POTENTIAL BENEFITS OF CONSUMING OMEGA-3 FATTY ACIDS FOR ARTISTIC GYMNASTS

Boštjan Jakše, Barbara Jakše

Prej-potem co., Slovenia

Review article

Abstract

For an efficient daily training of gymnasts and, at the end, for an efficient performance, it is important to have an energy- and nutrient-sufficient diet, which enables a proper balance between maintaining appropriate body composition, excellent physical preparation, and general health. The combination of an intake of negative-calorie food and an increased amount of training, which enables the control of body weight, can have negative consequences when it comes to nutritional inadequacy, which can lead not only to a weakened immune system but also to an insufficient recovery after daily trainings. Today, athletes as well as gymnasts consume various dietary supplements to improve physical and cognitive abilities, for a more efficient recovery, a stronger immune system, and an easier control of appropriate body weight. A sufficient intake of omega-3 fatty acids – as is also true of vitamin B_{12} and D – is usually a part of a special assessment of dietary habits and needs of gymnasts, which they can fulfil with ordinary diet or dietary supplements. The purpose of this article is to relatively clearly evaluate the scientific evidence about the potential benefits of consuming omega-3 fatty acids (ALA, EPA, and DHA) for a variety of objectives for gymnasts and, at the end, to critically sum them up in a sensible recommendation, while being aware of limitations of the evidence. Furthermore, this article is intended to encourage researchers to study the direct influence of nutrition and potentially beneficial and permitted dietary supplements for a variety of objectives for gymnasts.

Keywords: *body weight, physical ability, cognitive abilities.*

INTRODUCTION

Omega-3 fatty acids are an essential nutrient that is vital for the functioning of the immune system, brain development, and cognitive functioning, while at the same time having an anti-inflammatory effect. Humans ordinarily consume omega-3 fatty acids, which are synthesized only by plants, through the consumption of sea fish or dietary supplements. If they do not consume any of these two, they are at risk due to a possible deficiency, such as increased vulnerability to impaired cognitive functions and brain structure, increased emotional behavior and decreased visual capacity, mood disorders and decreased immune function (Simopoulos, 2013). Despite the existing recommendations of the World Health Organization (WHO) and the European Food Safety Authority (EFSA) about the recommended intake of essential omega-3 fatty acids (ALA – alpha-linolenic acid)

and "half essential" derivatives of omega-3 fatty acids (EPA, i.e. eicosapentaenoic acid and DHA, i.e. docosahexaenoic acid*) (EPA and DHA are not technically "essential" because they can be produced endogenously, but the process is slow and inefficient and is affected by genetics, sex, age, and dietary composition (Saunder, Davis & Garg, 2013)),* there exists a concern from the side of the gymnasts about the potential inadequacy of the intake of omega-3 fatty acids due to different qualities of nutrition, which controls the energy intake. There is also the need to evaluate the studies that have proven the potential benefits of consuming omega-3 fatty acids in the form of dietary supplements on the improvement of body composition, physical and cognitive abilities, and recovery. Gymnasts also wish to know whether the fish that contain also non-essential fatty acids (e.g. saturated fat) *(Fats are usually divided into two categories (Haver, 2016): essential (EFAs) and non-essential fatty acids (non-EFAs). EFAs belong to the group of polyunsaturated fats – PUFA (i.e. α-linolenic acid or ALA, omega-3 fatty acid and linoleic acid or LA, omega-6 fatty acid) and since the body cannot synthesize them, it must obtain them from food. Plants are generally the original source of both types of PUFA in the food chain (found in seeds and their respective oils, soybean, microalgae, fish, and marine oils). Non-EFAs, which the body does not need to get from food, belong to the group of monounsaturated fats – MUFA (found in olives, avocados, certain nuts and seeds and their respective oils; considered neutral or potentially beneficial) and saturated fats – SFA (found in animal products, vegetable oils, and tropical fats such as palm and coconut; can promote CVD). Trans fatty acids – TFA are also non-EFAs but are laboratory-made via hydrogenation and are found in processed, fried, and fast food and are not considered safe)* are even a healthy and a representative food for the intake of essential omega-3 fatty acids, given the fact that it does not synthesize the omega-3 fatty acids by itself, especially in addition to the total food intake that already contains a lot of saturated fat and the fact that a fish may be potentially quite contaminated with industrial chemicals. They also wonder if we really need EPA and DHA in addition to ALA, which are known as essential fats, and what the risks are of regular consumption of fish or EPA and DHA dietary supplements, extracted from fish oil or seaweed. Contradictory evidence, which is usually the result of different study designs, erroneous interpretations, conflicts of interest of researchers, and consequently contradictory information, which appears in various sports media, does not always offer credible information to the gymnasts and, consequently, affects making the right decisions.

Characteristics of competitive artistic gymnastics

A successful performance on the floor, the pommel horse, the rings, the vault, the parallel bars, and the horizontal bar requires a number of motor skills, such as speed, strength, endurance, agility, flexibility, and balance, while the level of gymnast's skills is tightly connected with the absence of injury (Sleeper, Kenyon, Elliot & Cheng, 2012). Appropriate body weight, excellently developed motor skills, and a high level of various perceptual abilities enable the gymnasts to control their posture while executing demanding elements, despite the fact that they cannot completely rely on their eyesight. Because competitive gymnastics (Marina & Rodríguez, 2014) demands a combination of explosive and submaximal muscle contractions when executing numerous demanding elements, there is also a relatively high heart rate (from 170–190 beats/min with women and from 150–180 beats/min with men). Due to repetitive gymnastics elements with short breaks (lasting up to 90 seconds), competitive

gymnastics primarily includes anaerobic metabolism (average assessment is 80% of energy requirements) and blood lactate concentration between 8 and 11 mmol/L. The performance on the floor can be an exception in certain cases, because there remains a possibility that the gymnast will reach up to 85% of maximal oxygen consumption (Marina & Rodríguez, 2014). So we can see that appropriate eating habits are very important for an efficient execution at trainings and at competitions. Due to the repetitive trainings, gymnasts usually train in a constant state of fatigue, while pushing their physical and cognitive abilities to the maximum limit. Muscular and nervous fatigue can weaken the immune system and general health, decrease efficient recovery and, consequently, the quality of trainings and performances, and can increase the possibility of injuries, especially due to calorie restriction, inappropriate diet, and potential nutrient deficiency of certain nutrients (among others also omega-3 fatty acids). At some point, the ability to efficiently control body weight while simultaneously maintain a high level of motor skills is made more difficult, which also includes special physical preparation. According to our knowledge, the published studies about gymnasts that are available at the moment did not measure the levels of omega-3 fatty acids in the blood, nor the direct influence of the intervention of omega-3 fatty acids (ALA, EPA, and DHA) or the potential benefits and risks of long-term deficiency of its intake on general health, the improvement of physical and cognitive abilities, and a successful control of appropriate body weight. Based on everything stated above, the authors will present this problem in this article from different viewpoints, because there is a lack of complete information about the effects and benefits of consuming omega-3 fatty acids for the needs of artistic gymnasts.

