Relative Energy Deficiency in Sports (RED-S) – Screening and Risk Assessment in Elite Indian Male and Female Handball Players

Dr Jahnavi Dande[1], Dr Anirban Mallick[2]

ABSTRACT

Relative energy deficiency in sport (RED-S), a comprehensive term introduced by IOC, refers to impaired physiological function due to energy deficiency and low energy availability which causes health effects and performance consequences in athletes. Elite athletes, irrespective of the type of sport, are at risk of developing this syndrome. The purpose of this study hence is to clinically screen the elite male and female athletes of Indian Handball team for risk factors of RED-S, and to categorize them based on IOC proposed RED-S CAT risk assessment model. The study depicted that elite Indian male handball players are more at risk of relative energy deficiency compared to female Handball players.

KEY WORDS:

Low energy availability, Risk stratification, Clinical assessment tool

INTRODUCTION

Relative energy deficiency syndrome (RED-S), in sports, refers to impaired physiological function including, but not limited to metabolic rate, menstrual function, bone health, immunity, protein synthesis, cardiovascular health caused by relative energy deficiency (Mountjoy et al, 2014). The underlying aetiology of this syndrome is low energy availability(EA) or 'an energy deficiency relative to the balance between energy intake in the form of food and energy expenditure required for activities of daily living, healthy bodily functions, growth and sport activities such as training and competition (Mountjoy et al, 2015). Relative energy deficiency connotes that low energy availability can occur even in the scenario where energy intake and total energy expenditure are balanced (i.e. there is no overall energy deficit). Although the literature on low EA has focused on female athletes, it has also been reported to occur in male athletes (Sundgot Bargen et al, 2013 ; Filaire et al, 2007). Prevalence studies of low EA in male athletes have been few, however, low EA appears to occur among the males in risk sports as for female athletes. Owing to the high volume training and intense energy expenditure, the elite athletes both male and female irrespective of type of sport are at risk of developing this syndrome. The syndrome has potential health consequences with deleterious effects on various systems including endocrine, metabolic, haematological,

1. Junior Scientific Officer, Department of sports medicine, SAI, NSNIS, Patiala
2. Junior Scientific Officer, Department of sports medicine, SAI, NSNIS, Patiala

growth and development, cardiovascular, gastro intestinal, immunological, bone health (Figure 1). Male athletes with relative energy deficiency have been shown to have decreased immunological function, impaired bone health, lower sex hormones and impaired reproductive function.

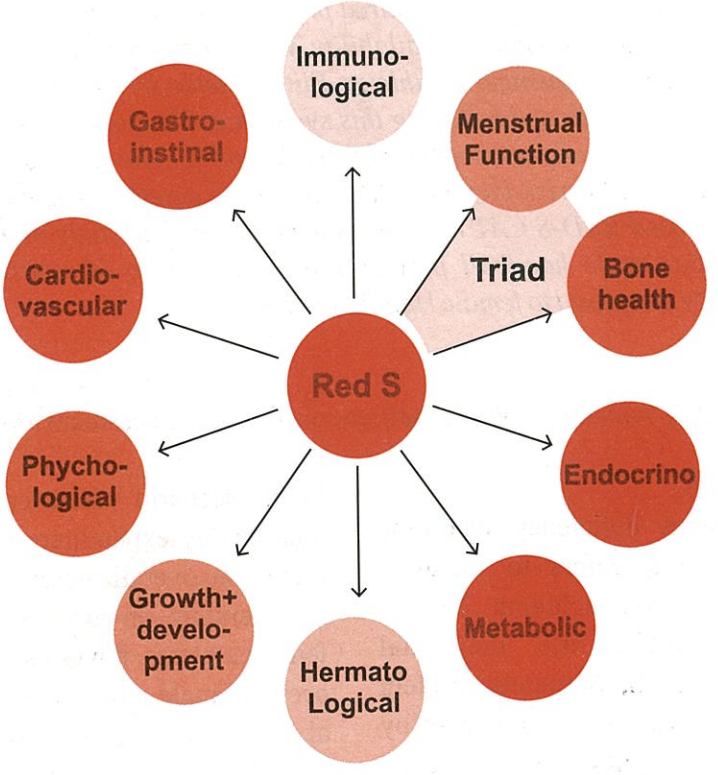

Fig-1:Health consequences of relative energy deficiency

The psychological effects may either precede RED-S or be a consequence of RED-S. Relative energy deficiency can also have a negative effect on performance (Figure 2). Decreased training response and increased injury risk are two preventable factors associated with relative energy deficiency that directly impact on athletic performance (Margo, 2015). Early detection of symptoms and causes of energy deficiency is crucial to improve performance and prevent long-term health consequences. Screening for RED-S is recommended by IOC to be undertaken as part of an annual Periodic Health Examination (PHE) and when an athlete presents with disordered eating or eating disorders, weight loss, lack of normal growth and development, menstrual dysfunction, recurrent injuries and illnesses, decreased performance or mood changes.

