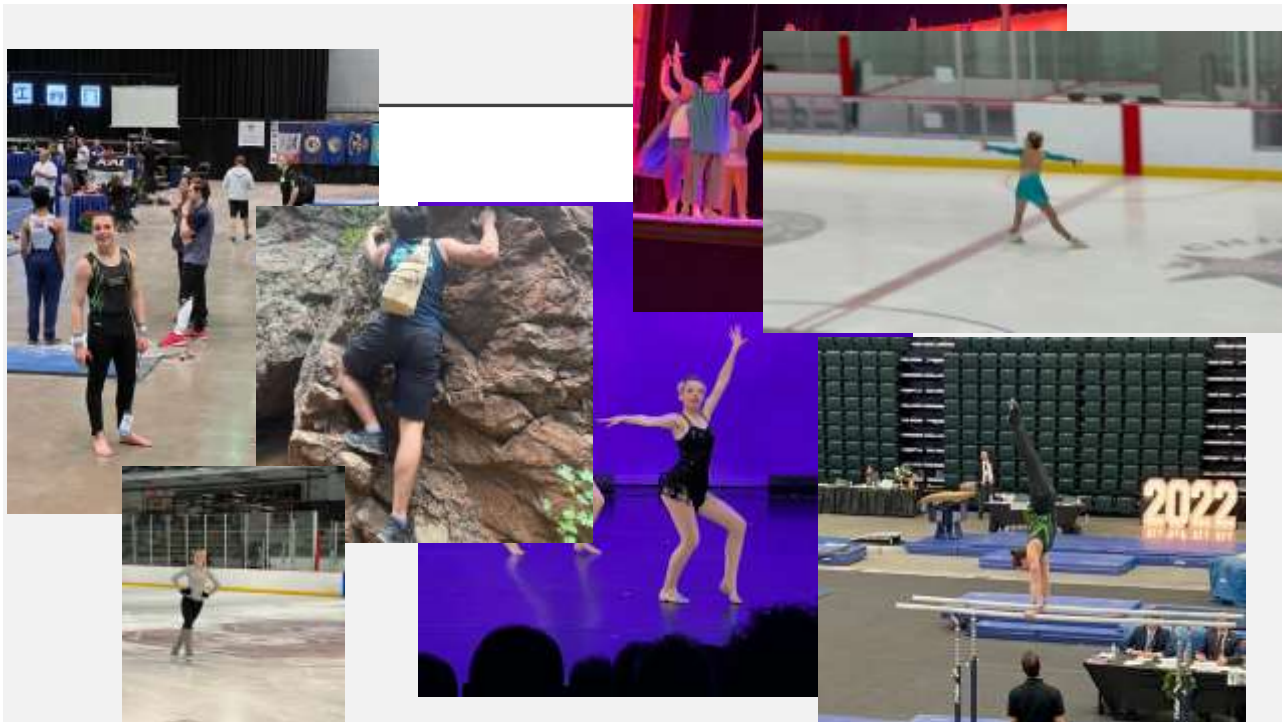
16

THE RELATIVE ENERGY DEFICIENCY IN SPORT RETURN-TO-PLAY MODEL

• (modified from Skårderud et al, 2012)

High risk red light	Moderate risk yellow light	Low risk: green light
<ul style="list-style-type: none"> ▶ No competition ▶ Supervised training allowed when medically cleared for adapted training ▶ Use of written contract 	<ul style="list-style-type: none"> ▶ May compete once medically cleared under supervision ▶ May train as long as following the treatment plan 	<ul style="list-style-type: none"> ▶ Full sport participation

17



18

SELECTED REFERENCES

- Mountjoy M, Sundgot-Borgen J, Burke L, Carter S, Constantini N, Lebrun C, Meyer N, Sherman R, Steffen K, Budgett R, Ljungqvist A. The IOC consensus statement: beyond the Female Athlete Triad--Relative Energy Deficiency in Sport (RED-S). *Br J Sports Med.* 2014 Apr;48(7):491-7. doi: 10.1136/bjsports-2014-093502. PMID: 24620037.
- Statuta SM, Asif IM, Drezner JA. Relative energy deficiency in sport (RED-S). *British Journal of Sports Medicine* 2017;51:1570-1571.
- Mountjoy M, Sundgot-Borgen J, Burke L, Carter S, Constantini N, Lebrun C, Meyer N, Sherman R, Steffen K, Budgett R, Ljungqvist A, Ackerman K. RED-S CAT. Relative Energy Deficiency in Sport (RED-S) Clinical Assessment Tool (CAT). *Br J Sports Med.* 2015 Apr;49(7):421-3. doi: 10.1136/bjsports-2015-094873. PMID: 25896450.
- Dipla K, Kraemer RR, Constantini NW, Hackney AC. Relative energy deficiency in sports (RED-S): elucidation of endocrine changes affecting the health of males and females. *Hormones (Athens)*. 2021 Mar;20(1):35-47. doi: 10.1007/s42000-020-00214-w. Epub 2020 Jun 17. PMID: 32557402.
- Papageorgiou M, Dolan E, Elliott-Sale KJ, Sale C. Reduced energy availability: implications for bone health in physically active populations. *Eur J Nutr.* 2018 Apr;57(3):847-859. doi: 10.1007/s00394-017-1498-8. Epub 2017 Jul 18. PMID: 28721562; PMCID: PMC5861178.