IOC REDs CAT2

International Olympic Committee (IOC) Relative Energy Deficiency in Sport (REDs) Clinical Assessment Tool Version 2 (IOC REDs CAT2)

For use by medical professional only

Name: _____ Date: _____ Examiner: _____

What is the IOC REDs CAT2?

The IOC REDs CAT2 is a clinical assessment tool for the evaluation of athletes/active individuals suspected of having problematic low energy availability (LEA) leading to REDs and for guiding the determination of level of sport participation. The IOC REDs CAT2 is designed for use by athlete health and performance teams, led by a physician, in the clinical evaluation and management of athletes with this syndrome. The IOC REDs CAT2 is based on the 2023 IOC REDs Consensus Statement[1], replacing the original RED-S CAT[2]. For more details on the development, underpinning science, and validation process, please see the IOC REDs CAT publication in the 2023 British Journal of Sports Medicine (BJSM) REDs dedicated edition[3].

This tool may be freely copied and translated in its current form for use by the athlete health and performance team. We encourage sports organisations, as well as sports medicine physicians to implement the various steps of the tool into their athlete health screening, diagnosis, and treatment policies. Alterations to the tool or reproduction for publication purposes require permission from the IOC and BJSM.

Note: *The diagnosis of REDs is a medical diagnosis to be made by a sports medicine physician. Clinical treatment of athletes with REDs should be implemented by an experienced, multidisciplinary athlete health and performance team.*

What is REDs?

REDs is defined as:

A syndrome of impaired physiological and/or psychological functioning experienced by female and male athletes that is caused by exposure to problematic (prolonged and/or severe) low energy availability. The detrimental outcomes include but are not limited to decreases in metabolic function, reproductive function, musculoskeletal health, immunity, glycogen synthesis, cardiovascular and haematological health, which can all individually and synergistically lead to impaired well-being, increased injury risk, and decreased sports performance[1].

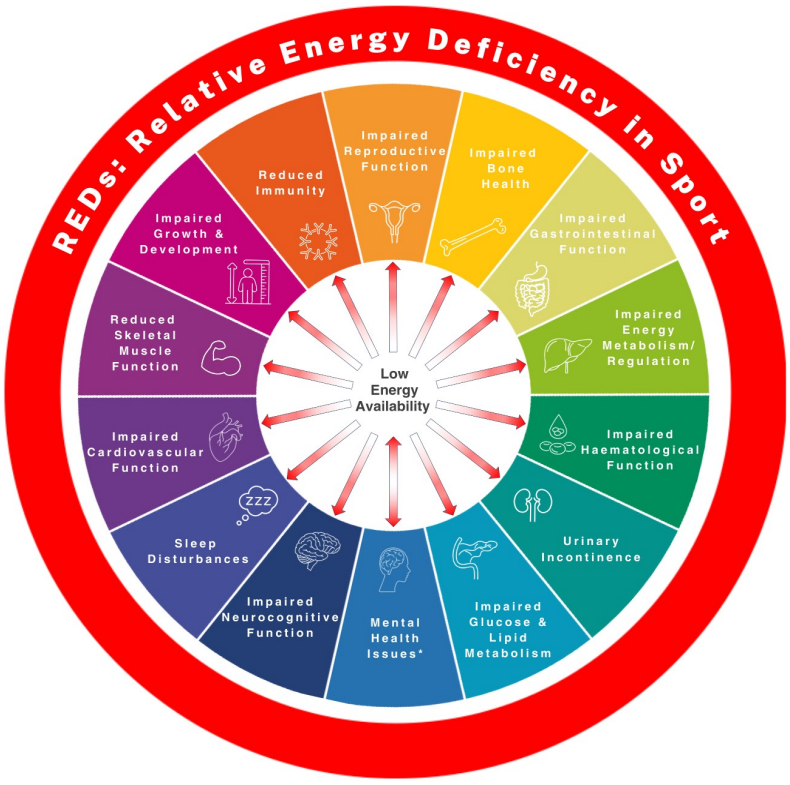
The cause of REDs is the clinical syndrome that results from exposure to problematic LEA where an individual's dietary energy intake is insufficient to support the energy expenditure required for health, function, and daily living once the cost of exercise and sporting activities is taken into account.

