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Research article

NUTRITIONAL PRACTICES OF NATIONAL FEMALE SOCCER PLAYERS: ANALYSIS AND RECOMMENDATIONS

Louise Martin [1] ✉, Anneliese Lambeth [1] and Dawn Scott [2]

[1] University of Worcester, School of Sport & Exercise Science, Henwick Grove, Worcester, UK
[2] Medical and Exercise Science Department, The Football Association, Lilleshall Hall, Shropshire, UK

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ABSTRACT

The aim of the study was to establish the nutritional practices and activity patterns of elite female soccer players. The nutritional intake of 16 female England Soccer players was self-reported over a seven-day period. Participants were provided with written and verbal guidelines for the completion of the diaries. Training details were also recorded, and used in combination with BMR predictions to calculate daily energy expenditure. Energy, macronutrient and micronutrient intakes were determined using DietMaster 4.0 software. Results suggest that energy intake was low (1904 ± 366.3 kcal) in relation to previous recommendations for soccer players. Energy expenditure (2153.5 ± 596.2 kcal) was not significantly different ($p > 0.05$) from intake, suggesting energy balance was achieved. Carbohydrate (53.8 ± 6.8%), protein (16.8 ± 2.1%) and fat (28.8 ± 6.6%) intakes were in line with recommendations. Fluid intake (2466 ± 1350.5ml·day^{-1}) was sufficient to meet baseline recommendations, but would need to be higher to meet the additional requirement of training and competition. With the exception of vitamin A and iron, all micronutrient intakes were higher than the DRI. In conclusion, recommendations for female soccer players are to encourage consumption of carbohydrate-electrolyte beverages to enhance carbohydrate intake and increase fluid intake, and ensure sufficient iron rich foods are included in the diet to meet the DRI.

KEY WORDS: Energy, intake, expenditure, carbohydrate, fluid, micronutrient.

INTRODUCTION

Good nutritional practice is essential to athletic success by improving the quality of training, maximising performance and speeding recovery time. Soccer is described as a high intensity intermittent sport involving continual changes in activity (Hargreaves, 1994). Elite female players have been reported to cover total distances of 8.5km, 9.5km (Bangsbo, 1994) and 12.4km (Holmes, 2002) with a maintained relative exercise intensity of 70% VO_2max (Brewer, 1994) despite spending 76% and 11% of their time in low and high intensity activities respectively (Holmes, 2002). Such high metabolic and energy demands of soccer training and competition must be met by adequate nutritional intake. Previous research of the nutritional practices of female soccer players is limited but have reported daily energy intakes ranging from 1778 ± 715 to 2290 ± 310 kcal·day^{-1} (Clark et al., 2003; Scott et al., 2003) with percentage carbohydrate, protein and fat intakes of 47.8 ± 9.8 to 55.0 ± 7.5%, 13.9 ± 4.0 to 15.0 ± 3.1 and 29.0 ± 5.7 to 33.3 ± 9.5 respectively (Scott et al., 2003; Clark et al., 2003). Furthermore, the nutritional practice of female athletes should be concerned with gender specific considerations of iron and calcium (Piehl-Aulin, 1995). Clark et al. (2003) reported that NCAA Division 1 players failed to meet the Daily Recommended Intakes for both of these essential minerals, whilst Scott et al. (2003)

also reported iron deficiencies.

The validity of data collected via self-reported food diaries have been questioned due to inherent limitations in the technique. These include frequent bias towards underestimation of habitual intake (Black et al., 1991), failure to report all foods consumed (Goldberg et al., 1991) and/or modification of the normal eating pattern (Stockley, 1985). In addition to this, Bingham (1987) stated that seven days is the shortest time necessary to cover fluctuations in dietary patterns e.g. weekdays and weekends, and the longest time participants can be expected to co-operate. Indeed, both of the aforementioned studies may be limited in that they have collected data over relatively short time frames; 2 days not including weekends (Scott et al., 2003) and 3 days incorporating weekends (Clark et al., 2003). Previous research is further limited by failing to provide parallel activity data to indicate energy expenditure, which would enhance the interpretation of nutritional intake. The current study attempts to address some of these limitations by recording nutritional intakes for 7 days as well as reporting the corresponding activity patterns during this timeframe.