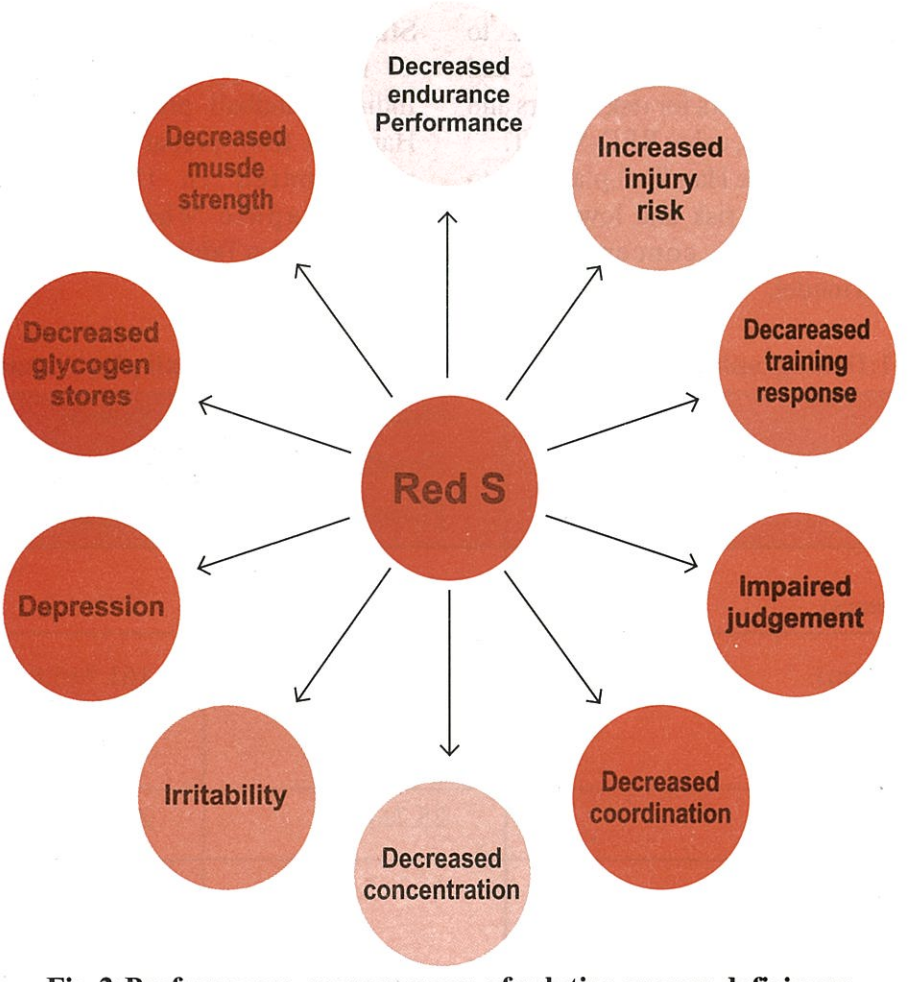

Fig-2:Performance consequences of relative energy deficiency

Unfortunately there are no standardised guidelines to determine EA. A clinical assessment tool, the RED-S CAT was created by IOC to assist clinical sports medicine professionals with the screening, diagnosis and management of RED-S in a practical, usable format that is both evidence-based and effective(Mountjoy et al, 2015). A risk assessment model has also been proposed to categorize athletes into three stages subsequently (Mountjoy et al, 2015). The main characteristic of team sports such as Handball is the intermittent activity pattern in which high intensity and lower-intensity activities alternate. This pattern thus combines the use of aerobic and anaerobic systems and high cardio respiratory endurance. Though certain sports are at high risk for RED-S such as endurance sports, weight category sports, weight controlled sports, athletes in any sport including team sports like Handball may be affected.