The formula representing this is:

$$EA = \frac{\text{energy intake (EI) (kcal)} - \text{exercise energy expenditure (EEE) (kcal)}}{\text{FFM (kg)}} \text{ per day}^{-1}$$

REDs Health Conceptual Model

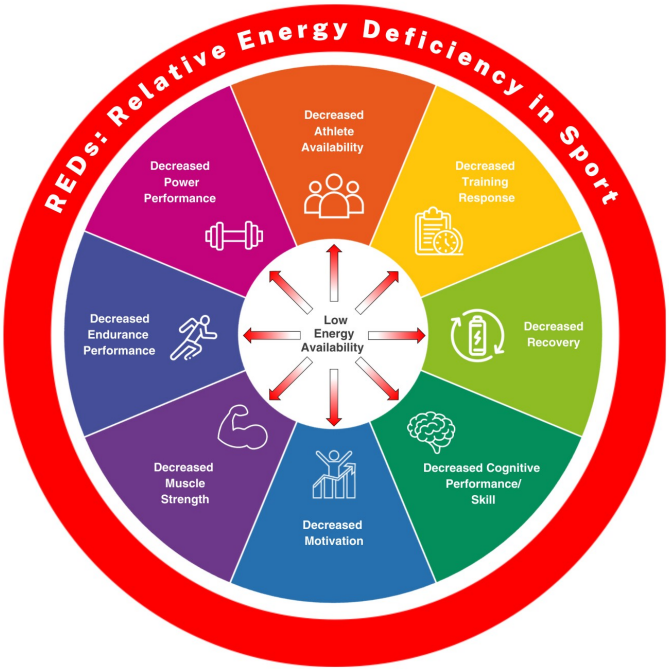
The potential health consequences of REDs are depicted in the REDs health conceptual model. Psychological problems can be both the result of and/or the cause of REDs.



REDs Health Conceptual Model
The effects of LEA exist on a continuum. While some level of exposure to LEA is mild and transient, termed adaptable LEA (arrow depicted in white), problematic LEA is associated with a variety of adverse REDs outcomes (arrow depicted in red).

REDs Performance Conceptual Model

REDs may also affect athlete sports performance. The potential effects of REDs on sports performance are illustrated in the following model:



REDs Performance Conceptual Model
The effects of LEA exist on a continuum. While some level of exposure to LEA is mild and transient, termed adaptable LEA (arrow depicted in white), problematic LEA is associated with a variety of adverse REDs outcomes (arrow depicted in red).

IOC REDs CAT2 Three Step Model

The screening and diagnosis of REDs is challenging, as symptomatology can be subtle and further complicated by the diverse list of potential differential diagnoses; as well, the measurement of energy availability and exercise expenditure is fraught with challenges. A special focus on the athlete at risk is needed. Although any athlete or active individual can suffer from REDs, those at particular risk are female athletes, those in weight-sensitive and leanness-demanding sports, including but not limited to weight class sports (e.g., combat disciplines), aesthetically judged sports (e.g., gymnastics disciplines), sports in which a low body weight might provide a performance advantage (e.g., anti-gravity disciplines, such as high jump), and in sports with high exercise energy expenditure (e.g., endurance disciplines). Detection through self-reported and/or objective screening is important to identify an athlete at risk for REDs early, providing an opportunity to intervene promptly to maintain and improve performance and prevent long-term health consequences.

