THE ROLE OF CLUB MANAGEMENT IN ORGANIZING, EDUCATING, AND SELECTING SUPPLEMENTS AND ADEQUATE NUTRITION FOR SWIMMERS

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PROFESSIONAL ARTICLE

Abstract: Organizing the nutrition of athletes represents a crucial factor for their professional advancement and is a key part of everyday life without which success is impossible. Sports clubs pay special attention to organizing proper supplementation and nutrition. In recreational sports, it is often said that nutrition accounts for 70% of the impact, while exercise accounts for 30% of athletes' physical fitness. Without adequate nutrition, it is impossible for the body to endure the efforts both in training and in sports competitions. The recovery of athletes after strenuous exercise is conditioned by quality nutrition and proper supplementation. This paper was created for the needs of the management of Belgrade swimming clubs by reviewing the latest global research in the field of sports nutrition and supplementation, by students and professors of the Faculty of Sport.

Keywords: organization, nutrition, proteins, hydration, supplementation, swimming

INTRODUCTION

Organization of athletes nutrition represents a very important factor for their professional progress, a crucial part of everyday life without which success is impossible. In this paper, we investigated the impact and significance of nutritional organization in swimmers. This paper deals with sports nutrition through the relationships of various nutrients, macro and micronutrients, the principles of healthy eating, its specifics, and supplementation in aerobic and anaerobic activities using swimmers as an example.

METHODOLOGY

The research was conducted at the request of the management of sports swimming clubs with the aim of raising the level of knowledge among club members and improving and preserving the health of athletes, as well as enhancing sports performance. The research is of a descriptive type and includes a comparative analysis of domestic and foreign professional and scientific literature. The research was carried out based on the analysis of available literature and studies that focused on this issue, as well as research that provides statistical data on nutrition and supplement use in anaerobic and aerobic swimming disciplines. Professional domestic and foreign literature, scientific studies, and research relevant to this issue will be used as sources of data.

Subject, Aim, and Objectives of the Research

The subject of the study pertains to investigating the role and impact of supplementation and nutrition among athletes in terms of enhancing physical fitness for competitions.

The aim of the study is to determine whether the use of supplements influences the improvement of sports performance, as well as whether balanced sports nutrition affects the athletic performance of athletes (swimmers), all for the purpose of club management in preserving and enhancing the health status of athletes and improving their physical and sports form through education, counseling, and monitoring the implementation of the same.

THEORETICAL BASIS AND REVIEW OF RESEARCH AND STUDIES

Energy-Rich Nutrients

The energy required for cellular functions during rest and muscular effort is obtained by the body from carbohydrates, fats, and proteins. Energy for muscle work can be created anaerobically through the process of glycolysis, where glucose or glycogen is exclusively broken down, or aerobically, through the Krebs cycle, where metabolic products of glucose are used together with fatty acids via the process of beta-oxidation. When the body is at rest, the majority of energy (about 60%) comes from fat burning, while carbohydrates contribute significantly less (about 35%). The remaining 5% on average comes from protein. During muscular effort, the relative contribution of fuel to the production of required energy depends on the intensity and duration of exercise, as well as on the athlete's diet and training level. (Klissouras, 2013).

Meeting energy needs is the primary goal of adequate sports nutrition to ensure athletes achieve peak performance. Energy balance is a state in which energy intake (the sum of energy from food, fluids, and supplements) equals energy expenditure (the sum of energy expended as basal metabolism, the thermic effect of food, and the thermic effect of activity, which is defined as the energy expended through planned physical activity and non-exercise activity thermogenesis) (Burke et al., 2006). Athletes must have sufficient energy to maintain appropriate body weight and body composition. Inadequate energy intake negatively impacts athletic performance and negates numerous benefits of training. With restricted energy intake, both fat and lean tissue will be used as an energy source (ADA, 2009).

Loss of lean tissue contributes to a decrease in strength and endurance, negatively impacting endocrine and muscle function. Similarly, prolonged low energy intake leads to insufficient nutrient intake, especially vitamins and minerals, which can cause metabolic dysfunctions associated with nutritional deficiencies, compromising the normal performance of vital functions. Energy expenditure depends on the duration, frequency, and intensity of physical activity, as well as on gender and nutritional status. Additionally, heredity, age, body size, and lean body mass influence energy expenditure (ADA, 2009).

Proteins in Athlete Nutrition

Carbohydrates and fatty acids are the primary fuels used as energy sources during exercise. With prolonged exercise, muscle glycogen reserves decrease, and proteins begin to be utilized. Amino acids are converted in the liver through gluconeogenesis, leading to oxidative processes (Klissouras, 2013). Many athletes believe that proteins are the most important for achieving good sports results. In strength sports, some form of protein supplementation is increasingly used. Excessive protein intake can reduce the possibility of adequate intake of other essential nutrients. Situations where the need for proteins is greater than the intake are also common. Competitors in aerobic endurance sports have nearly as high a need for proteins (per unit of body weight) as athletes in strength sports (Butterfield & Calloway, 1984; Meredith et al., 1989).