Aim

The purpose of this study was to clinically screen the elite Indian male and female Handball players for risk factors and symptoms of RED-S, using RED-S CAT.

To categorize the Handball players into high risk, moderate risk and low risk, for RED-S, based on conceptual risk assessment model.

METHODOLOGY

Study Design: Pilot, cross sectional study

Elite male (N = 27) and female (N = 25) Indian Handball players of the national Handball team preparing for SAF Games participated in the study. Their demographic characteristics are enumerated in Table 1.

Table –1:Demographic data of Indian male and female Handball players(mean ±SD)

Demographic Data	Male Handball Players	Female Handball Players
Age (years)	26.5 ± 5.8	22.9±3.4
Height (cm)	180.3±4.6	161.7±5.8
Weight (Kg)	83.8±7.6	57.2±4.9
BMI	25.7±1.9	21.9±1.99
Training age (years)	11.2±5.1	9.9±2.5

The athletes were screened for RED-S during pre participation evaluation by RED-S specific criteria (Hawley, Tipton & Milliard, 2006) which included a thorough history focussing on diet and disordered eating, weight loss and fluctuations, psychological health, endocrine and gastro intestinal abnormalities, growth and development, injury response, bone health and stress fractures. Physical examination for signs of energy deficiency, colorimetric estimation of haemoglobin levels and a 12 lead electrocardiography (ECG) had also been done. A detailed menstrual history has been taken for female athletes. Informed consent was taken from the athletes to carry out screening. The screening and assessment was done in the Department of Sports Medicine, NIS, Patiala. The findings were then analyzed and risk assessment and

stratification has been done using the conceptual risk assessment model (Figure 3). Depending on the findings, the athletes are categorized into 3 categories, Red light – high risk, yellow light – moderate risk, Green light – low risk of RED-S.

HIGH RISK NO START RED LIGHT	MODERATE RISK: CAUTION YELLOW LIGHT	LOW RISK GREEN LIGHT
- Anorexia nervosa and other serious eating disorders - Other serious medical (Psychological and physio-logical) conditions related to low energy availability - Use of extreme weight loss techniques leading to dehydration included hermo-dynamic Instability and other life threatering conditions.	Prolonged abnormally low % body fat measured by DOCA* or anbthropometryy Substanitial weight los (5-10 % body mass in one month) Attenuation of expected growth and development in addolescent athlete	Appropriate physique that is managed without undue stress or un-healthy diet/ exercise strategies
	Low **LA of prodcenged and/or severe nature	Healthy eating habits with appropriate EA
	Abnormal mentural cycle functional hupothanic amenthoria>3 months No menarcha by age 15y in females	Healthy fundtion-ing endocrime system
	Reduced bone mineral density (either in compari-son to prior DXA or z-score <-1 so.) History of 1 or more stress fractures associated with hormonal/menstrual dysfunction and/or low EA.	Healthy bone mineral density as expected for sport , age and ethonology Healthy musculaskeletal system
Severe ECG abnormalities (i.e. bradycardia)	Athlete with physical phychological compli-cations relaed to low EA+/-disordered eating Diagnonic testing abnor-malities related to low E.A. +/- disordered eating	
	Proloonged relative energy dficiency Disordered eating behaviour negatively affecting other learn members Lack of progress in treatment and/or non-compliance	

* dual energy X-ray absorptiometry

**EA Energy availablity-Energy intake - Energy cost of exercise (additional energy expanded in undertaking exercise).

Fig-3 : RED-S risk assessment model for sports participation

The number and percentage of male and female athletes in each category is thus calculated and compared.

RESULTS & DISCUSSION

The risk factors identified in Indian male and female Handball players, the number and percentage of players positive for each risk factors are depicted in Table 2 and Table 3 respectively. None of the Handball players reported with extreme weight loss or eating disorders, or severe physiological or psychological conditions related to low energy availability. Based on the risk factors thus screened for, the athletes are stratified into high risk, moderate risk and low risk of developing relative energy deficiency using risk assessment model. The number and percentage of athletes in each category are represented in Table 4. Haemoglobin levels estimated colorimetrically revealed nearly three quarters of male athletes and more than half of female athletes have low values (males < 13gm/dl and females < 12gm/dl). Though sinus bradycardia (Heart rate (HR) < 60 bpm) has been reported in both male and female athletes, severe bradycardia (HR ≤ 30 bpm) has not been reported. Training related gastro intestinal disturbances have been reported only in male athletes. Though few athletes reported with history of injuries in the past none of them reported with non compliance to treatment or lack of progress in treatment.

