ANALYSIS OF THE ADEQUACY OF ACTUAL NUTRITION ATHLETES IN TRAINING CAMPS

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Abstract: Increasing special performance in elite sports requires optimizing the metabolic background of the body at all stages of the annual training cycle. In this regard, it is relevant to analyze the adequacy of the actual nutrition of athletes, taking into account the energy orientation of training loads in different seasons of the year.

The purpose of this study is to analyze the integral adequacy and balance of the main and essential components of the diet of athletes in different seasonal periods of the annual training cycle.

Material and methods. The study involved 20 highly qualified road cyclists (candidates and masters of sports), the average age was 22.4 ± 0.7 years. Individual energy expenditures of the subjects were determined using a generally accepted method, the actual nutrition was investigated by the method of 24-hour (daily) reproduction of nutrition. In different seasons of the year, in the conditions of training camps, 1540 dietary rations of athletes were analyzed for 5 years. The energy balance and the adequacy of the actual nutrition were studied using the developed author's automated system "FP Diet".

Results. The average daily energy consumption of cyclists at different stages of the annual training cycle varied from 4503 ± 69 to 4646 ± 88 kcal, which indicates that athletes belong to one of the energy-intensive sports. The energy value of the actual diet of athletes practically satisfies the average daily energy consumption, however, the low values of the integral indicator of adequacy: 43.2% - in the winter-spring season and 60.0% - in the summer-autumn season - indicate significant imbalances in the balance of actual food rations in terms of basic and essential food substances, especially noticeable in the groups of vitamins and fatty acids. Against the background of insufficient consumption of vegetable oils, which causes a lack of monounsaturated fatty acids in the diet, an excessive consumption of saturated fatty acids, a deficiency of vitamins B1 and B2, vitamin C in the winter-spring period, as well as calcium and magnesium.

Conclusion. The qualitative characteristics of the diet of cyclists in different seasons of the annual training cycle does not meet the physiological needs of the body. Optimization of athletes' nutrition in terms of calorie content and chemical composition must be carried out taking into account the nature and methods of the
training cycle, which have significant differences in the energy orientation of loads and daily energy consumption.

**Key words:** nutrition, sports, summer-autumn, winter-spring seasons, road cyclists.

**Introduction.** According to modern studies of the largest domestic and foreign nutritionists, the rate of adaptation to intense muscular activity under conditions of a tense neuro-emotional state largely determines adequate nutrition [1-5].

Assessment of the integral nutritional adequacy of athletes requires the use of criteria that allow, along with the energy value and the amount of nutrients, to analyze the balance of the main and essential ingredients, taking into account the degree of their assimilation and the energy orientation of training loads [6, 7].

**Material and methods.** The study involved 20 highly qualified road cyclists (candidates for master of sports and master of sports), representatives of the national teams of Russia and the Krasnodar Territory. From the standpoint of the integral indicator of adequacy, 1540 dietary rations of athletes were studied over 5 years. The actual nutrition of athletes was investigated by the method of 24-hour (daily) nutritional reproduction.

In the conditions of training camps, training sessions in the field (natural) conditions included loads of different energy orientations, which was taken into account when calculating individual daily energy expenditures.

The nutritional adequacy of the athletes was analyzed seasonally, in the conditions of training camps. The compliance of actual diets with the principles of rational nutrition was assessed from the standpoint of the integral indicator of adequacy (IPA), which equally takes into account the caloric content and balance of diets for all analyzed parameters (animal and vegetable proteins, animal and vegetable fats, carbohydrates of varying degrees of complexity: polysaccharides, oligosaccharides and indigestible, irreplaceable amino acids, fatty acids, vitamins and minerals) [8, 9]. The level of balance of individual groups of nutrients in the studied diets was assessed according to the indicators of their balance (PS).
The energy balance and the adequacy of the actual nutrition were studied using the developed author's automated system "FP Diet" [10], the archive of food products of which was compiled and processed on the basis of reference tables of the chemical composition and energy value of products [11]. The algorithm of the automated system is based on a mathematical model (optimal control apparatus - convex quadratic programming), which allows calculating the IPA, which assesses the adequacy of the diet in relation to the recommended norms of energy value and chemical composition (%), equally taking into account all the ingredients of each product, taking into account losses during cold and thermal cooking, and PS - the balance of a separate group of ingredients of the studied diet.

