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Eating disorders among athletes: causes, symptoms, and health consequences

A review of the literature on the most common eating disorders among athletes, their causes, impact on physical and mental health, and difficulties associated with diagnosis and treatment.

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Abstract

Introduction: Eating disorders are a group of serious psychiatric conditions that include anorexia nervosa, bulimia, binge eating disorder (BED), and other disorders such as orthorexia and muscle dysmorphia, which are not fully described in the DSM-V. These

disorders are characterized by abnormal eating behaviors that can severely impact both physical and mental health. Research indicates that athletes, particularly those involved in strength or aesthetic sports, are at a higher risk for developing these issues compared to non-athletes. This highlights the importance of addressing eating disorders within the context of public health. This review aims to explore the definition of eating disorders, their symptoms, risk factors, especially those specific to athletes, and the available treatment options.

Purpose of study: This is a review of the literature on the most common eating disorders among athletes, their causes, impact on physical and mental health, and difficulties associated with diagnosis and treatment.

Materials and methods: The literature review was based on materials retrieved from the PubMed and Google Scholar databases, using keywords such as “eating disorder” AND “sports”, “eating disorders in athletes”, “eating disorders causes”, and “eating disorders treatment”. The scope of the studies analyzed covered the years 2005 to 2024, with a focus on recent research

Conclusion: Athletes, especially women and those involved in strength or aesthetic sports, are at a higher risk of developing eating disorders. Among athletes, there are specific symptoms of eating disorders, such as reduced energy availability, which can lead to conditions like RED-S (Relative Energy Deficiency in Sport) and the Female Athlete Triad. Effective treatment for these disorders should focus on early recognition, with particular attention to early symptoms. Treatment involves both non-pharmacological methods, such as cognitive-behavioral therapy and PED-T (Physical Exercise and Diet Therapy), as well as interventions to correct nutritional deficiencies and pharmacotherapy.

Keywords: eating disorders, eating disorders in athletes, eating disorders risk factors, eating disorders symptoms, eating disorders treatment

1.Introduction

Eating disorders are a group of serious mental disorders characterized by abnormal eating behaviors, which, if untreated, can lead to the death of the patient. (1–4) Approximately 5% of the general population is affected by these conditions. Interestingly, research indicates that athletes report a higher prevalence of such issues compared to non-athletes. (5) Types of eating disorders include anorexia nervosa, bulimia nervosa, binge eating disorder, avoidant restrictive food intake disorder, other specified feeding and eating disorder, pica and rumination disorder. (1–4) There are also conditions, not classified within the DSM-5, such as muscle dysmorphia (6,7) or orthorexia, which can be associated with physical activity. (7–10)

There is also a concept known as disordered eating, which describes a state between healthy dietary habits and clinically diagnosed eating disorders. In this condition, the symptoms are less pronounced, and food-related concerns do not dominate daily life. Typical behaviors may include sporadic restrictive dieting, occasional use of weight-loss supplements, and a focus on calorie expenditure during exercise. However, these behaviors lack the intensity or compulsiveness characteristic of clinical eating disorders. (11)

1.1 Anorexia nervosa

It is characterized by weight loss caused by the patient through dietary restrictions, exhaustive exercise and the use of laxatives or appetite suppressants and diuretics. There are two types of anorexia: the restrictive and the bulimic type. In restrictive, patients restrict the amount of food they eat, while in bulimic there are bulimic symptoms such as overeating and then provoking vomiting, abusing laxatives, and exercising excessively. (1–4) It is the most deadly mental disorder, with between 10% and 20% dying from suicide or somatic complications. (3)

1.2 Bulimia nervosa

It manifests itself in excessive focus on food and eating excessive amounts of food in a short period of time. To avoid gaining weight, people affected by the disorder use various compensatory behaviors, such as provoking vomiting, abusing laxatives and diuretics, and overindulging in exercise. (1–4) People with bulimia may have varying body weights, ranging from mild underweight to normal weight, or even overweight. (1)