The IOC REDs CAT2 is a three-step model

Step 1

REDs Screening (Population-specific Questionnaires or Clinical Interview)

- Lower sensitivity and specificity
- Inexpensive and easy to use
- Questionnaires allow for large athlete group screening

greater than low risk proceeds to Step 2

Step 2

REDs Severity/Risk Assessment

- High sensitivity
- More expensive
- Clear scoring allows for easy and reliable implementation

yellow, orange, or red to proceed to Step 3

Step 3

REDs clinical diagnosis and treatment

- Physician diagnosis based on information from Steps 1 and 2 along with clinical history and examination
- Individualized treatment plan implemented by the multi-disciplinary athlete health and performance team

Step 1) REDs Screening: initial screening using population-specific questionnaires assessing the presence of REDs indicators or clinical interviewing. Athletes deemed at risk for REDs based on Step 1 should complete ***Step 2)*** REDs Severity/Risk Assessment (see Table below) and Stratification and Sports Participation Guidelines (see REDs Stratification and Sports Participation Guidelines Figure below). Collected clinical data from Step 2 informs ***Step 3)*** a sports medicine physician-led clinical diagnosis and the implementation of a individualised treatment plan, ideally integrating a collaborative multi-disciplinary REDs health and performance team.

Step 1: Screening for REDs

Screening for REDs using a population-specific, REDs-related questionnaire or clinical interview can be undertaken as part of an annual periodic health examination and when an athlete presents with Disordered Eating (DE)/Eating Disorders (ED), weight loss and/or fluctuations, lack of normal growth and development, endocrine dysfunction, recurrent injuries and illnesses, bone stress injury, decreased performance/performance variability or mood changes. As with all self-reported symptom screening tools, sensitivity and validity can be challenging[4], but they are inexpensive and scalable for large athlete populations. Depending on the athlete-population, and typical symptoms, initial screening tools for consideration include:

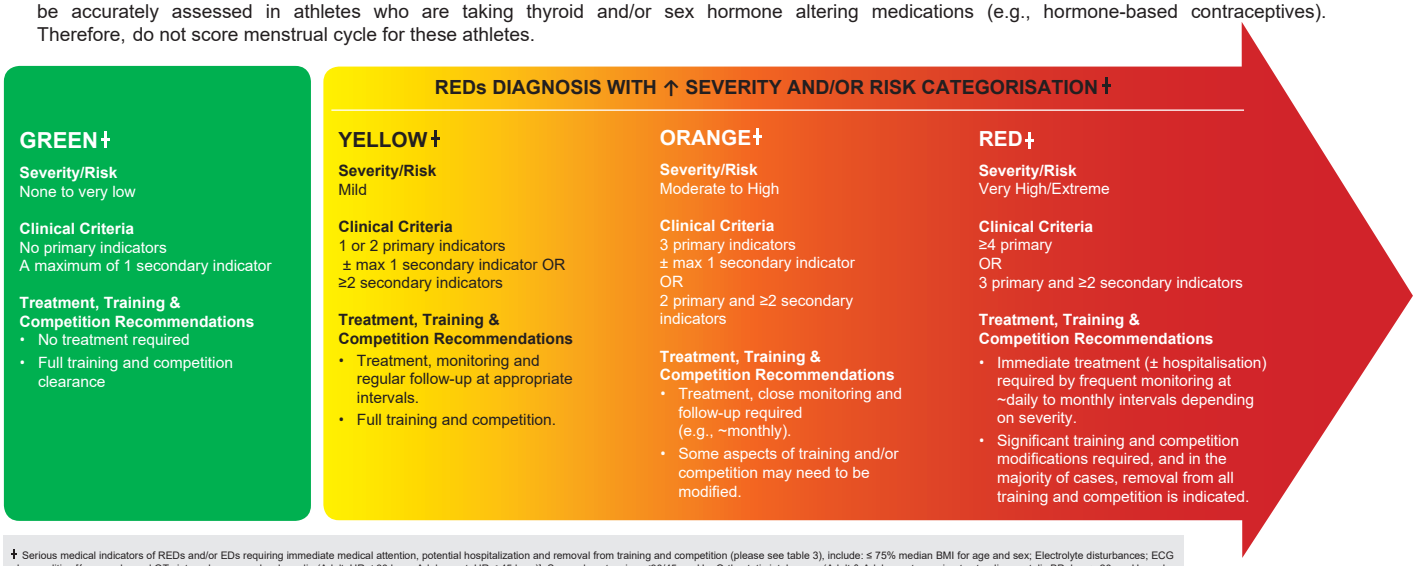
- LEAF-Q (Low Energy Availability in Females Questionnaire) [5]
  https://bjsm.bmj.com/content/bjsports/suppl/2014/02/21/bjsports-2013-093240.DC1/bjsports-2013-093240supp1.pdf
  LEAF-Q Scoring Guide:
  https://bjsm.bmj.com/content/bjsports/suppl/2014/02/21/bjsports-2013-093240.DC1/bjsports-2013-093240supp2.pdf
- LEAM-Q (Low Energy Availability in Males Questionnaire) [6]
  https://www.mdpi.com/2072-6643/14/9/1873 (see supplementary material)
- RST (RED-S Specific Screening Tool) [7]
  https://assets.cureus.com/uploads/original_article/pdf/30734/1612430181-1612430175-20210204-18268-i9k6n7.pdf
  (Questionnaire in appendix C, scoring guide in appendix B)
- SEAQ-I (Sport-Specific Energy Availability Questionnaire and Interview) [8]
  https://bmjopensem.bmj.com/content/4/1/e000424
  (see supplementary material)
- EDE-Q (Eating Disorder Examination Questionnaire) [9]
  https://socialwork.buffalo.edu/content/dam/socialwork/continuing-education/documents/Eating-Questionairre-EDE-Q.pdf
- SCOFF (Sick, Control, One (stone), Fat, and Food Questionnaire) [10]
  https://www.nutritionhealth.com.au/site/assets/files/1064/scoff-questionnaire.pdf
- EAI (Exercise Addiction Inventory) [11]
  https://doi.org/10.1080/16066350310001637363 (see appendix 1)
- EDS (Exercise Dependence Scale) [12]
  https://www.personal.psu.edu/dsd11/EDS/EDS21Manual.pdf

