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Review

Sports gynaecology

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Key content

- While the physiological, psychosocial and obstetric health benefits of exercise are well established, there is less awareness of the health implications of long-term intense exercise.
- Relative Energy Deficiency in Sport (RED-S) represents a complex inter-relationship of health consequences that arise as a result of low energy availability.
- The common presentations of elite sportswomen to gynaecologists include menstrual abnormalities, delayed menarche, subfertility and urinary incontinence.
- Gynaecology input, including screening, recognition and management, can minimise the risk of consequences and optimise health, fertility and performance.

Learning objectives

- To understand the short-term and long-term impacts of elite sport on gynaecological health.
- To describe the gynaecologist's role in the screening, investigation and management of elite sportswomen.

Ethical issues

- Elite sportswomen should be fully informed about the potential health implications of long-term vigorous exercise to enable autonomous decision making.
- While it is the role of the coach to optimise performance, it is the physician's responsibility to prioritise the health of sportswomen, even if this is at the expense of performance level, ability to train or competition rules.
- To reach an elite level, training is often necessary from childhood; however, many girls will not have capacity, and the health consequences of RED-S can cause them irreversible problems.

Keywords: amenorrhoea / gynaecology / infertility / Relative Energy Deficiency in Sport / urinary incontinence

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Introduction

There is an abundance of research that has shown that exercise plays an integral role in the promotion of women's health. Physiologically, it has long been known that exercise plays a key role in weight loss,[1] blood pressure control[2] and the maintenance of bone mineral density (BMD),[3] as well as being beneficial in the prevention of a wide spectrum of diseases. Exercise also has the potential to influence mental health by enhancing physical perception and self-esteem,[4] and it can help alleviate anxiety.[5] Following the development and subsequent uptake in use of contraception in the 1960s, the advancement of gender equality globally has enhanced both educational and professional opportunity. The consequent evolution of societal perceptions toward women has resulted in greater female empowerment, which further enhanced the potential for female participation in elite sport. Record numbers of women are participating in sport, with 7.2 million women in the UK partaking at least once weekly,[6] and 59% of women are undertaking in excess of 150 minutes of physical activity each week.[7]

Despite the recognised benefits of physical activity, participation in sport or exercise to an elite level has an array of negative health implications, many of which are gynaecological. Not only can intense physical activity impact women's health, but female-specific physiological processes such as menstruation may be viewed as a hindrance to optimal athletic performance, creating a complex inter-relationship. However, whereas it is the role of the coach to focus on optimising performance, it is the responsibility of the physician to prioritise the woman's health, even if this is at the expense of her performance quality, ability to train or competition rules.

Despite this, there is a lack of knowledge among healthcare professionals with regard to the impact of intense exercise on gynaecological health, and less than 10% of physicians feel comfortable managing amenorrhoeic athletes.[8] The aim of this review is to evaluate the inter-relationship between elite sports performance and gynaecological health and to propose a framework for the management of such women.

Relative Energy Deficiency in Sport

Energy availability (EA) is determined by subtracting energy expenditure from energy intake relative to fat-free mass. A state of optimal EA arises when there is sufficient energy remaining to maintain bodily functions. It has been proposed that 45 kcal/kg fat-free mass/day equates to energy balance.[9] When expenditure outweighs intake, the resultant state of negative energy balance is referred to as low EA. Chronic low EA can impact on a number of key physiological systems, including metabolism, bone health, immunity, cardiovascular health and psychological wellbeing, as well as menstrual and reproductive function. This syndrome of inter-related health consequences has been termed Relative Energy Deficiency in Sport (RED-S) by the International Olympic Committee (Figure 1).[10] The updated terminology supersedes the previously used term 'female athlete triad',[11] which explored the relationship between EA, menstrual function and bone health in women. RED-S more accurately reflects the wider array of physiological processes that are influenced by chronic low energy availability EA and includes men, who can also be affected.[12]

