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CURRENT APPROACHES TO NUTRITION OF CHILDREN INVOLVED IN SPORTS (LITERATURE REVIEW)

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Abstract. Proper nutrition for children involved in sports will help to correct the possible adverse effects of increased physical activity, achieve high performance and improve the health of young athletes. Knowledge about the rational nutrition of athletes should be available not only to doctors of sports dispensaries, but also to outpatient doctors, since a large number of children are engaged not only in sports schools, but also at additional education sites and do not always visit dispensaries. The article discusses the basic principles of rational nutrition of children involved in sports, adopted in the Russian Federation. Preparation of a balanced diet, taking into account the type of sport, the intensity of loads and the period of training activity; the use of adequate forms of nutrition, including specialized products, standards of basic nutrients, mineral and vitamin support and drinking regimen. Foreign approaches to nutrition of athletes' children are similar to domestic recommendations. Of interest is a new direction in nutrition using probiotic products to maintain the microbiome that affects the psychological state of an athlete, as well as measures of nutritional support for vegan children. The appointment of adequate nutrition for children involved in sports will allow them to achieve high results while maintaining their health.

Keywords: *nutrition, sports, children, dysmicroelementoses, dysmacroelementoses*

АКТУАЛЬНЫЕ ПОДХОДЫ К ПИТАНИЮ ДЕТЕЙ, ЗАНИМАЮЩИХСЯ СПОРТОМ (ЛИТЕРАТУРНЫЙ ОБЗОР)

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Резюме. Правильное питание детей, занимающихся спортом, поможет скорректировать возможные неблагоприятные воздействия усиленных физических нагрузок, добиться высокой работоспособности и улучшить состояние здоровья юных спортсменов. Знания о рациональном питании спортсменов должны быть как у врачей спортивных диспансеров, так и у врачей амбулаторного звена, потому что большое число детей занимаются не только в спортивных школах, но и на площадках дополнительного образования и не всегда посещают диспансеры. В статье рассматриваются основные принципы рационального питания детей, занимающихся спортом, принятые в РФ. Составление сбалансированного рациона питания с учетом вида спорта, интенсивности нагрузок и периода тренировочной деятельности, использование адекватных форм питания,

в том числе специализированных продуктов, нормативы основных питательных веществ, минерально-витаминной поддержки и питьевого режима. Зарубежные подходы к питанию детей-спортсменов, схожи с отечественными рекомендациями. Представляют интерес новое направление в питании с использованием пробиотических продуктов для поддержания микробиома, влияющего на психологическое состояние спортсмена, а также меры нутритивной поддержки детей-веганов. Назначение адекватного питания детям, занимающимся спортом, позволит добиться высоких результатов при сохранении их здоровья.

Ключевые слова*: питание, спорт, дети, дисмикроэлементозы, дисмакроэлементозы*

INTRODUCTION

In recent years, the Russian Federation has paid considerable attention to the development of children's sport. Russia is implementing the federal project "Sport is the norm of life" (https://norma-sport.ru/) from January 2019 to the end of 2024. Its goals are to promote healthy lifestyles and rational nutrition, to improve conditions for physical education in Russia, primarily for the child population [1, 2]. The "Concept of development of children's and youth sports in the Russian Federation until 2030" was adopted in December 2021. Its aims are supporting and developing children's and youth sports as a priority area in the social policy of the state, which is of crucial importance for the future of the country, contributing to increasing the duration and improving the quality of life of Russian citizens, revealing the talent of each person, including persons with disabilities and persons with disabilities [3]. The measures taken have led to the fact that sports activities have become more widespread. About 23 million people aged from 3 to 18 years (85% of the total number of children and youth, according to 2019 data) are systematically engaged in physical culture and sports in the Russian Federation. According to the Ministry of Sport, in Russia 41% of children aged 6 to 15 years are engaged in specialized sports institutions [4]. Regular sports activities have a positive impact on the development and health of children, ensure full physical and intellectual development, and instill a culture of a healthy lifestyle. The positive influence of sports activities on psychological well-being and mental health of children has been proved [5]. All this creates strong prerequisites for comprehensive harmonious development of the younger generation [6].

