Hrana u zdravlju i bolesti, znanstveno-stručni časopis za nutricionizam i dijetetiku (2019) 8 (1) 25-32
Food in Health and Disease, scientific-professional journal of nutrition and dietetics (2019) 8 (1) 25-32

THE GENERAL NUTRITION KNOWLEDGE OF PROFESSIONAL ATHLETES

Ivan Miškulin[1*], Anja Šašvari[2], Albina Dumić[1], Vesna Bilić-Kirin[1], Željko Špiranović[2], Nika Pavlović[1], Maja Miškulin[1]

[1]Josip Juraj Strossmayer University of Osijek, Faculty of Medicine Osijek, Josipa Huttlera 4, Osijek, Croatia
[2]Health institution dr. Spiranovic for occupational and sports medicine, Stjepana Radića 54, Osijek, Croatia

original scientific paper

Summary

Proper nutrition and nutrition knowledge are necessary for health benefits both for general population and athletes, professional and non-professional ones. Of course, proper nutrition is not the same for all populations and should be adapted depending on gender, age, physical activity, health status and other needs. The physical condition, training and athletes' success also depend on their diet. The aim of this study was to examine nutrition knowledge of professional athletes and compare it with the nutrition knowledge of their peers not professionally engaged in sports. This cross-sectional study was conducted with a specially designed anonymous questionnaire that was distributed to 211 participants (110 professional athletes and 101 non-athletes) by a specialist of occupational and sports medicine in Osijek, Eastern Croatia during September 2017. The median age of the participants was 20.0 years. There were 74.4% males and 25.6% females. The overall proportion of accurate answers among all participants was 27.6% with no statistically significant differences between professional and non-professional athletes as well as between females and males (p=0.584 and p=0.904, respectively). Likewise, there were no statistically significant differences in proportion of accurate answers regarding to educational level, socioeconomic status and body mass index (p=0.547, p=0.491, p=0.459, respectively). One participant (0.5%) had good nutritional knowledge, 9 (4.2%) had medium nutritional knowledge while most of the participants, 202 (95.3%), had poor nutritional knowledge with no statistically significant differences compared to whether they were professional athletes or not. According to the results in this study, the unsatisfactory level of nutrition knowledge is evident in both groups of participants. Obviously, additional education is needed how for professional athletes also as for non-professional ones.

Keywords: nutrition knowledge; professional athletes; non-professional athletes; proper nutrition; Eastern Croatia

Introduction

Nutrition, as one of the most important factors in training and exercise, affects athletes in many ways by playing a significant role in achieving and maintaining better health. Optimal nutrition can reduce fatigue and thus allow athlete longer training, competition and faster recovery between training. Also, it is important to emphasize how nutritional status of the athlete directly affects the level of physical efficiency (Sedek and Yun Yih, 2014; Arazi and Hosseini, 2012). Most athletes today realize how optimal nutrition is an important and integral part of the training program, but still most of them are not familiar with healthy nutrition practices (Spendlove et al., 2012). Nutrition of athletes is application of nutrition knowledge to a practical diet plan that would provide energy for physical activity, performing body processes, improving sports performance in competitions, and providing health and well-being. Unhealthy food habits not only affect competition performance but also negatively effect general health. Oppose to that, healthy eating habits provide energy needs and maintenance of body mass as well as body fat at a suitable level (Sedek and Yun Yih, 2014). Consumers should be familiar with the principles of proper nutrition and nutrition guidelines in order to achieve enough nutrition knowledge and to be able to apply it properly (Grunert et al., 2012). Inadequate dietary knowledge in combination with improper food intake is still present in many athletes (Abood, Black and Birnbaum, 2004; Fox et al., 2011; Rosenbloom, Jonnalagdda and Skinner, 2002). Proper nutrition as an element of athlete training, especially young ones, is necessary due to strong connections between nutritional deficiency, growth, development, injury prevention and sports performance (Petrie, Stover and Horswill, 2004). Recent studies compared athletes and non-athletes' nutrition knowledge and discovered how athletes have equal or slightly greater nutrition knowledge than non-athletes (Dragičević and Šatalić, 2015). A priority for athletes' nutrition is a satisfaction of daily energy needs. Energy balance is achieved when energy input (energy from food, liquids and supplements) becomes equal to the energy utilization. Basal metabolism, the thermal effect of food and the thermal effect of the body activity are the components of energy utilization (Poehlman, 1989). Recommended daily energy intake differ individually