Physiology

The hypothalamic-pituitary-ovarian axis is modulated by a complex feedback system. The pulsatile release of gonadotrophin-releasing hormone (GnRH) from the hypothalamus stimulates the production of luteinising hormone (LH) and follicle-stimulating hormone (FSH) in the anterior pituitary gland. LH accordingly controls the production of estradiol while FSH stimulates follicle growth and inhibin production. Estrogen levels are regulated by exerting negative feedback to the hypothalamus, controlling the production of GnRH, which in turn regulates LH and FSH secretion. When plasma estrogen is increased for a sustained period, LH and FSH secretion are enhanced, causing a gonadotrophin surge, which signals ovulation. While amenorrhoea can be caused by a variety of aetiologies, hypothalamic amenorrhoea refers to amenorrhoea caused by a deficiency in GnRH secretion, which results in a reduction in LH secretory episodes, with resultant diminished ovarian stimulation. In sportswomen, hypothalamic amenorrhoea or menstrual dysfunction ensues as a result of chronic low EA.

Clinical presentation

Menstrual dysfunction

The impact of RED-S on reproductive function leads to downregulation of the hypothalamic–pituitary–ovarian axis,[13] manifesting clinically as oligomenorrhoea or amenorrhoea. While amenorrhoea is prevalent in

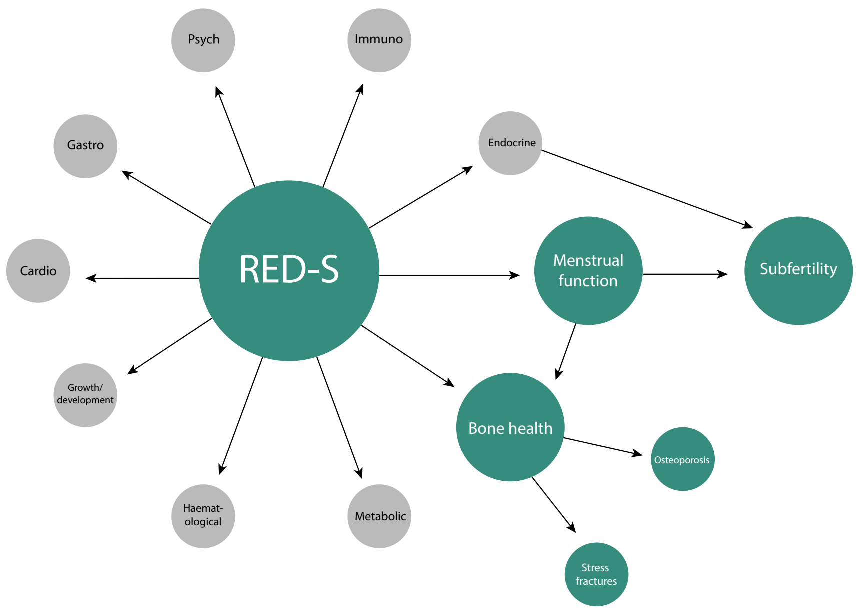

Figure 1. Diagrammatic representation of Relative Energy Deficiency in Sport (RED-S), including the female athletic triad in green. (Adapted from Mountjoy et al. 2014)[10] (Key: Cardio = Cardiological, Immuno = Immunological, Gastro = Gastrointestinal, Psych = Psychological).

approximately 5% of the general population,[14] it has been shown to affect up to 65% of long-distance runners[15] and up to 79% of ballet dancers.[16] It has been demonstrated that LH pulsatility is disrupted when energy availability decreases below a critical value of 20–25 kcal/kg fat-free mass/day.[17] It is therefore unsurprising that amenorrhoeic sportswomen have been shown to have 53% of the energy availability of their menstruating counterparts.[18] Those who partake in sports that emphasise leanness, such as ballet or gymnastics, or those governed by weight classifications, including combat sports, are inherently predisposed to RED-S, owing to the necessary combination of intense exercise and strict dietary monitoring.