Thus the aim of the present study was to further investigate the nutritional practices of elite female soccer players by reporting diet and activity records over a period of seven days.

METHODS

Participants

Sixteen international female soccer players (Age = 25.5 ± 3.9 yrs; Height = 1.67 ± 0.08 m; Body Mass = 61.5 ± 5.3 kg) participated in the investigation. Players were fully informed of the purpose and procedures of the investigation and provided consent at the outset.

Dietary and activity collection

The participants' dietary intake and activity levels were collected, via self-reporting diaries, during the second half of the 2003/04 competitive season when all players were participating in full training and competition. Participants were required to record all food and beverage intake, and any training, matches or other physical activities for a period of seven-days. Reporting over seven-days provides the best opportunity to collect valid information as it encompasses the potential diversity of diet and activity practices of weekdays and weekends (Bingham, 1987; Tilgner and Schiller, 1991).

Players attended a training camp immediately prior to the collection period. During this time they were issued with a food and activity diary along with verbal and written instructions for its completion. Information provided focused on average portion sizes for a range of common foods (e.g. pasta, rice, cereals) and a guide to universal household measures (e.g. teaspoon, tablespoon, cup) to improve the estimation of daily intake.

The food section of the diary included the following headings; 'meal', 'food/beverage description', 'portion size/quantity', 'brand', 'food type' and 'cooking method' to facilitate accurate analysis. The activity section requested that participants record the type, duration, and approximate intensity of each activity on a daily basis. Participants were requested to follow their customary eating patterns during the prospective recording days and were asked to confirm this via a series of brief questions at the end of the food and activity diary. Finally space was provided for participants to include any other information including details of any dietary supplements consumed.

On completion of the seven-day recording period, participants were requested to return their completed diary for analysis. Dietary analysis was undertaken by a single researcher using the computerised package 'Dietmaster 4.0' (Stuart Dyson Associates, London, UK). Estimation of energy expenditure was undertaken by a second single researcher by calculating BMR (COMA, 1991) alongside analysis of reported activities using the computerised package 'Diet Organizer 2.0' (Mulberrysoft, USA). The use of a single researcher for these analyses enhanced reliability of data by minimising potential variations in the interpretation of food or activity reports (Deakin, 2000).

Data analysis

A seven-day average for total energy intake (kcals), total energy expenditure (kcals), macronutrients ($g \cdot kg^{-1}$, %), micronutrients (mg, ug) and fluid intake (L) was determined for each participant. Descriptive statistics were determined for all variables. Paired samples t-tests were used to assess energy balance (energy intake vs. energy expenditure), and to identify possible nutrient deficiencies via comparison to Reference Nutrient Intakes (COMA, 1991).

RESULTS

Energy balance

The average daily intake from the 7-day analysis was 1904 ± 366 kcal, and the mean energy expenditure was 2154 ± 596 kcal. This represents a 250 kcal energy deficit, though statistical analysis reveals no significant difference between intake and

Table 1. Comparison of macronutrient and fluid intake to recommendations ([a] Devlin and Williams, 1991, [b] Williams, 1995). Data are means (±SD).

Nutrient	Intake ($g \cdot kg^{-1}$)	Recommended [a] ($g \cdot kg^{-1}$)	Intake (% of total)	Recommended [b] (% of total)
Carbohydrate	4.1 (1.0)	4.0-6.0	53.8 (6.8)	60-70
Protein	1.2 (.3)	1.2-1.4	16.7 (2.1)	12
Fat (total)	.9 (.2)	-	29.0 (6.6)	18-28
Saturated Fat	-	-	10.6 (3.3)	<10
Mono- Fat	-	-	13.6 (3.8)	-

expenditure ($p > 0.05$), suggesting average energy balance was achieved.