At the same time, high physical and psychological activities against the background of active growth of a child can lead to unfavorable consequences for the health of a young athlete. Depending on the type of sport, the athlete's body is exposed to excessive or uneven impact of physical load, which can lead to disorders of various organs and systems. For example, hockey players have flat feet in the first place among the background conditions, and in 50% of cases fencers have pathology of the musculoskeletal system — posture disorders and scoliosis [7].

Athletes who specialize in one sport for a long time have higher injury rates. In addition, in individual sports there are significantly more injuries from overstrain than in team sports [8, 9].

Training activities of young athletes require the tension of metabolic processes, increased expenditure and demand for energy, vitamins and minerals. Therefore, the deficiency of macro- and microelements is observed in a significant number of young athletes. Deficiency of bioactive elements leads to homeostasis disturbance, which limits vital functions of the organism [10]. Individual peculiarities of indicators of chemical elements in the studied biological substrates in terms of calcium, iron, selenium, and magnesium have been revealed. The levels were different and depended on the type of sport. The levels of calcium and magnesium in saliva are reduced, and the iron content in hair is increased in fencers. Children involved in field hockey are characterized by higher values of zinc levels. The obtained data reflect the intensification of mineral metabolism under conditions of intensive physical exertion. Statistically significant interrelation of potassium and selenium indicators was proved when comparing the content of bioelements in hair and saliva. These results substantiate the necessity to single out young athletes into a risk group for the development of dysmacro- and microelementosis [11, 12]. One of the most common conditions is iron deficiency. All athletes are at risk of developing iron deficiency anemia due to increased iron requirements and impaired iron absorption due to hepcidin, the level of which increases against the background of intense physical exertion. Regular monitoring of blood iron profile and adequate correction in case of its violation are necessary for all young athletes [1].

Various hypovitaminoses are also quite often detected in most athletes and have a combined character. In a study to assess the provision of young athletes with vitamins E, A, C, B_2 and caro-

tene, conducted at the Scientific Center for Children's Health of the Russian Academy of Medical Sciences together with the Research Institute of Nutrition of the Russian Academy of Medical Sciences, it was shown that the deficiency of one vitamin (usually vitamin B_2 or carotene) in young swimmers was observed in 31% of cases. In 49% of children there was a deficiency of two vitamins simultaneously (most often B_2 and carotene). Combined deficiency of three vitamins (vitamin E, carotene and vitamins A or B_2) was experienced by 15% of children. At the same time, the level of vitamin C in more than half of athletes was determined at the upper limit of the norm (excessive supply), which was associated with the common practice of children taking a drink containing only one vitamin C in an amount 1.5–2 times higher than the recommended daily intake during training [14].

Nutrient deficiency in adolescent girls, especially in sports associated with the need to maintain a certain weight, can lead not only to deterioration of general health, performance, but also psychological state with the development of eating disorders. This knowledge is lacking in athletes, coaches and parents alike [15].

Due to the high risks of health disorders in young athletes, it is necessary to provide medical support for such children with periodic medical examinations [16] and development of individual recommendations based on the child's health status, primarily on rational nutrition. This knowledge should be possessed by a district pediatrician, since some children are not only involved in sports schools and do not always visit sports dispensaries.

