A desire for weight loss in season increases disordered eating behaviour risk and energy deficiency in athletes

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Abstract

Objective: The objective was to explore eating behaviour, body image and energy status in female university team sport athletes.

Design: This was a cross-sectional, descriptive study design.

Setting: The setting was North-West University, Potchefstroom, South Africa.

Subjects: Subjects were top university female field hockey and netball player volunteers, aged 18-30 years (n = 22), and recruited during their sport season.

Outcome measures: Athletes completed demographic, health and sport, and body weight questionnaires. The Eating Disorder Inventory and the Three-Factor Eating Questionnaire's cognitive dietary restraint subscale were used to measure disordered eating behaviour. Body composition was measured with dual-energy X-ray absorptiometry. Estimated energy availability ($_{est}$EA) was determined from a three-day diet and exercise record.

Results: Fifteen (68%) athletes were identified with an increased risk of disordered eating. Sixteen (73%) were dieting. A low $_{est}$EA (24 ± 12 kcal/kg fat-free mass/day) was found in 59% of the athletes, of whom 85% (11/13) had increased risk of disordered eating. A significantly positive (p-value < 0.05) association was found between cognitive dietary restraint and drive for thinness (r = 0.4) and body weight (r = 0.5). A negative association was found between desired weight loss (r = –0.5), energy intake (r = –0.5) and $_{est}$EA (r = –0.7).

Conclusion: Nonlean build athletes who diet in season are at increased risk of disordered eating behaviour and low energy availability.

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Introduction

Traditionally, athletes who compete in nonlean build sports were considered to be at a lower risk of insufficient energy intake and disordered eating behaviour than athletes who competed in endurance-type and aesthetic sports.[1-3] However, evidence is now emerging that female athletes who compete in nonlean build sports may also be at risk of insufficient energy intake and/or disordered eating behaviour,[3-5] especially subelite and elite athletes who often have personality traits that are associated with an eating disorder, or who experience pressure from coaches and/or parents to conform to a specific physique.[1,6] Disordered eating is a subclinical eating disorder and refers to abnormal eating patterns and behaviour which include pathogenic weight control measures, such as body weight and body image anxiety; undernutrition or insufficient energy intake (or a combination of both); and bingeing and vomiting and the exploitation of laxatives, diuretics and diet pills.[7] It should also be noted that female university students, in general, are more vulnerable to disordered eating behaviour because of the socio-cultural environment in which they find themselves.[8] Therefore, female university student athletes may be at increased risk of disordered eating behaviour owing to exposure to various environmental risk factors.

Disordered eating behaviour in athletes is linked to insufficient energy intake.[9] Energy deficiency in sport is relative to the balance between dietary energy intake and energy expenditure required to support all bodily functions and physical activity.[9] Low energy availability plays a pivotal role in the development of relative energy deficiency. Energy availability is defined as daily dietary energy intake minus exercise energy expenditure. Therefore, it is the sum of residual energy subsequent to exercise completion required for other metabolic processes of the body.[10] Low energy availability may be a result of deliberate undereating, but may also be due to non-pathogenic behaviour, such as the inability to match energy intake with exercise energy expenditure.[10] Relative energy deficiency is associated with various health and performance consequences, including, but not limited to, compromised bone health, reproductive dysfunction, clinical eating disorder, performance decrements and an increased risk of injury.[2,9] Therefore, screening and the early detection of energy deficiency is crucial to prevent performance decrements and long-term health consequences.

Data are scarce regarding the energy status of South African athletes, and lacking altogether with regard to female university student team sport athletes. Previously, we found low energy availability in a group of female student track and field athletes.[11] Also, most of the athletes (73%) with low energy availability presented with disordered eating behaviour, which raised grave concerns about energy status and the risk of eating disorders in these athletes. Therefore, this study aimed to further explore eating behaviour, body image and energy status within a group of subelite and elite female university student team sport athletes.