The mathematical model and computational algorithm embedded in the automated system include mathematical calculus, on the basis of which the formula for calculating the IPA and PS is derived. IPA (a measure of the proximity of the vector of the studied diet $C \rightarrow$ and the vector of the standard $B \rightarrow$) in this problem is determined by the formula:

$$IPA = 100 - 100 \sqrt{F},$$

where $P$ is the number of optimized parameters, $F$ is the normalized geometric distance between vectors $C \rightarrow$ and $B \rightarrow$:

$$a = \sum_{i=1}^{p} \left( \frac{c_i}{b_i} - 1 \right)$$

where $c_i$ are the parameters of the studied diet (vector $C \rightarrow$), $b_i$ are the parameters of the physiological norm (vector $B \rightarrow$).

The number $F$ (2) with complete coincidence of the parameters of the diet with the corresponding standard can be equal to 0. In the case of ideal coincidence of the analyzed diet with the reference values in all parameters characterizing the caloric content and chemical composition of the diet, the IPA can be equal to 100%, in all
other cases the IPA <100%, and as a result of the calculation, deficit (-) and excessive (+) deviations from the standard (individual physiological norms) as a percentage for each studied ingredient. PS is set in stages and is the result of a balanced diet for individual groups of ingredients (proteins, fats, vitamins, amino acids, etc.), calculated using this formula, but only the nutrients of the selected group are taken into account.

In the work, the energy value of the diet and energy intake were calculated due to the consumption of proteins, including animals, fats, including vegetable fats, carbohydrates (poly- and oligosaccharides). The content of essential amino acids, fatty acids (saturated, mono- and polyunsaturated), vitamins (retinol, β-carotene, thiamine, riboflavin, niacin, ascorbic acid), macronutrients (sodium, potassium, calcium, magnesium, phosphorus) and iron was calculated. The system allows you to implement an individual approach, taking into account the energy consumption, anthropometric data of the athlete and the established norms of physiological needs (Methodical recommendations MR 2.3.1.2432-08 "Norms of physiological needs for energy and nutrients for various groups of the population of the Republic of Uzbekistan").

The results were statistically processed using the Statistica 6.0 package [12]. The research results were presented as mean and standard error of the mean (M ± m). The significance of differences in mean values was assessed using the Student's t-test. The level of significance was considered significant at p <0.05.

**Results and discussion.**

In the conditions of training camps, regardless from the season of the year, the IPA of the actual rations of road cyclists showed low values (43.2% in the winter-spring and 60.0% in the summer-autumn season), which are due to imbalance, especially in the groups of vitamins and fatty acids. At the same time, in the summer-autumn period, the PS of vitamins and fatty acids increased in comparison with the winter-spring period by 24 and 31%, respectively. The content of proteins and fats (taking into account their origin), carbohydrates (of varying degrees of complexity) and their ratio, as well as the energy value of actual diets are given.
It was revealed that the diet of cyclists, regardless of the season, is characterized by a reduced intake of protein, including protein of animal origin, in the diets of the summer-autumn season. In the diets at all stages of the annual training cycle, a low content of vegetable fats was noted, and the imbalance in the winter-spring season was increased due to the excess of hidden fats of animal origin. The carbohydrate component also showed a distinct violation, especially in the diets of the winter-spring period, due to the low content of dietary fiber (-43.0%).

An individual assessment of the calorie content of the athletes' diets revealed significant fluctuations, however, the average values of their energy balance at these stages of training did not exceed 8.5%, i.e. were within the permissible deviations.

At the same time, the energy value of rations in the summer-autumn period is provided by an increased amount of carbohydrates with a protein and fat content below individual physiological norms, taking into account energy consumption. The energy value of the rations of the winter-spring period it is provided with an overestimated amount of fat and is characterized by a deficient protein content. In addition, in the winter-spring period, a low energy supply was found due to vegetables and fruits (individual fluctuations were 3.2–5.1%, and in the summer-autumn period this indicator reached the lower limit of the recommended values - 10%) [13]. This is due to a significant deficiency in the diet of these food groups, which is especially pronounced in the winter-spring period. For athletes, it is important to meet the need for vegetables and fruits, which support the body's alkaline reserve, and their deficiency can lead to a decrease in the effectiveness of training tasks fulfillment [14, 15].