[*]Corresponding author: ivan.miskulin@mefos.hr

and depends on gender, age, height, weight and physical activity during the day. In a negative energy balance, the fatty tissue and muscles serve as a source of energy. Lack of muscle mass will result in loss of strength and endurance, as well as compromised immunity, endocrine and musculoskeletal function (Burke, Loucks and Broad, 2006). Long-term reduced energy intake could lead to significant micronutrient deficiency that could cause metabolic dysfunction (Howarth et al., 2010). Ensuring adequate energy intake is a key step for all athletes who want to achieve optimal results. The first and most important condition for optimal exercise efficiency is an appropriate energy intake that will enable delivery of required fuels not only during exercise period, but also in periods of recovery (Kerksick, 2019). The main difference between athletes' nutrition and the nutrition of general population is that athletes require additional fluid to compensate loss of sweat as well as additional energy intake to perform physical activity. There is also a disproportion between the increased need for additional energy and the additional need for individual nutrients. As most of the extra energy comes from carbohydrates, it is highly recommended to intake food rich in these components (bread, cereals, milk, fruits, vegetables). The timing of nutrient intake is performed individually for each athlete, depending on his gastrointestinal characteristics and the intensity of the training. In extraordinarily hard training or more training sessions, athletes should eat three main meals and three snacks. For increasing muscle mass, eating at the end of the training is proposed and to have more than one afternoon snack as well as additional snack before bedtime. Utilization of maximum energy during training will be enabled by intake of 200-300g of carbohydrates 3-4 hours before training. The athletes diet before the competition must be individually adjusted. Athletes should experiment with different types of food and drink during the holiday season in order to find which food best suits them before training (Howarth et al., 2010). Optimal hydration is an important factor for athlete success. Opposite to that, dehydration is considered as liquid deficiency in the amount of 2-3% of body mass, and is responsible for compromising the performance of aerobic exercises while increasing the risk of potentially lethal heat states such as heat stroke. Athletes should therefore seek adequate fluid intake before, during and after the training or competition. It is important to consume the fluid long enough before the body activity allowing it to absorb and to achieve optimal hydration, along with excretion of excess urine fluid through the kidneys. Today it is no longer recommended taking too much fluid before training or so-called hyperhydration due to increasing the extracellular and intracellular spaces what significantly increases the risk of discharge during the competition and is not more beneficial than euhydration (Bemben and Lamont, 2005). The required amount of fluid for compensation and rehydration depends on the amount of individually extracted sweat, training duration as well as drinking conditions. During the extreme efforts, sport drinks are preferred because they contain electrolytes and carbohydrates which allow fluid replenishment and electrolyte balance. Drinks that contain potassium and sodium help in correcting electrolyte loss, stimulate thirst and kidney fluid retention (Groeneveld et al., 2005). The role of nutrition on growth, development and health is well known. To obtain better performance advantages, athletes often use various supplements like creatinine, caffeine and different multivitamins. Creatinine provides ergogenic effects while its long-term effects in young athletes are poorly investigated and that is why the American College of Sports Medicine Roundable states how "creatinine monohydrate is not recommended for children under 18 years of age". Caffeine on the other hand, has impact on performance endurance and vigilance while higher doses are associated with adverse effects. Also, given the differences in maturity, children are more vulnerable to the adverse effects of caffeine. Regarding multivitamins usage during a well-balanced diet applied in athletes, it is unlikely to have any additional benefits (Smith and Jeukendrup, 2013). The aim of this study was to evaluate the level of nutritional knowledge between young professional athletes and to determine whether there is a difference in knowledge compared to their peers, non-athletes.

