The female football player, disordered eating, menstrual function and bone health

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Most female football players are healthy. However, recent findings from our studies on Norwegian female elite athletes also show that football players are dieting and experiencing eating disorders, menstrual dysfunction and stress fractures. Dieting behaviour and lack of knowledge of the energy needs of the athlete often leads to energy deficit, menstrual dysfunction and increased risk of bone mass loss. Although dieting, eating disorders and menstrual dysfunction are less common than in many other sports, it is important to be aware of the problem as eating disorders in female athletes can easily be missed. Therefore, individuals, including the players themselves, coaches, administrators and family members, who are involved in competitive football, should be educated about the three interrelated components of the female athlete triad (disordered eating, menstrual dysfunction and low bone mass), and strategies should be developed to prevent, recognise and treat the triad components.

The term female athlete triad (the triad) refers to three interrelated conditions: disordered eating (DE), menstrual dysfunction and low bone mass.¹ Some female athletes do not consider training or exercise sufficient to accomplish their idealised body shape and a significant number diet and use harmful weight-loss practices to achieve their goals.²⁻⁴ This behaviour may lead to one or more of the triad components. Each disorder of the triad increases the risk of morbidity and mortality, but the dangers of the three together are synergistic.⁵

This article addresses three aspects of the female athlete triad in connection with football players: (i) the nature and prevalence of DE and eating disorders (EDs), (ii) menstrual function and bone health in football players, and (iii) how to help players who have one or more of the triad components. Results from our latest study on the triad in Norwegian elite athletes will be included⁶⁻⁷ and data concerning football players, handball players and endurance athletes will be presented.

Our study⁶⁻⁷ was conducted in three phases: screening by means of a detailed questionnaire (part I), measurement of bone mineral density (BMD) (part II) and clinical interview (part III). In part I, all female elite athletes aged 13-39 years and representing the national teams at junior and senior level ($n = 938$) and an age group-matched randomly selected population-based control group ($n = 900$) were invited to participate. The questionnaire was completed by 88% of the athletes and 70% of the controls. Based on data from part I, a stratified random sample of athletes ($n = 300$) and controls ($n = 300$) was selected and invited to participate in parts II and III of the study.⁶⁻⁸ Data from parts I-III are presented in table 1 and figs 1 and 2.

ENERGY AVAILABILITY, DISORDERED EATING AND EATING DISORDERS

Definitions

Most athletes with low energy availability have reduced their dietary energy intake without reducing their exercise energy expenditure. Some athletes practice abnormal eating behaviours ranging from restrictive eating to anorexia nervosa (AN)⁹ and including fasting, vomiting, diet pills, laxatives, diuretics and enemas.¹⁰⁻¹¹ Binge eating is also common in athletes with restrictive eating.¹²

The second way to reduce energy availability is to increase exercise energy expenditure without increasing energy intake. The

body has no automatic mechanism for matching energy intake to activity-induced energy expenditure.¹³ Dietary restriction increases hunger, but the same energy deficit produced by exercise does not.¹⁴ The energy deficits resulting from inadequate ad libitum energy intake are more extreme when consuming a high carbohydrate diet such as those recommended for endurance athletes.¹⁵⁻¹⁷ Inadvertent low energy availability may occur without clinical EDs, DE behaviours or even dietary restriction.¹²⁻¹⁶⁻¹⁸

DE behaviour is characterised by disturbances in eating behaviour, body image, emotions and relationships.¹ AN is the most extreme restrictive eating behaviour in which an individual continues to starve and feel fat in spite of being 15% or more below an ideal body weight. Bulimic behaviour refers to a cycle of food restriction or fasting followed by bingeing and purging. AN and bulimia nervosa (BN) are clinical EDs.¹⁹

The eating disorder not otherwise specified category (ED-NOS) refers to disorders of eating that do not meet the criteria for any specific EDs. This category acknowledges the existence and importance of a variety of eating disturbances.