FORMATION OF A PROPER DIET OF CHILD ATHLETES

Proper nutrition ensures a high level of performance, psychophysiological state and health of athletes. The nutrition of child athletes differs significantly from that of adults, since along with the need to ensure an effective training process, it is important to support the natural processes of growth and development of the child. The main approaches to nutrition of child athletes are considered in the methodological recommendations of the chief nutritionist of the Ministry of Health of the Russian Federation, academician of the Russian Academy of Sciences V.A. Tutelyan [17]. The main principles of rational nutrition of an athlete are: an individual approach, supplying the necessary amount of energy (respectively high spending); balanced nutrition taking into account the type of sport, intensity of loads and period of training activity; use of adequate forms of nutrition, including specialized products. It is necessary to prescribe a dietary regime, selecting the amount of proteins, fats, carbohydrates and mineral and vitamin support, drinking regimen and specialized food product if necessary depending on the age of the athlete, type of sport and training regimen [18].

Thus, during aerobic loads (weightlifting, power loads) it is necessary to increase protein in the diet. However, it should be remembered that the excess of protein over 2 g/kg per day is undesirable and does not lead to the strengthening of adaptive abilities of the body, and in some cases can lead to adverse effects — the impaired kidney function and negative calcium balance. The average norms of protein intake are 1.2–1.7 g/kg per day [19]. The ratio of proteins of animal and vegetable origin should be at least 60% and 40%, respectively. Foreign norms of protein requirements coincide with the Russian recommendations [20]. Modern nutritional standards indicate the ratio of proteins and fats 1:0.8–0.9 as the most favorable in the diets of young athletes. The main food sources of polyunsaturated fatty acids (PUFAs) of the omega-3 family are fish and seafood. Some vegetable oils are good sources of PUFAs — flaxseed oil, pumpkin oil, rapeseed oil. Their optimal share in the diet is 25–30% of the total amount of consumed fats. It is recommended to consume carbohydrates in the form of polysaccharides (starch) up to 65–70%, in the form of simple and easily digestible carbohydrates (sugar, fructose, glucose) about 25–30% and 5% in the form of dietary fiber.

Anaerobic exercise (cycling, skiing, swimming) increases total calorie intake, primarily due to carbohydrates (low glycemic index) and fats. In mixed aerobic-anaerobic exercise (playing sports), the diet approaches that of a healthy child with a slight decrease in fat and an increase in protein, depending on age and type of exercise. The optimal ratio of protein to fat is 1:0.8–0.9 [18].

Not only the diet, but also the mode of nutrition is important in the formation of health of young athletes. Optimal is considered 4–5 meals with intervals of 2.5–3.5 hours. Before the start of training after the main meal should be at least 1–1.5 hours for sports associated with prolonged physical exertion, and for speed and power sports

that interval should be at least 3 hours. An interval of no more than 1 hour after training is considered optimal. Distribution of caloric content of the daily ration during the day also takes into account the time and number of training sessions. The energy value of the first meal should not be not less than 10–15%, and the second is 20–25% of the total daily caloric content. The caloric value of lunch is 35%, afternoon snack is 5–10%, dinner is no more than 25% of the total daily caloric value of the diet. The last meal should be 1.5–2 hours before bedtime [21].

Calculation of daily energy expenditure should be carried out depending on the type of sport, period of training process, age and sex of athletes. Accordingly, the main diet is corrected in terms of calorie intake [22–24].

Compliance with the water regime is essential for maintaining homeostasis and high physical performance. Water is involved in the accumulation of glycogen in muscles. The daily need for free fluid varies from 1.5–2 to 5–6 liters and depends on the age, health, physical activity of the child, as well as the ambient temperature. It is advisable to use sports drinks containing carbohydrates and electrolytes. Drinks containing caffeine, guarana extract and other stimulants are prohibited for child athletes [25].

