BARÇA INNOVATION HUB

SPORTS NUTRITION FOR FOOTBALL

An evidence-based guide for nutrition practice at FC Barcelona

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*“If you want to get better
you must train hard every day,
but without the right nutrition,
it will not be possible.”*

Lionel Messi
FC Barcelona
#10

Summary

2 Micronutrient Requirements for Football

MICRONUTRIENT REQUIREMENTS FOR FOOTBALL

Besides consuming the macronutrients (i.e., carbohydrate, fat, and protein), players must consume relatively small amounts of certain micronutrients (i.e., organic vitamins and inorganic minerals) in the diet to maintain health (Rodriguez et al., 2009; Thomas et al., 2016).

Micronutrients have been reported to play a role in energy production, hemoglobin synthesis, bone health, immune function, and protection of the body against oxidative damage. They also assist with synthesis and repair of muscle tissue during recovery from exercise and injury (Rodriguez et al., 2009) (Chapter 8).

In addition to being found in foods, micronutrients are available individually or in a variety of combined preparations, referred to as supplements. Many players may consume large quantities of vitamin and mineral supplements in the mistaken belief that they will help prevent infection or injury, speed recovery, or improve performance. In reality, vitamin and mineral supplementation may improve the nutritional status of players who consume marginal amounts of micronutrients from food and may improve performance in players with deficiencies (Clarkson 1991). Dietary surveys in athletes report food intakes that easily supply vitamin and minerals in excess of the recommended daily allowances (RDAs). Furthermore, it is also important to note, that no evidence suggests that doses of vitamins and minerals in excess of the RDAs will improve performance (Fogelholm 1994).

At present, we are unable to quantify the additional micronutrient requirements for football players. Nevertheless, an adequate intake of vitamins and minerals can be achieved by a moderate to high energy intake from a varied diet of nutritious foods (Williams 2005; Yavari et al., 2015). Thus, most players are likely to meet micronutrient RDA requirements automatically as a consequence of increased energy intake to support training and matches (van der Beek 1991) (Chapter 2). Studies have reported that there are no significant differences between the micronutrient status of athletes in comparison to sedentary controls (Volpe 2007). The general consensus amongst scientists is that a varied and balanced diet with adequate energy intake should supply sufficient micronutrients for optimal performance (Chapter 2). However, there may be a few exceptions. For example, in our experience not all players eat varied diets of adequate energy intake and some may require help to improve both the quality and quantity of their food selections. To this end, the micronutrients that may require extra attention will be discussed below.

ANTI-OXIDANT VITAMINS

The anti-oxidant nutrients, vitamins C and E, carotene and selenium are involved in protecting cell membranes from oxidative damage (Rodriguez et al., 2009; Powers et al., 2014). Exercise has been linked with an increased production of free oxygen radical species capable of causing cellular damage (Powers et al., 2010). A sudden increase in training stress (such as an increase in volume or intensity) or a stressful environment (training in hot conditions or at altitude) is believed to increase the production of these reactive oxygen species leading to an increase in markers of cellular damage. Supplementation with anti-oxidant vitamins such as vitamin C or vitamin E is often suggested to increase anti-oxidant status and provide protection against this damage (Taghiyar et al., 2013).

However, the literature on the effects of anti-oxidant supplementation on anti-oxidant status, cellular damage and performance is complex and confusing (Powers et al., 2011). Some, but not all, studies show that acute supplementation during periods of increased stress may provide bridging protection until the player is able to adapt his or her own anti-oxidant status to meet this stress. The available literature provides little evidence that antioxidant supplementation enhances physical performance or reduces muscle damage from intense exercise (Powers et al., 2004). Whether on-going supplementation is necessary or even desirable for optimal training adaptations and competition performance of football players is also unknown. Furthermore, the increase in free radical production during a period of intensified training acts as signal for adaptation and therefore ingesting anti-oxidant vitamins may actually interfere with the desired adaptation (McArdle & Jackson 2000).