The recommended daily protein intake level for the general population is 12-15% of total calorie intake, which would amount to about 0.8 grams of protein per kilogram of body weight. Athletes need more proteins due to greater tissue recovery needs and because a small amount of protein is burned during physical activities. This increases the protein needs for athletes to approximately double that of non-athletes (1.2 to 1.7 grams per kilogram) (Table 1) (Benardot, 2010).

Table 1. Protein Needs of Physically Active Individuals

Type Activity	Total Energy (kcal/day)	Protein g/kg/day kcal/day	g/day	% Of Total Energy
Endurance (a,b)	3800	1,2-1,4	84-98	9-10
Strength (a,c)	3200	1,6-1,7	112-119	14-15

Source: Dr.M.J.Gibala, 2002, "Dietary protein, amino acid supplements, and recovery form exercise",GSSI sports Science Exchange, br87, 15(4).

Under the assumption that energy consumption at rest is 40 kcal per kg of body weight per day. Under the assumption that a male athlete runs 16 km per day at a pace of 3.7 minutes per km. Under the assumption that an additional 6 kcal per kg of body weight per day is required for high-intensity training.

The rule of sports nutrition is that carbohydrates have a protein-sparing effect. This means that if an athlete consumes enough carbohydrates for energy purposes, proteins will be spared from burning so they can be used for much more important functions (Tab.2).

Table 2. Amino Acid and Protein Functions

Functional proteins (hemoglobin, enzymes, hormones; maintaining normal blood osmolarity; antibodies; energy source)	Enzymes Antibodies Transport proteins Hormones
Structural proteins (constitute cell structure; assist in development, repair, and maintenance of tissues)	Muscles, tendons, ligaments Skin Dental and bone marrow Hair and nails

Source: Benardot D. "Napredna sportska ishrana"; Beograd: Data status, 2010 p. 27.

Recommendations for increased protein intake in athletes are based on four factors (Tarnopolsky et al., 1988; Meredith et al., 1989; Butterfield, et al., 1992). Athletes typically have higher lean body mass, which requires more protein for maintenance; they lose a small amount of protein through urine (a phenomenon known as proteinuria), burn a small amount of protein during physical activity (approximately 5% of total energy expenditure), and require additional protein to recover from muscle damage incurred during training. High-protein foods have a slow gastric emptying rate, so their consumption is not recommended immediately before or during exercise.

Hydration

Physical exercises can induce high rates of sweating and significant losses of water and electrolytes, especially in warm weather. If water and electrolyte losses are not replenished, a person will become dehydrated during physical activity. Excessive dehydration can worsen exercise performance and increase the risk of heat-related illnesses. Excessive drinking can lead to exercise-associated symptomatic hyponatremia. Women and older adults are at increased risk of fluid and electrolyte imbalance during and after intense exercise.

Daily water balance depends on the net difference between water intake and loss. Water intake occurs through consumption (fluids and food) and production (metabolic water), while water losses occur due to respiratory, gastrointestinal, renal losses, and sweating. The volume of metabolic water produced during cellular metabolism (~0.13 g x kcal-1) is approximately equal to water losses in the respiratory tract (~0.12 g x kcal-1) (Brilla & Lanerholm, 1990), resulting in a water turnover without a net change in total body water. Gastrointestinal losses are small (~100–200 mL x d-1). Sweating represents the primary route of water loss during exercise-induced stress. The kidneys regulate water balance by adjusting urine excretion, with minimal and maximal urine excretion rates of approximately 20 and 1000 mL x h-1, respectively. During exercise and heat stress, both glomerular filtration and renal blood flow are significantly reduced, leading to decreased urine excretion (Struški, 2006). Therefore, excessive fluid consumption during exercise (hyperhydration) may lead to reduced urine production capacity for excreting excess volume. With intermittent activities, these effects may not be as pronounced in reducing urine production.

Prehydration with fluids, if needed, should commence at least several hours before the exercise task to allow for fluid absorption and to enable urine excretion to return to normal levels. Consuming fluids with sodium and/or salty snacks or small meals with fluids may help stimulate thirst and retain necessary fluid (Water. In: Dietary Reference Intakes for Water, Sodium, Chloride, Potassium and Sulfate, Washington, D.C: National Academy Press, pp. 73–185, 2005).

Before exercise: When hydrating before exercise, a person should slowly consume beverages (for example, ~5–7 ml x kg-1 per body weight) at least 4 hours before the exercise task. If a person is not producing urine, or if urine is dark or highly concentrated, they should slowly consume additional fluids (for example, another approximately 3–5 ml x kg-1) around 2 hours before the event. Hydrating several hours before exercise allows enough time for urine excretion to return to normal before the start of the event.