Table – 2: Male Handball players and risk factors for RED-S

S. No	Risk factors	Male Handball players	
		N	%
1	Weight concern	24	88.9
2	Weight loss/ fluctuations (> 5 10% in a month)	12	44.4
3	Diet concern	22	81.5
	Recurrent dieting	9	33.3
4	ECG (Bradycardia)	10	37
5	Low Haemoglobin	20	74.1
6	Bone stress related symptoms	17	63
7	GI disturbances	3	11.1

Table – 3: Female Handball players and risk factors for RED-S

S. No	Risk factors	Female handballers	
		N	%
1	Weight concern	10	40
2	Weight loss/ fluctuations (> 5 – 10% in a month)	4	16
3	Diet concern	9	36
	Recurrent dieting	1	4
4	ECG (Bradycardia)	3	12
5	Low Haemoglobin	15	60
6	Hormonal abnormalities	1	4
7	Delayed menarche ≥ 15 years	7	28
8	Irregular cycles	3	12
8a	Amenorrhea ≥ 3 months	1	
8b	Amenorrhea ≤ 3 months	2	
9	Bone stress related symptoms	3	12

Table 4 : Risk stratification in male and female athletes by screening

	High Risk	Moderate Risk (N)	Low risk (N)
Males	0	44.4% (12)	55.6% (15)
Females	0	36 % (9)	64%(16)

Training and nutrition are closely interrelated, since optimum adaptation to meet the demands of repeated training sessions generally requires an appropriate diet in terms of the amounts and types of nutrients(Hawley e al, 2006). Energy intake in Spanish professional handball players has been evaluated and found, that energy intake was below energy expenditure((Jorge et al, 2013). Although energy balance is not a priority for training and performance, athletes should aim to maintain energy balance within healthy limits (Koehalar, et al, 2010). Currently there is no standardised protocol for undertaking an assessment of EA in free-living athletes. Also a universal recommendation to measure EA is unwise in the absence of a protocol that is sensitive, reliable, time-efficient and cost-effective.

The RED-S CAT as recommended by IOC has hence been chosen as a clinical assessment tool for the evaluation of athletes during pre participation evaluation and for guiding fitness to participation and return to play decisions. The study demonstrated the presence of individual risk factors for RED – S in both male and female players. Presence of Low haemoglobin levels in both indicate a micro nutrient deficiency and sinus bradycardia even upto 40 bpm is seen in male players probably due to low energy availability. Also high cardio respiratory endurance in Handball players could also be a reason for sinus bradycardia. In females however HR < 55 bpm is not noticed. Although, there is a dearth of prevalence studies in low EA in male athletes, Vogt et al (Vogt et al, 2005) showed that male cyclists had severely reduced EA of 8 kcal/kg/FFM/day and Müller et al (Muller et al, 2006) have reported high prevalence of underweight international level ski jumpers. Scientific evidence and clinical experience around the effects of RED-S shows that several body systems in addition to the reproductive and musculoskeletal systems are affected, and that men are at risk as well as women. High risk factors for RED-S are not reported in Handball probably because Handball is not a weight dependant, or weight category sport.

LIMITATIONS

Screening is mainly subjective and has only been done by a thorough clinical history taking nutritional and psychological concerns, though physical examination with high index of suspicion for RED, a 12 lead ECG and colorimetric estimation of haemoglobin levels have been done.

Body fat percentage, bone mineral density measurement by Dual X-ray Absorptiometry (DEXA), hormonal assay, serum electrolytes have not been performed. So prevalence of risk could not be calculated

CONCLUSIONS

The study is first of its kind on male and female elite Indian handball players done merely by screening in a clinical setup. The study highlights that elite Indian male hand ball players compared to female counterparts are more at risk of developing RED-S. The study questions the general concept that female athletes rather male athletes will be at a higher risk of nutritional and energy deficiencies.

FUTURE RECOMMENDATIONS FOR RESEARCH

Validation of tools to diagnose low energy availability in clinical setting needs to be developed to allow clinicians for early diagnosis and prompt management.

Gender specific diagnosis and screening tools for low energy availability should be developed as male athletes also are not spared from energy deficiency.

More number of studies need to be conducted in Indian athletes especially in endurance, weight category and weight dependant aesthetic sports as prevalence of energy deficiency may be high in these groups.

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