Athletes constitute a unique population and special diagnostic considerations should be taken into account when working with this group.²⁰⁻²²

Prevalence

The prevalence of DE behaviour and EDs among athletes has been estimated to range from 1% to 62%.³ Prevalence seems to be higher in elite athletes when compared to athletes and lower competitive level individuals and controls.³⁻⁴⁻¹²⁻²³⁻²⁴ Furthermore, DE and EDs are more frequent among female athletes competing in aesthetic, weight-class and endurance sports than among athletes competing in sports where leanness is considered less important.²⁻⁴⁻⁷⁻²⁵

In our recent study, 32% of football players reported a history of dieting. This is a lower percentage than the reported number of dieting athletes in other sports.⁶⁻⁷⁻¹² All these dieting football players had body mass index values within the recommended level (table 1).²⁶ Also a significantly lower percentage of football

Abbreviations: ACSM, American College of Sport Medicine; AN, anorexia nervosa; BMD, bone mineral density; BN, bulimia nervosa; DE, disordered eating; ED, eating disorder; ED-NOS, eating disorder not otherwise specified; LH, luteinising hormone

Table 1 Characteristics of the total population of athletes

	Football (n = 69)	Handball (n = 60)	Endurance (n = 115)	Controls (n = 607)
Age, mean (SD) (years)	19.6 (4.1)	19.9 (3.1)	22.3 (6.3)	27.3 (7.9)
BMI, mean (SD) (kg/m ²)	21.5 (1.6)	22.5 (2.0)	20.5 (1.8)	23.3 (4.2)
Training, mean (SD) (hours/week)	12.3 (3.7)	15.8 (4.2)	13.1 (4.5)	–
Eating disorders*	5.9%†	22.4%	25.7%	21.1%
Current use of oral contraceptives	35.8%	43.9%	38.2%	27.8%
Current menstrual dysfunction‡	9.3%	18.8%	27.9%	15.2%
Stress fractures	13.6%	23.2%	13.4%	12.4%

Characteristics of the total population of athletes representing football, handball and endurance sports participating in the large screening study (part I).⁶ BMI, body mass index.

*Self-reported; †football significantly different from the other groups ($p < 0.05$); ‡oral contraceptive users were excluded.

players compared to handball and endurance athletes reported EDs (table 1).

Results from part III of the study (clinical interview) showed that 32% of the athletes met the DSM-IV criteria for clinical EDs.²⁷ The prevalence of clinical EDs in ball game players has previously been reported as being relatively low compared to other sport groups.² However, 24% of the football players, 29% of the handball players and 44% of the endurance athletes met the criteria in our study (fig 1). Based on practical experience from the Norwegian Olympic Training Center, it was not surprising that quite a high percentage of both handball and football players met the DSM-IV criteria for BN and ED-NOS (fig 1). In contrast to the expected findings, 7% of the handball players participating in the clinical study (table 1 and fig 1) met the criteria for AN (fig 1). This high prevalence among ball game players might be explained by the increased focus on body composition and leanness in ball sports.

Factors associated with the development of EDs

Psychological, biological and social factors are implicated in the development of EDs.²⁵ Because of the additional stress associated with the athletic environment, female elite athletes competing in leanness sports appear to be more vulnerable to EDs than the general female population and athletes engaged in sports where leanness is not as important.^{21–23} Risk factors include restrained eating and training, frequent weight cycling, early sport-specific training, personality factors, injury, a sudden increase in training volume and the impact of coaching behaviour.^{3–12}

Pressure to reduce weight has been the common explanation for the increased prevalence of eating-related problems among athletes. Data from the Norwegian screening study⁶ indicate that pressure to reduce weight is not a typical problem in

football. However, the important factor may not be dieting per se but rather the situation in which the athlete is told to lose weight, the words used and whether the athlete receives guidance or not. In addition to the pressure to reduce weight, athletes are often pressed for time and have to lose weight rapidly to make or stay on the team. As a result they often experience frequent periods of restrictive dieting or weight cycling.¹² Weight cycling has been suggested to be an important risk or trigger factor for the development of EDs in athletes.^{12–28}

In football, the relationship between utilising muscle glycogen stores and the ability to maintain high intensity work, especially in the second half of the match, is well known. The warm environment requires a strategy for fluid as well as for carbohydrate intake to minimise the negative effects of dehydration on performance.²⁹

Although there are individual differences between team members depending on the player's position and playing style, a football player typically covers about 10–13 km during a match,²⁹ including approximately 3 km in sprinting and high intensity running, and the intermittent work makes great demands on the anaerobic energy system. Thus, carbohydrate is the most important substrate for energy production during a match.²⁹

Low carbohydrate availability can lead to reduced skill and judgment, causing the player to make more errors during the game. Since low carbohydrate availability is detrimental to performance, it is important to maximise glycogen storage before and during the match and to optimise hydration status. Football players typically restrict fluid consumption to the breaks during the game and at half time. This can be a challenge, especially in a hot environment. Thus, there is great potential for players who have an individual drinking plan to enhance their performance during both training and matches.²⁹

Figure 1 The prevalence of AN, BN and ED-NOS among football players (n = 17), handball players (n = 14), endurance athletes (n = 40) and control subjects (n = 145).