1.3 Binge eating disorder

It involves losing control over food and consuming excessive amounts of food, leading to feelings of guilt, depression and discomfort. Unlike bulimia, this disorder is not linked to compensatory behaviors such as vomiting or the use of laxatives. As a result, individuals affected by it are often overweight. This condition affecting 2-3% of the population, it is the most prevalent eating disorder in the United States. (1–4)

1.4 Muscle dysmorphia

It is a type of Body Dysmorphic Disorder (BDD), sometimes called “reverse anorexia’’. People suffering from the condition, despite often having a normal physique and even being very muscular, see themselves as too thin and not muscular enough. Preoccupation with one’s appearance manifests as discomfort, significant impairment in social functioning, and can lead to self-destructive behaviors, such as drugs abuse (especially anabolic androgenic steroids) and excessive exercise. This disorder often affects weightlifters and bodybuilders. (6,7,12,13)

1.5 Orthorexia nervosa

People suffering from orthorexia are hyper-focused on the quality of the food they eat, leading to significant dietary restrictions. They spend an enormous amount of time planning, buying, preparing and eating meals, which disrupts their psychosocial functioning. This disorder can lead to a number of consequences, such as deficiency anemia, weight loss and hormonal disorders. (7–10) Orthorexia can be linked to sports, especially endurance sports. (7,10)

2. Risk factors contributing to the development of eating disorders among athletes.

The causes of eating disorders are multifaceted, due to the interaction of biological, sociocultural, psychological, genetic (14), as well as sports-specific factors. (11)

Biological factors affecting the development of eating disorders include age, with a higher risk in younger athletes. (11,15) During adolescence, the body undergoes numerous changes that can affect the way it perceives itself, which can lead to comparisons with peers and increase the risk of negative body image and eating disorder development. Female gender is a significant risk factor, female athletes show a greater predisposition to these disorders compared to men. (11,15–20) One study estimated that the prevalence of eating disorders ranges from 0% to 19% among men and 6% to 45% among women. (11,18) Another study reported a prevalence of 16.4% in men and 25.5% in women, highlighting the higher risk in female athletes. (17)

Sociocultural factors, particularly the overwhelming influence of social media, play a significant role. (11,18,19,21) Mass media can cause body dissatisfaction in teenagers (both male and female), which in turn can lead to eating disorders. (21) In contrast, greater self-acceptance and comfort with one's body significantly reduce this risk. (22) Social media pressures athletes to conform to an ideal body image, often causing sports performance to take a backseat as they strive to meet these standards. (18) The promotion of a slim figure, both by the media and society, can contribute to the development of eating disorders. (11,21)

Psychological factors predisposing individuals to eating disorders include anankastic personality traits, which are characterized by perfectionism. (3,11,23) Psychological states such as anxiety, depression, stress, low self-esteem, compulsive behaviors, experience of a traumatic event and a lack of social support can also play a contributing role. (11,15,23)

Sports-specific factors include athletic pressure, lack of support from coaches and the nature of the sport being played. Studies indicate a higher risk of developing eating disorders in aesthetic sports such as gymnastics or figure skating, endurance sports such as long-distance

running, strength sports, and some technical sports such as golf and tennis. (6,11,15–17,24–27) A study highlights a pervasive mentality among American female distance runners that fosters body dissatisfaction, rooted in the belief that "lighter equals faster." This culture promotes restrictive eating practices and excessive training to achieve an idealized “runner’s body”. (28) Similarly, research indicates that a significant proportion of bodybuilders and weightlifters struggle with dissatisfaction with their physiques, which strongly correlates with disordered eating behaviors. (6) Furthermore, eating disorders tend to manifest with greater severity in individual sports compared to team sports, where athletes may face heightened pressure to achieve personal goals and conform to aesthetic standards. (29)

3. Symptoms and effects of eating disorders

Eating disorders represent a diverse group of conditions, each defined by unique symptoms. Among athletes, specific signs are often linked to RED-S (Relative Energy Deficiency in Sport) syndrome, which arises from Low Energy Availability (LEA). This issue presents a significant challenge within the sports community, as it can lead to serious health complications and impair athletic performance.