The history of popularization of omega-3 fatty acids

Essential omega-3 fatty acids have been a very well researched nutrient in the last decades and among all the alleged benefits its most positive proven effect is on cardiovascular health. It all started with anecdotes about the Eskimo who lived in extreme circumstances and consumed a lot of fish and various sea animals, rich in omega-3 fatty acids or, in other words, high-fat food with a lot of dietary cholesterol and practically without any fiber, while showing a very low incidence of cardiovascular diseases, cancer, or chronic diseases in general. In literature, the Eskimo paradox first appeared in the middle of the 1970s, when Bang and Dyerberg carried out a research which did not study the incidence of cardiovascular disease and attributed a protective role against chronic diseases to omega-3 fatty acids (Fodor, Helis, Yazdekhasti & Vohnout, 2014). Already in the 1930s, scientists refuted the supposition about the absence of atherosclerosis among the Eskimo (Rabinowitch, 1936). Furthermore, scientists retrieved the remains of the Eskimo that have been frozen for thousands of years and they saw the presence of atherosclerosis (Zimmerman, 1993). An examination of mummified remains of the Eskimo with the help of a *computed tomography (*CT) scanner clearly indicated atherosclerosis of the blood vessels of the heart, brain, and legs, which contradicts general belief that atherosclerosis is more a disease of the modern age (Thompson et al., 2013). Fodor et al. (2014) conclude that a comprehensive overview of scientific evidence proves that the Eskimo have a similar incidence of atherosclerosis as the rest of the world, a higher mortality rate due to heart attack, twice as high general mortality rate, and a lifespan that is ten years shorter than e.g. the lifespan of the Danish. The authors rhetorically asked themselves why numerous researchers uncritically cite the research by Bang and

Dyerberg as proof that the Eskimo have a lower incidence of cardiovascular disease when this is scientifically not entirely correct. Therefore, those types of claims are either a result of misinterpretation or a case of study's bias. Despite the fact that there is a need for more well-designed studies that would strengthen the position of omega-3 fatty acids in the science of nutrition and nutrients, there is quite a high amount of scientific evidence connected with the potential benefits and protective effects of omega-3 fatty acids.

Sources of omega-3 fatty acids

Omega-3 fatty acids consist of short chains (ALA) and long chains (EPA and DHA) of omega-3 fatty acids. ALA can be found in flaxseeds, hemp seeds, and chia seeds, in walnuts, soya, and, in smaller amounts, also in dark green vegetables, e.g. Brussels sprouts, spinach, and sea vegetables, while EPA and DHA are present in marine microalgae and plankton and also in fish that feed on marine microalgae *(the fish get EPA and DHA from a primary source, i.e. by consuming seaweed. The amount of EPA and DHA fatty acids in certain types of fish depends on their environment and the type of the consumed seaweed)* e.g. salmon, sardines, tuna, mackerel, and others. The World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), and the European Food Safety Authority (EFSA) specify the recommended daily intake for adults (RDI), which is 0.5% (up to 2 grams) of ALA calories (FAO, 2010). According to the Academy of Nutrition and Dietetics (AND), a person may already consume the RDI of ALA with one spoon of flaxseeds and chia seeds, and partly by eating dark green vegetables and various berries (Vannice & Rasmussen, 2014). Even though our body can synthesize EPA and DHA from ALA, clinical studies have shown a potential inadequate or inefficient conversion, which results in the current consensus of WHO and EFSA that it is recommended to consume – especially for the health of a pregnant woman, a nursing mother, and the proper development of the fetus – at least 250 mg of EPA and DHA from the source of sea fish or marine microalgae (Flock, Harris & Kris-Etherton, 2013). Meanwhile, Simopoulos (2007) states, based on the available scientific evidence, that it is recommended for most athletes to consume omega-3 fatty acids in quantities of 1–2 g of EPA and DHA daily in the ratio 2:1. If we think about the benefits and potential risks, we can see that fish is not the most appropriate source of EPA and DHA, because it is contaminated with polychlorinated biphenyl (PCB), dioxin, mercury, and other heavy metals (Jacobs, Ruzzin & Lee, 2014). The Slovenian Jožef Stefan Institute measured the content of mercury in 52 fresh fish and 56 canned fish on the Slovenian market and discovered that with a typical portion (100 g) of fresh fish we consume from 58% to 1940% of mercury, while with a typical portion of canned fish we consume from 3% to 1556% of the permitted daily intake of mercury (Zajc, 2006). A recent study, conducted in five EU countries (Belgium, Ireland, Italy, Portugal, and Spain), which assessed the risks of the contamination of fish with different chemicals from the environment, showed a typical contamination with mercury in tuna, hake, cod, bream, sea bass, and octopus. The authors state that these results and the examination of the results from other authors indicate a justified need to inform people about the benefits of consuming certain fish as well as the potential health risks (Jacobs et al., 2016). Most of the fish is not only contaminated with mercury (Nielsen, Kit, Aoki & Ogden, 2014) and PCBs, but also party contaminated with dioxin and chlorinated pesticides, which have harmful effects on the nervous, immune, and cardiovascular system (Bushkin-Bedient & Carpenter, 2010). On the other hand, the most widely used dietary supplements with omega-3 fatty acids on the market are produced

exactly from fish oil. Numerous companies usually clean the various industrial chemicals found in fish oil, but these processes of removal are not always effective with fat-soluble toxins, such as dioxin and PCB (Fernandes, Rose, White, Mortimer & Gem, 2006). In addition, in many cases there exists a well-founded concern about the potential oxidation of fish oils due to the potential presence of heavy metals, inappropriate composition of fatty acids, exposure to oxygen, light, and temperature, the content of antioxidants, and the presence of water (Cameron-Smith, Albert & Cutfield, 2015). We should devote special attention to fish when an individual is allergic or sensitive to it or to fish oils or when an individual is taking certain pills (e.g. for thinning the blood or lowering blood sugar). However, fish oils are in general considered as a dietary nutrient without negative side effects (NIH, 2015), given that we control the factors that may influence their adulteration. In addition to the already mentioned potential problems, there remains the concern of increased environmental pressure (the increasing number of population, global warming) on the fish population, which poses a legitimate question about the adequacy of consuming fish or fish oils (Kang, 2011). On the other hand, the market offers more and more EPA and DHA dietary supplements that are produced from laboratory cultured seaweed and are, from the standpoint of clinical efficiency, comparable with fish oil, without any traces of industrial chemicals (Doughman, Krupanidhi & Sanjeevi, 2007). There are also no signs of digestive problems (diarrhea) or any consequences of the taste of fish after consumption (burping) or belching (Neff et al., 2011).