NUTRITION OF ATHLETES DURING THE COMPETITION PERIOD

Organization of rational construction of the training process and increase of its efficiency is possible only with a properly designed diet, corresponding to the energy expenditure of the athlete and including all essential components of nutrition. Special attention should be paid to nutrition in the period of competition. The organization of nutrition in the period of intense physical exertion provides for the use of products of increased biological value, for a directed effect on the metabolism in the body both before and after the competition period. The use of biologically active additives in the pre-competition, competition and recovery periods should be carried out in accordance with the type of sport and preferably with the addition of trace elements (magnesium, potassium, calcium, chromium, iron, zinc and selenium) [26]. Individual nutrition programs for young athletes in the pre-competition period are developed for different sports, such as judo as one of the energy-consuming martial arts, where there is a need for weight loss, which, given the characteristics of the child's body, requires a competent approach. Dietary restrictions in pre-competition weight loss should be limited to fats and sugars only. Starvation and complete avoidance of water intake is contraindicated. Reduction of food calories is possible by 25–30%, in rare cases up to 50% of the usual consumption. The start of weight loss should be determined in advance and planned at least two weeks before the upcoming important competitions [27].

Energy-intensive sports also include cyclic sports such as cycling, short track, rowing (academic rowing, canoeing), swimming, speed skating (multiathlon), skiing (cross-country skiing, biathlon, Nordic combined), track and field, modern pentathlon, triathlon. The load is performed with high tension and significant intensity in all of these disciplines. Accordingly, the ratio of the main nutrients in endurance athletes is shifted in favor of carbohydrates, which should cover the high needs for physical activity, depending on the stage of the training process and the amount of load. The use of high-fat diets to provide energy function is not justified, the fat content in the diet of athletes should be about 25% of the total caloric content of the diet. Protein content should not exceed 1.2–1.6 g / kg of weight. The consumption of sports drinks containing carbohydrates and electrolytes is mandatory. Furthermore, it is more preferable than drinking only water [28].

SPECIALTY FOODS, VITAMIN AND MINERAL SUPPLEMENTS

The use of specialized food products has a number of advantages: a given chemical composition (a small volume contains an adequate amount of balanced nutrients in an easily digestible form), increased nutritional and biological value and/or directed efficiency allow to compensate for high energy expenditures in a small volume. However, the list of specialized products for child athletes approved for use in the Russian Federation is extremely limited. Currently, there are no foreign-made products that have an official certificate of state registration [17]. There are very few domestic products of specialized nutrition, only two products are allowed for use in child athletes from 6 years of age and 11 years of age. Studies on the use of these products have shown that a group of athletes receiving these specialized foods had normalized nutritional status and body mass index, increased performance and functional reserves of the body, which was manifested by improved sports performance [29–31].

The need for minerals and vitamins in children engaged in sports is much higher, especially in potassium, magnesium, calcium, phosphorus, iron, vitamin A, E, D, which requires mandatory correction. Vitamins are almost do not synthesize independently in the body. In this regard, it is necessary to monitor their intake with food, and if necessary, to address the issue of additional intake of multivitamin preparations or fortified foods. Lack of vitamins in the diet negatively affects the general state of metabolism and performance of young athletes [32].

The recommendations of sports dietitians in Australia (SDA) indicate the mandatory need for correction of vitamin D, calcium and iron, while the SDA position is that the nutrient requirements should be met by the main products, rather than supplements [33].

CURRENT TRENDS IN THE NUTRITION OF YOUNG ATHLETES

The positions of foreign sports nutritionists regarding the nutrition of child athletes (Canada, America) are similar to the Russian recommendations on the main directions. Attention is paid to individual selection of vitamin and mineral supplements and specialized food products. The issues of nutritional correction of vegetarian athletes with a risk of low intake of protein, fat and micronutrients (iron, calcium, vitamin D, riboflavin, zinc and vitamin B_{12}) are considered. Vegan athletes have low levels of carnosine and creatine, which also need correction. Such children need the consultation of a sports dietitian. Domestic guidelines do not accept a vegan diet in professional sports, especially in children. Despite the availability of theoretical data, the results of practical research on the effect of vegan diet on athletes' health and performance are needed [34, 35].

