

Relative Energy Deficiency in Sport (RED-S) and the Athlete Triads

- Relative energy deficiency in sport (RED-S) is a condition resulting from chronic low energy availability
- Remember to ask young athletes about symptoms – be proactive about having the discussion
- The suggested tests are guidance only – a clinical diagnosis can be made
- Once a diagnosis is made – a multidisciplinary teamwork approach is important
- Proactive education of athletes helps to prevent RED-S

Introduction

Energy status plays a crucial role in the health of athletes and exercising individuals. Energy deficiency/low energy availability (EA) is a low caloric status in which energy intake deficiency or excessive energy expenditure or both, results in metabolic adaptation and compensation to conserve energy leading to many adverse physiologic effects and health consequences^{1,2}. Proactive education of athletes has been advocated to help prevent relative energy deficiency in sport³.

Relative Energy Deficiency in Sport (RED-S) Syndrome

RED-S is a broader term than the Athlete Triad (composed of three entities of energy availability [EA], menstrual function, and bone health), and is a syndrome that impacts many facets of physiological function, health, and athletic performance. It indicates the complexity involved with EA deficiency and the fact that not only female, but male athletes are also affected. In males, the hypothalamic pituitary-gonadal hormonal pathway is affected².

The RED-S syndrome describes alterations in physiological function due to EA including, but not limited to metabolic rate, menstrual function, bone health, protein synthesis, immunity, cardiovascular, other endocrine, and psychological health caused by relative energy deficiency². Psychological consequences can either precede RED-S or be the effect of RED-S⁴.

Female Athletes Triad (FAT)

FAT is a syndrome on a continuum of three interrelated health issues that require prompt health intervention in exercising women^{2,5}. Identification of one or more of these elements is crucial for early intervention and prevention of serious adverse health effect. The triad includes^{2,5}:

- Low energy availability (EA) with or without disordered eating
 - Identification of low EA is challenging. Low resting metabolic rate, low fat mass and low free T3 and BMI < 17.5 kg/m² are measurable indicators of low EA

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- Menstrual dysfunction; ranging from subclinical menstrual disturbances (anovulatory cycles) to oligomenorrhea to primary/secondary amenorrhea²
 - Diagnosis²: from history and physical examination
 - Menstrual dysfunction may need further investigation refer to [CCHPW](#)
- Low bone mineral density (BMD); instead of bone T scores, bone Z scores (comparisons to comparable aged individuals) are used². Weight bearing athletes BMD tends to be 5-10% higher than non-athletes², thus in this population:
 - Z score < -1.0 indicates low BMD and requires further investigation²
 - Z score < -2.0 indicates osteoporosis with a secondary clinical risk factor for fracture².

Dual-Energy X-Ray Absorptiometry (DEXA) scans are used for BMD values. *NB: Canterbury criteria for BMD mean that this is not available in the public system.*

Male Athletes Triad (MAT)

Across the last 2 decades, it has become more evident that male athletes may experience a similar Triad-like syndrome^{6,7}.

The Male Athlete Triad is most common in adolescent and young adult male weight and endurance- class athletes³. MAT triad includes clinically interrelated issues including:

- Energy deficiency/low EA, with or without subclinical/clinical eating disorders,
- Hypothalamic- pituitary- gonadal (HPG) axis suppression, and
- Low bone mineral density or osteoporosis with or without bone stress injury (BSI)^{3,7,8}.

At the healthy end of the continuum, energy intake is adequate to meet exercise and physiological needs. Thus, bone health is age, sex, and exercise appropriate and HPG axis function is normal. When energy deficiency develops and EA decreases, a progressive deterioration of bone and reproductive health takes place. At the extreme unhealthy end of the continuum, clinical results include:

- Energy deficiency/low EA with or without eating disorders or disordered eating
- Hypogonadotropic hypogonadism
- Decreased libido
- Oligospermia
- Osteoporosis with or without BSI³

References

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In comparison with FAT, in MAT, specific subclinical outcomes are less clearly defined and represented as slight HPG changes with high BSI risk. Also, the degree of energy deficiency/low EA that is required to cause triad alterations has not clearly been identified.

- There is some evidence that more severe energy deficiency or low EA is required to cause MAT bone and reproductive alterations than in FAT
- Some evidence has indicated that HPG axis recovery is quicker than in FAT^{3,8,9}

Low EA is the energy level status where one or more of the following metabolic adaptations occur reflecting long-term failure to consume adequate energy to cover the energy expenditure (low EA objective indicators)³:

- Resting metabolic rate suppression to be normalised with body size or free fat mass (FFM)
- Body weight loss
- Low body mass index (BMI)
- Suppression of metabolic hormones, as Triiodothyronine (T3) and leptin³

Treatment

Treatment should address reversing the energy deficit, and any other findings (e.g., osteoporosis). Ensuring adequate micronutrient intake especially vitamin D and calcium is recommended. A multidisciplinary team approach is recommended^{2,10}.

Further Information

A recent Goodfellow webinar gives an Aotearoa NZ context to diagnosis and management of RED-S. <https://www.goodfellowunit.org/events/relative-energy-availability-sport-%E2%80%93-diagnosis-pay-attention>

Some sports clinics and endocrinologists in Christchurch offer private services to those with RED-S. Check their websites for details.

Resources for Athletes

- Aotearoa NZ Sport Organisations – High Performance Sport New Zealand <https://hpsnz.org.nz/home/whisper-healthy-women-in-sport-a-performance-advantage/relative-energy-deficiency-in-sport/>
- Athletics NZ <https://athletics.org.nz/wp-content/uploads/2020/12/RED-S-article-January-2020.pdf>

6. Koltun KJ, Williams NI, De Souza MJ. Female Athlete Triad Coalition cumulative risk assessment tool: proposed alternative scoring strategies. *Applied Physiology, Nutrition, and Metabolism*. 2020;45(12):1324-31.
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8. The Female and Male Athlete Triad Coalition. What is the Male Athlete Triad? : An International Consortium; 2020; Available from: <https://femaleandmaleathletetriad.org/athletes/male-athlete-triad/>.
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