Method

Subjects and study design

Twenty-two female field hockey (n = 9) and netball player volunteers (n = 13), aged 18-30 years from North-West University, Potchefstroom, South Africa, were recruited into this cross-sectional study. Ethics approval was obtained from the ethics committee of North-West University (Ethics No NWU-0014-08-S1). Athletes gave written informed consent. Athletes competed in the university's first or second teams, some at a provincial or national level, and exercised ≥ 5 hours per week, including training sessions and games. This study took place in season, when training volumes and nutritional needs were high. Athletes were assured that the information gathered would be confidential, that their results would not be shared with coaches or trainers, and that only participant numbers would appear on the questionnaires. During completion of the questionnaires, talking was not permitted to minimise possible peer influence on responses. A research assistant was available at all times if any questions were unclear.

Demographic, health and sport information

A demographic, health and sport questionnaire was completed to attain socio-demographic information, body weight information (i.e. weight change during the past 12 months, amount of weight gain or loss, and currently dieting, maintaining weight or gaining weight), and training volume.

Height, weight, and body composition

Weight (kg) and height (cm) were measured to the nearest decimal according to the International Standards for Anthropometric Assessment criteria,[12] using a calibrated stadiometer and scale. Body mass index (BMI) was calculated as weight divided by height squared. Body composition was measured with a whole body scan by a registered radiographer using dual-energy X-ray absorptiometry (Hologic Discovery W®, Apex® system software version 2.3.1, Vertec Scientific SA, Johannesburg, South Africa).

Disordered eating behaviour and body image

The original Eating Disorder Inventory (EDI) drive for thinness (EDI-DT), body dissatisfaction (EDI-BD) and bulimia (EDI-B) subscales were used to investigate symptoms of disordered eating behaviour.[13] The EDI-DT and EDI-BD subscales have been shown to predict the development of eating disorders, and have been used as selection criteria when investigating the prevalence of eating disorders in athletes.[14] Owing to the risk of false responses to the EDI, the Three-Factor Eating Questionnaire's (TFEQ) cognitive dietary restraint (CDR) subscale, i.e. TFEQ-CDR, was also completed.[15] The TFEQ-CDR subscale measures the intent to control food intake to achieve or maintain desired body weight, described as subclinical disordered eating.[16] A body weight questionnaire, including a body silhouette assessment scale, where athletes chose a schematic figure on a scale from 1 ("very thin") to 9 ("obese"), that they think best represents their actual and ideal body silhouette,[17] was also completed. The discrepancy between the "actual" and "ideal" silhouette termed "feel minus ideal discrepancy" was calculated to provide an indication of body image dissatisfaction, and whether or not the athletes desired weight loss, gain or maintenance. Weekly use of pathogenic weight control measures, including fasting, vomiting, diuretics or laxatives, diet pills or "fat burners", and meal skipping, as well as non-pathogenic weight control measures, e.g. very low-energy diets and additional exercise beyond normal training, were recorded. Monitoring the use of pathogenic weight control measures is important as it may contribute to disordered eating.[2] Athletes scoring high on the EDI-DT (≥ 15), and/or EDI-BD (≥ 14), and/or TFEQ-CDR (≥ 9) subscales, and/or those who used pathogenic weight control measures on a weekly basis, were classified as "at risk of disordered eating behaviour".[7,18]

Energy status

The athletes were asked (and trained) to keep diet and exercise records on three training days over a period of 1-2 weeks. Energy status was calculated using energy availability. The diet records reported food intake using standardised household measurements and generic sketches of food and beverage portion sizes to assess the amounts eaten. Upon their return, the diet records were checked for completeness, and any uncertainties clarified between the researcher and athletes. Food data were converted to nutrient intakes, using FoodFinder® version 3. Possible under-reporters were identified by calculating the relation of mean energy intake to calculated basal metabolic rate (BMR) according to the method of Goldberg.[19] BMR was calculated using the Cunningham formula.[20] A Goldberg ratio (energy intake to BMR) of < 1.11 was considered to consitute possible under-reporting as this represents the cut-off for women with a medium physical activity level.[21]