Potential inadequacy of EPA and DHA omega-3 fatty acids

Numerous professionals for maintaining optimal health advocate the consumption of either fish or omega-3 fatty acids (EPA and DHA) in the form of dietary supplements. Their arguments are, firstly, that the body cannot efficiently convert the essential omega-3 fatty acids (ALA) into EPA and DHA and, secondly, that certain individuals do not consume (enough) fish, which are a rich source of EPA and DHA. Under the term "omega-3 fatty acids" we usually think of the essentially short chain of omega-3 fatty acids (ALA), which the body converts into SDA (i.e. *stearidonic acid), EPA, and DHA* omega-3 fatty acids. SDA can be directly consumed with blackcurrant, hemp seeds, or fish, and EPA and DHA with fish or eggs, sea vegetables (EPA), and marine microalgae (EPA and DHA). The conversion from ALA into EPA and DHA is slow and inefficient and generally depends on heredity, gender, age, and dietary patterns *(under the dietary factors we consider a large enough intake of ALA, consuming food that helps with the conversion of ALA into EPA and DHA (e.g. fruit and vegetables), an inadequate intake of protein and fasting, consuming food that inhibits the process (e.g. saturated and trans fats, too much omega-6 fatty acids, dietary cholesterol, alcohol), direct intake of DHA from the source of sea fish or marine microalgae, while under the non-dietary factors we count age (when we get older the conversion decreases), gender (women have better synthesis), chronic diseases (diabetes, high blood pressure, high cholesterol), smoking, and hereditary differences Saunder, Davis & Garg, 2013).* Scientists assess that the body can convert approximately 0.3 to 21% of ALA into EPA and 0–9% into DHA, while women, compared to men, have a significantly higher percentage of converting ALA into EPA (Burdge, Jones & Wootton, 2002; Burdge & Wootton, 2002), but not ALA into DHA (Childs et al., 2014). If the intake of omega-6 fatty acids (e.g. consuming various types of vegetables oils) is too high, it may slow down the process of conversion for up to 40–54% (Emken, Adolf & Gulley, 1994;

Gerster, 1998), while a low-fat diet and calorie restriction improve the level of conversion of ALA into EPA and DHA (Das, 2006). A randomized controlled cross-over study measured the effect of a low-fat (20% of fat) and high-fat diet (45% of fat) lasting for 12 weeks, where the two diets had the same amount of calories and a similar ratio between omega-6 and omega-3 fatty acids. The researchers discovered that the low-fat diet enabled a higher percentage of conversion of ALA into EPA and DHA compared with the high-fat diet (Raatz, Bibus, Thomas & Kriss-Etherton, 2001). On the other hand, a direct intake of DHA, e.g. by eating fish, eggs, or dietary supplements, slows down the process of conversion of ALA into EPA and DHA from 72% to 88%, which means that we can potentially increase the percentage of conversion of ALA into DHA by not eating the direct source of DHA (e.g. fish) (Emken, Adolf, Duval & Nelson, 1999; Welch, Shakya-Shrestha, Lentjes, Wareham & Khaw, 2010). Smoking during pregnancy also results in worsening the conversion of ALA into EPA and DHA in the breast milk (Marangoni et al., 2004). Scientifically speaking, it is undisputable that humans do not need to consume fish at any stage of their life in order to achieve optimal health, but they do need ALA. Clinical interventions in people with a previous lack of consuming DHA from a direct source show that DHA is most likely a half-essential fatty acid. Health authorities for adult males and non-pregnant/non-lactating adult females recommend daily intakes of EPA and DHA ranging from 250 to 550 mg/day (FAO, 2010; Harris et al., 2009). People can consume it from more representative and less unhealthy sources than directly eating different types of fish rich in EPA and DHA, which can also be applied to gymnasts.

Omega-3 fatty acids and diets without fish or vegan diets

Our body is able, with the right amount and ratio between omega-6 (LA) and omega-3 fatty acids (ALA), to synthesize DHA and EPA from the essential ALA, but it often raises the question of sufficiency, which is why today there is a scientific consensus that DHA are most likely essential fats. Rosell et al. (2005) discovered that the concentration of ALA in the blood plasma is similar with vegetarians and non-vegetarians, while the concentration of EPA and DHA is lower with vegetarians (28% and 31%) and even lower with vegans (53% and 59%), but that it is stable. *(Welch et al. (2010) discovered that people who do not eat fish (vegans, vegetarians who do not eat fish, "carnivores" who do not eat fish) consume from 57% to 80% less omega-3 fatty acids in comparison with people who eat fish, although the differences in the index of omega-3 fatty acids in the blood plasma are then smaller, most likely due to the already discovered better conversion of ALA into EPA and DHA with people who do not eat fish).* .In one study (Sarter, Kelsey, Schwartz & Harris, 2015) the researchers wanted to define the index of omega-3 fatty acids in 165 long-term vegans and the differences between different age groups and gender and compare this measured index with people who have an omnivorous diet. The researchers also wanted to determine the extent to which this index of omega-3 fatty acids *(a biomarker that is expressed as the percentage (%) of EPA and DHA content in red blood cells based on the entire amount of fat in red blood cells)* can improve by prescribing 46 participants with the initial index lower than 4% (authors assume that anything lower than 4% is undesirable) a daily dietary supplement of 254 mg of EPA and DHA from seaweed for four months. They discovered that two thirds of the assessed vegans have an index of omega-3 fatty acids that is lower than 4% (even though

they consume enough ALA), but this is in general similar to people who have omnivorous diet (the control group) and who also do not consume fish on a regular basis (3.5%). Even though it is not exactly clear whether a lower index of omega-3 fatty acids has negative consequences on health, the authors conclude that vegans from this study improved their index above 4% after the four-month supplementation. To conclude, the results of epidemiological research consistently suggest that a long-term deficiency of DHA in vegans presents a potential risk for impaired cognitive functioning in a later period of life. But, on the other hand, there is no direct evidence that the rise in the index of omega-3 fatty acids has an additional positive effect on their health, which is already protected by a vegan diet.

Consuming fish or omega-3 dietary supplements and health throughout life

Omega-3 fatty acids are polyunsaturated fatty acids, which are present in certain types of food. They are a part of the essential nutrients, which means we are supposed to consume them daily with our food. They represent vital components of various cell structures of the brain, the nervous system, the cell membranes, and chemical processes, and they are also responsible for the transfer and oxidation of cholesterol. In various studies (discussed below) EPA and DHA were connected with an improved general and cardiovascular health (the main cause of death in Western societies), improved cognitive and physical abilities, control of body weight, fetal development during pregnancy, and various diseases, which is the reason why many scientists recommend a regular consumption of fish or omega-3 dietary supplements. An overview of randomized controlled studies conducted on a number of people and of double-blind placebo-controlled studies, which examined the influence of consuming fish or fish oils (EPA and DHA) in the form of dietary supplements, showed that this type of intervention is not justifiable for the needs of primary or secondary prevention against cardiovascular diseases (Greene, Ashburn, Razzouk & Smith, 2013; Kowey, Reiffel, Ellenbogen, Kromhout, Giltay & Geleijnse, 2010; Kwak, Myung, Lee & Seo, 2012). Even a decade ago, a systematic overview of 48 randomized controlled studies and 41 cohort studies did not show any positive effect of consuming fish or fish oil on health or, in other words, a lower incidence of cardiovascular disease and cancer or a lower mortality rate (Hooper et al., 2006). Cundiff, Lanou, and Nigg (2007) emphasize that a credible research that would confirm the inverse relationship between consuming fish and omega-3 fatty acids from the source of dietary supplements and the incidence of cardiovascular disease does not exist. A lower incidence is most likely a consequence of dietary factors (in general a healthier eating pattern) and a lifestyle that is a result of people who are more aware and also eat fish. It is generally accepted that decreasing the amount of saturated fats and dietary cholesterol in food (meat and meat products, milk and dairy products, eggs, fish, oils), not smoking, and regular physical exercise reduces the risk of cardiovascular disease. Based on examining the results of 20 randomized controlled studies of adults, which measured the effect of consuming omega-3 fatty acids on the primary and secondary prevention of cardiovascular disease, Rizos, Ntzani, Bika, Kostapanos, and Elisaf (2012) discovered that the supplementation with omega-3 fatty acids is not connected with a lower risk of mortality from any reasons. In the past, some studies showed the benefits of consuming fish and fish oil in the form of dietary supplements on cardiovascular health, while recent studies do not confirm this, most likely due to a lower quality of modern nutrition, which cannot be improved by simply consuming contaminated and inadequately prepared