Materials and methods

Methods and Participants

The cross-sectional study was conducted at the Department of Health Care Dr. Spiranovic for occupational health and sports in September 2017. From 212 volunteerely participants, 111 were professional athletes from the Osijek area, aged 19-24 and 101 participants also from the Osijek area, the same gender, age and level of education as well as professional athletes, with the condition that they are not professional athletes and that they have physical activity for up to 5 hours a week.

Participants have previously signed informed consent for participation in the study. The special anonymous questionnaire was used as a research instrument. The questionnaire was taken from the previous study (Sedek and Yun Yih, 2014) and consisted from two parts. The first part of the questionnaire was with general data about the participant (age, gender, degree of education, economic status, body weight, body height, body mass indeks-BMI) while the second part measured nutrition knowledge so that participants had to choose one of the four offered answers. It took them about 10 minutes to complete the questionnaire. The Ethic Commitee of the Faculty of Medicine Osijek approved this study.

Statistical analysis

Category data were represented by absolute and relative frequencies. The differences between the category variables were tested by a $\chi 2$ test and if necessary also by Fisher's exact test. The numerical data were described by the median and the interquartile range. Normality of the distribution of numeric variables was tested by the Shapiro - Wilkinson test. Differences between numeric variables between the two independent groups were tested by Mann-Whitney U test and between three or more groups by Kruskal Wallis test (Ivanković et al., 1988). All p-values were two-sided. The level of significance was set to α (alpha) = 0.05. For statistical analysis, statistical software MedCalc Statistical Software version 17.8.2 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2017) was used.

Results

The study included 212 participants, of which 111 (52.4%) were professional athletes while 101 (47.6%) participants were non-professionally engaged in sports. There were 83 (39.2%) those who were football players, 15 (7.1%) were basketball players, 8 (3.8%) were kickboxing players, (0.5%) were volleyball and archery players, one in each sport, while 3 (1.4%) were handball players. According to Fisher's Exact Test, men are more professionally engaged in sports 106 (95.0%) (p<0.001). According to educational level, 31 (15.0%) of participants have uncompleted or completed elementary school, 152 (73.0%) have completed secondary school, and 25 (12.0%) have completed college or faculty. A bit worse estimated economic status than the average was reported by 5 (2.0%) of the participants, average economic status by 118 (57.0%), slightly better than average by 75 of them (36.0%), while much better than the average was reported by 10 (5.0%) of participants (Table 1).

Table 1. Participants according to their basic features

	Number (%) of participants by sport mode			**p**
	Professional	**Unprofessional**	**Total**	
Gender				
Men	106 (95)	52 (51)	158 (75)	<0.001*
Women	5 (5)	49 (49)	54 (25)	
Total	111 (100)	101 (100)	212 (100)	
Level of education				
Uncompleted or completed elementary school	15 (14)	16 (16)	31 (15)	0.920†
Secondary school completed	81 (74)	71 (72)	152 (73)	
A completed college or faculty	13 (12)	12 (12)	25 (12)	
Total	109 (100)	99 (100)	208 (100)	
Estimated economic status				
A bit worse than the average	3 (3)	2 (2)	5 (2)	0.920†
Average	53 (49)	65 (66)	118 (57)	
A bit better than average	45 (41)	30 (30)	75 (36)	
A much better than the average	8 (7)	2 (2)	10 (5)	
Total	109 (100)	99 (100)	208 (100)	

*Fisher's exact test; †$\chi 2$ test

The median age of the participant was 21 years (interquartile range 19 to 24 years). Body height was considerably higher in subjects who were professionally engaged in sports, median 183 cm (interquartile range 178 cm to 188.3 cm) as well as body weight, median 80 kg (interquartile range 73 kg to 85 kg) (p<0.001) when compared to non-professional ones. The BMI was 23 kg/m^2 (interquartile range 21 kg/m^2 to 24.8 kg/m^2), without significant differences between the groups.
According to the BMI, we divided the participants into three groups: malnourished participants

(BMI<18.5), those with normal body weight (BMI 18.5-24.6); overweight participants (BMI 25.0-29.9) and obese participants (BMI 30.0 and above). There were 9 (4.0%) of the participants who were malnourished, 152 (75.0%) were with normal body weight, 38 (19.0%) were overweight and 5 (2.0%) of them were obese.