Mean estimated exercise energy expenditure ($_{est}$EEE) was measured from the exercise records. All planned exercise (defined as all exercise performed for sport, including games and recreational exercise) was recorded in terms of type of exercise, duration (in minutes), and intensity level, based on the rate of perceived exertion (RPE), where 1 is "very easy" up to 5 "very hard". Each activity was subjectively assigned a metabolic equivalent (MET) value as per Ainsworth's compendium, according to the reported RPE score, which corresponds to the exercise effort. For example, weight lifting with an RPE score of 5 was assigned a MET value of 6, which corresponded to weightlifting, i.e. vigorous effort according to Ainsworth's compendium.[22] To calculate estimated energy availability ($_{est}$EA) expressed in kcal/kg fat-free mass (FFM)/day, the following formula was used (adapted from Manore et al):[23]

$$_{est}EA = \frac{\text{mean energy intake (kcal)} - \text{mean } _{est}EEE \text{ (kcal)}}{\text{FFM (kg)}}$$

Where $_{est}$EEE is:

[(MET x minutes of exercise) – (activities of daily living)],[24] and activities of daily living is minutes of exercise x 2.3.

A MET value of 2.3 represents an average value of assumed general activities of daily living, as per Ainsworth's compendium, i.e. sitting, walking, cleaning and using transport. Low $_{est}$EA was defined as < 30 kcal/kg FFM/day, and an optimal $_{est}$EA as ≥ 45 kcal/kg FFM/day, as described by Loucks[25] for sedentary women.

Statistical analyses

Statistical analyses were conducted with IBM® SPSS® Statistics version 20. Data were analysed for normality using the Shapiro-Wilk test. Normally distributed data are reported as means and standard deviations, and not-normally distributed data, e.g. age, EDI-DT and EDI-B, as medians and interquartile ranges. Categorical data were analysed with cross-tabulations and expressed as percentages of the total group. Chi-square analyses were used to determine the differences between groups for pathogenic weight control measures and non-pathogenic weight control measures, as well as under-reporting. Athletes were grouped according to their energy availability and disordered eating behaviour. Parametric variables were compared with t-tests, while non-parametric variables were compared with the Mann-Whitney U test. Paired t-tests were used to compare the actual and desired weight for athletes with low and normal energy availability. Associations between continuous variables were identified with the Spearman's rank-order correlation test. The significant level for tests was set at p-value < 0.05.

Results

Subject characteristics and body composition measurements are presented in Table I. Sixty-four per cent (n = 14) of the athletes competed at national or international level.

Disordered eating and body image

Collectively, 68% of the athletes were identified as at risk of disordered eating behaviour, of whom 80% (n = 12/15) were currently dieting (Table II). One athlete's TFEQ-CDR questionnaire was incomplete and therefore was excluded from the analysis. Only three athletes reportedly sought nutrition counselling from a health professional when trying to control their body weight.

Twelve (55%) athletes believed that they were currently slightly overweight. Seventy-three per cent (n = 16) were currently dieting, 23% (n = 5) wanted to maintain their weight and 5% (n = 1) wanted to gain weight. During the previous 12 months, 53% (n = 11/21) said that they had gained, and 47% had lost, weight. Most of the weight change ranged from > 0-2 kg (48%) or between > 2-4 kg (44%). Athletes had been at their current weight for 4.7 ± 2.9 months.

Table I: Subject characteristics and body composition

Variable	n = 22
Age (years)	19.5 (19, 21)
Training sessions (hours/week)	6 (6, 9)
Duration of sessions (minutes)	120 (90, 120)
Weight (kg)	65.7 ± 7.9
Desired weight (kg)	61.6 ± 1.3
Height (cm)	170.4 ± 7.6
Body mass index (kg/m²)	22.6 ± 1.8
Percentage body fat (%)	23.5 ± 3.6
Fat-free mass (kg)	49.0 ± 5.6

Data are reported as means ± standard deviation for the parametric variables, and the median and interquartile range (25th, 75th percentile) for the non-parametric variables.

