In memory of Vladimir Ivanovich Kruglik
who dedicated his life to development of
modern Russian foods for healthy and ill children

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Nutritive support of young sportsmen using a specialized Russian product

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Organization of adequate nutrition of children and adolescents actively going in for sports is of the highest importance both for improving sports results and preserving children's health. On the modern stage of sports neutraceuticals development, it is relevant to substantiate approaches to nutrition on all stages of the training process, develop methodological basis for individual nutrition selection and conduct demonstrative trials in order to evaluate efficacy of nutritional measures. The pediatric nutrition department of the FSBI "Scientific Center of Children's Health" conducted a controlled trial of efficacy of a new Russian product for nutritive support of children in the training period in 2012 in order to study possibilities of nutrition optimization for young sportsmen. We noticed statistically significant alterations of bioimpedance analysis values – lean and active cell body mass – in the setting of nutrition correction – intake of 200-400 ml/day of the product for 21 days; at the same time, the fat mass remained the same. Psychological testing using WAN questionnaire (well-being, activity, mood) conducted in the recovery period of the training process also revealed positive dynamics. The product may be used in the dose of 200-400 ml at any time of day; at the same time, it is most reasonable to take it as an additional food intake in the event of considerable training stress immediately before or after training, when adequate nutrition organization is hindered.
Keywords: *nutritive status, bioimpedance analysis, young sportsmen, nutritive support.*

The issue of adequate nutrition for children going in for sports is rather urgent. Despite the developed dietary recommendations for children sportsmen [1-3], literature data and evaluation of real diet of such children showed that the real consumption of macro- and micronutrients is considerably different from the recommended norms [4-7]. The main reasons of insufficient consumption of certain nutrients are intensive training regimen, which impedes compliance with the necessary dietary pattern (in almost all children), selective appetite, food allergy or intolerance, whereas diet of a child or an adolescent actively going in for sports ought to provide the body with the necessary amount of calories and nutrients, such as proteins, fats, carbohydrates (macronutrients), mineral substances, vitamins and other vital bioactive food factors (micronutrients) and ensure natural processes of its growth and development. Moreover, it ought to cover the additional caloric and plastic needs in order to compensate for physical stress, muscle bulk upbuilding, psychoemotional stress and strain.
Unfortunately, the analysis we conducted previously showed that the most unsatisfactory diet is observed among adolescent sportsmen, i.e. in the most difficult body development period – puberty, which is even further complicated by considerably training and competitive stress. A

child's growing body reacts especially rapidly to shortage or excess of certain nutrients in a diet with physical or emotional developmental disability, malfunction of the organs vital for homeostasis and decrease in immunity. Imbalanced nutrition in such a situation is a real threat to a child's health and, without any doubt, affects sports results [5-7].

We developed a complex personified approach aimed at correcting a child's diet in the course of individual consultations based on evaluation of the real diet, its chemical composition and individual preferences: body weight composition parameters (bioimpedance analysis) and the malfunctions of a child's body organs and systems revealed in the course of examination. Threpsological approach is based on the formation of an adequate diet out of regular wholesome products. However, one of the dietary issues of young sportsmen to be resolved is to provide a child with all the necessary macro- and micronutrients in a compact form. This issue is especially critical for high-level sportsmen in the process of intensive physical training, when demand of proteins, vitamins and mineral substances considerably increases in the setting of reduced ability to observe an adequate diet due to intensive training regimen. This creates a demand of using special products enriched with a certain set of nutrients. At the same time, there is a deficit of trials employing principles of evidence-based medicine with regard to sports nutrition all over the world, especially of children and adolescents [8, 9].

The **aim** of this trial is to assess efficacy of sterilized specialized dietary product for sportsmen "Nutrisport Standart" manufactured by Infaprim, CJSC (Russia).

Trial design

The trial was conducted at the sports medicine division (head – MD, PhD, Professor I.T. Korneyeva) of the exercise therapy and sports medicine department (head – MD, PhD, Professor S.D. Polyakov) at the research institute of preventive pediatrics and medical rehabilitation of the FSBI SCCH and at the pediatric nutrition department (head – MD, PhD, Professor T.E. Borovik) at the research institute of pediatrics of the FSBI SCCH. The trial took place in February-May 2012.