fish, which also contain a high level of saturated fat and dietary cholesterol, or by consuming a few pills of dietary supplements. An in-depth overview of a few studies that showed the potential benefits of consuming fish and fish oil, in comparison with those studies that did not show that, revealed that there is basically no controversy, since the main problem of intervention studies (in addition to the potentially rancid fish oil) is the surplus of the prescribed 3 g of fish oil. Studies indicate a problematic negative influence of the amount of EPA and DHA higher than 1 g or, in other words, we get a U-shaped curve of the influence of consuming omega-3 fatty acids on health, where an intake that is too small or too large presents a health risk, especially for atrial fibrillation, which is the most common disorder of heart rate in adults (Metcalf et al., 2014) that significantly increases the risk of a stroke. An appropriate, but not exceeded, intake of EPA and DHA can have a positive influence on cardiovascular health. Most likely one of the best studies in recent years assessed the benefits and risks of an adequate level of EPA and DHA in 2692 participants without any cardiovascular diseases and with an average age of 75 years. Here, the researchers relied on the measurements of blood and discovered that an intake of 250–400 mg of EPA and DHA results in a lower mortality rate due to cardiovascular diseases (Mozaffarian et al., 2013). Observational and interventional studies that examine the influence of a certain type (monounsaturated and polyunsaturated, saturated, and trans fat) or the amount of fat on the factors and the incidence of cardiovascular disease clearly state that a higher intake of trans fat and saturated fat leads to a higher incidence of cardiovascular disease, while a higher intake of omega-3 fatty acids leads to a lower incidence of cardiovascular disease. These findings do not support the interventional study in a consistent or statistically significant manner. A reductionist approach to the study, which wishes to measure the difference by increasing or decreasing one nutrient or a certain type of food, rarely brings the expected health outcomes. At the same time, this type of study bares no greater utility value, since it is a dietary pattern that makes a difference in the end.

Competitive gymnastics is, among other things, a sport discipline "for life" and gymnasts are first and foremost people and that is why it is ethical that their sports goals are not achieved at the expense of their health. Gymnastics is also a sport discipline with a majority of female population *(e.g. data for Portugal for the year 2012 shows that from the sample of 14742 gymnasts from all gymnastic disciplines 81.2% are female and only 16.7% are male (Silva & Barata, 2016). In the USA (USAGym, 2016) there are over 5 million registered gymnasts over the age of 6 and the majority of them are female (76%))* so it is probably worth stressing the importance of consuming omega-3 fatty acids as an essential nutrient that a person does not consume naturally from a representative source in the event they are not properly informed or do not have a properly planned diet. Gymnasts often end their career in the late teenage years or early 20s and many take on various roles in the world of gymnastics, so it seems reasonable that female gymnasts acquire information about the importance of omega-3 fatty acids in connection with motherhood and breastfeeding, which is what usually follows after the period of performing in competitions. There is also a justified concern that many female gymnasts, especially in the time of puberty, develop an eating disorder (energy deficiency and nutritional insufficiency), which is usually connected with dissatisfaction with appearance and the attempt to improve their performance (Nordin, Harris & Cumming, 2003). Eating disorders *(eating disorder in athletes is characterized by a wide spectrum of maladaptive eating and weight control*

behaviors and attitudes. These include concerns about body weight and shape; poor nutrition or inadequate caloric intake, or both; binge eating; use of laxatives, diuretics, and diet pills; and extreme weight control methods, such as fasting, vomiting, and excessive exercise (Bonci et al., 2008)), which are proven to be connected with hormonal imbalance (reproductive disorders), are more frequent with female athletes in aesthetic sports than in endurance and team sports (Torstveit & Sundgot-Borgen, 2014). Estimates of incidence of eating disorders, which can have negative, sometimes even fatal, consequences on health as well as on physical performance, reach up to 62% with female athletes and 33% with male athletes (Bonci et al., 2008). There are concerns over the negative energy balance among gymnasts in the period between 6 and 15 years of age, since there is a high risk of pathological eating disorder (Malina et al., 2013) that can manifest into a mental disorder even later in life, after the finished period of competing, due to different pressures of the environment and expected behavior. Besides the recommendations on the appropriate energy and micro nutrient sufficiency and a regular exposure to sunlight for the required vitamin D, the information on the needs of the essential omega-3 fatty acids are also important in order to avoid potential reproductive disorders in female gymnasts. The recommended daily intake of DHA during pregnancy is therefore at least 200 mg daily, but that does not mean that pregnant women are encouraged to eat fish, since most of them are contaminated, among other substances with mercury, which is a neurotoxin that especially damages the fetus (Koletzko, Cetin & Brenna, 2007). A quantitative assessment of the risk of contamination with mercury when consuming fish and the benefits due to the content of DHA that was done by the Dutch scientists showed that the negative effect of mercury on the *intelligence* quotient (IQ) is greater than the potential positive effect of DHA in the majority of fish (Zeilmaker et al., 2013). Eating habits throughout the person's entire life are equally important, since exposure to heavy metals, PCBs, and other industrial chemicals in the period of breastfeeding, childhood, and adolescence (breastmilk, eating fish) has a long-term negative effect for decades to come, including the period of pregnancy (Glynn et al., 2007). Consuming DHA dietary supplements during pregnancy has proved to be unjustified in some cognitive tests with properly fed and healthy children, which some studies that were included in previous scientific reviews did not include, e.g. the test of attention, working memory, or the precision of looking for the hidden toy (Gould, Makrides, Colombo & Smithers, 2014). One of the last studies (Shulkin et al., 2016), which examined the influence of supplementation with omega-3 fatty acids during pregnancy and breastfeeding, was based on 15 studies which included 2525 children and it concluded that EPA and DHA supplementation during pregnancy or in the period of breastfeeding improves the child's development of the nervous system. Asthma is a chronic inflammation of the respiratory tract that is also present among athletes and the nutrition of the Western world, which is based on a high content of fat, might be one of the most important risk factors (Wood, Garg & Gibson, 2011). A systematic overview of 7 observational studies, which examined the connection of asthma and consuming fish or EPA and DHA from fish oils during the time of pregnancy, revealed that consuming fish or EPA and DHA is inversely related with the development of asthma in childhood. This analysis only adds evidence to the existing literature of randomized controlled studies about the importance of consuming omega-3 fatty acids for general health, the health of pregnant women, and babies (Yang, Xun & He, 2013) as well as for reducing the incidence of asthma and respiratory infections in childhood

(Bisgaard et al., 2016). Breastmilk contains variable amounts of DHA, which depend on the diet of the nursing mother, raising the question whether consuming omega-3 fatty acids in the form of dietary supplements might only be beneficial in the event when the pregnant woman does not eat fish on a regular basis. Nursing mothers who had a vegan diet in one of the studies had a lower amount of DHA in their milk when compared with vegetarians and nursing mothers who had an omnivorous diet, but researches did not find any consequences of these differences in the growth or the neurological and intellectual development of the children, as long as their nutrition contained an appropriate intake of vitamin B12 (Sanders & Reddy, 1992). According to recent studies, the general belief is that a lower content of DHA in the breastmilk in not necessarily connected with a defective development of the fetus (Mulder, King & Innis, 2014). However, in several examples in which they could suffer a fatal lack of DHA needed for a comprehensive and long-term cognitive development, there is a consensus that pregnant women and nursing mothers should consume 200 mg of DHA (Koletzko, Cetin & Brenna, 2007), probably best in the form of a dietary supplement from a non-toxic source.