Table II: Disordered eating behaviour, and pathogenic and non-pathogenic weight control measures

Eating disorder inventory subscales	Score, n = 22
Body dissatisfaction	9.2 ± 5.1
Body dissatisfaction ≥ 14 (%)	14
Drive for thinness	2.5 (0, 10)
Drive for thinness ≥ 15 (%)	5
Bulimia	0 (0, 2)
Three-Factor Eating Questionnaire subscale	n = 21
Cognitive dietary restraint	9.2 ± 5.5
Cognitive dietary restraint ≥ 9 (%)	57
	Percentage, n = 22
Pathogenic weight control measures	
Meal skipping	22.7
Use of "fat burners" and diet pills	4.5
Non-pathogenic weight control measures	
Additional exercise beyond training for sport	68.2
Commercial weight-loss programmes	4.5
Liquid weight-loss supplements	13.6
Very low-calorie diets (< 1 200 Kcal/day)	4.5
Low-carbohydrate, high-protein diets, e.g. Atkins diet	4.5

Data are reported as mean ± standard deviation for the parametric variables, as well as the median and interquartile range (25th, 75th percentile) for the non-parametric variables. Categorical data are presented as a percentage above the cut-off, or of the total group.

Average "feel minus ideal discrepancy" (zero indicates body image dissatisfaction and a positive value indicates desired weight loss) was 1.5 (1, 2.3), and desired weight loss (defined as desired body weight minus actual body weight) was –4.1 ± 3.9 kg. Reasons for trying to change body weight included sporting performance (59%), appearance (23%), health (5%) and other reasons (14%).

Table III: Spearman's rank order correlations (n = 22)

Variables	Desired weight loss	BMI	$_{est}$EA	TFEQ-CDR	EDI-DT
Body weight	−0.62**	0.71**	−0.51*	0.50*	NS
Desired weight loss		−0.79**	NS	−0.46*	NS
Exercise energy expenditure	NS	NS	NS	NS	0.45*
Training hours/week	NS	0.47*	NS	NS	NS
Energy intake	NS	NS	0.90**	−0.46*	NS
TFEQ-CDR	NS	0.59**	−0.67**		0.43*

BMI: body mass index, EDI-DT: Eating Disorder Inventory's drive for thinness subscale, $_{est}$EA: estimated energy availability, NS: non-significant, TFEQ-CDR: Three-Factor Eating Questionnaire cognitive dietary restraint subscale
*: p-value < 0.05, **: p-value < 0.001

When athletes were grouped according to their risk of disordered eating, the only significant difference was that athletes at risk of disordered eating behaviour had a larger reported desired weight loss (−5 ± 3.9 kg) than those without risk (−2.3 ± 3.6 kg) (p-value 0.04).

Energy status

Mean reported energy intake was 1 683 ± 504 kcal/day (7 ± 2.1 MJ/day) and exercise energy expenditure 636 ± 213 kcal/day (2.7 ± 0.9 MJ/day). Twelve athletes (55%) were identified as possible under-reporters. The average Goldberg cut-off of the total group was 1.1 ± 0.4. Of the possible under-reporters, 67% (n = 12) were currently dieting. No differences were found for BMI, body fat percentage, EDI subscales or the CDR-TFEQ subscale between under-reporters and normal reporters. With the exclusion of the under-reporters, the mean energy intake was 2 179 ± 107 kcal/day (9.1 ± 0.5 MJ/day), whereas the energy intake of the under-reporters was 1 329 ± 230 kcal/day (5.6 ± 1 MJ/day). Since athletes are known to ingest insufficient energy on heavy training days, possible under-reporting was noted, but not excluded from the analyses.[23] Average $_{est}$EA was 24 ± 12 kcal/kg FFM/day. Fifty-nine per cent (n = 13) of athletes fell below the 30 kcal/kg FFM/day cut-off point for sedentary women. Of those with low $_{est}$EA, 85% (n = 11/13) were identified as at risk of disordered eating behaviour. Seventy-seven per cent (n = 10/13) were dieting. With the exclusion of possible under-reporters, the average $_{est}$EA was 37 ± 2 kcal/kg FFM/day, and the $_{est}$EA of possible under-reporters was 19 ± 7 kcal/kg FFM/day, of who 58% (n = 7/12) were dieting.