Delayed menarche

Whereas downregulation of the hypothalamic–pituitary–ovarian axis causes menstrual disturbance in women of reproductive age, it can manifest in childhood as primary amenorrhoea or delayed menarche. This has been demonstrated in a number of sports that demand intense training from a young age including swimming,[19] gymnastics[20] and ballet.[21] A study in the USA, which analysed menstrual abnormalities in 425 collegiate athletes, reported delayed menarche in 7% of athletes overall, but with rates of up to 22% in higher-risk sports such as athletics.[22] A 2018 study assessing age of menarche of 663 elite athletes found the mean age at onset to be 12.9 years, but in aesthetic sports such as gymnastics it was 4 years later.[23]

Subfertility

The age at which women should attempt to conceive to optimise reproductive outcome unfortunately corresponds to the time when most sportswomen are at the peak of their performance. This fertile window may therefore be voluntarily deferred to optimise competitive opportunity during their peak physiological years, or unintentionally impaired due to the downregulation of the hypothalamic–pituitary–ovarian axis.[24] Given the exponential decrease in oocyte quality and quantity from the age of 37 years onwards,[25] deferring pregnancy into or after the late thirties may inadvertently cause involuntary childlessness. Advances in oocyte cryopreservation techniques, with the development and subsequent success of vitrification, have created the opportunity for elite sportswomen to freeze oocytes or embryos until professional contentment has been achieved. However, postponing childbearing in this manner is a reproductive gamble owing to the possibility of treatment failure with a finite number of stored eggs, and there are significant financial, legal and obstetric considerations.[26] As such, it is essential that sportswomen wishing to defer pregnancy, or electively cryopreserve their oocytes or embryos, receive comprehensive fertility counselling.

Intense exercise, defined as more than an hour a day with an estimated energy expenditure of 6 kcal/minute, has been shown to result in a six-fold increase in infertility.[27] Higher frequency, longer duration and greater intensity of physical exertion have also been demonstrated to be associated with subfertility,[28] where women who exercise 'most days', and those who exercise to exhaustion have a 3.2- and 2.3-fold increased risk of infertility, respectively.[28] Theoretically, it should be possible to overcome the hormonal downregulation seen in RED-S by using ovulation induction or in vitro fertilisation. However, a study assessing in vitro fertilisation outcomes in the context of exercise longevity found that women who exercised for more than 4 hours/week for 1–9 years were 40% less likely to achieve a live birth, had a three-fold increased risk of cycle cancellation and had double the risk of miscarriage.[29]

Following conception, there is scant epidemiological data to suggest physical activity with high impact or physical strain may confer a higher miscarriage risk, particularly around implantation.[30] This has been reinforced by a prospective study that found higher miscarriage rates in women who reported higher than average physical strain 6–9 days following their estimated ovulation date.[31]

Disordered eating

While disordered eating may not be the primary presentation to a gynaecologist, it is highly prevalent among sportswomen, can contribute to low EA and therefore requires consideration when treating sportswomen. The spectrum of disordered eating ranges from maintaining an energy balance with a healthy body image, to clinical eating disorders such as anorexia nervosa, bulimia nervosa and binge eating disorder as defined by the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*.[32] For sportswomen, disordered eating may arise for a multitude of reasons including striving for performance improvement benefits or conforming to societal pressures to maintain a particular body composition. A number of studies have demonstrated a higher prevalence of disordered eating in sportswomen, particularly in sports with weight categories or those that emphasise leanness,[33,34] with clinical eating disorders being prevalent in up to 46.7%.[35]