Interesting data is emerging regarding "anti-oxidants" and other food components that may indirectly influence the recovery process. Vigorous (eccentric) exercise, synonymous with football, has been shown to increase muscle damage, inflammation, delayed onset muscle soreness and reduced muscle function (Bowtell et al., 2011). This response is potentially triggered by inflammatory cytokines (Davis et al., 2007). This is a healthy process to some extent, but it might overshoot and limit recovery. In that case, food components that modulate the inflammatory process might be helpful in the acute recovery process (Nedelec et al., 2013). Studies have shown some beneficial effects of omega-3 fatty acids (Tartibian et al., 2009), curcumin (Davis et al., 2007), tart cherry juice (Connolly et al., 2006; Howatson et al., 2010) and N-acetyl cysteine (Michailidis et al., 2013) in the recovery process due to their anti-inflammatory and/or anti-oxidant effects. Although these data show promising results, it should be noted that not all results were obtained from human experiments, effects on functional outcomes are not always clear and long-term effects have not been evaluated. In any case, anti-inflammatory and anti-oxidant supplementation should be carefully dosed, as the inflammatory process and redox reactions trigger exercise adaptations. Thus, chronic high or poorly timed dosages of anti-oxidant supplementation may be detrimental to long-term training (Baar 2014). Furthermore, it is important to note that training up-regulates anti-oxidant and anti-inflammatory defences (Gomez-Cabrera et al., 2008). Thus, the anti-inflammatory effects of food and supplementation are likely to be less in well-trained players. The use of functional foods or food ingredients to enhance recovery is an exciting new area of research, but clearly, more research should be done to be able to determine optimal timing, ingredients, dose and judging long-term effects (Chapter 7).

Vitamin C supplementation has not been reported to be ergogenic but prolonged intense exercise or periods of fixture congestion may increase the need for vitamin C. This is because physical performance and immune function may be compromised with vitamin C deficiency (Moreira et al., 2007). The ingestion of 200 mg of vitamin C per day should sufficiently saturate body tissues and also enhance the absorption of iron. In addition, the co-ingestion of 50 mg of vitamin C with gelatin may also be beneficial in connective tissue remodelling (Chapter 8) (Monsen 2000). Players at risk of poor vitamin C intakes are those following low fat diets, restricting energy intakes or consuming low quantities of vegetables, fruits and whole grains (Rodriguez et al., 2009).

MINERALS

The main minerals of interest, which may be low in the diet of players, are iron, magnesium and calcium (McDonald & Keen 1988; Lukaski 2004). At present mineral status may be assessed either directly from body tissues (blood analysis) or indirectly from dietary analysis. Deficiencies in these minerals are often a consequence of low energy intakes or avoidance of animal products and may be more prevalent in female players (Monsen 2000; Rodriguez et al., 2009; 2016).

IRON

Iron is required for the formation of oxygen carrying proteins. Inadequate iron status can reduce exercise capacity via sub-optimal levels of hemoglobin, and perhaps iron-related enzymes involved in energy production (Haas & Brownlie 2001). Reductions in the hemoglobin levels of distance runners first alerted sports scientists to the issue of the iron status of athletes (Ricci et al., 1988). Iron losses can result from a host of mechanisms during exercise such as hemolysis, hematuria, sweating and gastrointestinal bleeding (Peeling et al., 2008). Recent research has raised the problem of distinguishing true iron deficiency from alterations in iron status measures that are caused by exercise itself. Low iron status in athletes is over-diagnosed from single measures of low hemoglobin and ferritin levels (Taniguchi et al., 1991). A major problem is the failure to recognize that the increase in blood volume that accompanies training will cause a dilution of all the blood contents. This hemodilution, often termed "sports anemia," does not impair exercise performance (Balaban 1992;Sacirovic et al., 2013).

Nevertheless, some players are at true risk of becoming iron deficient. The causes are essentially the same as for members of the general community: a lower than desirable intake of bioavailable iron and/or increased iron requirements or losses. Iron requirements may be increased in some players due to growth needs, or to increased losses of blood and red blood cell destruction. However, the most common risk factor among players is a low energy and/or low iron diet. Other likely targets are females, "restricted" eaters, vegetarians and players eating high carbohydrate/ low meat diets (Mann et al., 2002; Kim & Nattiv 2016).