When athletes were grouped according to $_{est}$EA, those with an $_{est}$EA < 30 kcal/kg FFM/day had significantly higher (p-value < 0.05) body weight (68.8 ± 7.2 vs. 61.5 ± 6.5 kg), BMI (23.4 ± 1.6 kg/m^2 vs. 21.7 ± 1.7 kg/m^2), longer training hours a week [8 (6, 9) vs. 6 (5, 6) hours], TFEQ-CDR scores (11.7 ± 4.6 vs. 5.1 ± 4.6), and more scored above the cut-off for the TFEQ-CDR (77% vs. 35%, chi-square 5.5, p-value 0.02) than those with an $_{est}$EA ≥ 30 kcal/kg FFM/day. Energy intake (1 418 ± 330 vs. 2 145 ± 426 kcal, p-value < 0.05) and Goldberg ratio (0.92 ± 0.22 vs. 1.48 ± 0.25) was significantly lower in those with low $_{est}$EA than in those with a higher $_{est}$EA, respectively. Interestingly, 69% (9/13) athletes with low $_{est}$EA were reportedly currently ingesting the same amount of energy as that ingested in the past month, 57% (4/13) more than usual, and none less than usual. Lastly, there was a significant difference between current body weight and desired body weight in athletes with an $_{est}$EA < 30 kcal/kg FFM/day (59.2 ± 7.2 kg vs. 55 ± 6.5 kg, p-value < 0.01).

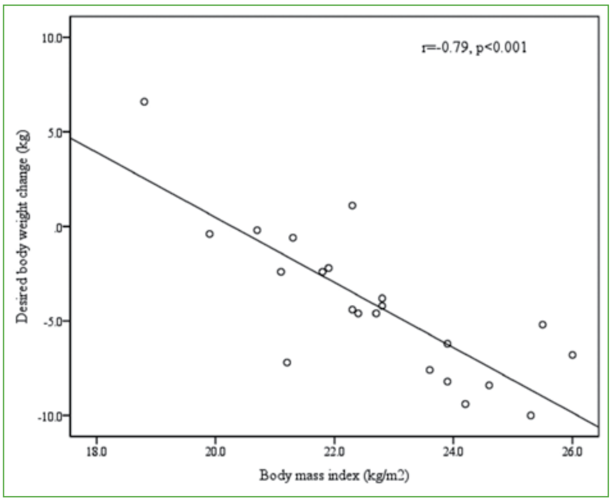

Figure 1: Negative association between body mass index and desired body weight change (n = 22)

The significant associations that were found between variables are illustrated in Table III. Athletes that weighed more wanted to lose more weight (Figure 1) and had higher cognitive dietary restraint. High cognitive dietary restraint was associated with a high drive for thinness, and lower energy intake and energy availability.

Discussion

The main findings of this study were that almost two thirds of the team sport athletes in the study were reportedly dieting in season, which probably contributed to disordered eating behaviour and low energy availability. Increased exercise beyond what was needed for training purposes for the athlete's sport, followed by meal skipping, were the most popular methods used to lose weight.

Disordered eating and body image

The prevalence of disordered eating and eating disorders is higher in athletes than in non-athletes, and in female athletes, than in male athletes.[26] Psychosocial factors, e.g. body dissatisfaction, low self-esteem, peer pressure and the training environment, linked to both appearance and performance, are often associated with disordered eating in sport.[10,26] The risk of disordered eating behaviour in university student athletes may further be compacted by the internalisation of a "lean" ideal body image depicted by the media, as well as having to adapt to an unfamiliar tertiary environment.[8] Disordered eating may be transient as athletes strive for a certain body weight or body composition using extreme weight-loss methods, but it may also progress and develop into a clinical eating disorder, such as anorexia nervosa or bulimia nervosa.[9,26,27]

In the present study, 68% of the athletes were classified as being at risk of disordered eating, of whom 77% (n = 11/14) had low energy availability. Although 73% of the athletes were trying to lose weight, and 96% reported that their ideal body silhouette was smaller than their current perceived body silhouette, only 14% and 5% scored high on the EDI-BD and EDI-DT subscales, respectively. Perhaps some of the respondents falsified their responses in the EDI. However, Torstveit et al[7] showed that false negative reports using the EDI to identify disordered eating behaviour were used by only 4% (n = 4/96) of nonlean-build athletes. Furthermore, even though many wanted a smaller body size, they may not necessarily present with pathogenic body dissatisfaction and/or drive-for-thinness symptoms.[28] The desire for body weight loss and a leaner physique seemed to be performance orientated, as more than half of the athletes reported that weight loss was desired for sports performance. The majority of the athletes in our study scored high on the TFEQ-CDR subscale, indicating restrained eating. This is supported by a negative association between TFEQ-CDR and energy intake. Similarly, in another study, active women with high cognitive dietary restraint had energy deficiency,[18] while Smith, Manore, Carroll and Skinner[29] did not find an association between dietary restraint and energy deficiency in active midlife women. Our findings on disordered eating behaviour were comparable to what we reported previously on top-level student netball players,[5] where 54% were identified to be at risk of disordered eating behaviour using the Eating Attitude Test-26 and EDI questionnaires, but higher compared to other studies.[3,4] Nichols et al[4] identified 21% nonlean-build high school athletes with disordered eating behaviour using the eating disorder examination questionnaire. Differences in prevalence between the studies may be owing to the different instruments used to identify disordered eating behaviour.