Long-term considerations

While menstrual abnormalities or delayed menarche represent acute symptoms of low EA, the resultant hypoestrogenic state can have a number of bone health-related complications that may remain asymptomatic until the damage is irreversible, such as the development of osteoporosis or stress fractures. Normal physiological levels of estrogen have been shown to slow bone resorption and maintain healthy BMD.[36] Contrarily, in a similar fashion to the BMD decline associated with decreased estrogen concentrations in postmenopausal women,[37] sportswomen with hypothalamic amenorrhoea have also been demonstrated to experience BMD deterioration,[38] with studies previously demonstrating 10–20% lower BMD in amenorrhoeic sportswomen compared with their eumenorrhoeic counterparts. Moreover, a linear relationship exists between number of menstrual cycles/year and BMD.[39] This decline in BMD begins when energy availability is reduced below 30 kcal/kg fat-free mass/day.[40] Following the onset of hypoestrogenism, osteoclast resorption accelerates in the initial 6 months and peaks within 3 years.[41] This can be particularly problematic in adolescent girls, in whom the bone loss occurs during peak bone mass development and is unlikely to be reversible,[42] particularly in those with delayed menarche, which is in itself a risk factor for osteoporosis.[43] This reinforces the need for safeguarding of children in sport to ensure the adoption of a healthy culture to facilitate their development.[44] This includes instilling realistic perceptions of body image, ensuring appropriate information and education, and preventing systems that encourage over-training or that promote low EA, with the ultimate goal to optimise health, as well as performance. Given the close association with disordered eating, deficiencies in calcium and vitamin D from inadequate nutritional intake may potentiate BMD loss further. Low EA is now independently recognised as a risk factor for poor bone health.[45]

Women with amenorrhoea or oligomenorrhoea are also at greater risk of developing stress fractures.[46] This risk extends into the future, even following resumption of menstruation, where women with a previous history of amenorrhoea continue to be at two- to four-times greater risk,[46–48] highlighting the potential irreversible damage caused by RED-S.

Urinary incontinence

While not considered as part of RED-S, elite sportswomen are also at an increased risk of urinary incontinence.[49] A 2018 systematic review and meta-analysis reported a prevalence of 36% across different sports,[50] but it can be as high as 76%.[51] Other studies comparing elite sportswomen to sedentary controls found sportswomen to be three times more likely to experience urinary incontinence.[52] Not only do more than one-third of sportswomen attribute urinary incontinence to having a negative impact on performance,[52] but it has also been shown to be detrimental to quality of life.[53] Sportswomen are at risk of urinary incontinence as a result of raised intra-abdominal pressure, which is synonymous with intense physical exertion. If intra-abdominal pressure exceeds the capacity of the urethral sphincters, it manifests as urinary leakage. Urinary incontinence is even more prevalent in elite sportswomen with eating disorders,[54] highlighting the inter-relationship between eating disorders and health implications in sportswomen. Urinary incontinence is almost twice as common during training as during competition, owing to higher catecholamine levels during competition, which help maintain urethral closure by acting on the urethral α-receptors.[55] Despite being more prevalent in sportswomen, urinary incontinence is under-reported in this population, with less than 10% of affected women presenting to healthcare professionals.[56,57] This highlights the need for active healthcare professional involvement and direct questioning. Urinary incontinence is also highly prevalent among adolescent female athletes, with more than one-third being affected.[58]

Clinical assessment

Prevention and early detection of RED-S is essential to prevent long-term health consequences. Screening should be undertaken annually as part of a routine follow-up of elite sportswomen as well as opportunistically when sportswomen present with symptoms related to RED-S or urinary incontinence. Screening in adolescent athletes is particularly important, owing to the fact that 90% of peak bone mass is achieved by the age of 18 years.[59] While there is limited evidence related to the efficacy of screening questions, a proposed framework, based on International Olympic Committee and American College of Sports Medicine recommendations on RED-S,[60] but with the incorporation of assessment of urinary incontinence and subfertility, is demonstrated in Box 1.

The likely presentation to a gynaecologist will be menstrual dysfunction, which requires assessment and investigation if it persists for more than 6 months. Moreover, adolescent sportswomen who have not yet developed secondary sexual characteristics by the age of 14 years or have not started menarche by the age of 16 years warrant a similar assessment.