During exercise: The goal of drinking during exercise is to prevent excessive dehydration (>2% body weight loss due to water deficit) and excessive changes in electrolyte balance to prevent compromised exercise performance. The amount and rate of fluid replacement depend on individual sweat rates, exercise duration, and fluid availability (Noakes et al., 2014).

Individuals should develop customized fluid replacement programs that prevent excessive (<2% decrease in body weight compared to initial body weight) dehydration. Routine weighing before and after exercise is useful for determining sweat rates and customized fluid replacement programs. Consuming beverages containing electrolytes and carbohydrates can help maintain fluid and electrolyte balance and exercise performance (Noakes et al., 2014).

After exercise: The goal is to fully replenish fluid and electrolyte deficits. The aggressiveness needed depends on the speed at which rehydration must be achieved and the size of the fluid and electrolyte deficit. If time allows and recovery opportunities are available, consuming regular meals and snacks with adequate amounts of plain water will restore optimal hydration, provided that the food contains enough sodium to replace sweat losses. If dehydration is significant with relatively short recovery periods (<12 hours), aggressive rehydration programs are worthwhile (Lenn et al., 2002; Jukendrup et al., 2003).

Individuals aiming for rapid and complete recovery from dehydration should drink ~1.5 liters of fluid for every kilogram of body weight lost (Jukendrup et al., 2003). Food consumption is crucial to ensure complete daily hydration (Jukendrup et al., 2003). Eating encourages fluid intake and retention. Sweat electrolyte losses (e.g., sodium and potassium) should be replenished to restore total body water, which can be achieved through meal consumption in most individuals (Lenn et al., 2002; Jukendrup et al., 2003).

If an athlete intends to achieve optimal sports results, fluid levels must be satisfactory, so athletes must develop personal strategies to maintain optimal fluid levels in the body while exercising. Since fluid levels decrease so slowly, occasional consumption of a glass of water or other fluids is an adequate means of maintaining hydration status.

Without fluid intake, blood volume will rapidly decrease, sweating rates will decline, and body temperature will increase rapidly and dangerously, at a rate of approximately 1 degree Celsius (1.8 degrees Fahrenheit) every 5 to 7 minutes. Since it is difficult to ingest enough fluid during strenuous training, athletes should devise fixed fluid intake schedules. If fluid is not replaced, premature fatigue with the possibility of heat stroke can occur. It is crucial for athletes to be in a state of optimal hydration before starting exercise or competition. All evidence suggests that even minimal dehydration (e.g., a deficit of just 2% of body weight) can cause measurable differences in endurance and sports performance. The greater the degree of deficit, the more pronounced the negative impact (Hargreaves, 1996).

Many studies have shown that consumption of beverages containing 4-8% carbohydrates provides effective rehydration during exercise and provides a useful source of energy for muscles and the central nervous system. Current guidelines for rehydration during exercise support the use of ready-made sports drinks (4-8% carbohydrates, 10-25 mmol/L sodium) during various prolonged competitions and training sessions, although water is still considered the most suitable drink for activities lasting less than 60 minutes (Burke, 2007).

Supplementation and Nutrition in Swimming

The term ergogenic aids refer to substances that can enhance athletic performance, particularly by alleviating fatigue symptoms. Nutritional ergogenic aids include nutrients or metabolic byproducts of nutrients, food extracts (plants), or substances commonly found in foods (e.g., caffeine and creatine) in amounts above usual levels.

Ergogenic aids are claimed to improve sports performance. Nutritional ergogenic aids are defined as such because they function by participating in some of the energy metabolic processes or because they consist of one or more known nutrients. For example, additional intake of carbohydrates to enhance sports performance constitutes that product, by definition, a nutritional ergogenic aid. Taking creatine monohydrate to improve sports performance constitutes creatine as a nutritional ergogenic aid because it is a common food ingredient, and its intake through dietary supplements enables the occurrence of a known metabolic reaction.

The symbol USP indicates that the supplement has passed standard tests for solubility, breakdown, impact, and purity. Make sure the product is produced by a reputable food and drug manufacturer. Supplementation in sports should be performed when nutritional analysis has shown a clear need for certain nutrients. Supplements with proven ergogenic potential in sports are: caffeine, creatine, and sodium bicarbonate (Grahovac, 2019).

Part of the research focuses on the impact of creatine on swimming speed. In earlier studies, creatine monohydrate was considered an effective nutritional supplement readily available for improving exercise performance. Nearly 70% of these studies reported significant improvements in exercise capacity, while in other studies, there was generally no significant improvement in results.

Regarding athletic performance, caffeine enhances overall and muscle endurance. Increased mobilization of fats from adipose tissue and muscle cells has been observed, along with an increase in the number of engaged muscle fibers. Additionally, it reduces the perception of fatigue and increases motor activity.

Beta-alanine as a supplement is highly popular among athletes seeking performance enhancement. This non-essential amino acid is naturally found in the body and in foods such as fish, chicken, pork, and beef. Amino acids are the building blocks of proteins, the primary "material" for muscle growth. Beta-alanine itself cannot be synthesized into protein.