Analysis of the amino acid composition of the diets showed that the most significant deviations from the reference values are within the range of deviations from the permissible values. Attention should be paid to the low balance of linoleic and linolenic fatty acids due to the predominance of linoleic acid. This requires the addition of vegetable oils with a high content of linolenic acid to the menu [20].

The results of assessing the content of vitamins in the actual diet of athletes, presented in table. 5 showed their significant seasonal fluctuations. First of all, this
concerns vitamin C, a significant deficiency of which was detected in the winter-spring period. In the diets of the winter-spring period, a deficiency of vitamin A was found in the form of the sum of retinol compounds, which amounted to about 1/3, and in the summer-autumn season - 22.0%. In addition, in winter and spring diets, the ratio of retinol itself and β-carotene was violated, which was the reason for such a lack of the sum of retinol compounds with a sufficiently high absolute amount.

The values of the average daily intake of the remaining studied vitamins are less dependent on the seasons of the year. Thus, the diets of all periods were characterized by a deficiency of thiamine and riboflavin, which amounted to about 40% in the diets of both the summer-autumn and winter-spring seasons.

When assessing the provision of actual diets of cyclists with niacin, its formation from the amino acid tryptophan was taken into account (1 mg of niacin is synthesized from 60 mg of tryptophan). Calculations showed that the intake of vitamin PP in niacin equivalents was higher than the recommended one throughout the year.

When optimizing diets in terms of the content of vitamins, it is necessary to take into account the amount of protein in their composition, the deficiency of which has a negative effect on the intensity of assimilation, retention and deposition, and also to take into account the participation of many vitamins in the formation of coenzyme forms of one or another vitamin [21, 22].

The mineral composition of the diets of road cyclists, presented in table. 6, regardless of the season, was characterized by a reduced content of the studied macro- and microelements, the only exceptions are sodium, the deficiency of which is easily compensated by the consumption of sodium chloride, and potassium, the content of which is close to optimal values [23].

Particularly significant deviations from the norm in the rations of organized nutrition are found by calcium, in particular dairy, which is the main source of this mineral that is bioavailable for the human body (it is considered to be optimal its daily consumption of at least 400-500 mg). As for iron, its absolute content in diets is high. However, if we characterize the level of consumed iron by its origin, then most of it enters the body with plant food, while the content of heme iron in the diet
is about 2.8-3.3 mg / day. It is known that the degree of absorption of iron in the body largely depends on its nature and varies within fairly wide limits: from 1% with a plant diet to 10–30% with the consumption of animal products [24]. Even the level of bioavailability of iron from various animal products varies, therefore, the total content of this element in the diet cannot be fully judged on the amount of iron absorbed and assimilated in the body.

The study of the balance of individual components of the mineral spectrum made it possible to establish serious disturbances in the ratio of calcium and phosphorus, which in the average daily actual rations reaches 1: 2, and in individual daily rations had even more significant fluctuations (1: 2.5), while the balance of these macronutrients are determined by a ratio of 1: 1.5. These data indicate an imbalance in the mineral composition of the diet of the surveyed contingent of athletes, which can lead to a decrease in special performance.

**Conclusion.**

The analysis of the adequacy of the actual nutrition of road cyclists in the conditions of training camps in the summer-autumn and winter-spring seasons indicates violations of the principles of rational balanced nutrition at all stages of training, despite the correspondence of the average energy consumption to energy consumption. When studying the structure of actual nutrition, serious imbalances in the balance of both basic and essential nutrients were found, especially in the winter-spring period. Based on the results of the revealed violations, recommendations were developed for each athlete, taking into account his individual characteristics and the stage of preparation. Optimization of nutrition of athletes at educational and training sports bases should be carried out taking into account sports specialization, the specifics of the periods of the annual training cycle, which differ significantly in energy orientation and daily energy consumption.

For athletes specializing in road cycling races, special attention should be paid to the balance of vitamins and macro- and microelements, which provide the regulation of metabolic parameters and bioenergetic mechanisms under conditions...
of training loads aimed at improving aerobic endurance, which will contribute to the
growth of sports results and readaptation of the body.

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