A full gynaecological history is required, including menstrual and urogynaecology assessment, use of

Box 1. Suggested screening framework for sportswomen presenting to gynaecologists (adapted from De Souza et al. 2014)[60]

1. When did you start having periods?
2. When was your last menstrual period?
3. How long is your menstrual cycle?
4. Are you presently taking contraception or hormone replacement therapy?
5. Have you ever missed a menstrual period for a year or longer?
6. Is your body mass index <18.5?
7. Do you worry about your weight?
8. Have you ever had an eating disorder?
9. Have you lost more than 5 kg in the last 3 months?
10. Have you ever had a stress fracture?
11. Have you ever experienced low bone mineral density or osteoporosis?
12. Do you leak urine when training or competing?
13. Have you ever had a problem becoming pregnant?

contraception, previous pregnancies and future pregnancy plans. While measurement of energy availability is difficult to assess and often inaccurate,[61] it can be estimated using food diaries and exercise logs and can be supplemented with fitness technology equipment such as heart rate monitors.

Given the prevalence of urinary incontinence in sportswomen and the low percentage of women who subsequently seek help owing to perceived shame and embarrassment,[62] opportunistic screening for urinary incontinence should be undertaken in an empathetic manner. If urinary incontinence is identified, a more detailed urogynaecological history should be undertaken, including an assessment of the impact on the woman's quality of life. A formal assessment, using a validated questionnaire such as the International Consultation on Incontinence Questionnaire-Urinary Incontinence-Short Form,[63] may help quantify severity and impact on quality of life. Screening for disordered eating and eating disorders should also be undertaken in sportswomen who present with menstrual disturbance, and on clinical suspicion in women with urinary incontinence. The Brief Eating Disorder in Athletes Questionnaire is a validated screening tool to assess for eating disorders,[64] which can be assessed further with the eating disorder examination interview.

Examination should include objective measurements of height and weight and calculation of body mass index (BMI). Given the inherent complexity and inaccuracy of assessing energy balance, sportswomen are currently diagnosed as having low EA if their BMI is less than 17.5 kg/m^2 or if there has been recent weight loss of 10% or more over a period of 1 month.[60] Signs of hypoestrogenism such as vaginal atrophy should be assessed, while other signs that may guide diagnosis, such as evidence of pregnancy, hyperandrogenism or thyroid disease, should also be noted. A urogynaecology assessment, including assessment of prolapse or the demonstration of incontinence should also be undertaken if indicated. In girls who present with delayed menarche, pubertal signs of development should be assessed, and an examination undertaken to exclude other aetiologies, including assessment of obstructive causes such as an imperforate hymen or Mayer–Rokitanky–Küster–Hauser syndrome.

Management

Sportswomen presenting with menstrual dysfunction for more than 6 months should be investigated to exclude pregnancy and identify pathology, and to diagnose hypothalamic amenorrhoea by exclusion. The appropriate investigations, along with the expected results in sportswomen with hypothalamic amenorrhoea, are demonstrated in Table 1. A hormone profile will characteristically reveal low FSH and low LH with coexistent low estradiol. Anti-müllerian hormone concentrations may be low in this population and therefore may not be a reliable method of detecting ovarian reserve.[65] Pelvic ultrasound often reveals the presence of polycystic ovaries, and in the context of oligomenorrhoea or amenorrhoea would meet the widely accepted Rotterdam criteria to diagnose polycystic ovary syndrome.[66] However, polycystic ovary syndrome is a diagnosis of exclusion, and given the low LH and estrogen and normal testosterone levels in amenorrhoeic sportswomen, and contrasting raised LH and testosterone and normal estrogen found in women with polycystic ovary syndrome, there should be little diagnostic uncertainty.

Once the diagnosis is confirmed, a dual energy X-ray absorptiometry scan should be performed to assess BMD. Given that sportswomen who participate in weight-bearing sports should have a higher BMD than sedentary counterparts,[67] a BMD *Z*-score below 1.0 SD demands further attention, and a value below 2.0 is considered osteoporotic in the presence of risk factors such as hypoestrogenism or nutritional deficiencies.[10]

When considering RED-S, prevention is better than cure, owing to the potentially irreversible nature of the long-term health associations. Given that more than two-thirds of sportswomen report adverse effects from menstruation on their performance,[68] amenorrhoea associated with RED-S may be welcome to uninformed sportswomen. Therefore, it is essential that all sportswomen and associated personnel must be made fully aware of the aetiology and short-term and long-term performance and health-related risks of RED-S.