Iron is found in a range of plant and animal food sources in two forms. Heme iron is found only in flesh or blood containing animal foods, whereas organic iron is found both in animal foods and plant foods. Whilst heme iron is relatively well absorbed from single foods and mixed meals (15-35% bioavailability), the absorption of non-heme iron from single plant sources is low and variable (2-8%). The bioavailability of non-heme iron, and to a lesser extent, heme iron is affected by other foods consumed in the same meal. Factors that enhance iron absorption include vitamin C, peptides from fish and meat, alcohol and food acids, while factors that inhibit absorption include phytates, polyphenols, calcium and peptides from plant sources such as soy protein (Lane & Richardson 2014). The absorption of both heme and non-heme iron is increased as an adaptive response in people who are iron-deficient or have increased iron requirements. While the iron bioavailability studies from which these observations have been made have not been undertaken on special groups such as football players, it is generally assumed that the results can be applied across populations of healthy people.

The assessment of total dietary iron intake of players is not necessarily a good predictor of their iron status; the mixing and matching of foods at meal time plays an important role by determining the bioavailability of dietary iron intake. Low iron status, indicated by serum ferritin levels lower than 20 ng/mL, should be considered for further assessment and treatment. Present evidence does not support that low iron status without anaemia reduces exercise performance. However, players with low iron stores, or a sudden drop in iron status, may complain of fatigue and inability to recover after heavy training. Many of these players should respond to strategies that improve iron status or prevent a further decrease in iron stores (DellaValle & Haas 2014).

A skilled practitioner is needed to accurately interpret the results and assess iron status (Table 3.1). Prevention and treatment of iron deficiency may include iron supplementation, with a recommended dose of 100-300 mg/day of elemental iron in conjunction with vitamin C to enhance absorption. Iron supplementation is needed to recover depleted iron stores and an iron-rich diet is needed to maintain the increase in iron stores. Full recovery is slow and can take as long as three months. Blood levels should be collected at appropriate times (Jamurtas et al., 2015) and reviewed after 10-12 weeks. Additional iron supplementation may cease when measurements return to usual ranges.

To this end, the management plan should include dietary counselling to increase the intake of bioavailable iron, and appropriate strategies to reduce any unwarranted iron loss. Many players self-prescribe iron supplements. However, this practice does not provide the player with the opportunity for adequate assessment of iron losses and expert dietary counselling from a professional. Dietary guidelines for increasing iron intake should be integrated with the player's other nutritional goals.

MEDICAL SUPPLEMENTS FOR NUTRIENT DEFICIENCIES	SUPPLEMENT
Medical supplements are used to treat clinical issues, including diagnosed nutrient deficiencies.	**Iron**
Requires individual dispensing and supervision by appropriate sports dietician/ medical professional.	**Calcium**
	Multivitamin/Mineral
	Vitamin D

<
Table 3.1
Dietary supplementation for miconutrient deficiencies

The following dietary supplements should be used in specific situations using evidence-based protocols. They should be used by some players to directly contribute to optimal performance. The supplements should be used in individualised protocols under the direction and monitoring of an appropriate sports nutrition/medicine/ science practitioner.

MAGNESIUM

Magnesium has been reported to be involved in carbohydrate, protein and fat metabolism and play a role in neuromuscular, immune and hormonal functions (Lukaski 2004). Magnesium status has been reported to be related to aerobic capacity (Lukaski et al., 1983). However, prolonged intense exercise is associated with a reduction in serum magnesium concentrations (McDonald & Keen 1988; Terink et al., 2016). Magnesium deficiency may impact performance by increasing the oxygen requirement of sub-maximal exercise (Rodriguez et al., 2009). Most evidence indicates no effect of magnesium supplementation on performance (Newhouse & Finstad 2000; Finstad et al., 2001). Thus, to avoid deficiency players should be encouraged to regularly consume good food sources of magnesium such as nuts, peas and seafood.

CALCIUM

Calcium is important for bone tissue (growth, maintenance, repair), transmission of nerve impulses and muscle contraction (Rodriguez et al., 2009). Diets that are low in calcium (and vitamin D) increase the risk of low bone mineral density and fractures (American Dietetic & Dietitians of 2003; Tenforde et al., 2010). Weight-bearing exercise is considered to be one of the best protectors of bone health. Consequently, female soccer players have been found to have higher bone mass and lumbar spine and hip bone mineral density than age- and body weight-matched controls (El Hage 2013; El Hage et al., 2014; Plaza-Carmona et al., 2016).