Taking sodium bicarbonate hours before exercise leads to an increase in blood pH, enhancing the capacity to buffer the increase in hydrogen ions and acidosis that occurs in high-intensity exercises where anaerobic energy pathways are highly involved.

Caffeine

One of several methylxanthines found in coffee, tea, cola beverages, chocolate, and various other foods, has been shown to improve parameters of muscle and overall endurance. This is particularly evident in individuals who are not accustomed to consuming caffeine-rich products. Recently, it has been removed from the list of banned substances by the International Olympic Committee. Numerous studies have demonstrated that caffeine intake significantly increases the concentration of free fatty acids in the plasma. It enhances the availability of free fatty acids, increasing the cells' ability to use these fats as fuel during low-intensity exercises. Since people easily develop a tolerance to caffeine intake, frequent and regular consumption often leads to an adaptation effect. Excessive caffeine intake is associated with irritability, insomnia, diarrhea, and anxiety. Additionally, consuming large amounts of caffeine can induce diuresis, which may increase the risk of dehydration.

It seems that caffeine intake in doses between 3 and 9 milligrams per kilogram of body weight, or approximately 250 milligrams in total, leads to improvements in sports performance in activities requiring extreme endurance. However, caffeine can also enhance sports results during more intense short-duration exercises. It's not entirely clear why caffeine possesses these apparent ergogenic effects, although there is a hypothesis that it may stimulate the sympathetic nervous system and increase the utilization of fatty acids, thus sparing limited glycogen stores. As a central nervous system stimulant, caffeine can stimulate the brain and reduce the sensation of fatigue, allowing for prolonged activity and improved sports performance. Now that the International Olympic Committee no longer prohibits caffeine, athletes will likely include caffeine supplementation in their regular intake regimen. Apart from the dependency issue that arises from regular use (discontinuation leads to irritability, headaches, and frequent mood swings), caffeine is a substance that is relatively safe to consume (Benardot, 2010).

Regarding sports performance, caffeine improves general and muscular endurance, increases mobilization of fat from adipose tissue and muscle cells, and enhances the recruitment of muscle fibers. Additionally, it reduces the perception of fatigue and increases motor activity. In small doses (1-2 mg/kg), it enhances attention, visual information processing, reaction time, and wakefulness. However, these positive effects of caffeine occur only within a certain dosage range. Beyond that range, there is no improvement, and negative or harmful consequences may arise.

Caffeine is a supplement that enhances sports performance. Its use in sports is permitted, but during competitions, to prevent potential abuse, it is subject to monitoring.

Swimmers undergo extensive training regimes. During competitions, they must exert high levels of energy and execute precise and skilled movements in a short amount of time. Wagenmakers et al. (1991) demonstrated a significant reduction in sprint times for trained swimmers, but not for untrained swimmers, after the administration of caffeine at a dose of approximately 4 mg/kg. In the following two studies, swimmers were tested in 1,500m and 2,000m events, and improvements in performance were observed after caffeine administration in both cases (Bruce et al., 2000; MacIntosh, 1995). Pingitore et al. (2015) tested swimmers who were given 3 mg/kg of caffeine in the form of caffeinated beverages and showed improvements in sprint performance. Furthermore, the administered doses had marginal side effects. Clearly, additional specific studies covering these sports are needed to determine the minimum effective dose with positive effects.

Table 3. The influence of caffeine on swimming performance

Study	**Participants**	**Caffeine Intake**	**Performance Measures**	**Improvement Observed?**	**Technical Comment**
Burke et al. (submitted for publication)	Elite and highly trained swimmers (7M, 8F)	Dose: 2mg/kg Time of intake: 60min before event	100m race (best style)	No, but RPE decreased	No difference in reaction time for 50m sprint or 100m, but RPE was lower in the caffeine test. Caffeine increased time to fall asleep and reduced sleep quality.
Vandenbogaerde and Hopkins 2010	9 competitive swimmers (6M, 3F)	Doses: variable up to 5mg/kg Time of intake: 75min before competition Note: study design includes a combined model of 2-8 training TTs and 2-7 swim races with different caffeine intakes, placebo during the day. Swimmers completed	100-400m TT or determined by individual participant's main competition (style and length)	Yes	100mg caffeine improved training performance by 1min and TT competition by 1.3%. Each additional 100mg of caffeine had a reduced benefit of 0.1%. Placebo effect showed a minor improvement of 0.2%. Caffeine also had minor effects on improving focus, reducing sleep length, and

		their competitions, varying in style and distance.			increasing time to fall asleep.
Pruscino et al. 2008	Elite swimmers (6M)	Dose: 6.2 mg/kg Time of intake: 45min before race 1 Note: study includes bicarbonate and caffeine + bicarbonate	2*200m freestyle, races 30min apart	Race 1: maybe Race 2: no, maybe even slower	Compared to the placebo experiment, caffeine improved performance by 1% during the first swim but worsened the second swim time by 0.7%. Bicarbonate seems to help neutralize performance degradation but is uncertain due to sample size.
Macintosh and Wright 1995	Well-trained swimmers (7M, 4F)	Dose: 6mg/kg Time of intake: 60min before race	1500m freestyle	Yes	23sec improvement in swimming time with caffeine.
Collomp et al. 1992	Well-trained swimmers (3M, 4F)	Dose: 250mg (~4mg/kg) Time of intake: 60min before race 1	2*100m with a 20min pause between races	Yes	Caffeine improved swimming speed in both races and prevented the decline in speed seen in the second swim with the placebo effect.