3.1 Symptoms of Anorexia nervosa

Physical

- Menstrual cycle disorders and other hormonal disorders (thyroid, adrenal glands).
- Dizziness and fainting spells.
- Chronic muscle fatigue.
- Anemia associated with nutritional deficiencies.
- Gastrointestinal problems: bloating, constipation, abdominal pain, heartburn.
- Cold intolerance.
- Dry, thin skin and thinning hair.
- Electrolyte disorders, such as hypokalemia.
- Bradycardia and low blood pressure.

Mental

- Depression and anxiety.
- Deterioration of concentration and memory.
- Chronic mental fatigue.
- Suicidal thoughts and risk of suicide attempts. (1–3)

3.2 Symptoms of Bulimia

Complications of bulimia are similar to those associated with anorexia, including symptoms such as fainting, weakness, anemia and electrolyte disturbances such as hypokalemia. However, bulimia is also characterized by more specific symptoms, including salivary gland enlargement, damage to tooth enamel caused by stomach acid, and skin damage on the fingers that results from provoking vomiting or gastroesophageal reflux. In addition, serious gastrointestinal problems such as gastric ulcers, esophageal perforation and gastrointestinal bleeding can occur. (1–3)

3.3 Symptoms of Binge Eating Disorder

Binge Eating Disorder can lead to the development of obesity, which is a serious health risk, leading to diseases such as hypertension, diabetes and other cardiovascular conditions. (1–3)

3.4 Symptoms of Muscle Dysmorphia

Muscle dysmorphia can lead to injuries or delay recovery due to excessive gym workouts. It also causes cognitive disturbances, such as concentration problems, triggered by intrusive thoughts. Abuse of anabolic steroids is associated with a number of health consequences, including increased levels of irritability and aggression. In addition, after they are discontinued, depressive symptoms can occur due to hormonal and mental disorders associated with the sudden change in the levels of these substances in the body. (6,7,12,13)

3.5 Symptoms of Orthorexia nervosa

The restrictive diets characteristic of orthorexia can lead to malnutrition, with consequences such as weight loss, anemia or endocrine disruption. Additionally, excessive time spent exercising and obsessively planning and preparing meals can result in social isolation, as well as increase the risk of injury. (7–10)

3.6 Low Energy Availability (LEA) and Relative Energy Deficiency in Sport (RED-S)

Low energy availability occurs due to excessive energy expenditure, insufficient food intake, or a combination of both. This condition may be deliberately induced to meet weight requirements for competition or result from an eating disorder. (30) It triggers a series of bodily changes that prioritize maintaining essential functions necessary for survival, often at the expense of processes like growth and reproductive functions. Energy availability is calculated by subtracting the energy expended (in kcal) during exercise from the energy intake (in kcal), and then dividing the result by the fat-free mass (in kilograms).

EA = (EI - EEE) / FF

where:

- EI = Dietary energy intake (in kcal)
- EEE = Exercise energy expenditure (in kcal)
- FFM = Fat-free mass (in kg) (31)

To maintain health and body weight, energy availability (EA) levels should exceed 45 kcal/kg FFM/day. However, a drop in EA below 30 kcal/kg FFM/day is associated with negative changes in the body that can affect health and metabolic functioning. (31,32) The body's need to conserve energy in order to maintain essential life functions triggers a series of neuroendocrine adaptations. These include a reduction in the secretion of leptin, oxytocin, and insulin-like growth factor 1 (IGF-1), along with reduced levels of high-sensitivity insulin . There is also a rise in ghrelin and peptide YY levels, increased resistance to growth hormone, and activation of the hypothalamic-pituitary-adrenal (HPA) axis. (32)