However, it is important to note that low bone mineral density has been reported in female athletes, notably distance runners. Thus, female players should be considered a high risk group especially if experiencing menstrual disturbances. This is because a serious outcome of menstrual disturbances in female athletes is the high risk of either direct loss of bone density, or failure to optimize the gaining of peak bone mass during early adulthood. Individually, or in combination, the problems involved in the female athlete triad (disordered eating, menstrual dysfunction and reduced bone status) can directly impair football performance. Significantly, there will reduce the players' career span by increasing the risk of illness and injury, including stress fractures (Okamoto et al., 2010). Long-term problems may include an increased risk of osteoporosis in later life.

Optimal nutrition is important to correct factors that underpin the menstrual dysfunction, as well as those that contribute to sub-optimal bone density. Adequate energy intake and the reversal of disordered eating or inadequate nutrient intake are important. A team approach involving sports physician, sports dietician, psychologist and/or psychiatrist, coach and family may be needed to treat the player with disordered eating or eating disorders.

Adequate calcium intake (~1000 mg/d) is important for bone health, and requirements may be increased to 1200-1500 mg/day in female players with impaired menstrual function. Again, strategies to meet calcium needs must be integrated into the total nutrition goals of the player. Where adequate calcium intake cannot be met through dietary means, usually through the use of low-fat dairy foods or calcium-enriched soy alternatives, a calcium supplement may be considered.

SODIUM, CHLORIDE AND POTASSIUM

Sodium is an essential electrolyte for cell function, body fluid and blood pressure regulation, blood volume and pH (Stachenfeld 2014). Players may require more than the upper intake recommended for both sodium (2.3 g/d) and chloride (3.6 g/d) (Rodriguez et al., 2009).

This is because some players will experience greater losses of sodium and chloride as a consequence of greater concentrations in sweat or high sweat rates (Chapter 6) (Maughan & Murray 2001; Maughan et al., 2005; Maughan & Shirreffs 2007). Although there is wide variation across individuals and activities, players can lose as much as 5 g sodium in sweat during a single high intensity training session or match (American College of Sports et al., 2007; Baker et al., 2016).

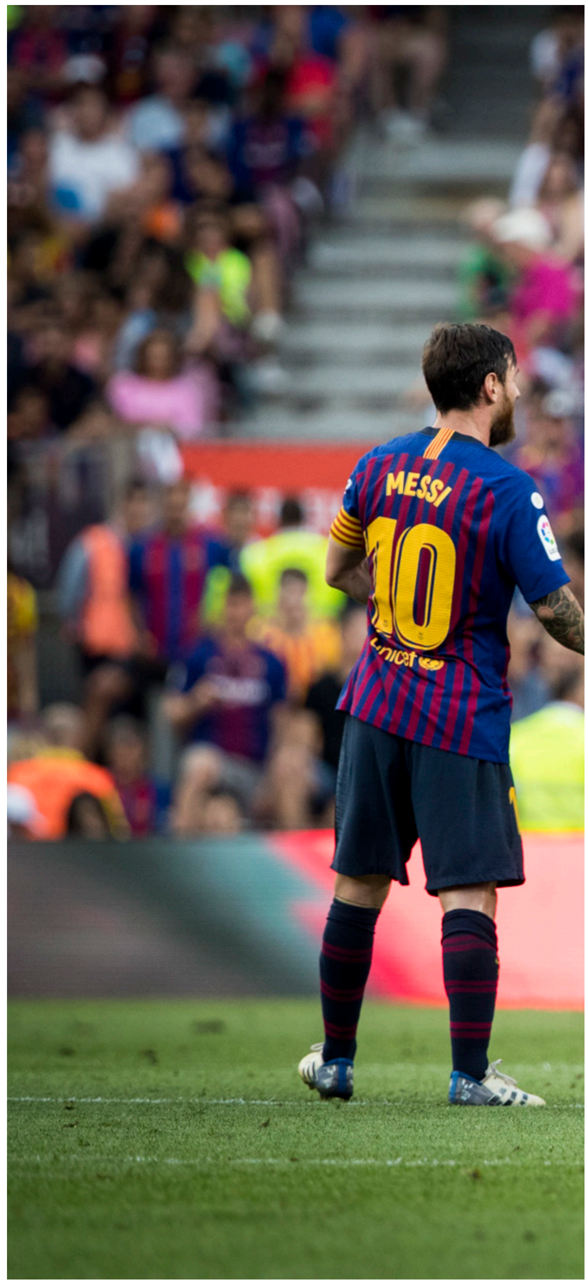
Thus, during prolonged football match play or training, sodium ingestion can play a role to assist with body fluid maintenance and electrolyte balance (Baker et al., 2005). Post exercise, replenishment of sodium loss is advised for rapid rehydration (Chapter 6).