The trial consisted of a comparative prospective medical observation conducted in compliance with the European Good Clinical Practice Guidelines applied since 1991, directive guidelines of the RF MH and experience of testing at the FSBI Research Institute of Pediatrics, the FSBI Scientific Center of Children's Health and other medical and medical preventive institutions of the RF.

Table 1. Characteristics of trial participants

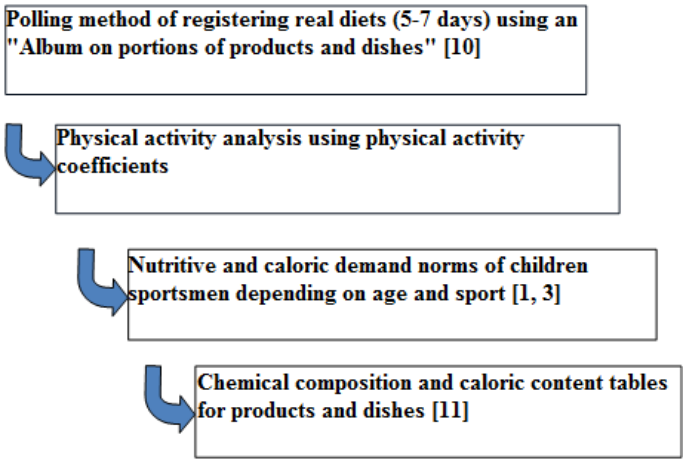
Children's characteristics	Number of children		
	Main group (n=23)	**Control group** (n=12)	**Total** (n=35)
Age, in years M±m	10-16 11.33±1.96	10-16 12±1.83	10-16 11.6±1.8
Girls	5	2	7
Boys	18	10	28
Sports category: No category Junior (1-3) Senior (1-3) Candidate for Master of Sport Master of Sport	 5 4 6 2 1	 1 5 3 1 -	 6 9 9 3 1
Sport: Swimming Tennis Hockey Skiing	 10 2 5 1	 7 1 2 0	 17 3 7 1
Training hours per week	14.8±6.6	13.9±4.6	14.2±7.5

Characteristic features of the examined children

The trial involved 35 children of 10-17 years of age going in for different kinds of sport at Children and Youth Sports Schools and the Moscow specialized secondary Olympic Reserve School. The selection criteria also included absence of chronic diseases and metabolic disorders, lack of acute disorders of gastrointestinal tract (exacerbation of a chronic disease or acute gastrointestinal disorders). By examination beginning all children were apparently healthy.
The students were randomly divided into 2 groups (tb. 1). The main group children (n=23) were taking the product for 21 days. The control group children (n=12) were observing traditional diets without any specialized products. The trial was conducted in both groups at the same time, in spring, i.e. in the end of the training season.
The groups were comparable in terms of age, sex and amount of physical training.
The children were going in for sports in a regular training regimen; each child underwent examination at least twice within the period of observation. All children were given recommendations on diet correction after the first examination.

TRIAL METHODS
Real diet of the children was assessed using computer program 1C "Nutrition" adapted to assess diets of children of 0-18 years of age. Diet assessment algorithm is given in pic. 1.
Body composition evaluation (bioimpedance analysis)
In order to determine body composition parameters, we used bioimpedance analyzer AVS-01 Medass (research and development center Medass, Moscow) – a device for functional diagnostics used to obtain objective data on body composition [12]. Measuring and current electrodes were put according to the standard tetrapolar scheme. The analyzer's principle of operation is based on measuring electrical resistance of body tissues – bioimpedance – used to quantitatively assess various body components.

Pic. 1. Algorithm of computed chemical composition analysis of real children sportsmen's diets



The following parameters were assessed:
- Body mass index (BMI);
- Fat mass in relation to height;
- Lean mass;
- Active cell mass (ACM) and percentage of active cell mass (ACM%);
- Musculoskeletal mass (MSM);
- Amount of fluid body secretion;
- Basal metabolism;
- Specific metabolism;
- Phase angle.