Conservative management

If hypothalamic amenorrhoea due to low EA is diagnosed, the overall treatment strategy is to increase energy intake or reduce energy expenditure. Expert dietician input is essential to help to tailor an appropriate diet to increase energy input in a sufficient manner to restore physiological function, following an individualised assessment of energy expenditure. Additional protein and carbohydrate intake should be advised to restore liver glycogen, which may facilitate resumption of physiological LH pulsatility.[69] Weight gain has been demonstrated to be the best predictor of resumption of physiological menstrual function.[70] A logical treatment approach is therefore to increase energy intake by between 300 and 600 kcal/day, as recommended by the International Olympic Committee,[71] with a target BMI above 18.5 kg/m^2. Specialist psychological and dietetic input should additionally be sought in the diagnosis and treatment of formal eating disorders. Serial LH measurements can be used to aid treatment, as LH pulsatility should be restored following resumption of energy balance.[69]

The simultaneous management approach involves reducing exercise intensity to reduce energy expenditure. The RED-S clinical assessment tool should be used to help guide decisions regarding continuing training and

Table 1. Suggested investigation of sportswomen presenting with menstrual dysfunction

Investigation	Specific tests	Expected results in hypothalamic amenorrhoea in sportswomen
Assess energy availability	• Calculate energy availability: ◦ Assess dietary intake using prospective or retrospective food diaries ◦ Assess energy expenditure by fitness logs, facilitated with fitness technology equipment (heart rate monitors, pedometers, etc)	Low energy availability
	• Measure body mass index	<17.5 kg/m^2
Assess menstrual function	• Menstrual diary	Hypothalamic amenorrhoea/ oligomenorrhoea/ delayed menarche
If evidence of menstrual dysfunction (>6 months)	• Pregnancy test	Negative
	• FSH	Low
	• LH	Low
	• TFTs	Normal
	• Prolactin	Normal
	• Estradiol	Low
	• Anti-müllerian hormone	Low
	• Dual-energy X-ray absorptiometry scan	Low
	• Pelvic ultrasound	Thin endometrium/polycystic ovaries
If clinical evidence of hyperandrogenism	• LH/FSH ratio • Total testosterone • Sex hormone binding globulin • 17-hydroxyprogesterone	Normal

FSH = follicle-stimulating hormone. LH = luteinising hormone. TFTs = thyroid function tests.

competition.[71] A simplified version is demonstrated in Figure 2. Based on the assessment and subsequent risk group, participation recommendation can vary from no competition in high-risk women to full participation in those deemed low risk. It is important to consider that sportswomen may resist increasing their energy intake or reducing their training intensity, as they may perceive this as being detrimental to performance, particularly in sports such as gymnastics. However, contrarily, not only does RED-S impact health, but it also has adverse effects on a person's performance, ability to train and mood. Sportswomen with RED-S may develop nutrient deficiencies, experience chronic fatigue, become anaemic, and be at increased risk of infection, all of which have the potential to negatively impact performance.[11] Research indicates that muscle protein synthesis is also reduced, even at an EA of 30 kcal/kg fat-free mass/day.[72] The many performance-related health consequences are demonstrated in Box 2.

This emphasises the need for appropriate patient information, detailing the potential performance-related and short-term and long-term health-related consequences. Moreover, multidisciplinary and inter-professional involvement including healthcare professionals, as well as managers, coaches, physiotherapists and other people involved in the sportswoman's training is essential to ensure a streamlined collaborative approach.