Nutrition knowledge

The fact that skipping the breakfast could negatively affect the sport performance is known to 139 (65.6%) of the participants, while only 13 (6.2%) of them knew how proteins are not the best and most efficient sources of energy. That nutrition affects mental performance 121 (57.3%) answered correctly, 118 (55.7%) that a meal should be eaten 3 to 4 hours before the performance while only 29 (13.9%) of the participants knew how calcium excretion grows with alcohol consumption. According to the pyramid of healthy diet, that 6-11 portions of bread, cereals, rice and pasta is not necessary to consume per day answered 55 (25.9%) of participants while 97 (45.8%) responded correctly how it is necessary to eat 2-4 fruit portions per day. The most accurate answers gave 158 (75.2%) of the participants about fact how breakfast consumption improves concentration, while 64 (30.6%) of the participants claimed how to much vitamin supplements may be poisonous. Participants showed poor knowledge about the fact how 60% of total calories should come from carbohydrates, 31 (14.9%), while the fact that it is necessary to eat 2-3 portions of dairy per day knew 39 (18.7%) of the participants. That carbohydrates are less dangerous for gaining weight than food rich in fat knew 38 (18.3%) of the participants.

That anemia is iron deficiency knew 105 (51.5%) of them while 74 (35.2%) of participants thought how athletes tend to consume twice as much protein as recommended. 64 (30.5%) of the participants confirmed how the best sources of iron are meat products and fish while 29 (14.3%) of the participants agreed about the average percentage of fat tissue in women to be 20-25%. Only 19 (9%) of the participants knew that excessive protein consumption is not useful for athletes.

The fact how dehydration does not mean thirstiness answered 65 (31.4%) of the participants and how cereals or breads enriched with iron should be eaten with vitamin C to improve the absorption of iron 35 (17.1%) of participants knew. Most participants, 80 (38.6%) of them knew how proteins work on repairing and building muscle tissues and on creating hormones to boost the immune system. The lowest number of participants, 24 (11.4%) of them knew how the recommended amount of fiber is 25 grams per day.

Of 29 statements, the mean value number of correct answers was 7 (interquartile range 5 to 10 exact answers) ranging from 0 to 24 exact answers, ie 24% of correct answers (interquartile range from 17% to 34% of correct answers), without significant differences between the groups (Table 2).

Table 2. Median number of correct answers by group

	Median (interquartile range) according to the mode of sport			**p***
	Professional	Unprofessional	Total	
Number of correct answers	8 (5 – 11)	7 (5 – 10)	7 (5 – 10)	0.750
Correct answers (%)	28 (17 – 38)	24 (17 – 34)	24 (17 – 34)	0.750

*Mann Whitney U test

Only one participant (0.5%) had good knowledge about nutrition while 9 (4.2%) participants had medium knowledge. Poor knowledge showed 202 (95.3%) of participants with no significant difference compared to whether they were in sports professionally or not (Table 3).

Table 3. Distribution of participants according to dietary knowledge in the relation to whether they are involved in sport professionally or not

Knowledge	**Number (%) of participants according to the mode of sport**			**p***
	Professional	Unprofessional	Total	
Good	1 (0.9)	0	1 (0.5)	>0.990
Medium	5 (4.5)	4 (4.0)	9 (4.2)	
Poor	105 (94.6)	97 (96.0)	202 (95.3)	
Total	111 (100)	101 (100)	212 (100)	