We used centile spread curves of average parameters for sportsmen of 7-20 years of age and body composition parameters obtained in the process of our previous trial of 695 sportsmen of 8-18 years of age in order to determine normal parameters [13].
We conducted **psychological testing** using the WAM personality test, which suggests answers to standard questions or statements.
The **WAM test (well-being, activity, mood)** is used to assess mental condition and fatigue. It contains 30 pairs of opposite adjectives on 2 ends of a 7-point scale. All pairs are divided into 3 groups corresponding to the mentioned parameters. The advantage of this test is that the children respond to the test 1 hour after training, i.e. the way the diet correction influenced by additional intake of product "Nutrisport Standart" affects a child's psychological condition directly in the training process period was assessed.
The children filled in the questionnaire themselves. The testing was performed before the trial, and once a week throughout a trial – on days 7, 14 and 21 of product intake. The first result was considered initial. Arithmetic mean of the 3 results in the setting of the product's intake was considered repeated.

Purpose of the product under study

This specialized protein product is a ready-to-use balanced formula based on milk proteins. The form of the product allows sportsmen to receive adequate nutrition both before and after physical stress in a compact form. The product was included into diets depending on the assessment of real diets of the children and parameters of bioimpedance analysis in the amount of 200-400 ml per day. 14 children were receiving 200 ml of the product per day, 9 older children with more pronounced disorders according to the real diets were receiving 400 ml per day. The children were taking the product under study either directly after training (with the total amount of 200 ml per day) or 200+200 ml before and after training (with the total amount of 400 ml per day).

Criteria of the product tolerance and clinical efficacy assessment

A. Compulsory:
    1. No complaints of skin eruptions, gastrointestinal disorders, no other signs of the product intolerance at a clinical examination.
B. Additional:
    1. Bioimpedance analysis results (in the beginning and in the end of the trial).
    2. Results of a computed analysis of real diets (in the beginning and in the end of the trial).
    3. Results of a poll assessing the product tolerance and efficacy.
    4. Psychological WAM questionnaire.

RESULTS

Evaluation of the product tolerance and organoleptic properties

The children were willingly taking the product. All 23 main group children highly appreciated its palatability, which is extremely important given the issue of dietary preferences and their influence on diet formation in adolescents [14].
The product tolerance was assessed highly as well. We observed no symptoms of food intolerance or allergic reactions in the process of the trial.

Assessment of a diet's chemical composition and correction of real diets using the product under study

All children were consulted by a nutritionist, who assessed their real diets using a computer program and corrected them using traditional products; in order to correct diets of the main group children the nutritionist also used the dietary product under study specialized for sportsmen.

Assessment of real diets of children given their demand of macro- and micronutrients according to the physical stress showed deficit of one or another nutrient, especially of proteins, polyunsaturated fatty acids and vitamins. Individual recommendations on correction of the revealed dietary disorders were given. However, intensive training schedule and educational process of the observed children sportsmen did not allow forming adequate diet in most cases; this corresponds with the previously obtained data [6]. It appeared that the most difficult problem was to organize adequate additional food intakes within a day. At the same time it is well known that intake of little amount of a balanced food substance directly before or after training aids to increase efficacy of muscular work. Introduction of one or two portions of the product under study to the diet according to the initial nutritive condition allows compensating deficit of nutrients partially or completely; this confirms reasonability of introducing this product to diets of children sportsmen (tb. 2).

Table 2. Comparative analysis of caloric content, content of main nutrients and micronutrients in 1 (200 ml) and 2 (400 ml) portions of the product under study and age norms of children sportsmen demands

Parameters	**Content per 100 ml of the product**	**Demand norms of children sportsmen of 10-16 years of age***	**Content per 200 ml of the product**		**Content per 400 ml of the product**	
			Absolute	RNN%	Absolute	RNN%
Caloric content, in kcal	100	2,350-3,650	200	8.5-5	400	17-10
Proteins, in g	4.0	77-134	8.0	10-6	16.0	20-11.9
Fats, in g	3.6	78-126	7.2	9-5.7	14.4	18-11.4
Carbohydrates, in g	12.9	335-528	25.8	7-4	51.6	15.4-9.7
Mineral substances						
Potassium, in mg	123	3,700-4,300	246	6-5	492	13-13.2
Calcium, in mg	74	1,100-1,550	148	13.4-9.5	296	26-19
Phosphorus, in mg	53	2,100-2,300	106	5-4.6	212	10-9.2
Magnesium, in mg	22	450-530	44	9.7-8.3	88	19-16.6
Iron, in mg	0.8	12-23	1.6	13-6.9	3.2	26-13.9
Vitamins						
Retinol (A), in mcEq	56	800-1,000	112	14-11.2	224	28-22.4
Tocopherol (E), in mg	0.8					
Ascorbic acid (C), in mg	4.4	100-146	8.8	8.8-6	17.6	17.6-12
Thiamine (B_1), in mg	0,080	2.0-2.9	0,160	11-5.5	0,32	16-11
Riboflavin (B_2), in mg	0,090	2.2-3.3	0,180	8-5.4	0,360	16.3-10.9

Note. * - age demand norms are given in accord with data of demand tables for vitamins and micronutrients of children sportsmen (sports groups 1 and 2) of different age (10-13 and 14-17 years) [1]. RNP – recommended nutritive norms.