More screening questionnaires can be found in Torstveit et al. (table 2)[4].

Athletes identified at any level of risk in Step 1 should be directed to complete Step 2. Note that there may be false positives (falsely identified) athletes in Step 1 which will be further clarified in subsequent steps. Having false positives decreases the risk of missing an athlete requiring care (false negatives).

Step 2: REDs Severity/Risk Assessment and Stratification and Sports Participation Guidelines

Step 2 includes a more in-depth assessment (See REDs Severity/Risk Assessment Table) and subsequent stratification (see REDs Stratification and Sports Participation Guidelines Figure below) of athletes into a four-level traffic-light (green, yellow, orange, and red) severity/risk stratification. The criteria in each traffic-light section are separated into primary and secondary indicators according to the level of scientific evidence, validity, and usability, and where scientifically supported, thresholds identified for each indicator are given[3]. Menstrual cycle, sex and thyroid hormone status indicators cannot be accurately assessed in athletes who are taking thyroid and/or sex hormone altering medications (e.g., hormone-based contraceptives). Therefore, do not score menstrual cycle for these athletes.



ǂ Serious medical indicators of REDs and/or EDs requiring immediate medical attention, potential hospitalization and removal from training and competition (please see table 3), include: ≤ 75% median BMI for age and sex; Electrolyte disturbances; ECG abnormalities [(e.g., prolonged QTc interval or severe bradycardia (Adult: HR ≤ 30 bpm; Adolescent: HR ≤ 45 bpm)]; Severe hypotension: ≤90/45 mmHg; Orthostatic intolerance (Adult & Adolescent a supine to standing systolic BP drop > 20 mmHg and a diastolic drop > 10 mmHg); Failure of outpatient ED treatment program; Acute medical complications of malnutrition; Any condition that inhibits medical treatment and monitoring while training and/or competing.