Low energy availability (LEA) can lead to both RED-S (Relative Energy Deficiency in Sport) and the Female Athlete Triad. While RED-S encompasses a broader range of health concerns, including metabolic and cardiovascular dysfunctions, the Female Athlete Triad specifically focuses on three core components: low energy availability (LEA), menstrual dysfunction, and low bone mineral density. (11,23,28,32–34) There is also the concept of the Male Athlete Triad, which includes hypogonadotropic hypogonadism in place of menstrual disturbances, leading to lower testosterone levels. (33)

3.6.1

RED-S Health Conceptual Model

- Reproductive system dysfunction
- Bone health dysfunction
- Gastrointestinal system dysfunction
- Metabolism dysregulation
- Hematologic dysfunction
- Dysregulated glucose and lipid metabolism
- Impaired urinary continence
- Neurocognitive dysfunction
- Mental health issues
- Sleep disturbances
- Skeletal and muscular system disorders

- Cardiovascular system disorders
- Growth and development disorders
- Reduced immunity

RED-S Performance Conceptual Model

- Decline in motivation
- Reduced training response
- Reduced player availability
- Reduced power performance
- Decreased performance skill
- Reduced endurance performance
- Decreased recovery
- Decreased muscular strength (30,31,35)

These symptoms affect both men and women, but are more common in women. (35)

3.6.2 Female Athlete Triad

Menstrual dysfunction

The prevalence of menstrual disorders like oligomenorrhea or amenorrhea in female athletes is high, ranging from 9% to 60%. (36) The most common cause of amenorrhea is Functional Hypothalamic Amenorrhea, which results from a disruption in the Hypothalamic-Pituitary-Gonadal (HPG) axis. The prevalence of functional hypothalamic amenorrhea (FHA) is significantly higher (69%) in populations with low energy availability compared to the general population, where it is reported to be around 2-5%. (32) It is a diagnosis of exclusion, meaning that it is determined after ruling out other potential anatomical or medical causes. Many adaptive changes that occur in low energy availability (LEA) lead to alterations in the pulsatility of GnRH (gonadotropin-releasing hormone), which subsequently results in a decrease in the levels of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), resulting in decreased estrogen and progesterone production. (23,28,30,32) These changes can lead to a decrease in bone mineral density, significantly increasing the risk of stress fractures. Additionally, they are a contributing factor to cardiovascular diseases and may result in infertility.(30) In addition, athletes with menstrual disorders are more likely to miss workouts compared to those with a regular menstrual cycle. (36) Athletes with functional hypothalamic amenorrhea (FHA) demonstrate slower reaction times and reduced neuromuscular performance compared to those without menstrual disorders. This impairment is assessed by lower knee muscle strength and endurance. Neuromuscular dysfunction correlates with

decreased levels of triiodothyronine (T3), estrogen, blood glucose, and fat-free mass (FFM) in the tested leg, while being associated with elevated blood cortisol levels. These changes not only threaten the health of athletes, but also contribute to the deterioration of their athletic performance, affecting their ability to train and achieve their maximum physical capabilities. (30)

Bone mineral density (BMD)

Athletes with eating disorders, low energy availability (LEA), and associated menstrual disorders lasting for more than 6 months should undergo bone densitometry to evaluate bone mineral density. The Z-score is preferred over the T-score as an indicator because it accounts for factors such as age and gender, offering a more individualized assessment. In athletes with risk factors such as hypoestrogenism, nutritional deficiencies, or a history of fractures, a Z-score between -1 SD and -2 SD indicates low bone mineral density, while a Z-score below -2 SD is diagnostic of osteoporosis. (11,32) Reduced bone mineral density (BMD), along with nutritional and menstrual disorders, can significantly hinder recovery from bone strain injuries, a common issue among athletes. (30)

4. Management and treatment of eating disorders

An essential aspect of treating eating disorders in athletes is the early identification of behavioral changes that may indicate a developing issue. Early detection significantly increases the likelihood of successful intervention. These changes can be categorized as follows:

1. Behavioral: avoidance of food-related situations, such as group meals, frequent visits to the bathroom after eating, and excessive focus on the caloric content of foods.
2. Physical: often appearing later than behavioral changes and noticed first by coaches (37) , including frequent illnesses, low body fat, dehydration, and sudden weight loss.
3. Psychological: dissatisfaction with body image, worsening mood, and a decline in mental well-being. (11)

Unfortunately, early detection of eating disorders is not always possible. This is often due to insufficient knowledge of ED, fear of rejection from the sports community, or shame, which causes athletes not to seek help from the appropriate institutions. (11) There is a study indicating that 75% of surveyed American athletes with eating disorders did not seek help. (7) The Australian Institute of Sport (AIS) and the National Eating Disorders Collaboration (NEDC) have introduced recommendations that include the establishment of a core multidisciplinary team (CMT), comprising a physician, sports nutritionist, and psychologist. This team is tasked with maintaining constant communication with both the coach and athlete,

as well as coordinating information among themselves to help in the early detection and effective treatment of disorders. (11)

The clinical response to treatment does not differ significantly between athletes and non-athletes, suggesting that similar therapeutic approaches can be employed for both groups. However, the type of sport practiced influences prognosis. Aesthetic and individual sports are associated with a poorer prognosis and more severe course of eating disorders. This highlights the need for future development of individualized treatment strategies that account for sport-specific factors and challenges. (29)

Treatment methods also depend on the severity of symptoms: patients with a BMI <13 should be hospitalized in somatic care units due to life-threatening conditions. Once their physical condition stabilizes, psychiatric treatment can be initiated. (3)

4.1 Non-pharmacological intervention

4.1.1 Psychological treatment

The primary treatment for ED is psychotherapy, particularly cognitive-behavioral psychotherapy. This identifies cognitive schemas and distortions regarding body image, weight and other aspects related to eating disorders, such as eating. Then, in the therapy process, these schemas are replaced with more adaptive and beneficial beliefs. (37) Typically, therapy lasts about 20 weeks, with one session per week, for bulimia and binge eating disorder. For anorexia, the therapeutic process is longer, lasting about 40 weeks. (4) Considering the psychopathology of eating disorders, which includes socio-cultural factors, family psychotherapy, which works best with younger patients, may also be useful. Family therapy fosters improved communication between its members, enabling the building of a safe and supportive space that plays a key role in the healing process. (3,4,37)

4.1.2 Exercise and PED-T

Exercise can be integrated into the treatment of eating disorders, provided it is included as part of a carefully planned therapeutic program. Such a program should be developed by an interdisciplinary team of experts, tailored to the specific needs of athletes and the individual capabilities and goals of the patient. When appropriately applied, exercise can support the treatment process by enhancing both physical and mental health. (29,38)

A new treatment for eating disorders, primarily bulimia and binge eating disorder (BED), is PED-T (Physical Exercise and Diet Therapy). This therapy integrates supervised physical exercise sessions lasting 45 minutes with subsequent dietary counseling sessions of 60 minutes. The frequency and duration of the program are similar to CBT, consisting of 20 weeks with one session per week. The dietary counseling component emphasizes patient

education, organized into three modules: module (a) focuses on meal size and frequency, module (b) addresses caloric and nutrient requirements as well as exercise physiology, and module (c) involves creating a personalized future action plan. Studies suggest that the effectiveness of PED-T is comparable to CBT, positioning it as a promising alternative for patients. (39)

4.2 Supplementation of nutritional deficiencies

People suffering from an eating disorder often experience significant nutritional deficiencies and, in cases of anorexia, may become severely malnourished.(3,37) Dietary care should be provided by a nutritionist experienced in managing patients with eating disorders. Their role is to develop a personalized dietary plan that considers the patient's health status, current eating patterns, use of weight-loss aids such as laxatives or diuretics, and level of physical activity. The priority in treatment is to achieve a normal body weight by increasing daily energy intake, while also alleviating the symptoms of malnutrition and educating individuals on healthy eating habits to prevent relapse. Initially, weight gain should be gradual: in patients with anorexia, an increase of approximately 0.5 kg per week is recommended. (37) The study found that an increase in caloric intake of 250-360 kcal per day was able to restore menstruation in female athletes with FHA. (28)