The relative energy intake of 30.9 ± 5.5 $kcal \cdot kg^{-1} \cdot day^{-1}$ falls below the recommendations for female soccer players of 47-60 $kcal.kg^{-1}.day^{-1}$ (Economos et al., 1993). This reported intake was significantly lower ($p < 0.05$) than the lower end of this recommended range (47 $kcal \cdot kg^{-1} \cdot day^{-1}$). Average daily training time was 108.2 ± 35.9 minutes, which represents 31.8 ± 6.5% of the total daily energy expenditure. There was no significant difference ($p > 0.05$) in body mass recorded before and after the 7-day report period (61.5 ± 5.3kg vs. 61.6 ± 5.3kg).

Macro-nutrients

The mean intakes of the energy producing macronutrients were 53.8 ± 6.8%, 28.8 ± 6.6% and 16.8 ± 2.1% for carbohydrate, fat and protein, respectively. When reported as a percentage of total calories, carbohydrate and protein intakes were significantly lower and higher ($p < 0.05$) respectively of the recommended levels. Fat intake was significantly higher ($p < 0.05$) than the lower value in the recommended range (18%), but not significantly different ($p > 0.05$) to the upper end of this range (28%). When macro-nutrient intake is expressed as $g \cdot kg^{-1} \cdot day^{-1}$ (Table 1), carbohydrate and protein intakes fell within their recommended ranges.

Micro-nutrients

With the exception of Vitamin A (56% of RNI) and iron (82% of RNI), all micronutrient intakes are above the RNI. Calcium and iron intakes are not significantly different ($p > 0.05$; Table 2) from the RNI.

Mean fluid intake was 2466 ± 1350 $ml \cdot day^{-1}$, which represents 99% of the baseline daily requirement proposed by Maughan (2000).

DISCUSSION

Energy

The results of this nutritional analysis of elite women's soccer players demonstrate an average daily intake, recorded over 7 days, to be 1904 ± 366 kcal. This is lower than previously reported values for female soccer players (Clark et al., 2003), and when expressed relative to body weight (30.9 ± 5.5 $kcal \cdot kg^{-1} \cdot day^{-1}$) falls significantly below ($p < 0.05$) previous recommendations for female soccer players (47-60 $kcal \cdot kg^{-1} \cdot day^{-1}$, Economos et al., 1993).

Energy expenditure data (2154 ± 596 $kcal \cdot day^{-1}$) present a 250 $kcal \cdot day^{-1}$ energy deficit to intake (1904 ± 366 $kcal \cdot day^{-1}$). Statistical analysis revealed no significant difference between intake and expenditure ($p > 0.05$), suggesting average energy

Table 2. Summary of the mean intake of the micronutrients analysed, with comparison to RNI (COMA, 1991, [a] Maughan, 2000).

Micro-Nutrient	Mean (± SD)	RNI	% RNI
Thiamin (mg)	2.6 (4.3)	0.8	323
Riboflavin (mg)	1.8 (.9)	1.1	167
Niacin (mg)	25.1 (6.6)	13	193
B6 (mg)	2.4 (.8)	1.2	203
B12 (mcg)	3.7 (1.2)	1.5	257
Vitamin C (mg)	126.8 (76.2)	40	317
Vitamin A (mcg)	336.1 (195.0)	600	56
Vitamin D (mcg)	2.1 (.8)	0	0
Calcium (mg)	840.0 (335.1)	700	120
Magnesium (mg)	285.5 (147.5)	270	106
Sodium (mg)	3006.7 (784.2)	1600	188
Iron (mg)	12.1 (6.0)	14.8	82
Fluids (ml)	2466.0 (1350.5)	2500 + sweat loss [a]	99

balance was achieved. The current findings are similar to those previously reported. Fogelholm et al. (1994) reported daily energy intake of 2131 ± 400 kcal with a 111 ± 450 kcals energy deficit in normal weight female soccer players. The achievement of energy balance is further supported by there being no significant change in body mass pre and post the reporting period (61.5 ± 5.3kg vs. 61.6 ± 5.3kg, $p > 0.05$), however it is recognised that this observation exists only within the limitations of the assessment techniques used. However, the non-significant calorie deficit of 248 kcals may have a number of detrimental practical implications. Regular energy deficit over time may lead to a decrease in body mass, including the potential loss of muscle mass, which would be detrimental to performance. The energy deficit reported in this study (248 $kcal \cdot day^{-1}$) would result in very gradual weight loss of $0.03 kg \cdot week^{-1}$ (McArdle et al., 1999), which is too small to be observed within the sensitivity of standard weighing scales but would be significant over time. Furthermore, a negative energy balance can also impact upon recovery rates, training adaptations, cognitive functioning and the immune system (O'Connor et al., 2000) that would all be detrimental to a players capability to undertake training and competition performance especially at an international level where demands are higher.