Figure 2 Bone mineral density (BMD) in football (n = 17), handball (n = 14) and endurance (n = 40) athletes and control subjects (n = 145) participating in the clinical section of the study.

Health consequences

Undernutrition and EDs may cause serious medical problems and can be fatal. Whereas most AN complications occur as a direct or indirect result of starvation, BN complications result from binge-eating and purging.²¹ The loss of fluids and electrolytes during purging can lead to serious medical problems such as dehydration, acid-base abnormalities, cardiac rhythm disturbances and electrolyte abnormalities, and decreased coordination, balance and muscle function. Such behaviour is therefore dangerous to the health of athletes and counterproductive to improving their performance.

Chronic low energy availability with or without DE can impair health and physical performance.^{30–31} Medical complications involve the cardiovascular, endocrine, reproductive, gastrointestinal, renal and central nervous systems.^{10–31–32} Psychological problems associated with EDs include low self-esteem, depression and anxiety disorders.^{10–31–32}

MENSTRUAL DYSFUNCTION

Definitions

The monthly menstrual cycle is the result of a complex interaction between the endocrine and reproductive systems. External stimuli affect the system through hormonal signals to the hypothalamus. The cessation of menses coincident with physical training has long been recognised.⁵

Eumenorrhea describes a normal menstrual pattern of 10–13 menses per year.^{33–34} Menstrual dysfunction seen in athletes is characterised by a significant decrease in reproductive hormones, especially oestrogen, and disruption of the normal menstrual cycle.³⁵ In the Norwegian study mentioned above, primary amenorrhea, secondary amenorrhea, oligomenorrhea and short luteal phase were all defined as menstrual dysfunction.⁸

Prevalence

Exercise-induced or athletic menstrual dysfunction is common in active women and can significantly affect health and sports performance.³⁵ It has been reported that menstrual dysfunction occurs in 6–79% of women engaged in athletic activity.^{8–34–37} Prevalence depends on the definition of menstrual dysfunction, the sport and the competitive level of the athletes investigated.^{34–35} In the questionnaire (part I) of the study on elite Norwegian athletes ($n = 669$) referred to above, a similar percentage of athletes (17%) and controls (15%) reported current menstrual dysfunction.⁸ However, significant differences were found in specific sports groups (table 1).

Factors associated with menstrual dysfunction

A number of factors, such as energy balance, DE behaviours, exercise intensity and training practices, bodyweight and body composition, and physical and emotional stress, may contribute to the development of athletic menstrual dysfunction. There also appears to be a high degree of individual variation regarding the susceptibility of the reproductive axis to exercise and diet-related stresses.³⁵ The percentage of football players reported to have current menstrual dysfunction is low compared to other sports (table 1) and could indicate that football players are less affected by the well-known risk factors for menstrual dysfunction compared to athletes engaged in other sports.

Nutritional factors

The energy-drain and exercise-intensity hypotheses suggest that athletic amenorrhea or other reproductive hormone abnormalities observed in female athletes may be partly due to periods of energy deficiency, or a combination of high energy expenditure, low energy intake and/or high psychological and physical stress.^{18–35} A few published studies have also indicated that football players have lower energy availability.³⁸ However, these studies have

methodological limitations and their results should be carefully evaluated.²⁹ In a study testing two hypotheses concerning the disruption of luteinising hormone (LH), Loucks *et al*¹⁶ suggest that LH pulsatility in women depends on energy availability and not necessarily on the stress of exercise.

Health consequences

Most athletes refer to the absence of menses as a pleasant convenience and are unaware that the skeleton could suffer irreversible consequences. Although athletic amenorrhea is the most extreme type of menstrual dysfunction, other forms can result in suppressed oestrogen levels and can affect bone health and fertility.³⁵ The loss of BMD is a silent process, and the athlete is usually unaware that a problem exists until a related injury, such as a stress fracture, occurs.