*Fisher's exact test

Discussion

Nutrition plays an important role in human health by affecting long-term health and due to the fact that it is a risk factor for chronic diseases. It can be influenced in order to improve the efficiency of exercise and training. Optimal health and sports nutrition strategy are today subject of numerous research. However, the recommendations may be controversial and may be misunderstood due to different opinions of the sports and fitness industry as well as too many articles and online materials that can provide unfounded claims (Furber, Roberts and Roberts, 2017). Many studies have shown how athletes often follow poor dietary habits that can jeopardize their sporting performance but, more importantly, their health (Sorić, Mišigoj-Duraković and Pedišić, 2006). One of the primary strategies for helping athletes to consume proper diet is to provide them a nutrition education. Although it is agreed how adequate nutrition knowledge does not always have to include appropriate dietary practice, it is claimed how even a small amount of nutritional knowledge is a key to healthier eating habits. Individuals who know more about nutrients have nearly twenty-five times more chance of satisfying the existing recommendations for fruits, vegetables, and fat intake than those who know less about it. Although athletes can prevent practical obstacles in applying appropriate nutritional strategies, there are also studies on limited athletes' knowledge about proper nutrition (Spendlove et al., 2012). Apart from the fact that proper nutrition improves the effectiveness of training and sports results, it also affects the athlete's health and helps to maintain the ability through sports career. Sports nutrition should be tailored to an individual athlete, so that it complies with the athletes age and gender as well as the specificity of the sports discipline, life habits and constitutional characteristics of athletes. It has also been shown how adequate nutrition also prevents injuries among athletes (Cigrovski et al., 2012). A recent review reported poorly positive correlation between nutritional knowledge of athletes and their nutritional intake (Folasire, Akomolafe and Sanusi, 2015). One participant (0.5%) showed good nutritional knowledge, 9 (4.2%) of the participants showed average nutritional knowledge while poor nutritional knowledge showed most of the participants 202 (95.3%), without any significant difference compared to whether they were in sports professionally or not. Dragičević and Šatalić (2015) also found similar results in their research, showing how the total knowledge of football players about proper nutrition was poor (42.6%) and was not significantly different from the nutritional knowledge of a group that was not professionally engaged in sports (44.8%). Often the difference in general nutritional knowledge between professional athletes and non-athletes usually cannot be noticed although the intakes differ. It is also not possible to notice differences in energy and nutrient intakes, distribution of macronutrients and quality of nutrition in general (Nikić et al., 2014). One study (Heaney et al., 2011) refers to seven different articles comparing nutrition knowledge of professional athletes from various sports with a group that is not professionally engaged in sports (Heaney et al., 2011; Barr, 1987; Collison, Kuczmarski and Vickery, 1996; Cupisti et al., 2002, Federick and Hawkins, 1992; Guinard et al., 1995; Raymond-Barker, Petroczi and Quested, 2007). Five of seven articles showed average results about nutrition knowledge but higher than 50%. Total nutrition score was equal or even greater than those in the comparison group. One study showed slightly higher result in professional athletes about proper nutrition (athletes 20%, comparative group 17%) and a slightly lower result on general nutrition knowledge (38% for athletes and 41% for comparative group, respectively). Three studies showed how athletes have significantly higher nutritional knowledge than the comparative group. Athletes also showed significantly better results than a comparative group in a questionnaire based on general nutrition. Heaney (2011) also summarizes 22 studies about nutrition knowledge in athletes only without a comparative group. Most of those studies (n=19) showed the results of 50-70%, while in three of them the results were 40-50% for proper nutritional knowledge. In this study, out of 29 statements, the median value of correct answers was 7 (interquartile range 5 to 10 exact answers) ranging from 0 to 24 exact answers, ie 24% of the correct answers (interquartile range 17% to 34% responses), without significant differences between the groups. Opposed to our research, Sedek and Yun Yih (2014) showed good general nutrition knowledge in most of the participants, without significant differences between gender and between the groups. They also mention Paugh's study which pointed how female runners showed better knowledge