Vitamin and nutrient supplementation should be introduced to address nutritional deficiencies that cannot be corrected through diet alone. (37) Vitamin D and calcium supplementation is particularly important in athletes with reduced bone mineral density due to RED-S, as it supports musculoskeletal function. During adolescence, it is recommended to take 15-25 mg of vitamin D daily to maintain optimal 25(OH)D levels above 50 nmol/L, and about 1300 mg of calcium per day. It is crucial to use tested and safe supplements to avoid the risk of contamination with substances that violate anti-doping regulations. (28)

4.3 Pharmacological intervention

Medications from the serotonin reuptake inhibitor (SSRI) group, such as fluoxetine, are used to treat eating disorders. However, it is important to avoid preparations that can increase appetite, as they can exacerbate the suffering of patients struggling with these conditions. Studies indicate that pharmacotherapy in the treatment of anorexia tends to be less effective unless depression is co-occurring. For binge eating disorder (BED) and bulimia nervosa, research demonstrates that pharmacotherapy is effective, but the best outcomes are achieved when it is combined with psychotherapy. (3,4)

In the case of the Female Athlete Triad, if menstruation is not restored after 6-12 months of non-pharmacological therapy, pharmacological treatment should be considered. Combined

oral contraception, despite its effectiveness, is not recommended because it can mask the processes of physiological normalization of the menstrual cycle, making it difficult to assess the effectiveness of therapy. Currently, one of the better pharmacological treatments for amenorrhea and BMD decline is short-term transdermal estradiol therapy (E2) in combination with a cyclic oral progestative. However, this therapy has no contraceptive effect. (28,32)

In cases of low BMD, short-term administration of recombinant parathyroid hormone may be considered. However, it is important to note that this treatment is not recommended for young individuals whose growth plates are still open. There are insufficient studies to confirm the efficacy of drugs such as denosumab, recombinant leptin, or testosterone. Additionally, bisphosphonates should be avoided in young women of reproductive age due to their potential teratogenic effects. (28,32)

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References

1. Guarda A. What are Eating Disorders? [Internet]. 2023 [cited 2024 Dec 2]. Available from: https://www.psychiatry.org/patients-families/eating-disorders/what-are-eating-disorders
2. Eating Disorders [Internet]. National Institute of Mental Health (NIMH). [cited 2024 Dec 2]. Available from: https://www.nimh.nih.gov/health/topics/eating-disorders
3. Gałecki P, Szulc A. Psychiatria. Wrocław: Edra Urban & Partner; 2020.
4. Hay P. Current approach to eating disorders: a clinical update. Intern Med J. 2020 Jan;50(1):24–9.
5. Flatt RE, Thornton LM, Fitzsimmons-Craft EE, Balantekin KN, Smolar L, Mysko C, et al. Comparing eating disorder characteristics and treatment in self-identified competitive athletes and non-athletes from the National Eating Disorders Association online screening tool. International Journal of Eating Disorders. 2021 Mar 30;54(3):365–75.
6. Devrim A, Bilgic P, Hongu N. Is there any relationship between body image perception, eating disorders, and muscle dysmorphic disorders in male bodybuilders? Am J Mens Health. 2018 Sep;12(5):1746–58.
7. Mitchell J, Tilbrook M, Kiropoulos L, Krug I. Australian elite sport coaches' mental health literacy of eating disorders, orthorexia, and muscle dysmorphia in athletes: A qualitative study. Body Image. 2024 Mar;48(101670):101670.
8. Foyster M, Sultan N, Tonkovic M, Govus A, Burton-Murray H, Tuck CJ, et al. Assessing the presence and motivations of orthorexia nervosa among athletes and adults with eating disorders: a cross-sectional study. Eat Weight Disord. 2023 Dec;28(1):101.
9. Donini LM, Barrada JR, Barthels F, Dunn TM, Babeau C, Brytek-Matera A, et al. A consensus document on definition and diagnostic criteria for orthorexia nervosa. Eat Weight Disord. 2022 Dec;27(8):3695–711.
10. Bert F, Gualano MR, Voglino Gianluca and Rossello P, Perret JP, Siliquini R. Orthorexia Nervosa: A cross-sectional study among athletes competing in endurance sports in Northern Italy. PLoS One. 2019 Aug;14(8):e0221399.
11. Wells KR, Jeacocke NA, Appaneal R, Smith HD, Vlahovich N, Burke LM, et al. The Australian Institute of Sport (AIS) and National Eating Disorders Collaboration (NEDC) position statement on disordered eating in high performance sport. Br J Sports Med. 2020 Nov;54(21):1247–58.
12. Peluso MAM, de Andrade LHS. Physical activity and mental health: the association between exercise and mood. Clinics (Sao Paulo). 2005 Feb;60(1):61–70.
13. Olivardia R, Blashill A, Hoffman J. Muscle Dysmorphia [Internet]. [cited 2024 Dec 2]. Available from: https://bdd.iocdf.org/expert-opinions/muscle-dysmorphia/
14. Donato K, Ceccarini MR, Dhuli Kristjana and Bonetti G, Medori MC, Marceddu G, Precone V, et al. Gene variants in eating disorders. Focus on anorexia nervosa, bulimia nervosa, and binge-eating disorder. J Prev Med Hyg. 2022 Jun;63(2 Suppl 3):E297–E305.