In contrast to others,[5,7] the athletes in our study did not make use of vomiting, bingeing, laxatives or diuretics to control their weight. Only one athlete used "fat burners" or diet pills on a regular basis, and 5 (23%) skipped meals. Our athletes wanted to lose approximately 4 kg of body weight, on average. The higher the BMI, the more body weight they wanted to lose. Those with a risk of disordered eating behaviour wanted to lose more body weight than those without risk. Fogelholm and Hiilloskorpi[30] showed that top-level, young adult female ball game athletes' preferred weight change range was comparable to that of our athletes' desired weight loss, namely ~ −4 kg (quartile 1 and 3: −6.2, −2). The important difference was that the athletes' weight loss was supervised in Fogelholm and Hiilloskorpi's study, while only 3 (14%) athletes in our study reportedly sought professional guidance when trying to control or lose their body weight. We also investigated the association between level of competition and disordered eating behaviour, but found no relationship. This may be because hockey players and netball players trained together, and often played as a team at university games, even though some also competed at a higher level, e.g. provincial or national.

Therefore, it seems that the high risk of disordered eating behaviour in the present study was probably owing to intentional weight-loss efforts. Since this was not appropriately managed, it resulted in eating behaviour changes, as well as in reduced energy availability.[27] In fact, current body weight was negatively associated with desired weight loss and positively associated with dietary restraint. The latter was negatively associated with energy intake and energy availability in the present study. These results highlight the importance of supervised weight-loss programmes to reduce the risk of disordered eating behaviour and energy deficiency. Identified athletes with disordered eating behaviour should be closely monitored, and must follow a medical treatment plan to improve their eating behaviour and energy status as well as establish what other factors contributed to weight loss. Additionally, attention should be paid to the effects of peer influence on athletes with disordered eating behaviour by fellow athletes and team members, as this is important when seeking to reduce their risk of disordered eating behaviour. Sports participation should be stopped when extreme weight-loss techniques are used, or if other medical conditions (psychological and physiological) are present relating to low energy availability, in order to improve the athlete's health, and to send a clear message of what constitutes healthy eating habits to the rest of the team.[9]

Energy status

Compared to the general public, athletes are at an increased risk of developing relative energy deficiency owing to high physical activity levels that contribute to increased daily energy expenditure. These high levels of physical activity can easily result in body weight loss, especially lean mass loss and performance decrements, if special care is not taken by athletes to meet their increased energy needs. Apart from an unintentional mismatch between energy intake and energy expenditure, other risk factors for energy deficiency in athletes include disordered eating behaviour and mismanaged efforts to reduce body weight or change body composition.[9]

A large number of athletes in this study presented with low energy availability [< 30 kcal/kg lean body mass (LBM)/day] which may be explained by the fact that so many of the athletes were reportedly dieting. This was supported by the established association between dietary restraint, body weight, energy intake and drive for thinness. The average energy intake of the total group, and in those with a low energy availability, was lower than that previously reported in nonlean-build female team sport athletes,[31] but comparable to that in female athletes with subclinical eating disorders[32] and those on weight-loss regimens.[33] Low energy availability levels might have been attributed to under-reporting since people who try to lose weight are known to under-report food intake.[34] However, we believe that most of our athletes were undereating, rather than under-reporting, as we found a negative association between energy availability and body weight, as well as dietary restraint, but a positive association between energy availability and energy intake. Undereating might have occurred during the course of the training and competition season as all of the athletes in the low energy availability group were reportedly eating the same or more than they had done during the past month. None of them were said to be eating less. Also, the data collection took place towards the end of the competition season. In addition to undereating, athletes with low energy availability reported engaging in significantly more training hours per week than those with higher energy availability. Training hours are positively associated with BMI, indicating that those with a higher BMI trained more. In fact, additional exercise beyond that required for training for their sport was the most popular weight loss method in our athletes. Taken together, it seems that the low energy availability was the result of a combination of undereating and increased exercise energy expenditure.