Consuming fish or omega-3 dietary supplements and cognitive abilities

Researchers conducted a randomized double-blind study of almost 3000 cardiovascular patients, aged between 60 and 80, in the period of 40 months, where one group received 400 -mg of EPA and DHA in the form of a dietary supplement from fish oils, the second group 2 g of ALA from plants, and the third and fourth group placebo, and they did not observe any positive effect on the cognitive functioning of the brain (Geleijnse, Giltay & Kromhout, 2012). On the other hand, a randomized double-blind study (Stonehouse et al., 2013) which lasted for 6 months and was conducted on 176 healthy non-smokers, aged between 18 and 45, who rarely consumed fish before the study (an intake of less than 200 mg of EPA and DHA per week), demonstrated positive effects of consuming EPA and DHA dietary supplements on certain aspects of the cognitive functioning of the brain and also showed differences in gender. In the intervention, the total intake was 170 mg of EPA and 1160 mg of DHA, which is comparable with the existing guidelines of a healthy diet that recommend eating fish rich in omega-3 fatty acids two to three times per week. The authors of the research state possible reasons for the different results of other randomized controlled studies in examining the influence of consuming omega-3 fatty acids on brain health, including the short duration of the studies in which they could not measure the significant effect, distinguishing the effects between gender, the diversity of effects that can be expected (memory, the reaction time of memory, attention, speed of processing), different amounts of intervention of EPA and DHA fats, different initial states of the participants according to the consumption of omega-3 fatty acids, etc., which could lead to inaccurate conclusions. Yurko-Mauro et al. (2010) conducted a randomized double-blind study of 485 healthy adults older than 55 years, which lasted for 2 years and in which they measured the influence of a daily supplementation of 900 mg of DHA omega-3 fatty acids. The intervention group, compared with the placebo-controlled group, showed an improvement in learning and functioning of the memory and other cognitive abilities connected with ageing. Meanwhile, Chew et al. (2015) conducted a randomized double-blind study of 4203 people with some sort of risk, e.g. developing age-related macular degeneration, where the experimental group consumed 1 g of omega-3 dietary supplement daily for 5 years (350 mg of EPA and 650 mg of DHA), and they did

not demonstrate any significant effects on cognitive health. The authors indicated that the possible reasons for the inefficient supplementation on cognitive health of the participants could be attributed to their good nutritional status and high education, the short period of intervention, and a possible late start of the intervention, since the average age of the participants was 72.7 years at the beginning of the study. Another study examined the brains with MRI twice in the period of 5 years and revealed that 3660 people older than 65 years, who in general consumed more food with omega-3 fatty acids, especially DHA, had healthier brains (Virtanen et al., 2013). A study that examined the connection between the intake of EPA and DHA and the volume of the brain, which is connected with a lower risk for dementia, included 1575 participants and showed, using MRI and various cognitive tests, that a lower amount of DHA fats in the blood is associated with a smaller volume of the brain and an impairment of cognitive functioning of the brain, even in people without clinical dementia (Tan et al., 2012). With a randomized double-blind study they confirmed for the first time the conclusions of the predecessors and, in a research that lasted for 26 weeks, with an intervention of 2.2 mg of omega-3 fatty acids from the source of fish oils, showed that consuming DHA and EPA is connected with a better cognitive functioning and a microstructural integrity of the brain of healthy older adults (Witte et al,. 2014).

The hypothesis of the effect of omega-3 fatty acids (more precisely DHA) on cognitive abilities is based on a double effect on the improved complex of reaction efficiency, namely slower fatigue, which enables a constant efficiency of motor sensations, and improving the processes of motoric sensations, leading to shorter reaction times and higher accuracy. A double-blind study (Guzmán et al., 2011) examined the influence of a 4-week intervention of consuming 3.5 g of DHA daily on the functioning of the nervous and motor system of 34 professional female football players. The test instrument was a part of the ASDE driver test and consisted of a series of psychological tests to assess psychomotor and perceptual-motor skills. The test examined the response to visual and auditory stimuli and registered responses. The researchers discovered that the experimental group had better results when it came to complex reaction time, accuracy, and efficiency (a more appropriate selection of technical and tactical solutions). The authors conclude that the reliability of the study is connected with the homogeneity of the sample and the control of the intake of macronutrients between the two groups, but there are justified concerns about the potentially inadequate nutrition of the female football players, since their 3050 calories per day consisted of 16% of protein, 44% of fat, and only 40% of carbohydrates. Numerous researchers examined the potential correlation between the consumption of dietary supplements EPA and DHA and the effect on cognitive abilities and mood, which is the basis for consistently successful trainings and performances in various sport disciplines. With some studies (Fontani, Lodi, Migliorini & Corradeschi, 2009), but not all (Jackson, Reay, Scholey & Kennedy, 2012), researchers have reported on the improvement of the learning curve or, in other words, visual attention and speed of information processing. Fontani et al. (2009) took a sample of martial arts athletes to measure the influence of consuming 2.25 g of omega-3 fatty acids on maintaining alertness and attentiveness and they discovered an improvement in the experimental group when it came to reaction time and mood. In one double-blind cross-over study that included 13 young adults, Bauer et al. (2014) compared the influence of DHA (417 mg of DHA and 159 mg of EPA daily) with the influence of EPA (590 mg of EPA and 137 mg of DHA daily) on the functioning of

the nervous system while executing cognitive tasks (STROOP, SWM, and SUCCAB tests) and discovered a higher efficiency of EPA in visual neural recovery and the choice of reaction times.