Macro-nutrients

Carbohydrate is the primary fuel substrate during soccer, and consequently high dietary intakes of 60-70% of total calorific intake have been recommended for athletes (Devlin and Williams, 1995) and footballers (Schokman et al., 1999). In the present study carbohydrate intake was significantly lower than these recommendations (53.8 ± 6.8%, $p < 0.05$), but fall within the range previously reported for female soccer players 47.8 ± 9.8 to 55.0 ± 7.5% (Clark et al., 2003; Scott et al., 2003). When expressed relative to body mass the daily carbohydrate intake of 4.0 $g \cdot kg^{-1} \cdot day^{-1}$ just meet the recommended 4.0 – 6.0 $g \cdot kg^{-1} \cdot day^{-1}$ (Williams, 1995). The current data provide further evidence to the commonly observed low carbohydrate intakes that are insufficient for adequate glycogen re-synthesis in female athletes (Nutter, 1991; Tanaka et al., 1995). Dietary recommendations for promoting maximal glycogen resynthesis and for the maintenance of muscle glycogen levels are to consume a high carbohydrate diet, 55 – 65% (Clark, 1994) and a daily intake of 7 – 10 $g \cdot kg^{-1} \cdot day^{-1}$ (Schokman et al., 1999). Based upon these recommendations players in the current study reported carbohydrate intakes that are likely to be inadequate to replace muscle and liver glycogen stores which rapidly deplete during repeated bouts of high intensity exercise performed during training and competition (Bangsbo, 1994). Ultimately both the quality of training and match performance may be compromised on a regular basis due to earlier onset of fatigue.

To alleviate this, it appears that players in the current study need to consider increasing their daily carbohydrate intake. However, Clark et al (2003) identified that the typically low daily calorific intake of female athletes (<2000 $kcals \cdot day^{-1}$) are insufficient to follow the recommended guidelines of ~60% carbohydrate, as this will only provide 4.0 – 5.0 $g \cdot kg^{-1} \cdot day^{-1}$. Similarly, Economos et al. (1993) recommended a minimum of 6.0 $g \cdot kg^{-1} \cdot day^{-1}$ for athletes consuming less than 45 $kcal \cdot kg^{-1} . day^{-1}$, which applies to the players in the current study who were only consuming an average of 31.0 $kcal \cdot kg^{-1} \cdot day^{-1}$. Players in the present study would be advised to increase their relative carbohydrate intake in preference to following percentage value recommendations to compensate for their low energy intake. This would need to be done carefully particularly since the players are statistically in energy balance, however there are a range of high carbohydrate foods that could be used to replace the moderate carbohydrate/high fat foods that players reported in their diaries. This would enable carbohydrate intake to be increased without simultaneously increasing energy intake.

Strength and endurance requirements of soccer mean that players need increased dietary protein than their sedentary counterparts to support muscle protein synthesis and possibly act as an additional fuel supply (Lemon, 1994). In the present study protein intake (16.8 ± 2.1%) was significantly higher ($p < 0.05$) than the 12% intake recommended by Devlin and Williams (1991). This in agreement with Clark et al. (2003) who also reported values higher than the DRI (1.4 ± 0.3 $g \cdot kg^{-1} \cdot day^{-1}$). The reported intake of the current players (1.2 $g \cdot kg^{-1} \cdot day^{-1}$) is in line with the recommended range of 1.2-1.7 $g \cdot kg^{-1} \cdot day^{-1}$ for elite and professional athletes (Maughan and Burke, 2002) and players should be encouraged to continue this practice.