Source: Caffeine for sports performance / Louise Burke, Ben Desbrow, and Lawrence Spriet. (2013).

Nutrition in long-distance swimming

If you spend long hours in the water, you need special nutrition and hydration, especially immediately before the race. In distance swimming, unlike cycling and running, refueling during your race is not always convenient or practical. Your pre-race nutrition and hydration should prepare you to cover the distance, prevent hunger, and optimize energy.

Two to three hours before the race, you'll want to have a solid meal consisting mainly of carbohydrates, along with a small amount of protein and fat. The size of the meal depends on your weight and how far ahead of the race you are eating - your body needs time to digest food. Examples of such a meal include instant oatmeal with dried fruit and milk; peanut butter on toast with a banana; dry cereals with berries and milk, or scrambled eggs with toast. If your race is later in the day - for example, after lunch - have a hearty breakfast, then enjoy foods such as a turkey sandwich, pasta with marinara sauce, or a peanut butter and jelly sandwich a few hours before the race. Additionally, two to three hours before the race, you should drink plenty of water, aiming for about 0.5 liters in total (Huffman et al., 2004).

Before the start: A small carbohydrate-rich dinner of 100 to 200 calories, such as an energy bar, dried fruit, or a banana, replenishes your energy stores within an hour to 30 minutes before you start running. Drink about 0.1 liters of water or a sports drink, with carbohydrates and electrolytes, every 10 to 20 minutes in the hour leading up to the start. For this hour, you want to consume at least 0.2 liters of fluids, up to 0.5 liters (Huffman et al., 2004).

During and after the competition: Pre-race nutrition is critical, but if you're going a distance covering several miles, you'll need fuel during the competition as well. Diana Nyad, the first athlete to swim 103 miles from Havana, Cuba to Key West, Florida, consumed energy chewing gums, gels, peanut butter, and liquid nutrition every 60 to 90 minutes. After the race, have a dinner containing both carbohydrates and proteins. Options include a whey protein smoothie made with fruit, or a turkey and vegetable sandwich. To optimize recovery, you should also have a substantial meal within four hours after finishing the swim (Huffman et al., 2004).

The volume of training will likely also deplete glycogen stores in the muscles, emphasizing the need for nutrition strategies aimed at replenishing glycogen for prolonged or more intense sessions, especially during phases of high volume. Failure to adequately replenish glycogen stores between training sessions can impair the open water swimmer's ability to complete high-intensity and volume training necessary for sustained success. Long-distance swimmers are therefore encouraged to aim for higher carbohydrate intake within the upper limits of sports nutrition guidelines (~6–10 g/kg body weight daily), especially during weeks of intense training, and utilize specific glycogen replacement strategies between key training sessions (Noakes et al., 2014).

During the competition phase, nutritional needs for open water swimmers significantly differ from pool swimmers. Specific considerations for each event will be determined by the duration of the race, environmental conditions, and the feasibility of consuming nutrients during the race (Noakes et al., 2014).

The pre-race meal provides the final opportunity for swimmers to begin the event with optimal carbohydrate availability. General recommendations for the pre-race meal include consuming easily tolerated food that provides the target amount of carbohydrates of 1–4 g/kg, 1–4 hours before the race, and sufficient fluid intake to ensure euhydration. Due to the early start times (before noon) of most open water events, the pre-race meal will likely take the form of breakfast. Since the race location may be distant from the competition accommodation and requires travel, the last opportunity for a formal meal may be up to 4 hours before the race time. In such scenarios, the swimmer should continue to consume fluids or carbohydrate-containing food as an option for a snack until the race begins (Noakes et al., 2014).

Races lasting less than 1 hour can still benefit from carbohydrate intake during the competition, even when glycogen levels are optimized before the race starts. Events of this duration are not limited by muscle glycogen depletion, and there may be minimal muscle carbohydrate oxidation from the carbohydrates consumed during such races (McConnell et al., 2000). However, there is consistent evidence that the performance of continuous high-intensity exercise lasting 45-75 minutes is enhanced when carbohydrates are ingested during exercise of this nature, with benefits isolated from situations where it is consumed orally at frequent intervals and absent when delivered intravenously (Struški, 2006).

Swimmers competing in 10 km races should optimize glycogen levels and hydration before the race. Since the duration and intensity of open water events of 10 km correspond to theoretical glycogen storage limits, swimmers are encouraged to identify opportunities during the race where the consumption of nutritious substances is possible (Noakes et al., 2014).