Some gymnasts face the most frequent neurobehavioral disorder from early childhood on; the attention deficit hyperactivity disorder or ADHD, but only a few ever speak of it. *(the fourfold American Olympic champion Simone Biles (Turner, 2016) and the twofold British Olympic silver medalist in competitive gymnastics Louis Smith (BBC, 2016) also suffer from ADHD)*. Healthcare professions usually solve the problem of restlessness, problems with attention and monitoring heart rate, and in some cases hyperactivity, which results in problems with learning, discipline, anxiety, and depression, by prescribing pills that have a number of perceived side effects. Inappropriate nutrition, in connection with hereditary and environmental factors, presents an important risk factor in preventing or controlling ADHD (Curatolo, D'Agati & Moavero, 2010). Authors Howard et al. (2011) connect ADHD with the nutrition of the Western world, which is characterized by micronutrient insufficiency and an excess of energy density and is full of highly processed food containing saturated fats, salt, and sugar. On the other hand, an overview of scientific effects of omega-3 fatty acids on ADHD showed that the supplementation with EPA and DHA in the period of 3 to 4 months significantly improved ADHD symptoms, especially in connection with GLA omega-6 fatty acids (Transler, Eilander, Mitchell & van de Meer, 2010). An analysis of 10 randomized, placebo-controlled studies, which included 699 children, showed "only" a moderate efficiency in comparison with the currently used pills, but the authors do emphasize a relatively innocuous side effect profile of omega-3 fatty acids (Bloch & Qawasmi, 2011). Another analysis of 24 randomized controlled studies (Cooper, Tye, Kuntsi, Vassos & Asherson, 2015) that examined the effect of supplementation of omega-3 fatty acids on cognitive abilities or ADHD, failed to prove the eligibility of the intervention, despite some individual studies with formulations with more EPA (perhaps because of lower concentrations of omega-3 fatty acids in plasma and red blood cells in children and adolescents with ADHD). This was most likely due to the incompatibility of various components of cognitive abilities and the tests that were used. The authors therefore warn that in practice there is a serious problem, due to the unwarranted advertising of the positive influence of consuming omega-3 fatty acids on cognitive abilities, since the claims about the potential benefits on cognitive abilities should be limited only to certain conditions.

Consuming fish or omega-3 dietary supplements and systemic inflammations, DOMS, and mood

Muldoon et al. (2015) conducted a randomized controlled study with 261 healthy adults, aged 30 to 54, examining the influence of 1400 mg of EPA and DHA (1000 mg of EPA and 400 mg of DHA) from fish oils in the form of a dietary supplement on the potential reduction of systemic inflammations. In a period of 18 weeks, the researchers compared the intervention group and the placebo-controlled group and found no reduction of systemic inflammation, which was measured by general markers of inflammation (CRP, IL-6, IL-1β, IL-8, and TNF-α), even though supplementation brought a 64% increase in EPA and DHA in the red blood cells. Consuming EPA and DHA in the form of a dietary supplement did result in a better "condition" of the blood, but it did not reduce systemic inflammation, most likely because the participants in the study were healthy. The CRP of 75% of the participants was under 2 ng/mL before the beginning of the study, but additional analysis of the group with the initial CRP above 2 ng/mL or IL-6

above the reference values also showed no change in the markers of systemic inflammation. In the modern world, two-thirds of adults are overweight and that is why they usually have abnormal markers pointing to systemic inflammations. Eating animal source foods, such as dairy products, meat, eggs, and vegetable oils, increases inflammations in the body. Even a single high-fat meal may increase inflammations in the body within a couple of hours, which can mostly be seen in arteries that are more stiff and narrowed (Bui et al., 2010; Vogel, Corretti & Plotnick, 2000), and can contribute to chronic inflammatory diseases of the respiratory system (Rosenkranz, Townsend, Steffens & Harms, 2010).

The next potential benefit of consuming omega-3 fatty acids for gymnasts is the influence on the reduction of inflammatory processes in the body due to an individual exercise or exercise program, which can further reduce delayed onset muscle soreness (DOMS). One of the randomized, double-blind, placebo-controlled studies that was conducted on 45 healthy men, who were not included in any exercise program prior to the study, examined the influence of consuming 1.8 g of omega-3 fatty acids in the form of a dietary supplement on the inflammatory processes during an eccentric exercise *(numerous gymnastic elements include rotations around the horizontal or linear axis and are executed with eccentric muscle contractions of the legs and arms)* which was tested before the exercise, immediately after it, 24 hours later, and 48 hours later. The research team found that the 4-week intervention with omega-3 fatty acids, in connection with the eccentric exercise, was efficient in reducing the inflammatory markers (Tartibian, Maleki & Abbasi, 2011). It is important for gymnasts that the potential reduction of inflammatory processes is also connected with reducing DOMS. DiLorenzo, Drager, and Rankin (2016) examined the effect of a prior consumption of 2 g of DHA that lasted for 28 days before the beginning of a training period that lasted for 17 days and was tested on 41 untrained men, which included an eccentric exercise for the strength of flexors in the elbow, while the researchers examined the progress of isometric strength and flexibility as well as DOMS after 1, 2, 3, 4, 7, 12, and 17 days. The research showed encouraging results of consuming DHA on the reduction of certain markers of muscle damage throughout the 17 days of executing the eccentric exercise for building strength. Gray, Chappell, Jenkinson, Thies, and Gray (2014) came to the same conclusions, namely that some (not all) markers of oxidative stress did improve in the randomized, double-blind, placebo-controlled study that lasted for 6 weeks and included a single exercise (extension of the knee) in eccentric conditions. A similar assessment was also given by researchers (Corder, Newsham, McDaniel, Ezekiel & Weiss, 2016) who conducted a randomized, placebo-controlled study, which included 14 women (the placebo group consisted of 13 women) and measured the influence on the inflammatory processes and DOMS with an intervention of 3 g of DHA from seaweed 7 days before and 2 days after an eccentric exercise for strength. DOMS in the experimental group was reduced by 23%, while numerous participants of the placebo group could not extend their elbow even 48 hours after the eccentric exercise. Authors conclude that intervention with a DHA dietary supplement ensures a better preservation of the amplitude around the joint in days of strenuous eccentric trainings and can be efficient in reducing DOMS and muscles stiffness and when introducing a new training program for the athlete, which can have a positive influence on the process of adapting to the training. One of the most representative studies was a randomized, double-blind, placebo-controlled study which was done by Atashak et al. (2013). They examined 20 young athletes and measured the effect

of consuming 900 mg of EPA and DHA daily on the level of oxidative stress, muscle damage, and inflammatory markers in a single high-intensity training for building strength (a scientifically already used protocol, i.e. circuit training with 3 exercises for strength, 4 series of 7 to 10 repetitions until failure, and 3-minute breaks) and measured the improvement in biomarkers of inflammations and muscle damages, with which they have proven a potential effectiveness of consuming omega-3 fatty acids in minimizing oxidative injuries and systemic inflammation due to a single high-intensity training for building strength, which included an eccentric function. On the other hand, another study (Bloomer et al., 2009) failed to show a positive influence of consuming omega-3 fatty acids on the reduction of inflammatory processes or DOMS, but this does not lessen the value of previous results, since the study was conducted on an unrepresentative training protocol that did not cause an eccentric contraction, e.g. a 60-minute walk uphill on the treadmill with additional burden. One of the scientific overviews that examined the influence of various nutritional interventions on DOMS, among other also with omega-3 fatty acids, showed that consuming omega-3 fatty acids in eccentric contractions is related more to the oxidative stress for reducing DOMS (Kim and Lee, 2014). In sports literature, omega-3 fatty acids have shown efficiency in reducing processes of inflammation and muscle damage and in deformation of red blood cells and metabolism during exercise, but the results of the studies of the intervention with omega-3 fatty acids in meta-analyses are often inconsistent due to inadequate study design. Jeromson, Gallagher, Galloway, and Lee Hamilton (2015) believe that the inappropriate ratio of omega n-6/n-3 in the dietary pattern is one of the main variables that can reduce the effect of intervention with omega-3 fatty acids.