15. Rice SM, Purcell R, De Silva S, Mawren D, McGorry PD, Parker AG. The mental health of elite athletes: A narrative systematic review. Sports Med. 2016 Sep;46(9):1333–53.
16. Magee MK, Jones MT, Fields JB, Kresta J, Khurelbaatar C, Dodge C, et al. Body Composition, Energy Availability, Risk of Eating Disorder, and Sport Nutrition Knowledge in Young Athletes. Nutrients. 2023 Mar 21;15(6):1502.
17. Uriegas NA, Moore K, Torres-McGehee TM. Prevalence and association of exercise dependence and eating disorder risk in collegiate student-athletes. J Athl Train. 2023 Oct;58(10):813–20.
18. Jagim AR, Fields J, Magee MK, Kerksick CM, Jones MT. Contributing factors to low energy availability in female athletes: A narrative review of energy availability, training demands, nutrition barriers, body image, and disordered eating. Nutrients. 2022 Feb;14(5):986.
19. Uchôa FNM, Uchôa NM, Daniele TM da C, Lustosa Romario Primeiro and Garrido ND, Deana NF, Aranha ÁCM, et al. Influence of the mass media and body dissatisfaction on the risk in adolescents of developing eating disorders. Int J Environ Res Public Health. 2019 Apr;16(9):1508.
20. Martinsen M, Sundgot-Borgen J. Higher prevalence of eating disorders among adolescent elite athletes than controls. Med Sci Sports Exerc. 2013 Jun;45(6):1188–97.
21. Stoyel H, Stride C, Shanmuganathan-Felton V, Serpell L. Understanding risk factors for disordered eating symptomatology in athletes: A prospective study. PLoS One. 2021 Sep;16(9):e0257577.
22. Baceviciene M, Jankauskiene R. Associations between body appreciation and disordered eating in a large sample of adolescents. Nutrients. 2020 Mar;12(3):752.
23. Logue DM, Madigan SM, Melin A, Delahunt E, Heinen M, Donnell Sarah-Jane Mc and Corish CA. Low Energy Availability in athletes 2020: An updated narrative review of prevalence, risk, within-day energy balance, knowledge, and impact on sports performance. Nutrients. 2020 Mar;12(3):835.
24. Flores R, Mon-López M, Gil-Ares D, Coterón J. Training Conditions Psychological Health: Eating Behavior Disorders Spanish High-Performance Women's Olympic Wrestling Athletes-A Qualitative Study. Int J Environ Res Public Health. 2023;20(3).
25. Chapa DAN, Johnson SN, Richson Brianne N and Bjorlie K, Won YQ, Nelson S V, Ayres J, et al. Eating-disorder psychopathology in female athletes and non-athletes: A meta-analysis. Int J Eat Disord. 2022 Jul;55(7):861–85.
26. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. Clin J Sport Med. 2004 Jan;14(1):25–32.
27. Kristjánsdóttir H, Sigurðardóttir P, Jónsdóttir S, Þorsteinsdóttir G, Saavedra J. Body image concern and eating disorder symptoms among elite Icelandic athletes. Int J Environ Res Public Health. 2019 Jul;16(15):2728.
28. Gould RJ, Ridout AJ, Newton JL. Relative Energy Deficiency in Sport (RED-S) in Adolescents – A Practical Review. Int J Sports Med. 2023 Apr 19;44(04):236–46.
29. Ibáñez-Caparrós A, Sánchez I, Granero R, Jiménez-Murcia S, Rosinska M, Thiel A, et al. Athletes with Eating Disorders: Analysis of Their Clinical Characteristics, Psychopathology and Response to Treatment. Nutrients. 2023 Jun 30;15(13):3003.
30. Melin AK, Heikura IA, Tenforde A, Mountjoy M. Energy Availability in Athletics: Health, Performance, and Physique. Int J Sport Nutr Exerc Metab. 2019 Mar 1;29(2):152–64.
31. Mountjoy M, Ackerman KE, Bailey DM, Burke LM, Constantini N, Hackney AC, et al. 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). Br J Sports Med. 2023 Sep;57(17):1073–98.
32. Coelho AR, Cardoso G, Brito ME, Gomes IN, Cascais MJ. The Female Athlete Triad/Relative Energy Deficiency in Sports (RED-S). Revista Brasileira de Ginecologia e Obstetrícia / RBGO Gynecology and Obstetrics. 2021 May 2;43(05):395–402.