Disclaimer: The IOC REDs CAT2 Severity/Risk Assessment and Stratification and Sport Participation Guidelines is not to be used in isolation and is not to be used solely for diagnosis. Furthermore, this tool is less reliable in situations where it is not possible to assess all indicators in theREDs Severity/Risk Assessment Table. The IOC REDs CAT2 Severity/Risk Assessment and Sport Participation Guidelines is not a substitute for professional clinical diagnosis, advice and/or treatment from a team of REDs health and performance experts led by a sports medicine physician. Along with the evaluation of health status presented here, sport participation decisions also need to be made in the context of various decision modifiers, such as level of the athlete, sport type, participation risk, conflict of interest, athlete/coach pressures, timing, and season etc.[13]. Abbreviations: BPM, Beats Per Minute; BMI, Body Mass Index; BP, Blood Pressure; ECG, Electrocardiogram; EDs, Eating Disorders; HR, Heart Rate; mmHg, millimeters Mercury; REDs, Relative Energy Deficiency in Sport.

Severe Primary Indicators (2 points)

- Primary amenorrhea (females: failure to reach menarche by age 15 when the development of secondary sexual characteristics is evident, or by age 14 years when no secondary sexual characteristics are present)
- Prolonged secondary amenorrhea (absence of 12 or more consecutive menstrual cycles) due to FHA
- Clinically low free or total testosterone (males: below the laboratory and age-specific reference range)

Primary Indicators (1 point)

- Secondary amenorrhea (females: absence of 3 to 11 consecutive menstrual cycles) caused by FHA
- Sub-clinically low free or total testosterone (males: within the lowest quartile of the laboratory and age-specific reference range)
- Sub-clinically or clinically low total or free T3 (within or below the lowest quartile of the laboratory and age-specific reference range)
- History of ≥1 high-risk (femoral neck or total hip, sacrum, pelvis) or ≥2 low-risk BSI (all other BSI locations) within the previous 2 years or absence of ≥6 months from training due to BSI in the previous 2 years
- Adults/Adolescents (age ≥15 years): BMD Z-score* <-1 at the lumbar spine, total hip, or femoral neck or total hip, or decrease in BMD Z-score from prior testing (can occur from bone loss or inadequate bone accrual), using paediatric norms/software for age <20 years
- Child/Adolescent (age <15 years): BMD Z-score* <-1 at the spine or TBLH or decrease in BMD Z-score from prior testing (can occur from bone loss or inadequate bone accrual)
- A deviation of a paediatric or adolescent athlete's previous growth trajectory (height and/or weight)
- An elevated score for the EDE-Q global (>2.30 in females; >1.68 in males) and/or clinically diagnosed DSM-5-TR-defined ED (only 1 primary indicator for either or both outcomes)

*BMD assessed via DXA within ≤6 months. [In some situations, using a Z-score from another skeletal site (e.g., distal 1/3 radius when other sites cannot be measured or including total hip or femoral neck) in some older (>15 years) adolescents may be warranted].

Secondary Indicators

- Oligomenorrhea caused by FHA (>35 days between periods for a maximum of 8 periods/year)
- History of 1 low-risk BSI (see high vs low-risk definition above) within the previous 2 years and absence of <6 months from training due to BSI in the previous 2 years
- Elevated total or LDL cholesterol (above reference range)
- Clinically diagnosed depression and/or anxiety (only 1 secondary indicator for either or both outcomes)