Medical management

Regarding exogenous hormonal supplementation, the combined oral contraceptive pill (COCP) or hormone replacement therapy should not be used as primary treatment to restore menses or improve BMD in women with RED-S. The high estrogen dose in traditional COCPs downregulates insulin-like growth factor 1 (IGF-I) secretion,[73] an important bone-trophic hormone, which may conversely hinder the attainment of optimal BMD. Moreover, exogenous hormone therapy may mask the condition for which it is given, making it difficult to assess clinical response. Therefore, barrier contraceptive methods should be used in women who need continuing treatment and follow-up, at least until they are deemed low risk. In adult sportswomen who have been undergoing conservative management for more than 12 months, the American College of Sports Medicine recommends the addition of hormonal therapy,[60] although it is essential continued attempts to improve energy availability are maintained. In this case, transdermal estrogen, with associated progestogen, should be

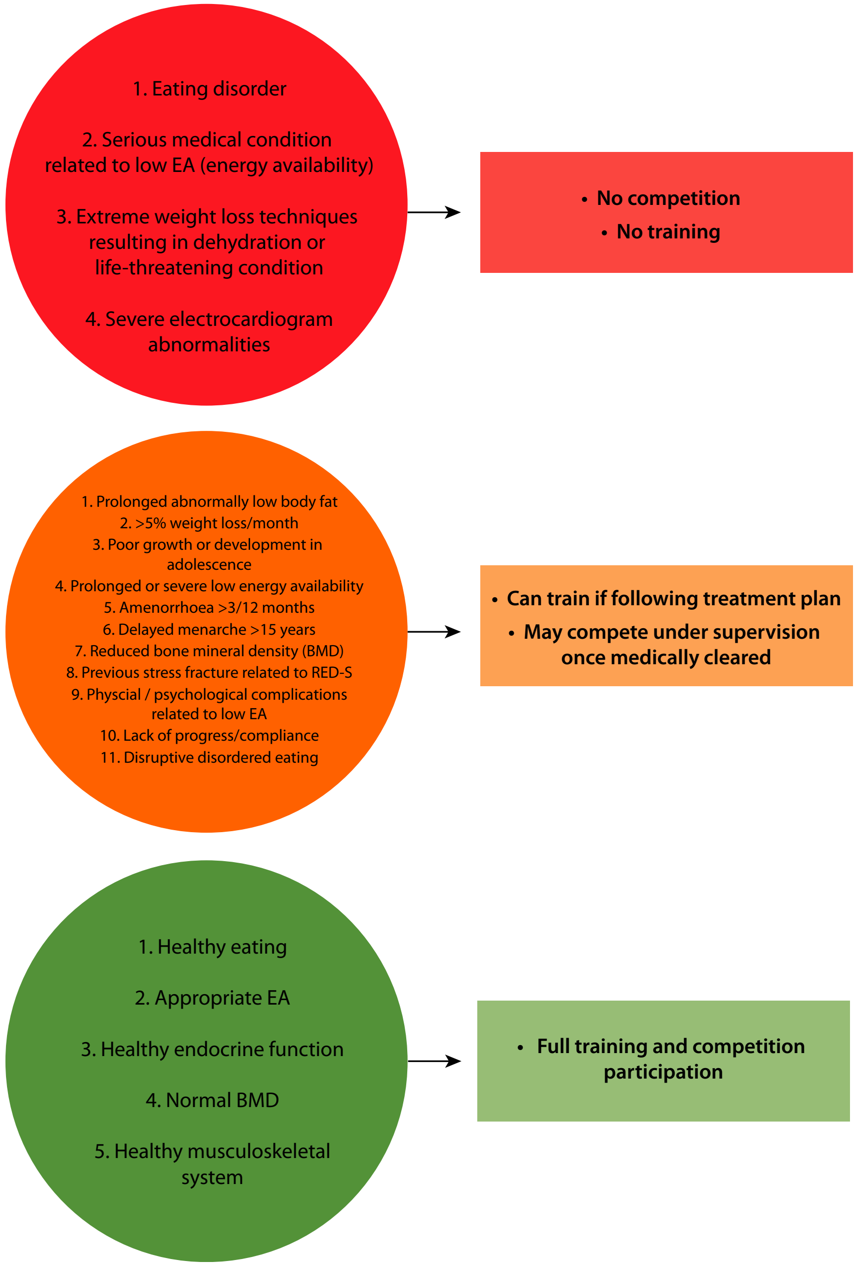

Figure 2. RED-S Risk Assessment Model for sports participation, including recommended return to play guidance (adapted from Mountjoy et al. 2015).[71]

used, as it does not interfere with IGF-I, and it has been shown to improve BMD in sportswomen with menstrual dysfunction.[74] Transdermal estrogen does not act as a contraceptive and therefore if contraception is required, it should be combined with a levonorgestrel-containing intrauterine system or barrier method.