33. Eichstadt M, Luzier J, Cho D, Weisenmuller C. Eating Disorders in Male Athletes. Sports Health: A Multidisciplinary Approach. 2020 Jul 11;12(4):327–33.
34. Maya J, Misra M. The female athlete triad: review of current literature. Curr Opin Endocrinol Diabetes Obes. 2022 Feb;29(1):44–51.
35. Lodge MT, Ward-Ritacco CL, Melanson KJ. Considerations of Low Carbohydrate Availability (LCA) to Relative Energy Deficiency in Sport (RED-S) in Female Endurance Athletes: A Narrative Review. Nutrients. 2023 Oct 20;15(20):4457.
36. Ravi S, Ihalainen JK, Taipale-Mikkonen RS, Kujala UM, Waller B, Mierlahti L, et al. Self-Reported Restrictive Eating, Eating Disorders, Menstrual Dysfunction, and Injuries in Athletes Competing at Different Levels and Sports. Nutrients. 2021 Sep 19;13(9):3275.
37. Clemente-Suárez VJ, Ramírez-Goerke MI, Redondo-Flórez L, Beltrán-Velasco AI, Martín-Rodríguez A, Ramos-Campo DJ, et al. The Impact of Anorexia Nervosa and the Basis for Non-Pharmacological Interventions. Nutrients. 2023 Jun 1;15(11):2594.
38. COOK BJ, WONDERLICH SA, MITCHELL JE, THOMPSON R, SHERMAN R, MCCALLUM K. Exercise in Eating Disorders Treatment. Med Sci Sports Exerc. 2016 Jul;48(7):1408–14.
39. Mathisen TF, Rosenvinge JH, Friborg O, Vrabel K, Bratland-Sanda S, Pettersen G, et al. Is physical exercise and dietary therapy a feasible alternative to cognitive behavior therapy in treatment of eating disorders? A randomized controlled trial of two group therapies. International Journal of Eating Disorders. 2020 Apr 16;53(4):574–85.