Potassium is important in the regulation of fluid and electrolyte balance, nerve transmission and active transport mechanisms (Rodriguez et al., 2009).

The concentration of potassium in extracellular fluid (4-5 mmol/l) is much lower in comparison to the intracellular fluid (150-160 mmol/l) (Maughan & Murray 2001) and losses during exercise are far lower than that of sodium. Thus, to replenish potassium players should include fresh vegetables, fruits, nuts and whole grains in their diet (Rodriguez et al., 2009).

SUMMARY

In summary, the available evidence suggests that football specific activities per se, will not lead to micronutrient deficiency. Overall, generalised vitamin and mineral supplementation for all players is not justified. Furthermore, studies do not support an increase in performance with such supplementation except in the case where a pre-existing deficiency was corrected (Fogelholm 1994). The best management for the player with a high risk of suboptimal intake of micronutrients is to provide nutrition education to improve the variety and quantity of their diet. Typically, this can be achieved by the ingestion of fresh fruit, vegetables, salads, meats and nuts as part of the players overall daily energy intake. Finally, if dietary supplementation of a micronutrient is required (Table 3.1), it should be prescribed by a qualified sports dietician/medical professional with the appropriate adherance to dietary supplement guidelines (Chapter 7) (Hespel et al., 2006).

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REFERENCES

(2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. Can J Diet Pract Res 77(1): 54.

American College of Sports, M., M. N. Sawka, L. M. Burke, E. R. Eichner, R. J. Maughan, S. J. Montain & N. S. Stachenfeld (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc 39(2): 377-390.

American Dietetic, A. & C. Dietitians of (2003). Position of the American Dietetic Association and Dietitians of Canada: vegetarian diets. Can J Diet Pract Res 64(2): 62-81.

Baar, K. (2014). Nutrition and the adaptation to endurance training. Sports Med 44 Suppl 1: 5-12.

Baker, L. B., K. A. Barnes, M. L. Anderson, D. H. Passe & J. R. Stofan (2016). Normative data for regional sweat sodium concentration and whole-body sweating rate in athletes. J Sports Sci 34(4): 358-368.

Baker, L. B., T. A. Munce & W. L. Kenney (2005). Sex differences in voluntary fluid intake by older adults during exercise. Med Sci Sports Exerc 37(5): 789-796.

Balaban, E. P. (1992). Sports anemia. Clin Sports Med 11(2): 313-325.

Beaudart, C., F. Buckinx, V. Rabenda, S. Gillain, E. Cavalier, J. Slomian, J. Petermans, J. Y. Reginster & O. Bruyere (2014). The effects of vitamin D on skeletal muscle strength, muscle mass, and muscle power: a systematic review and meta-analysis of randomized controlled trials. J Clin Endocrinol Metab 99(11): 4336-4345.

Bowtell, J. L., D. P. Sumners, A. Dyer, P. Fox & K. N. Mileva (2011). Montmorency cherry juice reduces muscle damage caused by intensive strength exercise. Med Sci Sports Exerc 43(8): 1544-1551.

Clarkson, P. M. (1991). Minerals: exercise performance and supplementation in athletes. J Sports Sci 9 Spec No: 91-116.

Close, G. L. (2015). VITAMIN D MEASUREMENT & SUPPLEMENTATION: WHAT, WHEN, WHY & HOW? Sports Science Exchange 28(147): 1-4.

Close, G. L., J. Leckey, M. Patterson, W. Bradley, D. J. Owens, W. D. Fraser & J. P. Morton (2013). The effects of vitamin D(3) supplementation on serum total 25[OH]D concentration and physical performance: a randomised dose-response study. Br J Sports Med 47(11): 692-696.