Works on the study of microbiome and its significance on the functional capabilities of an athlete have appeared, recommendations are given on the individual use of probiotics and foods to improve the intestinal microbiocenosis [34]. The influence of the gut microbiome on the psychological state of a person and changes in its composition under the influence of physical activity is considered. Emphasis is placed on the additional intake of probiotic foods and fiber, which are usually limited in the diet of athletes [36–39]. These studies were conducted on adult athletes. However, this direction is extremely important in pediatric sports dietetics due to the high frequency of gastrointestinal disorders in children involved in sports [40].

The position of the International Society of Sports Nutrition (ISSN) on the use of the ergogenic drug creatine has been updated. Studies show that short-term and long-term supplements (up to 30 g/day for 5 years) are safe and well tolerated by adolescent athletes [41, 42].

ASSESSMENT OF THE DIET IN CHILDREN INVOLVED IN SPORTS

Given the high importance of nutrition in maintaining the health of athletes, studies have been conducted to evaluate their diet. Nutritional quality was assessed among athletes engaged in cyclic sports. The deficiency of energy value of the diet of various degrees of severity was found in almost half of the children, more often in the older age group. Insufficient intake of protein, PUFAs, calcium and excessive intake of saturated fatty acids was noted. The following factors were identified during the analysis of the causes of inadequate nutrition: excessive intensity and frequency of training, leading to non-compliance with the necessary meal regime (in almost all children); selective appetite (food preferences — when a child does not like certain foods) — in 67% of cases; food allergy or intolerance — in 22% of children. In assessing the nutrition of preschool children, it was found that many children at this age do not get enough fresh fruit, dairy products, cottage cheese, cheese and legumes, which, in turn, negatively affects their physical development. At the same time, there is a lack of knowledge about proper nutrition among both coaches and parents [43, 44]. Nutritional imbalance and inconsistency with physiological norms were also observed in children engaged in the least energy-consuming sport — chess. This is largely due to the failure to fulfill daily nutritional norms — the consumption of products in general is 12–13% lower than the norm, which leads to insufficient intake of protein, fat, minerals and vitamins [45]. Evaluation of macronutrients in the nutrition of junior soccer players (11–17 years old) revealed increased protein intake (1.8–2.0 g/kg per day), asignificant decrease in carbohydrate intake and a sufficient proportion of fat from the recommended values [46].

The studies on water balance in children engaged in different sports were also conducted. Bioimpedance analysis was used to determine the total amount of water in the body, taking into

account age and gender norms. A pronounced decrease in water content was found in young athletes engaged in hockey, martial arts, rhythmic gymnastics, and tennis (boys), which indicates noncompliance with the rules of the water intake [47].

Organization of nutrition in sports schools is an important aspect, revealing violations related to a meal regime, an increase in the amount of carbohydrate products or the absence of a canteen itself [48].

CONCLUSION

Thus, the nutrition of child athletes has significant differences due to the need to provide high requirements in nutrients, macro- and micronutrients and to compensate for energy expenditure associated with active physical activity. Adequate nutrition preserves health, optimizes performance, ensures the safety of muscle mass, prevents injury, promotes the recovery process after active physical activity, and increases sports results [49].

Knowledge of the basics of rational nutrition is necessary not only for sports medicine doctors, but also for pediatricians, teachers and coaches. It is of interest to develop computer programs to calculate the individual diet of each athlete. Such a program was developed at the Institute of Physiology of the Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences (Russia), Syktyvkar (computer program "Sport: Calculation and Analysis of Ration" for calculation of nutritional and energy value of individual diets and further analysis of the obtained data). With its help it is possible to independently develop a diet with adequate nutritional and necessary energy value [50]. The development of such programs is a promising direction in the field of sportsmen's nutrition.

Foreign authors also pay much attention to research on the development of educational programs for athletes, parents and coaching staff, with the search for forms and methods for effective planning of sports diet [51, 52].

Rational nutrition will improve sports performance, recovery processes and adaptation to physical loads, will allow to achieve high results in sports while preserving the health of young athletes.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

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