One of the main arguments for recommending a regular consumption of fish or omega-3 fatty acids (EPA and DHA) in the form of a dietary supplement is that EPA and DHA are vital for the functioning of the brain and proper mood state. An overview of 13 randomized, placebo-controlled studies that were conducted on 731 participants and examined the impact of the efficiency of EPA and DHA omega-3 fatty acids on the level of depression did not show any significant benefits of prescribing omega-3 fatty acids for treating depression (Bloch and Hannestad, 2012). On the other hand, the cross-over and intervention studies have shown that a vegan diet, or even avoiding meat and fish for 14 days, has a significantly positive effect on the mood state, stress, and depression, even though vegans had a lower level of EPA and DHA in the blood. This is most likely due to avoiding high-protein (less arachidonic acid, which is the precursor of inflammatory hormones, and more polyunsaturated fats) and high-fat animal source foods and due to a higher intake of antioxidants, which significantly contributes to a lower oxidative stress (Beezhold, Radnitz, Rinne & DiMatteo, 2015).

Consuming fish or omega-3 dietary supplements and physical performance

Some researchers have connected the consumption of EPA and DHA fatty acids in the form of a dietary supplement from fish oil with a reduction in markers of systemic inflammations as a consequence of an immune response to exercise (Andrade, Ribeiro, Bozza, Costa Rosa & Tavares do Carmo, 2007), while many researchers failed to show the influence of consuming omega-3 fatty acids on the performance or a quicker recovery in healthy adults or well-trained athletes of team sports (Bortolotti, Tappy & Scheiter, 2007; Buckley, Burgess, Murphy & Howe, 2009; Raastad, Høstmark & Strømme, 1997). One research (Rodacki et al., 2012)

randomly divided 45 healthy women (65 years old) into 3 groups (exercise for strength; exercise for strength and EPA and DHA; EPA and DHA). The supplemented groups consumed 400 mg of EPA and 300 mg of DHA daily, 60 days before the beginning of the training (90 days altogether), which included exercises for strength three times a week in a period of 12 weeks. The research showed better results in muscle strength and functional capacity in the group that exercised and, in addition, consumed omega-3 fatty acids. Body weight remained unchanged in both groups after 12 weeks, which suggests the influence of omega-3 fatty acids on additional improvement of muscle activation and, consequently, on muscle strength. Walser, Giordano, and Stebbins (2006) conducted a study of 7 healthy people who were consuming 2 g of DHA and 3 g of EPA for 6 weeks and they measured an increase in brachial artery blood flow and conductance during a 90-second submaximal rhythmic squeezing of the fist (30% of maximal strength of the squeeze), while the placebo group did not show this effect. Clark, Monahan, and Drew (2016) conducted a study of 14 healthy young people (25 years old) and 15 older people (64 years old) and measured the impact of consuming 3.6 g of EPA and DHA for 12 weeks with a 15-second squeeze of the fist at 10%, 30%, 50%, and 70% of maximum conscious contraction and discovered that both teams of young and old participants who enjoyed the omega-3 fatty acids in the form of dietary supplements had a lower diastolic and mean arterial blood pressure. Omega-3 fatty acids additionally improve the blood flow during exercise, reducing the deformation of red blood cells, which theoretically increases the flow of oxygen and nutrients into the trained muscle. Tiryaki-Sönmez, Schoenfeld, and Vatansever-Ozen (2011) reviewed the studies that examined the influence of a combined consumption of omega-3 fatty acids on body composition and physical ability and they concluded that a generalization of scientific evidence about the potential synergistic benefits is problematic due to the limitations of the study designs. Mickleborough (2013) was faced with inconsistent results in the field of intervention with omega-3 fatty acids and physical performance when he was trying to determine the optimal intake of omega-3 fatty acids that would maximize the ratio between benefits and risks and he came to the conclusion that the reasons for such diverse results, which make it impossible to determine the final recommendations, are connected with the heterogeneity of the participants, the intensity and duration of the examined exercise or training, different types, amounts, and duration of the intervention with EPA and DHA dietary supplements, and the interval of duration of measuring the selected biomarkers of the studies. One of the last overviews of literature (Da Boit, Hunter & Gray, 2017) that examined the potential implication of consuming omega-3 fatty acids on physical ability showed that the majority of research focuses on measuring the increase in metabolic capacity, the reduction of delayed muscle pain and fatigue, the improvement in hypertrophy, recovery, and the immune system, and the reduction of oxidative stress. Based on the inconsistency of the majority of research, the authors conclude that the supplementation with omega-3 fatty acids for the needs of physical ability is potentially justified for athletes with asthma and in sport disciplines in which the primary motor ability that determines effectiveness is connected with strength, which can therefore also be applied to gymnasts. Even though today the mechanism of action is relatively well explained, the reliable implication of consuming 1–4 g of omega-3 fatty acids in the form of a dietary supplement for the needs of gymnasts requires research in various situations during trainings and competitions.

Consuming fish or omega-3 dietary supplements and body composition

The mechanism that theoretically connects consuming omega-3 fatty acids with losing body fat is connected with the improvement of insulin sensitivity, which results in an improved use of stored fat reserves. Numerous studies which have proven the benefits of consuming omega-3 fatty acids on body composition may be problematic when applying them to gymnasts, since they included overweight or even clinically obese ordinary people who might have a particular insulin resistance. The first randomized controlled study (Thorsdottir et al., 2007), which included 324 people (aged 20 to 40 years) that were divided into 4 groups (the control group; consuming 150 g of lean fish three times a week; consuming 150 g of fatty fish three times a week; 1300 mg of EPA and DHA from fish oils), examined the influence of omega-3 fatty acids on the loss of excess body weight in a period of 8 weeks by prescribing the same isocaloric intake and ratio between the nutrients (30% of fat, 50% of carbohydrates, 20% of protein) and a similar amount of exercise and found that men who consumed fish or dietary supplements from fish oil lost one kilogram more than the control group. When it came to women, the researchers did not find any differences among the four groups with different diets. Similar results, but this time with women, were obtained by Noreen et al. (2010), who, in addition to weight loss, also found a lower amount of subcutaneous fat, an increase in lean muscle mass, and a reduction of cortisol in the saliva in a period of 6 weeks. One of the most relevant studies was conducted by the researchers Munro and Garg (2012), which was a randomized, double-blind, placebo-controlled study that included 29 clinically obese people (aged 18 to 60 years) and measured the effect of consuming 420 mg of EPA and 1620 mg of DHA on the loss of excess body weight with a low-energy diet and a low intake of fat (720 calories, 40% of protein, 16% of fat, 40% of carbohydrates) in a period of 14 weeks, but they failed to confirm the eligibility of consuming EPA and DHA for the loss of excess body weight. One of the last overviews of 21 randomized, placebo-controlled studies that examined the influence of EPA and DHA from fish oil on overweight and obese people showed that current evidence does not support a weight-loss role of omega-3 fatty acids, but individuals can experience a reduction of abdominal fat and the waist-hip ratio, especially when they combine the intervention with omega-3 fatty acids with a change of lifestyle (Du, Jin, Fang & Su, 2015). The latter could be important for gymnasts who wish to lose excess fat while maintaining body weight (muscle and bone mass), with which they consequently maintain physical abilities and most likely also the immune system. Many differences between researchers point to the fact that a short-term influence of consuming omega-3 fatty acids on the control of body weight most likely does not represent a promising field of research so it might be better to direct this research into examining long-term supporting effects of consuming omega-3 fatty acids on the athletes' body composition, their immune system, and a successful recovery.