Close, G. L., J. Russell, J. N. Cobley, D. J. Owens, G. Wilson, W. Gregson, W. D. Fraser & J. P. Morton (2013). Assessment of vitamin D concentration in non-supplemented professional athletes and healthy adults during the winter months in the UK: implications for skeletal muscle function. J Sports Sci 31(4): 344-353.

Connolly, D. A., M. P. McHugh, O. I. Padilla-Zakour, L. Carlson & S. P. Sayers (2006). Efficacy of a tart cherry juice blend in preventing the symptoms of muscle damage. Br J Sports Med 40(8): 679-683; discussion 683.

Davis, J. M., E. A. Murphy, M. D. Carmichael, M. R. Zielinski, C. M. Groschwitz, A. S. Brown, J. D. Gangemi, A. Ghaffar & E. P. Mayer (2007). Curcumin effects on inflammation and performance recovery following eccentric exercise-induced muscle damage. Am J Physiol Regul Integr Comp Physiol 292(6): R2168-2173.

DellaValle, D. M. & J. D. Haas (2014). Iron supplementation improves energetic efficiency in iron-depleted female rowers. Med Sci Sports Exerc 46(6): 1204-1215.

El Hage, R. (2013). Geometric indices of hip bone strength in young female football players. J Musculoskelet Neuronal Interact 13(2): 206-212.

El Hage, R., R. Chatah, E. Moussa & D. Theunynck (2014). Adult female football players have higher lumbar spine and hip bone mineral density than age- and body weight-matched controls. J Sports Med Phys Fitness 54(2): 174-178.

Farrokhyar, F., R. Tabasinejad, D. Dao, D. Peterson, O. R. Ayeni, R. Hadioonzadeh & M. Bhandari (2015). Prevalence of vitamin D inadequacy in athletes: a systematic-review and meta-analysis. Sports Med 45(3): 365-378.

Finstad, E. W., I. J. Newhouse, H. C. Lukaski, J. E. McAuliffe & C. R. Stewart (2001). The effects of magnesium supplementation on exercise performance. Med Sci Sports Exerc 33(3): 493-498.

Fogelholm, M. (1994). Vitamins, minerals and supplementation in soccer. J Sports Sci 12 Spec No: S23-27.

Gomez-Cabrera, M. C., E. Domenech & J. Vina (2008). Moderate exercise is an antioxidant: upregulation of antioxidant genes by training. Free Radic Biol Med 44(2): 126-131.

Haas, J. D. & T. t. Brownlie (2001). Iron deficiency and reduced work capacity: a critical review of the research to determine a causal relationship. J Nutr 131(2S-2): 676S-688S; discussion 688S-690S.

He, C. S., X. H. Aw Yong, N. P. Walsh & M. Gleeson (2016). Is there an optimal vitamin D status for immunity in athletes and military personnel? Exerc Immunol Rev 22: 42-64.

Hespel, P., R. J. Maughan & P. L. Greenhaff (2006). Dietary supplements for football. J Sports Sci 24(7): 749-761.

Howatson, G., M. P. McHugh, J. A. Hill, J. Brouner, A. P. Jewell, K. A. van Someren, R. E. Shave & S. A. Howatson (2010). Influence of tart cherry juice on indices of recovery following marathon running. Scand J Med Sci Sports 20(6): 843-852.

Jamurtas, A. Z., Douroudos, II, C. K. Deli, D. Draganidis, A. Chatzinikolaou, M. Mohr, A. Avloniti, J. C. Barbero-Alvarez, K. Margonis, G. Mavropalias, T. Stampoulis, D. Giannakidou, A. D. Flouris, Y. Koutedakis & I. G. Fatouros (2015). Iron status markers are only transiently affected by a football game. J Sports Sci 33(20): 2088-2099.

Kim, B. Y. & A. Nattiv (2016). Health Considerations in Female Runners. Phys Med Rehabil Clin N Am 27(1): 151-178.

Lane, D. J. & D. R. Richardson (2014). The active role of vitamin C in mammalian iron metabolism: Much more than just enhanced iron absorption! Free Radic Biol Med.

Lukaski, H. C. (2004). Vitamin and mineral status: effects on physical performance. Nutrition 20(7-8): 632-644.