In comparison to the recommendations made by Devlin and Williams (1991) fat intake was significantly higher ($p < 0.05$) than the lower value (18%), but not significantly different ($p > 0.05$) to the upper end of this range (28%). The fat intakes of the players in the current investigation (28.8 ± 6.6%) is in accordance with the <30% recommendations for soccer players made by Ruiz et al. (2005), and slightly lower than those previously reported by Scott et al. (2003) and Clark et al. (2003) (29-33%). Furthermore, from a health perspective the percent of total fat consumption from saturated fat was 10.6 ± 3.3%, and the percent from unsaturated sources 13.6 ± 3.8%. This is just higher than the maximal intake of saturated fat (10%) recommended for the general population (COMA, 1991). Consequently, whilst current fat intakes meet recommendations these are towards the higher end for athletic performance and health and players should be advised that further increases in fat intake would be detrimental.

Despite the players in the current study being in statistical energy balance and consuming each of the macronutrients within previously published recommendations for athletic populations, there is scope for an alteration of the proportional intake of each which would have practical significance in enhancing recovery rates and facilitating players' ability to train and perform at a high intensity. Carbohydrate and protein are key nutrients for soccer performance and in the reported data both of these nutrients were at the lower end of recommended intakes and thus may be limiting both the performance and rate of recovery of these players. It is recommended, therefore, that daily intakes of carbohydrate and protein be increased to levels that would be more optimal for muscle glycogen resynthesis and protein resynthesis; alongside a concomitant decrease in fat intake that would be beneficial for health and performance.

Water

The observed fluid intake of 2466 ± 1351 $ml \cdot day^{-1}$ is slightly below the baseline recommendation of 2500 $ml \cdot day^{-1}$ (Maughan, 2000), however this value does not consider additional requirements to replace fluid losses during training and matches. Convertino et al. (1996) state that during exercise 600-1200ml fluid needs to be consumed per hour to replace sweat losses. The reported average daily training duration of 108.2 ± 35.9 minutes would therefore require a minimum of 1200 ml, suggesting a total daily requirement of ~3700 ml, although exact fluid needs are highly individual and depend upon intensity and duration of exercise, body size and composition, body surface area, individual sweat rates, clothing and environmental conditions (Broad et al., 1996, Maughan et al., 2004). The current data indicate a shortfall in daily fluid intake of approximately 1200 ml. This would have implications for performance since dehydration increases the thermal load of exercise and results in elevated heart rate (McGregor et al., 1999; Montain and Coyle, 1992) and earlier onset of fatigue due to an increased rate of glycogenolysis (Fallowfield et al., 1996; McGregor et al., 1999) and decreased performance of soccer skills (McGregor et al., 1999). To ensure adequate fluid replacement during and after exercise, players should consume prescribed volumes of fluid, calculated on an individual basis to replace body fluid losses, in preference to ad-libitum practices (Maughan et al., 2004; Wong et al., 1998). Furthermore, players in the current study did not report regular consumption of carbohydrate-electrolyte drinks post-exercise. This would be a further recommendation since the inclusion of energy substrate helps to maintain the desire to drink whilst initiating glycogen re-synthesis in the active muscle (Wong et al., 1998) and would be a simple and practical strategy to increase carbohydrate and fluid intakes in the players.

Micronutrients

Players reported Iron intakes of 12.1 ± 6.0 $mg \cdot day^{-1}$ which is below (82% of RNI), but not significantly different ($p > 0.05$) from the RNI (COMA, 1991). These data are similar to previously reported intakes of 12.2-17.3 $mg \cdot day^{-1}$ for female soccer players (Clark et al., 2003). Iron deficiency in female athletes appears to be common (Bean, 2003; Nutter, 1991; Tilgner and Schiller, 1991) and can be due to dietary intake and menstrual losses as well as iron losses in sweat, gastrointestinal and bladder blood loss, or haemaglobinuria from red blood cell damage in the plantar flasia during running (Tunstall-Pedoe, 1984). This said, without supporting haematological data, nutritional insufficiency alone does not indicate clinical iron deficiency. In addition to this, iron deficiency can occur even if the diet provides a sufficient amount (Iglesias-Gutierrez et al., 2005). Therefore ensuring daily intake is optimal will reduce the likelihood of such a condition arising, but should not be used as a marker per se. As a component of haemoglobin, iron is particularly important in the oxygen carrying capacity of an individual and deficiencies may therefore compromise aerobic capacity. Kang and Matsuo (2004) recently observed that 4-weeks of Iron supplementation by elite female soccer players significantly increased body iron stores and prevented training-induced decreases in Haemoglobin concentration. Players in the present study may benefit from ensuring sufficient iron rich foods or iron supplementations are included in the diet to meet the DRI.