According to tb. 2, intake of one portion of the product (200 ml) covers 6-10% of protein demand and 5-14% of demand of vitamins and main microelements depending on a sport, a child's age and sex. Intake of 2 portions of the product (400 ml) compensates 12-20% of protein demand and 10-28% of demand of vitamins and microelements.
Diets were corrected according to age demand norms of children sportsmen using traditional food substances in both groups.

Dynamics of body composition parameters

Assessment of nutritive status using body mass index (Quetelet index) showed that body mass index was lower than 18.4 kg/m^2 in 27 (77.1%) out of 35 children. Statistical analysis revealed negative correlation of a child's body mass index with the amount of training hours per week ($p<0.001$).
Initial body composition parameters of the examined children had considerable individual peculiarities (tb. 3). Fat mass in relation to height was low in almost half of the children (48.6%) and normal in all the other children. Decreased active cell mass indicates deficit of the dietary protein component. The previous trial [13] revealed significantly decreased ACM parameters in rhythmic gymnasts and moderately decreased parameters in hockey players; it may be caused both by protein deficiency and individual assimilation peculiarities of certain types of protein nutrition by certain sportsmen. It also showed that ACM% in lean mass of many children and adolescents going in for sports exceeds age-sex norms; this indicates high motion activity and physical capacity of sportsmen.

Table 3. Initial and repeated trial results of bioimpedance analysis of body composition in the setting of nutritive support using the product under study in the main group children and the control group children.

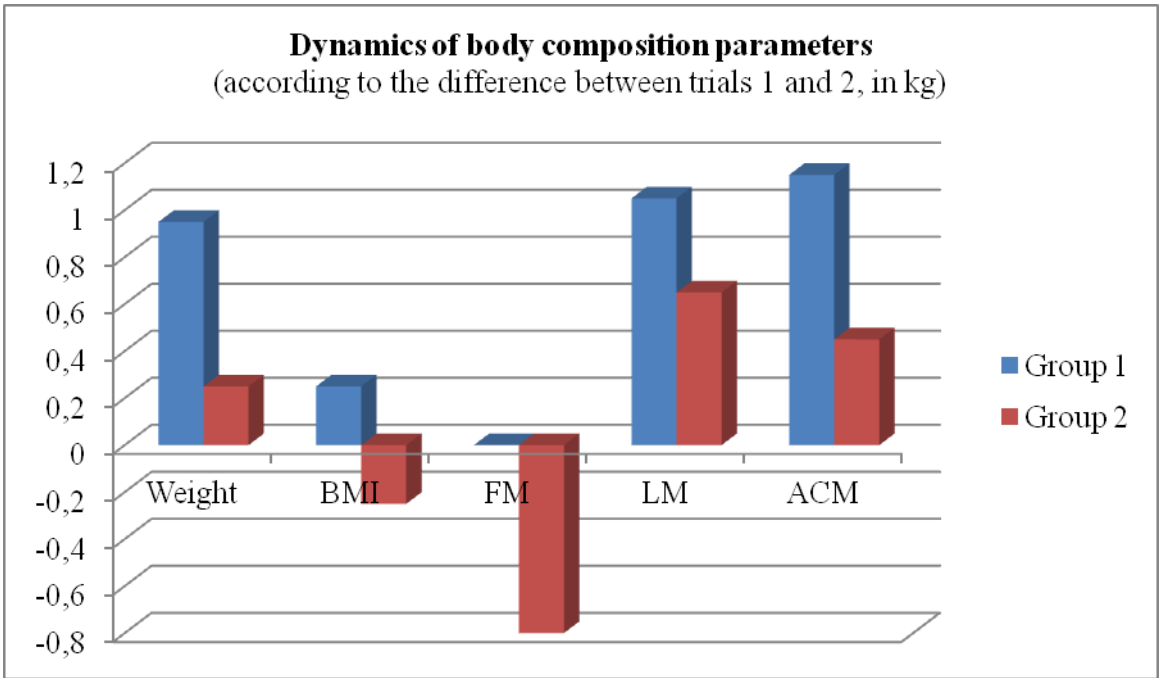
Parameter	Main group, n=23		Control group, n=12	
	Trial 1 M±m	Trial 2 M±m	Trial 1 M±m	Trial 2 M±m
Body weight, in kg	42.8±13.7	43.8±13.7	47.9±13.3	48.3±13.4
BMI	17.2±1.8	17.6±1.7	18.0±2.3	17.8±2.6
FM, in kg	7.3±2.9	7.3±3.0	8.3±2.4	7.6±2.1
LM, in kg	35.5±10.9	36.6±10.6	39.7±12.4	40.4±12.9
ACM, in kg	20.2±5.2	22.3±5.6	21.7±7.4	23.3±8.5
ACM%, in %	54.3±2.2	55.4±2.3	56.1±2.1	56.9±2.3
BML, kcal/m^2 per day	890±59.8	898±59.9	890.3±61.9	913.9±46.4
PA, in degrees	6.1±0.44	6.3±0.4	6.4±0.3	6.9±0.7