Lukaski, H. C., W. W. Bolonchuk, L. M. Klevay, D. B. Milne & H. H. Sandstead (1983). Maximal oxygen consumption as related to magnesium, copper, and zinc nutriture. Am J Clin Nutr 37(3): 407-415.

Mann, S. K., S. Kaur & K. Bains (2002). Iron and energy supplementation improves the physical work capacity of female college students. Food Nutr Bull 23(1): 57-64.

Maughan, R. J. & R. Murray (2001). Nutrtion in Exercise and Sports Sciences: Sports drinks. Basic sciences and practical aspects.

Maughan, R. J. & S. M. Shirreffs (2007). Nutrition and hydration concerns of the female football player. Br J Sports Med 41 Suppl 1: i60-63.

Maughan, R. J., S. M. Shirreffs, S. J. Merson & C. A. Horswill (2005). Fluid and electrolyte balance in elite male football (soccer) players training in a cool environment. J Sports Sci 23(1): 73-79.

McArdle, A. & M. J. Jackson (2000). Exercise, oxidative stress and ageing. J Anat 197 Pt 4: 539-541.

McDonald, R. & C. L. Keen (1988). Iron, zinc and magnesium nutrition and athletic performance. Sports Med 5(3): 171-184.

Meier, C., H. W. Woitge, K. Witte, B. Lemmer & M. J. Seibel (2004). Supplementation with oral vitamin D3 and calcium during winter prevents seasonal bone loss: a randomized controlled open-label prospective trial. J Bone Miner Res 19(8): 1221-1230.

Michailidis, Y., L. G. Karagounis, G. Terzis, A. Z. Jamurtas, K. Spengos, D. Tsoukas, A. Chatzinikolaou, D. Mandalidis, R. J. Stefanetti, I. Papassotiriou, S. Athanasopoulos, J. A. Hawley, A. P. Russell & I. G. Fatouros (2013). Thiol-based antioxidant supplementation alters human skeletal muscle signaling and attenuates its inflammatory response and recovery after intense eccentric exercise. Am J Clin Nutr 98(1): 233-245.

Monsen, E. R. (2000). Dietary reference intakes for the antioxidant nutrients: vitamin C, vitamin E, selenium, and carotenoids. J Am Diet Assoc 100(6): 637-640.

Moreira, A., R. A. Kekkonen, L. Delgado, J. Fonseca, R. Korpela & T. Haahtela (2007). Nutritional modulation of exercise-induced immunodepression in athletes: a systematic review and meta-analysis. Eur J Clin Nutr 61(4): 443-460.

Morton, J. P. (2014). Supplements for consideration in football. Sports Science Exchange 27(130): 1-8.

Morton, J. P., Z. Iqbal, B. Drust, D. Burgess, G. L. Close & P. D. Brukner (2012). Seasonal variation in vitamin D status in professional soccer players of the English Premier League. Appl Physiol Nutr Metab 37(4): 798-802.

Nedelec, M., A. McCall, C. Carling, F. Legall, S. Berthoin & G. Dupont (2013). Recovery in soccer : part ii-recovery strategies. Sports Med 43(1): 9-22.

Newhouse, I. J. & E. W. Finstad (2000). The effects of magnesium supplementation on exercise performance. Clin J Sport Med 10(3): 195-200.

Okamoto, S., Y. Arai, K. Hara, T. Tsuzihara & T.

Kubo (2010). A displaced stress fracture of the femoral neck in an adolescent female distance runner with female athlete triad: A case report. Sports Med Arthrosc Rehabil Ther Technol 2: 6.

Peeling, P., B. Dawson, C. Goodman, G. Landers & D. Trinder (2008). Athletic induced iron deficiency: new insights into the role of inflammation, cytokines and hormones. Eur J Appl Physiol 103(4): 381-391.

Plaza-Carmona, M., G. Vicente-Rodriguez, A. Gomez-Cabello, M. Martin-Garcia, J. Sanchez-Sanchez, L. Gallardo & I. Ara (2016). Higher bone mass in prepubertal and peripubertal female footballers. Eur J Sport Sci 16(7): 877-883.

Powers, S., W. B. Nelson & E. Larson-Meyer (2011). Antioxidant and Vitamin D supplements for athletes: sense or nonsense? J Sports Sci 29 Suppl 1: S47-55.