Calcium intake 840 ± 335 $mg \cdot day^{-1}$ was above the RNI of 700 $mg \cdot day^{-1}$ (COMA, 1991). Previous research has indicated that low calcium intake is not uncommon in female athletes who restrict calorie intake or follow a low fat diet (Tanaka et al., 1995). Since fat intakes of the players in the present study were at the upper end of athlete recommended values, calcium deficiency was not anticipated.

Methodological considerations

Due to the errors inherent of all dietary recall methods, the values for seven days dietary analysis may not be accurate for all the measured parameters and should not be taken as an exact reflection of long-term nutrient status. Bingham (1987) suggested that seven days is sufficient to assess energy intake but other nutrients may need to be observed over a longer period of time. Although nutrient intake recorded over seven days is subject to a degree of variability, this measure of consumption is more reliable than an observation of a single day (Marr and Heady, 1986). Methods used for measuring food intake rely on the participants' ability to accurately record 'what' and 'how much' is eaten. Unfortunately self-reported dietary intake protocols are frequently biased towards underestimation of dietary intakes, which may explain the discrepancy between energy intake and expenditure observed in the present study. Goldberg et al. (1991) proposed that energy intake data can be used to assess the validity of a seven day record, by the identification of a minimum level of energy expenditure. It was proposed that energy intakes below 1.1 x BMR are not viable and therefore unlikely to represent true habitual intake. Utilising this, the minimum level of energy expenditure in the present study is 1911 kcals, which is higher than the mean reported intake of 1904 kcals, suggesting that underestimation of true dietary intake may have occurred.

CONCLUSIONS

Despite limitations of the self-reporting techniques used, dietary intakes of elite female soccer players in the present study are in agreement with those previously reported (Clark et al, 2003; Scott et al, 2003) and meet the recommendations for carbohydrate, fat and protein intakes. From a performance perspective an adjustment of the relative intakes of each macronutrient is recommended to enhance rates of glycogen and protein resynthesis during recovery. A non-significant calorie deficit of 248 kcals·day^{-1} and a 1200 ml shortfall in fluid intake were observed and consumption of carbohydrate-electrolyte fluids during/after training is recommended to increase carbohydrate intake, increase fluid intake and to help players to remain in energy balance. Observed deficiencies in iron intake may also be compromising aerobic capability through a reduction in oxygen transportation. Future research should consider improving the accuracy of self-reporting techniques in athlete populations by providing more training on portion sizes and household measures and encouraging the importance to record all food and fluid consumed on a daily basis.

REFERENCES

Bangsbo, J. (1994) Energy demands in competitive soccer. *Journal of Sports Sciences* **12,** 5-12.

Bangsbo, J. (1994) The physiology of soccer with special reference to intense intermittent exercise. *Acta Physiologica Scandinavica* **151 (Suppl. 159),** 1-155.

Bean, A. (2003) *The complete guide to sports nutrition,* 4th Edition. London, A and C Black Publishers Ltd.

Bingham, S. (1987) The dietary assessment of individuals: methods, accuracy, new techniques and recommendations. *Nutrition Abstracts and Reviews* **57,** 705-741.

Black, A.E., Goldberg, G.R., Jebb, S.A., Livingstone, M.B. E., Cole, T.J. and Prentice, A.M. (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 2. Evaluating the results of published surveys. *European Journal of Clinical Nutrition* **45,** 583-599.

Brewer, J. (1994) Nutritional aspects of women's soccer. *Journal of Sports Sciences* **12,** 35-38.