Note. BMI – body mass index; FM – fat mass; LM – lean mass; ACM – active cell mass; BML – basal metabolism level; PA – phase angle.

Assessment of body composition dynamics in the setting of diet correction showed that positive dynamics of such a parameter as ACM (ACM%) prevailed in 19 main group children (82.6%), whereas fat mass remained the same. Fat mass decrease was observed in 4 main group children (17.4%). Fat mass decrease was observed in more than half of the control group children (58.3%), whereas ACM had positive dynamics in 25% of cases.
The difference (Δ) presented data of dynamics of the average body composition parameters show significant positive dynamics of such parameters as lean and active cell mass from the first to the second trial (pic. 2) in the main group children taking the specialized protein-carbohydrate product in order to correct their diets. Positive dynamics of body mass and body mass index was observed. Active mass cell and lean mass parameters increased to a lesser degree in the control group children, whereas the fat mass decreased; this indicates consumption of internal body

caloric reserves in the process of physical training. The obtained data demonstrate efficacy of the new Russian specialize product for nutritive support of muscles in the event of active physical stress of children sportsmen.

Pic. 2. Dynamics of average parameters of body composition in the main group and the control group: the difference (Δ) between indications of the first and the second trials ($p<0.01$ for weight, fat and active cell mass)

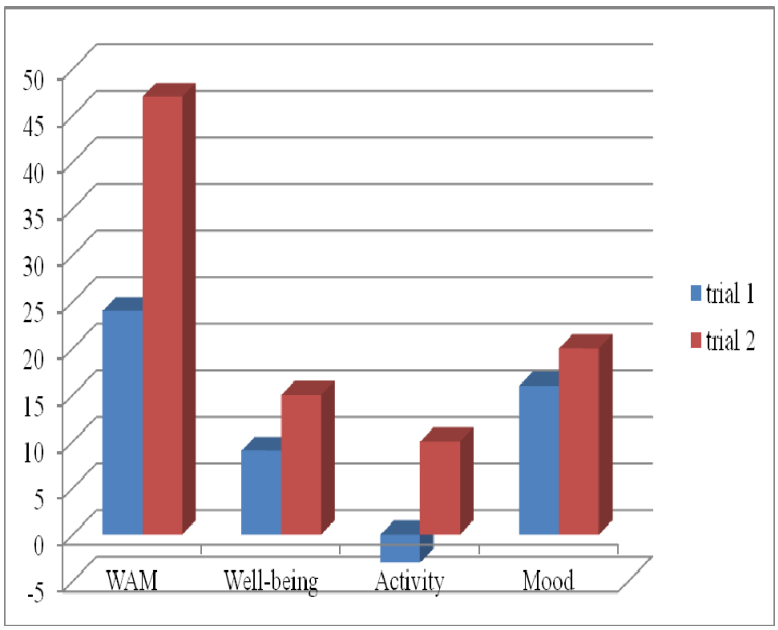


Note. BMI – body mass index; FM – fat mass; LM – lean mass; ACM – active cell mass.