It was particularly concerning that athletes who wanted to lose weight had energy availability of < 20 kcal/kg LBM/day, indicating severe energy deficiency. The cause for an energy deficiency in this group of student netball and hockey players was different to what we previously found in student track and field athletes who showed low energy availability, mainly because of insufficient energy intake.[11] These results highlight that causes of energy deficiency may be unique in different sports, and tailored advice is needed to improve athletes' energy status. Evaluating athletes' energy status regularly is crucial as energy deficiency is associated with an array of potential health consequences and performance effects. The health consequences of long-term energy deficiency affect many body systems, including cardiovascular, gastrointestinal, endocrine, reproductive, skeletal, renal and central nervous.[27] Performance effects may include reduced muscle strength, endurance performance and glycogen stores, irritability, decrements in concentration and coordination, and increased risk of injury and illness.[9,10] Readers are directed to the latest International Olympic Committee consensus statement on relative energy deficiency in sport for an in-depth overview on the topic.[9]

This study had limitations. Energy availability was calculated from training days, and did not represent the average energy availability during a week. Therefore, future studies should also include rest days when average energy availability is calculated. Furthermore, self-reported exercise energy expenditure may have resulted in under- or overestimations. An objective measure, such as an activity or heart rate monitor, is recommended for a more accurate calculation of daily and exercise energy expenditure. The lack of a control group was a major limitation of this study, and owing to the relatively small convenience sample, the results cannot be generalised. Lastly, the results may be biased as self-selected volunteer athletes may have been interested in the study because of their desire to lose body weight.

In conclusion, despite these limitations, important observations were made as to the energy status and disordered eating behaviour of student team sport athletes. A large proportion of athletes presented with disordered eating behaviour and low energy availability, probably owing to mismanaged efforts to lose body weight in season. This finding highlights the importance of supervised weight loss by a health professional who is trained in the area of nutrition, such as a registered dietitian. Knowledge with regard to sports nutrition, taking into account training periodisation and the body composition requirements for different sports, are also important to prevent relative energy deficiency, while facilitating desired body weight loss. Coaches should also be educated on healthy and strategic weight-loss practices, i.e. before season, which may reduce the pressure on athletes to attain the desired body weight in season. This is particularly important for student athletes, who face multiple psycho-social and environmental triggers that may result in disordered eating behaviour, or even a clinical eating disorder. More research is needed on weight management practices, energy status and key role players who have an influence on South African athletes' dietary patterns, to enable specific and targeted recommendations to prevent energy deficiency and disordered eating behaviour in South African athletes.

Recommendations

To reduce the risk of energy deficiency occurring (with or without disordered eating behaviour) and its associated health and performance consequences, it is recommended that:

- Athletes who want to change their body composition are referred to a registered dietitian with sports nutrition experience to obtain a supervised nutrition care plan.
- An early detection and a multidisciplinary treatment approach is recommended for athletes with disordered eating behaviour to prevent the development of an eating disorder.
- Athletes with low energy availability should be advised to increase energy intake, and/or to introduce a small reduction in their weekly training programme, and/or to introduce a rest day.
- The medical team must be educated on the screening and treatment of energy deficiency, with and without disordered eating behaviour.
- Coaches and other role players should place less emphasis on a "lean ideal" for enhanced performance, and more emphasis on a healthy body weight and diet.
- If body weight loss or composition change is required, coaches should ensure that this takes place out of season, and that interventions are not detrimental to the athletes' health.
- Athletes who need to lose weight should aim for an energy availability of 30-45 kcal/kg LBM/day.[21]
- Athletes must be educated on healthy weight-loss practices, as well as the health and performance consequences of extreme and unsupervised restrictive diets.

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Declaration

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