Broad, E.M., Burke, L.M., Cox, G.R., Heeley, P. and Riley, M. (1996) Body weight changes and voluntary fluid intakes during training and competition sessions in team sports. *International Journal of Sports Nutrition* **6,** 307-320.

Clark, K. (1994) Nutritional guidelines for soccer players in training and competition. *Journal of Sports Sciences* **12,** 43-50.

Clark, M., Reed, D.B., Crouse, S.F. and Armstrong, R.B. (2003) Pre- and post-season dietary intake, body composition, and performance indices of NCAA Division 1 female soccer players. *International Journal of Sport Nutrition and Exercise Metabolism* **13,** 303-319.

Committee on Medical Aspects of Food Policy (COMA) (1991) *Dietary reference values for food energy and nutrients for the United Kingdom*. London, Her Majesty's Stationary Office (HMSO).

Convertino, V.A., Armstrong, L.E., Coyle, E.F., Mack, G.W., Sawka, M.N., Senay, L.C. and Sherman, M. (1996) Position stand: Exercise and fluid replacement. *Medicine and Science in Sports and Exercise* **1;** I-IV.

Deakin, V. (2000) Measuring nutritional status of athletes: clinical and research perspectives. In: *Clinical sports nutrition.* Eds: Burke, L. and Deakin, V. Australia: McGraw Hill. 30-68.

Devlin, J.T. and Williams, C. (1991) Foods, nutrition and sports performance: A final consensus statement. *Journal of Sports Sciences* **9,** iii.

Economos, C., Bortz, S.S. and Nelson, M.E. (1993) Nutritional practices of elite athletes: Practical recommendations. *Sports Medicine* **16,** 381-399.

Fogelholm, M. (1994) Vitamins, minerals and supplementation in soccer. *Journal of Sports Sciences* **12,** 23-27.

Fallowfield, J.L., Williams, C., Booth, J., Choo, B.H. and Growns, S. (1996) Effect of water ingestion on endurance capacity during prolonged running. *Journal of Sports Sciences* **14,** 497-502.

Goldberg, G.R., Black, A.E., Jebb, S.A., Cole, T.J., Murgatroyd, P.R. Coward, W.A. and Prentice, A.M. (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *European Journal of Clinical Nutrition* **45,** 569-581.

Hargreaves, M. (1994) Carbohydrate and lipid requirements in soccer. *Journal of Sports Sciences* **12,** 13-16.

Holmes, L. (2002) A physiological analysis of work-rate in english female football players. *Insight* **5,** 54-55.

Iglesias-Gutierrez, E., Garcia-Roves, P.M., Rodriguez, C., Braga, S., Garcia-Zapico, P. and Patterson, A.M. (2005) Food habits and nutritional status assessment of adolescent soccer players. A necessary and accurate approach. *Canadian Journal of Applied Physiology* **30,** 18-32.

Kang, H-S. and Matsuo, T. (2004) Effects of 4 weeks iron supplementation on haematological and immunological status in elite female soccer players. *Asia Pacific Journal of Clinical Nutrition:* **13,** 353-358.

Lemon, P.W.R. (1994) Protein requirements of soccer. *Journal of Sports Sciences* **12,** 17-22.

Marr, J.W. and Heady, J.A. (1986) Within and between person variation in dietary surveys: number of days needed to classify individuals. *Human Nutrition: Applied Nutrition* **40,** 347-364.

Maughan, R.J. (2000) *Nutrition in sport.* IFSM, IOC Medical Commission, Oxford (England): Blackwell Science.

Maughan, R.J. and Burke, L.M. (2002) *Handbook of sports medicine and science: Sports nutrition.* Massachusetts: Blackwell Publishing Ltd.

Maughan, R.J., Merson, S.J., Broad, N.P. and Shirreffs, S.M. (2004) Fluid and electrolyte intake and loss in elite soccer players during training. *International Journal of Sport Nutrition and Exercise Metabolism* **14,** 333-346.

McArdle, W.D., Katch, F.I. and Katch, V.L. (1999) *Sport and exercise nutrition*. Philadelphia: Lippincott, Williams and Wilkins.