The duration of a 25 km race is 5 hours or more, so swimmers are encouraged to rely more on central feeding zones and support pontoons for nutritional assistance. Carbohydrate intake should be around 90 g/h from multiple portable carbohydrate sources (Jeukendrup, 2011), and given the likelihood of extreme temperature variations in these events (16–31 °C), swimmers may benefit from adjusting the temperature of their drinks to specific environmental conditions. Cold beverages (4 °C) can enhance endurance exercise performance by reducing thermal stress (Pingitore et al., 2015).

Nutrition in swimming (up to 400 meters)

Sprint swimmers largely rely on energy supply from muscle stores of high-energy phosphates (adenosine triphosphate, adenosine diphosphate, creatine phosphate). There is evidence that the capacity, strength, and recovery of this energy system can be modified by appropriate training and diet (Wagenmakers et al., 1991). Accordingly, training using repeated maximal efforts is often used in an attempt to create adaptations of this energy system as a means to improve muscle ability to reach peak speeds quickly and maintain race speeds during the event. Enhancing this energy system through nutrition mainly focuses on increasing muscle creatine phosphate content (creatine supplements) (Noakes et al., 2014).

Swimmers primarily rely on glycogen and phosphocreatine for their activities, with carbohydrates being the main source of energy for swimming sprints (to replenish glycogen stores) alongside phosphocreatine. With adequate overall nutrient intake, centered around carbohydrates (at least 30 kcal of carbohydrates per kilogram of body weight) and adequate protein intake through nutrition (approximately 1.5 – 2 grams per kilogram of body weight), there is a basis to consider that sufficient glycogen can be stored in athletes' bodies and enough phosphocreatine can be created to support muscle function (Benardot, 2010).

A practical principle to apply is the continuous intake of small amounts of water or sports drinks in sips while simultaneously avoiding strategies that could lead to excessive fluid accumulation in the body (Benardot, 2010).

Ideally, swimmers should maintain a stable daily protein intake of 1.2 to 2.0 grams per kilogram of body weight. Athletes should consume enough calories to maintain existing body and muscle mass. A meal plan containing 4000 kcal is suitable for an athlete with one early morning and one afternoon training session or for swimmers (Benardot, 2010).

Table 4. Intake 4000c kcal per day

Meal	Food	Quantity	Calories	Substitute
Early Morning Snack	Whole Wheat Toast Grape Juice	1 slice 270ml	70 170	1 starch unit 1.5 fruit units
Mid-morning Workout	Sports Drink (6% carbohydrates)	540ml	135	3 fruit units
Breakfast	Orange Juice Cantaloupe (fresh) Unsweetened Cereal Milk (1%) Whole Wheat Toast Margarine Jam	120ml 1/4 melon, sliced 2 cups 1.5 cups 2 slices 2 teaspoons 1 tablespoon	60 115 320 165 140 70 17	1 fruit unit 2 fruit units 2.75 starch units 1.5 dairy units 2 starch units 2 fat units 1-4 fruit
Afternoon Snack	Whole Wheat Roll Margarine Jam Coffee or Tea Sports Drink (6% carbohydrates)	1 medium size 1 tablespoon 2 tablespoons 1 cup 540ml	320 35 35 0 135	4 starch units 1 fat unit 1-2 fruit 3 fruit units
Lunch	Hamburger Hamburger bun Ketchup Green Salad Tomato French Fries Banana Fruit Cocktail	90g 1 roll 2 tablespoons 1 leaf 2 slices 1/2 cup 1 medium size 240ml	215 230 10 0 12 290 100 50	3 protein units with very low fat content 2 starch units 2 fat units 1-2 vegetable units 2 starch units 2 fat units 1 fruit unit 2.5 fruit units
Afternoon Snack	Cheddar Cheese Savory Crackers Grapes	30 grams 6 small 1 cup	115 80 60	1 protein unit with moderate fat content 1 starch unit 1 fruit unit
Afternoon Workout	Sports Drink (6% carbohydrates)	540ml	135	3 fruit units
Dinner	Baked Salmon Fillet Broccoli Margarine Baked Potato Sour Cream Fruit Cocktail	120 grams 2 cups 2 tablespoons 1 medium 1 teaspoon 1 cup, fresh fruit	185 90 70 190 30 120	4 protein units with very low fat content 4 vegetable units 2 fat units 1 starch unit 1 fat unit 1 fruit unit
Evening Snack	Milk (1%) Popcorn	1 cup 3 cups	110 92	1 dairy unit 1 starch unit
Total Daily Caloric Value	Total Calories: 2971	Total Carbohydrates (g): 647 (63.8%)	Proteins (g): 145 (14.3%)	Fats (g): 99 (21.9%)

Source: Benardot D. „Napredna sportska ishrana“, Beograd: Data Status, (2010).