Furthermore, studies report a higher incidence of injuries and stress fractures among amenorrhoeic and oligomenorrhoeic as compared to eumenorrhoeic athletes.^{9–39–40}

LOW BONE, MINERAL DENSITY AND STRESS FRACTURES

Definitions

Osteoporosis is a disease characterised by low bone mass and microarchitectural deterioration of bone tissue leading to enhanced bone fragility and increased risk of fracture.⁵

The American College of Sport Medicine (ACSM) recommends that the term “low BMD” should be used for female athletes with a history of hypo-oestrogenism, nutritional deficiencies, stress fractures and/or other secondary clinical risk factors for fracture who also have BMD z scores of between -1.0 and -2.0 .^{22–41–43} For female athletes with secondary clinical risk factors for fracture and BMD z scores less than or equal to -2.0 , ACSM recommends that the term “osteoporosis” should be used to reflect their increased risk of fragility fractures.⁴¹

Prevalence

The prevalence of osteopenia and osteoporosis among female athletes is low, but a number of studies have reported a significant decrease in vertebral BMD among young female athletes with menstrual dysfunction.^{44–49} In the previously mentioned Norwegian study,³⁰ 11% of athletes met the criteria for low bone mass.⁵⁰ Both football and handball players had high values at all measurement sites when compared to endurance athletes and controls (fig 2). This was expected due to the mechanical stresses that football and handball players experience during training and competition.

Thirteen percent of football players reported a history of stress fracture.⁶ This is about the same percentage as reported by endurance athletes. However, further investigation revealed that only two of the 17 football players and one of the 14 handball players reporting stress fractures had actually been clinically diagnosed with a stress fracture.⁵¹

The presence of bone loss at regional sites partly depends on the extent of mechanical loading at those sites in various sports. Not all amenorrhoeic athletes have low bone mass. Their skeletal status depends upon the length and severity of their menstrual dysfunction, as well as factors influencing their BMD prior to the onset of amenorrhea.⁵¹ The results from our study support findings regarding the prevalence of high BMD values in ball game players.⁵²

Factors associated with low bone mineral density

BMD is dependent on age, sex and race. In addition, heredity is thought to explain 60–80% of the variation in BMD among individuals.¹¹ Peak bone mass is the maximum amount of bone acquired at skeletal maturity, and those with a high peak bone mass may be at lower risk of developing osteoporosis later in

life.⁵² Modifiable factors that determine BMD are soft tissue composition (lean mass, fat mass), lifestyle factors (smoking, alcohol intake), medications, hormones, physical activity and nutrition. These factors may interact with one another, and their degree of influence varies depending on age and skeletal site.⁵³

Both oestradiol and progesterone contribute to the maintenance of bone density by affecting bone formation and remodeling.^{18 34 48 54} Therefore, any factor that contributes to menstrual dysfunction can have a direct or indirect influence on bone density and compromise bone health. Furthermore, it is well known that weight-bearing activity slows or reverses bone loss, thus decreasing a woman's risk of developing osteoporosis.⁵⁵ The mechanical loading related to football play is probably the main reason for the high values found in this group (fig 2). In addition, the prevalence of EDs and menstrual dysfunction is quite low and has probably not yet affected the BMD of these players. In addition to exercise, the most important of the modifiable factors are diet and energy and nutrient intake.⁵⁶

Nutritional factors

Insufficient nutritional intake has a detrimental effect on vertebral bone density.^{57 58} DE and low calcium intake combined with menstrual dysfunction may exacerbate bone loss.⁵ Athletes with anorectic ED have been shown to have decreased vertebral BMD.^{49 59}

In general, most experts agree that a calcium-rich diet is important to promote and sustain optimal bone density; if necessary, calcium could be added as a supplement to the female athlete's diet. In addition, vitamin D plays an important role in maintaining calcium homeostasis, while vitamin K deficiency is associated with an increased risk of hip fracture in adults.⁵⁶ Other minerals important for bone health include sodium, magnesium and zinc.⁵⁶ Although there is limited research on the dietary habits of female football players, the available literature suggests that many female players need to increase carbohydrate and fluid intake and improve dietary habits to sustain the demands of training and competition.⁶⁰

Health consequences

Reduced bone mass per se does not necessarily have an immediate physical effect. However, elite athletes can experience bone loss that leads to osteoporosis, increased risk of fractures, pain, a reduction in training volume, frequent training breaks caused by injuries and the end of an athletic career.

To date, no long-term study has shown that amenorrheic individuals can fully regain lost BMD, despite returning to a normal reproductive status.⁴⁶ This risk is especially critical for the adolescent or young adult athlete as peak bone mass is reached by the third decade of life.⁴⁶ However, further studies are needed to determine the long-term effects of the resumption of menses on BMD.