McGregor, S.J., Nicholas, C.W., Lakomy, H.K.A. and Williams, C. (1999) The influence of high-intensity shuttle running and fluid ingestion on the performance of a soccer skill. *Journal of Sports Sciences* **17,** 895-903.

Montain, S.J. and Coyle, E.F. (1992) The influence of dehydration on hyperthermia and cardiovascular drift during exercise. *Journal of Applied Physiology* **73,** 1340-1350.

Nutter, J. (1991) Seasonal changes in female athletes' diets. *International Journal of Sports Nutrition* **1,** 395-407.

O'Connor, H., Sullivan, T. and Caterson, I (2000) Weight Loss in Athletes. In: *Clinical sports nutrition.* Eds: Burke, L. and Deakin, V. Australia: McGraw Hill. 146 - 184.

Piehl Aulin, K. (1995) Gender-specific issues. *Journal of Sports Sciences* **13,** 35-39.

Ruiz, F., Irazusta, A., Gil, S., Irazusta, J., Casis, L. and Gil, J. (2005) Nutritional intake in soccer players of different ages. *Journal of Sports Sciences* **23,** 235-242.

Scott, D., Chisnall, P.J. and Todd, M.K. (2003) Dietary analysis of English female soccer players. In: *Science and soccer.* Eds: Reilly, T. and Williams, M. London: Routledge, an imprint of Taylor & Francis Books Ltd. 245-250.

Schokman, C.P., Rutishauser, H.E., and Wallace, R.J. (1999) Pre and post-game macro-nutrient intake of a group of elite Australian football players. *International Journal of Sports Nutrition* **9,** 60-69.

Stockley, L. (1985) Changes in habitual food intake during weighed inventory surveys and duplicate diet collections – a short review. *Ecology, Food and Nutrition* **17,** 263-269.

Tanaka, J.A., Tanaka, H., and Landis, W. (1995) An assessment of carbohydrate intake in collegiate runners. *International Journal of Sports Nutrition* **5,** 206-214.

Tilgner, S.A. and Schiller, M.R. (1991) Dietary intakes of female college athletes: the need for nutritional education. *Journal of the American Dietetic Association* **89,** 967-969.

Tunstall-Pedoe, D. (1984) Marathon medicine and introduction. *British Journal of Sports Medicine* **4,** 238-240.

Williams, C. (1995) Macronutrients and performance. *Journal of Sports Sciences* **13,** 1-10.

Wong, S.H., Williams, C., Simpson, M. and Ogaki, T. (1998) Influence of fluid intake pattern on short-term recovery from prolonged, submaximal running and subsequent exercise capacity. *Journal of Sports Sciences* **16,** 143-152.

KEY POINTS

- Female soccer players demonstrate a low energy intake in relation to predicted requirements, but were in energy balance in this study.
- Increased carbohydrate intake may be beneficial to both training and competition performance of elite female soccer players
- Fluid requirements should be addressed on an individual basis and matched to player requirements.
- The iron status of female soccer players may be compromised due to insufficient dietary intake to meet the DRV.

AUTHORS BIOGRAPHY

Louise MARTIN
Employment
Lecturer, University of Worcester, UK.
Degrees
MSc, BSc
Research interests
Applied physiology of performance, diurnal variation of performance, swimming.
Email: l.martin@worc.ac.uk

Anneliese LAMBETH
Employment
Lecturer, University of Worcester, UK.
Degrees
MSc, BSc
Research interests
Nutritional analysis and intervention in athletic groups. The female athlete. Lactate response to exercise, an applied perspective. Optimal pacing for endurance performance.
E-mail: a.lambeth@worc.ac.uk

Dawn SCOTT
Employment
Exercise Scientist, Medical and Exercise Science Department, The Football Associaiton, Lilleshall Hall UK.
Degree
MSc, BSc
Research interests
The physical and physiological demands of elite female football players, the nutritional status and needs of elite female football players
Email: Dawn.Scott@TheFA.com

✉ **Louise Martin**
University of Worcester, Henwick Grove, Worcester, WR2 6AJ, UK