Every day, more and more young people and athletes turn to a vegetarian diet, usually because of the assumed impact on preventing chronic diseases, improving the immune system, offering a more efficient recovery after training, and enabling an easier control of body weight, and perhaps also out of ethical reasons. In one research (Farmer, Larson, Fulgoni, Rainville & Liepa, 2011) vegetarian diets were proven to be nutritionally adequate, even with a calorie restriction of 500 calories less than the estimated energy requirements, and can be recommended for control of body weight without reservations. In one randomized controlled study (Turner-McGrievy, Davidson, Wingard, Wilcox, & Frongillo, 2015) authors compared the efficiency of

different plant-based diets (vegan, vegetarian, pesco-vegetarian, half-vegetarian diet) with an omnivorous diet and discovered that plant-based diets, especially the vegan diet, are most affective in losing excess body weight. Katz and Meller (2015) carried out an overview of scientific studies of the most common diets and concluded that the majority of scientific evidence strongly connects a well-planned vegan diet with health, a successful control of body weight, and prevention against systemic inflammations and chronic diseases. On the basis of the index of healthy nutrition and the assessment of a Mediterranean diet conducted on 1475 people (104 vegans, 573 vegetarians, 498 half-vegetarians, 145 pesco-vegetarians, 155 people with an omnivorous diet), Clarys et al. (2014) assessed that the vegan diet is the healthiest (related to body weight and nutritional adequacy), while the omnivorous diet received the lowest assessment of the two indicators of a quality nutrition. Not long ago, the Academy of Nutrition and Dietetics (AND) reiterated its position from the year 2009 about the adequacy of vegetarian diets for different groups of people and stated that a well-planned vegetarian diet, including the vegan diet, is healthy and nutritionally adequate and appropriate no matter the period of a person's life, even during pregnancy and breastfeeding, during childhood and adolescence and also for athletes (Melina, Craig & Levin, 2016).

On the other hand, Chen et al. (2009) write that, when talking about gymnasts and the reduction of unnecessary fat or the control of body composition while simultaneously maintaining or even improving the optimal level of physical abilities, this is a long-term process, since the latter must also include control over the amount of trainings. The case study of an Olympic gold medalist was based on the moto "less eating, more training" and turned out to be successful. A short-term diet (1600 calories, 68% of carbohydrates, 20% of protein, and 12% of fat) for achieving momentary loss of excess fat was, according to the authors, energy-efficient, did not include dairy products (35%–70% of calories came from fat), but did include vitamin and mineral dietary supplements. The gymnast lost 356 g of fat from the total of 840 g of weight loss, while the rest of the weight loss was due to the loss of muscle mass, which in the end fortunately did not have a negative impact on the performance. The short-term influence of the intervention in this case study, especially because the article does not mention BMI (or the height through which it would be measured) or body composition, cannot be generally applied to the long-term needs of other gymnasts who are faced with permanent control of optimal body weight, especially because the authors did not measure the numerous micronutrients, among others also the intake of omega-3 fatty acids, or potential consequences of a possible deficiency. However, this could present a basis for research in future studies that would include a larger number of gymnasts.

CONCLUSIONS

- Studies about the benefits of consuming omega-3 fatty acids (ALA, EPA, and DHA) on general human health as well as the potential risk of excessive intake (when EPA and DHA exceed 1 g daily) show that the ratio forms a U-shaped curve. Here we must emphasize that there exists no scientific evidence that would confirm that consuming EPA and DHA can compensate for an unhealthy diet or significantly improve our health.
- Numerous analyses of studies of adults, which measured the effect of omega-3 fatty acids on the primary and secondary prevention of cardiovascular disease, showed that the supplementation with EPA and DHA is not connected with a lower mortality rate due to any reason. A lower incidence of cardiovascular disease is most likely the result of other dietary

factors (in general a healthier eating pattern) and a lifestyle that is a result of people who are more aware and also eat fish. Throughout their gymnastic development, gymnasts require more education by qualified professionals about a well-planned and healthy diet and about monitoring the implementation of concrete guidelines through the strenuous rhythm of trainings, the yearly calendar with competitions, and the competitive career in general.

- It is difficult to uncritically imply the influence of consuming omega-3 fatty acids on cognitive abilities, which include a very broad and complex field of numerous neurological processes, for the needs of gymnasts, since there is currently a lack of research carried out with representative tests. Some studies have shown a greater direct applicability of the intervention with EPA and DHA in a potentially more frequent occurrence among gymnasts, i.e. ADHD, especially in combination with a healthy diet, which could be relevant since most of the medication that is used for ADHD carries numerous side effects (Gelperin, 2006).
- The evidence about the effects of consuming omega-3 fatty acids, especially EPA and DHA, on systemic and local inflammations and DOMS in eccentric contractions (exercise or training) is much more consistent in comparison with other muscle contractions. EPA and DHA from a verified manufacturer might present one of the permitted and safe dietary strategies if a gymnast uses all other known and permitted ways for an efficient recovery during their training rhythm and workout program, but only as part of a special assessment of needs by the coaching team, especially by a qualified professional from the field of ordinary diet and sports nutrition.
- An overview of studies that examined the influence of EPA and DHA on overweight and obese people showed that the current evidence does not support a weight-loss role of omega-3 fatty acids. On the other hand, researchers for vegetarian diets have proven that they are nutritionally adequate even with calorie restrictions and can be undoubtedly recommended to gymnasts for a successful control of body weight. Furthermore, AND reiterated that a well-planned and supervised vegetarian diet, including the vegan diet, is healthy and nutritionally adequate and appropriate no matter the period of a person's life, even during pregnancy, breastfeeding, during childhood and adolescence and also for athletes.
- Gymnasts who are vegetarians and do not consume fish or dietary supplements from various reasons (a type of vegetarianism, allergies to a specific source of omega-3 fatty acids) are recommended to either double their intake of ALA or to consume at least 200–400 mg of EPA and DHA in the form of a dietary supplement in order to avoid potential inadequate ability to convert ALA into EPA and DHA or in the case of greater needs.

Based on the majority of credible scientific evidence we can firmly conclude that a successful control of body weight, efficient trainings and recovery, and successful performances of gymnasts that have no long-term negative effects on health are based on a healthy diet, which is based on a well-structured diet that consists mainly (but not necessarily solely) of plants (e.g. starch and non-starch vegetables, fruits, nuts and seeds) and which, in its unrefined form, is also low in fat. When it comes to the optimal healthy diet of gymnasts we must also add to this 1–2 spoons of a representative intake of ALA (e.g. from flaxseeds) and, to be on safe side, also 200–400 mg of EPA and DHA in the form of a dietary supplement (fish oil or marine microalgae). It is of vital importance that the dietary supplement is strictly an addition to the ordinary diet and that is does not include any contaminants. This satisfies the two principles, i.e. the nutritional adequacy of

EPA and DHA for the needs of various body systems and their functions and the minimal exposure to industrial contamination, which could nullify the benefits of the intake of omega-3 fatty acids.

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Corresponding author:

Boštjan Jakše
Dragarjeva 9
1230 Domžale , Slovenia
phone: +386 41 278 586
e-mail: bostjanjakse@hotmail.com