HOW TO HELP ATHLETES WITH THE TRIAD

Players with one component of the triad should be screened for the other components. This screening could be carried out at the pre-participation examination and during evaluation of the following: energy and nutrient intake, possible ED behaviour, menstrual status and history, changes in weight, cardiac arrhythmias including bradycardia, depression and stress fractures.^{5 61}

As few have discussed treatment for the triad, this section mainly relies on the experience the authors have gained while working at the Norwegian Olympic Training Center. An ED team including a medical doctor, sports nutritionist, exercise scientist specialising in EDs and a psychiatrist was established in 1998. The treatment plan is based on a trusting relationship between the athlete and the care providers. This includes respecting the

athlete's desire to be lean for optimal athletic performance and expressing a willingness to help the athlete be lean and healthy.

According to Manore,³⁵ the most common nutritional issues in athletes with DE and/or menstrual dysfunction are poor energy consumption and/or poor food selection, which can lead to poor protein, carbohydrate and essential fatty acid intake. The micronutrients most commonly found to be low are the bone-building nutrients, especially calcium, the B vitamins, iron and zinc. If energy drain is the primary contributing factor to athletic menstrual dysfunction, better energy balance will improve overall nutritional status and may reverse menstrual dysfunction, thus returning the athlete to normal reproductive status. Because bone health can be compromised in female athletes with menstrual dysfunction, intakes of bone-building nutrients, such as calcium and vitamin D, are especially important. Iron and zinc are typically low in the diets of female athletes if meat products are avoided. Adequate intake of the B vitamins is also important to ensure adequate energy production and the building and repair of muscle tissue.

In addition, it is important (i) to focus on normalising weight, body composition and the menstrual cycle, (ii) to modify unhealthy thought processes that maintain the disorder and (iii) to deal with the emotional issues in the individual's life. The younger the athlete, the more the involvement of the family is recommended.

If menstrual dysfunction is confirmed, the therapist should inform the athlete about the detrimental effects of loss of menses on skeletal integrity. Emphasis should be placed upon both the short- and long-term consequences of decreased BMD. If the athlete has experienced irregular menses for 6 months or more, a bone density assessment using dual-energy x-ray absorptiometry (DXA) should be carried out. A diagnosis of osteopenia may persuade the athlete to change their behaviour and training practices. Some studies report an increase in BMD in amenorrheic athletes resuming normal menses, but these gains seem to be limited.^{5 62} Amenorrheic athletes given hormone replacement therapy in doses used for menopausal women have shown maintenance of bone mass but no gains.⁵

Health professionals should question athletes with stress fractures about their menstrual and eating histories. The presence of other symptoms such as tiredness/exhaustion, inadequate or poor nutrition, anaemia, electrolyte imbalance and depression should also prompt evaluation of the three triad components.

In our opinion, suspension from both training and competition is not recommended. First, if the athlete is suspended, she may train on her own, which in some cases may be more dangerous because no one will be monitoring her exercise. Second, preventing the athlete from participating in her sport may further reduce her self-esteem. Third, control is a key issue for the individual with an ED and she may view the total suspension as an attempt by others to control her. However, if the athlete is unable to increase her energy intake to an optimal level, training volume must be reduced. At the Norwegian Olympic Training Center we have established some minimal criteria for athletes with EDs to continue training: (i) the athlete must agree to comply with all treatment strategies as best she can; (ii) the athlete must be closely monitored on an ongoing basis by the health care professionals handling her treatment; (iii) treatment must always take precedence over training and competition; and (iv) if any question arises at any time as to whether the athlete is meeting or is able to meet the stated criteria, competition is not to be considered a viable option while the athlete is in treatment.

CONCLUSIONS

As some female athletes and non-athletes do not consider training or exercise to be sufficient to achieve their idealised

body shape or level of thinness, a significant number diet and use harmful, though ineffective, weight-loss practices such as restrictive eating, vomiting, laxatives and diuretics. Although dieting, EDs and menstrual dysfunction are less common in football than in many other sports, it is important to be aware of the problem as EDs in female athletes can easily be missed. DE may result in amenorrhea and loss of bone mass because of energy deficit. If untreated, EDs can have long-lasting physiological and psychological effects and can be fatal. Treating athletes with EDs should be undertaken only by qualified health care professionals.

Energy deficiency seems to be an important factor associated with menstrual dysfunction in athletes. The amount of bone loss seems to be correlated with the severity and length of menstrual dysfunction, nutritional status and the amount of skeletal loading during activity. Due to the severe consequences of EDs, menstrual dysfunction and low BMD, it is important to identify athletes at risk of the triad as early as possible.

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