of proper nutrition than the male basketball players, and also Sowell's study which showed how women who do not practice professional sport have greater nutritional knowledge than men who also do not deal with sport professionally. According to those observations, only 31 (14.9%) of the participants were familiar with the recommendations by pyramid of healthy diet on how 2-3 dairy portions should be consumed daily (Sedek and Yun Yih, 2014). The recommended daily intake of protein is known to be 1.2 g/kg of body mass, or 10-15% of the daily energy intake (Barr, 1987), while intake from more than 2.8 g/kg of body mass can lead to kidney function disorders in trained athletes (Worme et al., 1990). The liver inability to degrade too much substances increase the concentration of waste products such as ammonia and urea. Urea excretion results with a special need for water intake so it can be said how dehydration could actually be very dangerous consequence associated with too high protein intake. This study showed how only 19 (9%) of participants in this research knew that excessive protein consumption is not beneficial to athletes. The recommendations according to the pyramid of healthy diet to consume 2-4 fruit portions per day knew 97 (45.8%) of the participants according to this study, while 55 (25.9%) of the participants were familiar with the recommendations how it is not necessary to consume 6 to 11 portions of cereals, rice and pasta per day. As for carbohydrates, daily intake recommendations are 6-10 g/kg of body mass and the amount of intake differs depending on the intensity of the exercise as well as the type of activity, the gender and the environmental conditions (Elango et al., 2010). 31 (14.9%) of the participants new that 60% of total calories should come from carbohydrates. The recommended daily fat intake is 20-35% of the total daily intake (Devlin and Belski, 2015). Single and multiple saturated fatty acids should be taken equally (about 10%). Only 79 participants (37.8%) knew that fats are necessary in daily diet. Vitamins, minerals, and antioxidants are considered as protective substances. Vitamins play an important role in energy production, hemoglobin synthesis, bone and immune function maintenance, and body defense against oxidative stress. Micronutrients on the other hand help in synthesis and recovery of muscle tissue after training. Long-lasting training leads to biochemical muscle adaptation, thus increasing the need for vitamins and minerals. Daily exercise also causes loss of micronutrients due to sweating. As a result of increased need and loss, athletes are advised to intake additional vitamins and minerals. Except the fact the proper nutrition help athletes in exercise and to achieve the best performance, proper nutrition can also affect physiological adaptation to training, recuperation, immune function and general health. There are many reasons why dietary advices are not followed. This may be due to lack of knowledge and interest to change the nutrition or certain perceived barriers that can prevent people from eating healthier, such as lack of money, time or even taste of food. Athletes can often rely on nutritionists in certain sports so their knowledge is also important. Nutrition knowledge could be gained through regular and wide-ranging educational programs as well as self-education (Arazi and Hosseini, 2012). It has been anticipated how improved nutrition knowledge would help athletes to achieve and maintain a proper diet. Although knowledge is one of the few factors that are needed to change nutritional behavior, there are evidences suggesting how adequate nutrition knowledge plays a small but crucial, influential role in daily eating habits (Devlin and Belski, 2015). Nowacka et al. (2015) evaluated the intake of energy, basic nutrients and supplements with daily nutrition by professional slalom canoeists without dieticians control, before and after the nutritional education and concluded how nutritional education might improve eating habits. Carvalhais et al. (2018) evaluated the association between urinary incontinence and bad nutrition habits in elite female athletes. They discovered how those who had bad nutritional habits were three times more likely to have urinary incontinence than women without bad nutrition habits. Mitchell et al. (2018) investigated the level of general nutrition knowledge in registered exercise professionals and compared it with community members and university trained dietitians. They found how total nutrition knowledge in registered exercise professionals is limited and suggested to encourage them for collaboration with multidisciplinary team to accomplish best results. Philippou et al. (2016) proved the impact of nutrition education on nutrition knowledge and adherence to the Mediterranean Diet in adolescent competitive swimmers. The improvement was done by interactive nutrition education workshops. They also suggested parental participation in nutrition education.