Powers, S. K., K. C. DeRuisseau, J. Quindry & K. L. Hamilton (2004). Dietary antioxidants and exercise. J Sports Sci 22(1): 81-94.

Powers, S. K., A. J. Smuder, A. N. Kavazis & M. B. Hudson (2010). Experimental guidelines for studies designed to investigate the impact of antioxidant supplementation on exercise performance. Int J Sport Nutr Exerc Metab 20(1): 2-14.

Powers, S. K., K. J. Sollanek, M. P. Wiggs, H. A. Demirel & A. J. Smuder (2014). Exercise-induced improvements in myocardial antioxidant capacity: the antioxidant players and cardioprotection. Free Radic Res 48(1): 43-51.

Ricci, G., M. Masotti, E. De Paoli Vitali, M. Vedovato & G. Zanotti (1988). Effects of exercise on haematologic parameters, serum iron, serum ferritin, red cell 2,3-diphosphoglycerate and creatine contents, and serum erythropoietin in long-distance runners during basal training. Acta Haematol 80(2): 95-98.

Rodriguez, N. R., N. M. Di Marco & S. Langley (2009). American College of Sports Medicine position stand. Nutrition and athletic performance. Med Sci Sports Exerc 41(3): 709-731.

Sacirovic, S., J. Asotic, R. Maksimovic, B. Radevic, B. Muric, H. Mekic & R. Biocanin (2013). Monitoring and prevention of anemia relying on nutrition and environmental conditions in sports. Mater Sociomed 25(2): 136-139.

Stachenfeld, N. S. (2014). SODIUM INGESTION, THIRST AND DRINKING DURING ENDURANCE EXERCISE. Sports Science Exchange 27(122): 1-5

Taghiyar, M., R. Ghiasvand, G. Askari, A. Feizi, M. Hariri, N. S. Mashhadi & L. Darvishi (2013). The effect of vitamins C and e supplementation on muscle damage, performance, and body composition in athlete women: a clinical trial. Int J Prev Med 4(Suppl 1): S24-30.

Taniguchi, M., H. Imamura, T. Shirota, H. Okamatsu, Y. Fujii, M. Toba & F. Hashimoto (1991). Improvement in iron deficiency anemia through therapy with ferric ammonium citrate and vitamin C and the effects of aerobic exercise. J Nutr Sci Vitaminol (Tokyo) 37(2): 161-171.

Tartibian, B., B. H. Maleki & A. Abbasi (2009). The effects of ingestion of omega-3 fatty acids on perceived pain and external symptoms of delayed onset muscle soreness in untrained men. Clin J Sport Med 19(2): 115-119.

Tenforde, A. S., L. C. Sayres, K. L. Sainani & M. Fredericson (2010). Evaluating the relationship of calcium and vitamin D in the prevention of stress fracture injuries in the young athlete: a review of the literature. PM R 2(10): 945-949.

Terink, R., M. G. Balvers, M. T. Hopman, R. F. Witkamp, M. Mensink & J. M. Gunnewiek (2016). Decrease in Ionized and Total Magnesium Blood Concentrations in Endurance Athletes Following an Exercise Bout Restores Within Hours - Potential Consequences for Monitoring and Supplementation. Int J Sport Nutr Exerc Metab: 1-22.

Thomas, D. T., K. A. Erdman & L. M. Burke (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. J Acad Nutr Diet 116(3): 501-528.

van der Beek, E. J. (1991). Vitamin supplementation and physical exercise performance. J Sports Sci 9 Spec No: 77-90.

Volpe, S. L. (2007). Micronutrient requirements for athletes. Clin Sports Med 26(1): 119-130.

Webb, A. R. & M. F. Holick (1988). The role of sunlight in the cutaneous production of vitamin D3. Annu Rev Nutr 8: 375-399.

Webb, A. R., L. Kline & M. F. Holick (1988). Influence of season and latitude on the cutaneous synthesis of vitamin D3: exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin. J Clin Endocrinol Metab 67(2): 373-378.

Williams, M. H. (2005). Dietary supplements and sports performance: minerals. J Int Soc Sports Nutr 2: 43-49.

Yavari, A., M. Javadi, P. Mirmiran & Z. Bahadoran (2015). Exercise-induced oxidative stress and dietary antioxidants. Asian J Sports Med 6(1): e24898.