Potential Indicators**

- Sub-clinically or clinically low IGF-1 (within or below the lowest quartile of the reference range)
- Clinically low blood glucose (below the reference range)
- Clinically low blood insulin (below the reference range)
- Chronically poor or sudden decline in iron studies (e.g., ferritin, iron, transferrin) and/or haemoglobin
- Lack of ovulation (via urinary ovulation detection)
- Elevated resting or 24-hour urine cortisol (above the reference range or significant change for an individual)
- Urinary incontinence (females)
- GI or liver dysfunction / adverse GI symptoms at rest and during exercise
- Reduced or low RMR <30 kcal/kg FFM/d or RMR ratio <0.90
- Reduced or low libido/sex drive (especially in males) and decreased morning erections (males)
- Symptomatic orthostatic hypotension
- Sleep disturbances
- Psychological symptoms (increased stress, anxiety, mood changes, body dissatisfaction and/or body dysmorphia)
- Exercise dependence/addiction
- Low BMI (requires validation in athlete populations of varying ages, sex & ethnicities)
- Extreme bradycardia [(HR<40 in adult athletes; HR<50 in adolescent athletes (<18 years)]
- Low systolic or diastolic BP (<90/60mmHg)

**Potential indicators are purposefully vague in quantification, pending further research to quantify parameters and cut-offs more accurately. Therefore, they are not allocated points for calculation in the IOC REDS CAT2.

Abbrivation: BP, Blood Pressure; BMD, Bone Mineral Density; BMI, Body Mass Index; BSI, Bone Stress Injury; DXA, dual-energy X-ray absorptiometry; DSM-5-TR, Diagnostic and Statistical Manual of Mental Disorders, 5th edition, text revision; ED, Eating Disorder; EDE-Q, Eating Disorder Examination Questionnaire; FFM, Fat-Free Mass; FHA, Functional Hypothalamic Amenorrhea; GI, Gastrointestinal; HR: Heart Rate; IGF-1: Insulin-like Growth Factor 1; kcal, kilocalories; LDL: Low-density lipoprotein; RMR, Resting Metabolic Rate; TBLH, Total Body Less Head; T, Testosterone; T3, Triiodothyronine; RMR, Resting Metabolic Rate; TBLH, Total Body Less Head; T, Testosterone; T3, Triiodothyronine

IOC REDs CAT2 Calculator Tool

In order to assist with the scoring of the IOC REDs CAT2, please find below an Online Calculator Tool.

Step 3: REDs Clinical Diagnosis and Treatment

The collective results from Step 1 and Step 2, informed by the Severity/Risk Stratification with the 4-colour traffic light Sports Participation Guideline, are not to be used in isolation - as a sports medicine physician (if a sports medicine physician is not available, a family physician / general practitioner doctor would be ideal) led final diagnosis is required.

Athletes categorised in the red, orange, or yellow light zones should receive medical evaluation and treatment. An accurate diagnosis and evidence-informed approach to REDs management are vital to avoid further harmful consequences of problematic LEA. The treatment of REDs should be undertaken by a team of health professionals including a sports medicine (if a sports medicine physician unavailable, a well-versedfamily physician / general practitioner is preferred) physician, sports dietician, exercise physiologist, athletic therapist or trainer, sports psychologist/ sports psychiatrist as needed. It is important to ensure the athlete's coach, and parents/guardians are aware of the diagnosis, as appropriate, and are supportive of the treatment plan, which may impact training. ***Patient confidentiality must be maintained.

Along with the evaluation of health status presented here, severity/risk stratification and sport participation decisions also need to be made in the context of various decision modifiers, such as

- competitive level of the athlete
- sport
- health risk of continued participation (based on indicators of greater severity)
- conflict of interest among those involved in this decision
- intrinsic and extrinsic athlete pressures related to timing in the competition season
- desire to compete
- sponsorship
- athlete's importance to the team

The cornerstone of treatment for all REDs-affected athletes is to restore the athlete to optimal energy availability by increasing energy intake and/or decreasing energy expenditure (training)[14-16]. This will require agreement amongst the athlete health and performance treatment team members and consistent messaging and support for the athlete as they navigate changes to their diet and/or training regimen. Athletes with REDs should be re-assessed regularly by the treatment team (every days to months, depending on severity), with key diagnostic indicators being re-tested as appropriate to help confirm restoration of normal body system function and well-being.

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