PRESENTATION AND ANALYSIS OF RESEARCH RESULTS

A study on the organization of nutrition among swimmers was conducted on 60 male swimmers, aged 21-25, divided into three groups. The participants belonging to this population are at the peak of their morphological and motor development and are well motivated to progress in swimming. The participants were divided into three groups and were engaged in recreational swimming prior to the implementation of this research.

Swimmers, like all other athletes, are interested in sports nutrition and supplements that are produced or advertised for various purposes, as they are aware that they can progress faster and easier and achieve sports results. The supplements and sports nutrition used by swimmers include products that achieve practical nutritional goals as well as products that provide ingredients claimed to directly improve performance. The extent to which these products have become part of swimmers' daily routines is shown in the results of research on elite Australian swimmers (Bruce et al., 2001). Among 77 national and international representatives who participated in the study, 99% reported using supplements and sports nutrition, listing 207 individual products.

Swimmers had a clear stance on the issue related to safety in sports and supplement use, as shown in a study where the absence of doping problems was proven. The majority of swimmers stated that it was very important (79%) or important (16%) to consider the risk of inadvertent doping when using new supplements before deciding to take them. Only 5% of swimmers expressed a neutral opinion on this matter. Nutritionists, doctors, pharmacists, and sports scientists were the most significant sources of information when deciding whether to use supplements; for 53% of swimmers, this was the most important source of advice, while the remaining 31% of swimmers used another primary source of information. Coach advice is also considered a highly useful source of information, ranking it as second (31%) or third (30%) in importance among swimmers. The ingredient list provided on the supplement packaging is considered very important information about the supplement, with 22% of swimmers stating that it is their most important source of knowledge. Advice from alternative nutritionists, such as naturopaths, herbalists, or health food store agents, is not highly ranked; less than 10% of swimmers rank this type of advice among the top three sources of information.

Eighty-seven percent of swimmers stated that the use of sports nutrition such as sports drinks can be helpful to athletes in meeting specific nutritional needs during training or competition. On the other hand, 95% of athletes reported using nutritional ergogenic supplements, including various vitamin and mineral supplements (while 71% use more than one supplement), herbal products (61%), amino acid supplements (18%), and various supplements such as inosine (16%) and coenzyme Q10 (7%). A review of these supplements suggests that only creatine (used by 31% of the group), bicarbonate (3%), and caffeine (usage not documented) definitively have effects on swimmers when used in a certain way. Despite this or perhaps only due to professional advice, it seems that the majority of swimmers still engage in supplementation without sufficient evidence that it is truly beneficial.

By reviewing supplements and sports nutrition that seem to have some value for swimmers and briefly summarizing research specifically related to the effects of ergogenic supplements on swimming performance. A careful review of these studies aimed to find sports literature related to creatine, caffeine, bicarbonate, citrate, β-hydroxy β-methylbutyrate (HMB), colostrum, pyruvate, vitamins, and several other products. The studies presented in these tables relate to trained swimmers and exercise regimens that can be applied in real life. Of course, further research is needed that will use rigorous control and carefully select regimens to test claims related to many products. In the case of the majority of supplements and ergogenic ingredients popular among swimmers, studies examining claims that they contribute to better results have not been conducted.

Even in cases where there is confirmation of efficacy for a product in a study, it is still insufficient in terms of well-controlled research from the perspective of specific supplement use for the needs of swimmers. For example, although there is hypothetical use of continuous creatine supplementation in interval and resistance training for swimmers, more studies are needed to adequately monitor adaptation and changes in capabilities over a sufficient training period. This is also the case with administering bicarbonate before interval training to achieve better training results or better adaptation to training. These findings should be tailored to the young age of swimmers, who are elite athletes. Many experts believe that children and adolescents do not need creatine because they gain weight during their maturation and through training, and due to a lack of evidence of safety for long-term use at that age. Some supplements (such as caffeine) may affect fine motor control, which is not of primary importance in activities that involve gross body movements, leading to a decrease rather than an improvement in performance.

Since swimmers compete in both qualifications and finals when final results are determined (usually on the same day), there is a need to examine the effect of supplementation regimes, including their repetition. For example, the lowest effective dose of bicarbonate, citrate, and caffeine should be determined to minimize unwanted effects such as gastrointestinal discomfort or disturbances in rest and sleep after the race. Finally, although an acute supplementation regime may allow for better results during the immediate race, unwanted effects that may occur after the race can jeopardize the outcome of subsequent competitive activities. It is also important to investigate whether subsequent doses have effects and whether there are any unwanted effects at this level. Lower doses in a repeated administration regime may have effects, especially if previous doses have not completely disappeared. It is also possible that the next dose may have reduced or no effect at all, leaving the athlete to decide whether their priority is to improve their result and enter the finals or to wait for the finals to then apply a supplementation regime that would achieve the optimal result. In the case of bicarbonate, a regime of chronic or long-term loading, which involves 5 days of 500 mg/kg/day (in 4 doses per day), has been explored as an alternative to acute loading (McNaughton et al., 1999; McNaughton & Thompson 2001). It has been found that this regime achieves an increase in plasma bicarbonate continuously over 5 days and improves the result of prolonged sprinting the day after cessation of bicarbonate supplementation. The presence of an ergogenic outcome is considered a desirable factor for sports involving series of competitive activities.