Psychological status parameters in the setting of diet correction using the product under study according to the WAM test

Both permanent and temporary psychophysiological body characteristics reflect nervous system functioning peculiarities of young sportsmen.
Testing results revealed significant positive dynamics of parameters “well-being”, “activity” and “mood” in the post-training rehabilitation period in all cases. Pic. 3 presents dynamics of the group average WAM parameters throughout the trial. At the same time, the aggregate WAN parameter and parameter “activity” increased in the main group significantly ($p<0.01$).

Pic. 3. Questionnaire WAM parameters (well-being, activity, mood) in the setting of diet correction using the product under study (a) and in the control group children (b)



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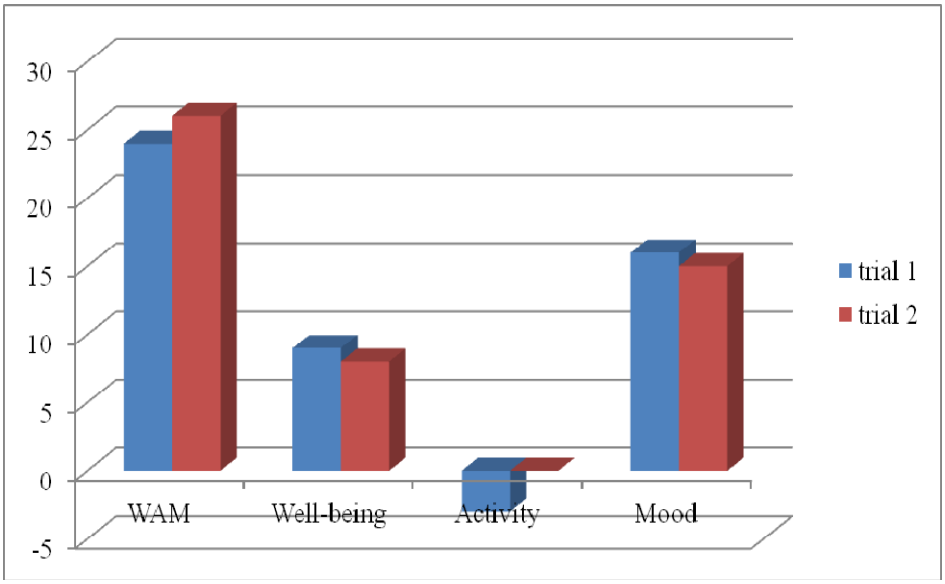

b

CONCLUSION

The issue of adequate nutrition of children sportsmen consists in the need in providing a child with all the necessary macro- and micronutrients in a sufficiently compact form. This issue is especially critical for high-level sportsmen in the process of intensive physical training, when demand of proteins, vitamins and mineral substances considerably increases in the setting of reduced ability to observe an adequate diet due to intensive training regimen. At the same time, inanition affects both sports results and sportsmen's health [15-18]. This calls forth use of special products enriched with a certain set of nutrients.

The complex nutritive status assessment of young sportsmen using comparative body composition analysis with the assessment of real diets and revealed predominant deficit of proteins and vitamins in nutrition allowed using specialized dietary product for sportsmen "Nutrisport Standart" as additional nutrition. The product's form – sterilized liquid – allows prescribing it to children in the period when it is especially difficult to organize adequate nutrition – before and after training. It is also known that additional intake of carbohydrates,

proteins, vitamins and microelements directly after physical stress aids to recover muscles more quickly and completely [19]. In the event of significant dietary deviations, especially in case of active cell mass deficit revealed by bioimpedance analysis, older children were prescribed additional intake of the product before training as well. It is important that the product's composition allows improving provision of a child's body not only with the main nutrients, but also with micronutrients (vitamins and minerals), where are consumed especially intensively in the event of high physical stress.

We revealed statistically significant changes of bioimpedance analysis, such as lean mass and active cell mass, whereas fat mass maintained on the same level, in the setting of diet correction with specialized product in the amount of 200-400 ml in the course of 21 days. Nutritive status improvement was accompanied by positive dynamics of results of psychological testing using the WAM questionnaire. Testing results of the main group children, who received the product under study, revealed significant positive dynamics of parameters "well-being", "activity" and "mood" in the post-training rehabilitation period. The product may be used in the amount of 200-400 ml at any time of day; at the same time, its most reasonable application is as additional food intake in the event of considerable training stress directly before and after training, when organization of an adequate nutrition is especially complicated.

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