There are several limitations in this study. First of all is a small sample of participants. Also, the fact that study was voluntary, probably had influence on how much athletes' and general population nutrition knowledge really is. Guidelines about proper nutrition for athletes are of great importance to ensure that physically active individuals and athletes to be more effectively trained, and thereby to reduce the risk of injury and disease as well as to improve the effectiveness of exercise (Cupisti et al., 2002). Proper nutrition habits will not turn an average athlete into a winner, but poor eating habits can be an explanation for his failure despite his great potential (Dragičević and Šatalić, 2015).

Conclusions

It can be concluded how both groups of participants have shown poor general nutrition knowledge without any significant difference in overall knowledge between groups of professional athletes and non-athletes. It has also been discovered that professional athletes, despite the importance of sports nutrition for their profession, show lack of proper nutrition knowledge. Educational interventions considering nutrition are needed.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abood, D.A., Black, D.R., Birnbaum, R.D. (2004): Nutrition education intervention for college female athletes, J. Nutr. Edu. Behav. 36 (3), 135-139.

Arazi, H., Hosseini, R. (2012): A comparision of nutritional knowledge and food habits of collegiate and non-collegiate athletes, Sport Logia. 8 (2), 100–107.

Barr, S.I. (1987): Nutrition knowledge of female varsity athletes and university students, J. Am. Diet. Assoc. 87 (12), 1660–1664.

Bemben, M.G., Lamont, H.S. (2005): Creatine supplementation and exercise performance: recent findings, Sports Med. 35 (2), 107-125.

Burke, L.M., Loucks, A.B., Broad, N. (2006): Energy and carbohydrate for training and recovery, J. Sports Sci. 24 (7), 675-685.

Carvalhais, A., Araújo, J., Natal Jorge, R., Bø, K. (2018): Urinary incontinence and disordered eating in female elite athletes, J. Sci. Med. Sport. 22 (2), 140-144.

Cigrovski, V., Malec, L., Radman, I., Prlenda, N., Krističević, T. (2012): Nutritional knowledge and dietary habits of young athletes' advisors, Hrvat. Športskomed. Vjesn. 27 (1), 28-33.

Collison, S., Kuczmarski, M., Vickery, C. (1996): Impact of nutrition education on female athletes, Am. J. Health Behav. 20 (1), 14–23.

Cupisti, A., D'Alessandro, C., Castrogiovanni, S., Barale, A., Morelli, E. (2002): Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes, Int. J. Sport Nutr. Excerc. Metab. 12 (2), 207–219.

Devlin, B.L., Belski, R. (2015): Exploring general and sports nutrition and food knowledge in elite male Australian athletes, Int. J. Sport Nutr. Excerc. Metab. 25 (3), 225-232.

Dragičević, I., Šatalić, Z. (2015): General nutrition knowledge among professional soccer players, Cro. J. Food Techn. Biotech. Nutr. 10 (3-4), 101-108.

Elango, R., Humayun, M.A., Ball, R.O., Pencharz, P.B. (2010): Evidence that protein requirements have been significantly underestimated, Curr. Opin. Clin. Nutr. Metab. Care. 13 (1), 52-57.

Folasire, O.F., Akomolafe, A.A., Sanusi, R.A. (2015): Does nutrition knowledge and practice of athletes translate to enhanced athletic performance? Cross-Sectional Study Amongst Nigerian Undergraduate Athletes, Glob. J. Health Sci. 7 (5), 215-225.

Fox, E.A., McDaniel, J.L., Breitbach, A.P., Weis, E.P. (2011): Perceived protein needs and measured protein intake in collegiate make athletes: an observational study, J. Int. Soc. Sports Nutr. 8, 1-6, doi: 10.1186/1550-2783-8-9

Frederick, L., Hawkins, S.T. (1992): A comparison of nutrition knowledge and attitudes, dietary practices, and bone densities of postmenopausal women, female college athletes, and nonathletic college women, J. Am. Diet Assoc. 92 (3), 299–305.

Furber, M.J.W., Roberts, J.D., Roberts, M.G. (2017): A valid and reliable nutrition knowledge questionnaire for track and field athletes, BMC Nutrition 3, 36, doi: 10.1186/s40795-017-0156-0

Groeneveld, G.J., Beijer, C., Veldink, J.H., Kalmijn, S., Wokke, J.H., van den Berg, L.H. (2005): Few adverse effects on long-term creatine supplementation in a placebo-controlled trial, Int. J. Sports Med. 26 (4), 307-313.

Grunert, K.G., Wills, J., Fernández Celemín, L., Lähteenmäki, L., Scholderer, J., Storcksdieck, S. (2012): Socio-demographic and attitudinal determinations of nutrition knowledge of food shoppers in six European countries, Food Qual. Prefer. 26 (2), 166-177.

Guinard, J.X., Seador, K., Beard, J.L., Brown, P.L. (1995): Sensory acceptability of meat and dairy products and dietary fat in male collegiate swimmers, Int. J. Sport Nutr. 5 (4), 315–328.