Sportswomen's diets should be supplemented with 1500 mg/day calcium.[75] While bisphosphonates would inhibit the resorption of bone, they should be avoided in women of reproductive age, owing to the unpredictable length of time they are stored in bone and potential teratogenic nature.[76] Selective estrogen receptor modulators should also not be given as they are prohibited by the World Anti-Doping Agency.

Sportswomen with urinary incontinence require intervention, particularly if there is evidence it is impeding performance or affecting quality of life. The mainstay of treatment is an individually tailored pelvic floor muscle training regime, which has previously been shown to cure or

Box 2. Potential adverse performance-related effects of Relative Energy Deficiency in Sport (RED-S) (Mountjoy et al. 2015)[71]

Decreased

- Endurance
- Muscle strength
- Training response
- Coordination
- Concentration

Increased

- Poor judgement
- Injury risk
- Irritability
- Depression

significantly improve the condition in 67–74% of sportswomen with urinary incontinence involved in high-impact sports.[77,78] Despite this, most sportswomen are unaware of the role pelvic floor exercises may play in improving their symptoms, although 70–80% would undertake them following instruction.[56] Bladder training may also be effective, but current evidence regarding efficacy is lacking. While duloxetine can occasionally be used in women with urinary incontinence who are unsuitable for surgery,[79] such as women who wish to become pregnant in the future, the risks have been shown to outweigh potential benefits, and it therefore should not be offered to sportswomen with urinary incontinence.[80]

Treatment for restoring fertility in women with RED-S is the same as in resuming menstrual function, by restoring an equal energy balance. Should assisted reproductive therapy be attempted, estrogen-deficient women should be pre-treated with estrogen supplementation. Ovulation induction using gonadotrophin therapy is a well-tolerated and cost-effective option. Luteal phase support with progesterone supplementation is not needed. While it is unlikely sportswomen will wish to continue competing during pregnancy, it is essential they understand that certain fertility treatments, including clomifene and growth hormone, are prohibited by the World Anti-Doping Agency. While LH and human chorionic gonadotrophin therapy are prohibited in males, it is not currently the case for women, so most ovulation induction protocols are World Anti-Doping Agency compliant, but this should be checked before treatment is commenced.

Following conception, given the association with strenuous exercise and miscarriage around the implantation phase, the International Olympic Committee advises limiting the intensity of high-impact training routines in the week after ovulation and avoiding repetitive heavy lifting in the first trimester.[81]

Conclusion

RED-S represents a complex inter-relationship of health consequences that arise as a result of low EA. Sportswomen are at inherent risk of RED-S owing to the strict dietary monitoring and intense physical training required to become an elite sportswoman, particularly in sports that emphasise leanness or those disciplines governed by weight categories. The common presentations of elite sportswomen to gynaecologists include menstrual abnormalities, delayed menarche, subfertility and urinary incontinence. Owing to embarrassment or concerns that their training and ability to compete may be affected, such symptoms are often under-reported. Given the long-term associated health consequences including stress fractures and osteoporosis, and the responsibility of physicians to prioritise health over performance level, it is essential that such symptoms are actively screened, investigated and managed in a multi-disciplinary setting, in collaboration with the coaching team where possible.

Disclosure of interests

There are no conflicts of interest.

Contribution to authorship

BJ instigated and wrote the manuscript. AL assisted in the writing of the manuscript. SS, JY and JRS provided guidance and helped to revise the final draft. MD helped to conceive the original concept, provided expertise throughout and helped to revise the final manuscript.

Supporting Information

Additional supporting information may be found in the online version of this article at http://wileyonlinelibrary.com/journal/tog

Infographic S1. Sport and its impact on gynaecological health.

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