Finally, due to the use of simultaneous supplementation and interactions between supplements such as caffeine and bicarbonate, or caffeine and creatine, research needs to be conducted to develop recommendations for swimmer supplementation. The only available information on the use of multiple supplementation in swimmers includes the examination of acute loading of creatine and bicarbonate. A study (Lenn et al., 2002) investigated the outcomes of two 100 m freestyle races held 10 minutes apart, where competitors applied a six-day regime of creatine intake (20 g/day) followed by bicarbonate loading (300 mg/kg) in the morning. It was found that this combination improved the result of the second race compared to the placebo application. However, the mechanisms explaining the improvement in results and the individual contribution of each supplement were not provided. Ideally, such studies would include a design that explores the individual and combined effects of each intervention, so that independent and mutual influences can be understood (Burke, 2007).

Of particular interest to open water swimmers are products that can enhance central drive and help alleviate acidic environments; this is especially crucial in the last few kilometers of any championship race. Current tactics in the final stages of 5 and 10 km races involve gradually increasing speed throughout the entire event, so that the last kilometers are covered at almost maximal intensity. Caffeine has been shown to be useful for swimmers competing in long pool disciplines (i.e., 1500 m) with moderate doses (~mg/kg). Caffeine supplementation protocols include intakes up to 3 mg/kg one hour before short open water events or lower doses consumed along with carbohydrates during longer races. Beta-alanine supplementation, a component that limits the rate of muscle dipeptide carnosine formation, has been shown to increase maximal power and average power during the final sprint in a simulated cycling race (Benardot, 2010), a protocol similar to sustained almost maximal efforts seen at the end of open water races. Specific studies should explore whether enhanced intracellular capacity results in improved race performances in open water; currently, there is a notable lack of such research in the literature (Noakes et al., 2014).

Management of Nutrition and Supplementation in Sports Organizations

Management of nutrition and supplementation in sports organizations should focus on the health and abilities of athletes as the primary goal. Effective management of nutrition and supplementation not only contributes to better sports results but also improves overall health and prevents injuries.

Planning and Organization of Nutrition: Club management has the responsibility to provide an adequate nutritional plan for its athletes. This includes collaboration with nutritionists who can create individualized meal plans according to the specific needs of each athlete. Meal planning should consider the type of sport, training intensity, and individual metabolic needs.

Providing Quality Supplements: Supplementation is an important part of athletes' nutrition, especially for elite athletes. Club management should ensure that athletes have access to high-quality supplements that are safe and effective. This includes regular quality checks of supplements and cooperation with reliable suppliers.

Education and Awareness: One of the key tasks of management is to educate athletes about the importance of proper nutrition and supplementation. Organizing workshops, lectures, and individual consultations with experts can significantly contribute to increasing athletes' awareness of the importance of these aspects. Athletes need to be aware of how their nutrition and supplementation affect their performance and recovery.

Monitoring and Evaluation: Continuous monitoring of athletes' nutritional status and evaluation of the effects of certain supplements is necessary to ensure that athletes receive optimal support. This includes regular medical check-ups, blood analyses, and monitoring performance in training and competitions.

A systematic approach, education, and continuous monitoring are key elements that ensure athletes receive the best possible support in their careers. After that, management should provide good conditions for training and competitions, as well as for other club needs.

Employment of Experts: Clubs should employ experts in the fields of medicine and sports science who are highly educated. These experts should not only regularly conduct health check-ups and treat injuries but also keep up with the latest research related to sports nutrition and supplementation.

CONCLUSION

Sport clubs, following global trends in the pursuit of achieving new records, pay special attention to organizing supplementation and nutrition for their athletes. No record or competition victory would be achieved solely with the help of training technologies, as fuel in the form of energy for the human body – nutrition – is needed. Even a healthy diet alone is not enough today; it is necessary to collaborate with pharmaceutical corporations that research and develop chemical formulas for supplements aimed at enhancing athletes' performance. The important fact is that athletes themselves are becoming aware of the impact of sports nutrition and supplementation, including products that achieve goals and those that affect results.

Swimming as a sport has the highest energy consumption, involving all muscles in the human body, thus requiring a special dietary regimen. A concern for athletes is the quality of supplements, as counterfeit products with no nutritional value can be found on the market. Every sports club, as well as every sports coach, has a special place in their team for a nutritionist whose task is to organize nutrition and supplementation systematically to prepare athletes for important competitions and elevate their performance. When competitions are won, all the praise goes to the coach and club manager, but only true experts know the significant role of the entire team, where the team responsible for nutrition and supplementation deserves the same recognition as the conditioning coach and head coach.

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