Heaney, S., O'Connor, H., Michael, S., Gifford, J., Naughton, G. (2011): Nutrition knowledge in athletes: a systematic review, Int. J. Sport Nutr. Excerc. Metab. 21 (3), 248-261.

Howarth, K.R., Phillips, S.M., MacDonald, M.J., Richards, D., Moreau, N.A., Gibala, M.J. (2010): Effect of glycogen availability on human skeletal muscle protein turnover during exercise and recovery, J. Appl. Physiol. 109 (2), 431-438.

Ivanković, D., Božikov, J., Kern, J., Kopjar, B., Luković, G., Vuletić, S., Suntešić, L., Tišljar, N., Car, M. (1988): Osnove statističke analize za medicinare. 24 ed.; University of Zagreb School of Medicine; Zagreb, Croatia, pp. 370. ISBN. 8680605182 9788680605180

Kerksick, C.M. (2019): Chapter 38. Requirements of proteins, carbohydrates, and fats for athletes in Nutrition and Enhanced Sports Performance, 2nd ed. 443-459. doi: 10.1016/B978-0-12-813922-6.00038-2.

Mitchell, L., McKean, M., O'Connor, H., Prvan, T., Slater, G. (2018): Are exercise professionals fit to provide nutrition advice? An evaluation of general nutrition knowledge, J. Sci. Med. Sport 22 (3), 264-268.

Nikić, M., Pedišić, Ž., Šatalić, Z., Jakovljević, S., Venus, D. (2014): Adequacy of nutrient intakes in elite junior basketball players, Int. J. Sport Nutr. Exerc. Metab. 24 (5), 516-523.

Nowacka, E., Leszczyńska, T., Kopeć, A., Hojka, D. (2016): Nutritional behavior of Polish canoeist's athletes: The interest of nutritional education, Sci. sports 31 (4), 79-91.

Petrie, H.J., Stover, E.A., Horswill, C.A. (2004): Nutritional concerns for the child and adolescent competitor, Nutr. 20 (7-8), 620-631.

Philippou, E., Middleton, N., Pistos, C., Andreou, E., Petrou, M. (2017): The impact of nutrition education on nutrition knowledge and adherence to the Mediterranean Diet in adolescent competitive swimmers, J. Sci. Med. Sport 20 (4), 328-332.

Poehlman, E.T. (1989): A review: exercise and its influence on resting energy metabolism in man, Med. Sci. Sports Exerc. 21 (5), 515-525.

Raymond-Barker, P., Petroczi, A. (2007): Quested E. Assessment of nutritional knowledge in female athletes susceptible to the female athlete triad syndrome, J. Occup. Med. Toxicol 2, 10, doi: 10.1186/1745-6673-2-10

Rosenbloom, C.A., Jonnalagadda, S.S., Skinner, R. (2002): Nutrition knowledge of collegiate athletes in a Division I National Collegiate Athletic Association Institution, J. Am. Diet Assoc. 102 (3), 418-420.

Sedek, R., Yun Yih, T. (2014): Dietary habits and nutrition knowledge among athletes and non-athletes in National University of Malaysia, Pak. J. Nutr. 13 (12), 752-759.

Smith, J.W., Jeukendrup, A. (2013): Chapter 55. Performance Nutrition for Young Athletes in: Nutrition and Enhanced Sports Performance. Ed. Bagchi, D.; Sreejayan, N.; Sen, C.K. Elsevier 523-528.

Sorić, M., Mišigoj-Duraković, M., Pedišić, Ž. (2006): Dietary habits and prevalence of smoking in team sports athletes, Hrvat. Športskomed. Vjesn. 21 (2), 84-90.

Spendlove, J.K., Heaney, S.E., Gifford, J.A., Prvan, T., Denyer, G.S., O'Connor, H.T. (2012): Evaluation of general nutrition knowledge in elite Australian athletes, Br J. Nutr. 107 (12), 1871–1880.

Worme, J.D., Doubt, T.J., Singh, A., Ryan, C.J., Moses, F.M., Deuster, P.A. (1990): Dietary patterns, gastrointestinal complaints, and nutrition knowledge of recreational triathletes, Am. J. Clin. Nutr. 51 (4), 690–697.