

# Evaluation of orientation and efficiency of schoolchildren nutrition in recreational period

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**Summary.** *Background:* determination of antioxidant orientation schoolchildren of nutrition in recreational period and evaluation of its efficiency. *Methods:* it is studied nutrition of 221 schoolchildren aged 7-15 years old at children's recreational institution. It is used the method of analysis of menu production records with the subsequent calculation of average daily set of foods, specifying its chemical composition and energy value. The efficiency of nutrition was estimated according to indicators of vitamin and antioxidant statuses. The dynamics of excretion of vitamins C, B2 and B6 was studied in hour-long portion of urine. The features of urine bio-chemiluminescence in 9 indicators are estimated. Studies were conducted on 2-3 and 22-23 days of recreation. *Result:* it is confirmed the existence of antioxidant direction of nutrition by means of sufficient content of total protein, aromatic amino acids, phospholipids, tocopherols, B vitamins, S, Zn. Content of Se, ascorbic acid in food ration was insufficient. It is determined 16 indicators which are most objectively characterized antioxidant direction of food ration. *Conclusion:* The nutritional factor influenced positively on vitamin and antioxidant status of organism. The determined correlation dependences between indicators of biochemiluminescence and level of vitamins egestion confirmed the efficiency of nutritional factor for influence on schoolchildren's health.

**Key words:** nutrition, schoolchildren, recreational period, health, indicators

## Introduction

Nowadays the exacerbation of social and economic situation is led to adverse health changes of children and youth, increase in probability of formation the pre nosological states (1, 2). The analysis of eating behavior of schoolchildren revealed prevalence of pre nosology of nutritional genesis (3). These states displayed themselves by overweight, deficiency of essential nutrients (vitamins, minerals, dietary fibers), functional digestive disorder. It demands development of the target actions directed to correction of nutrition and nutritional sta-

tus. Such approach allows increasing the potential of adaptative opportunities of children, providing organism with necessary biologically active agents (4, 5). It is advisable to carry out such programs in period of rest and recreation.

Nutrition is important preventive and remedy of modern medicine. Correctly composed food ration allows preventing development of illnesses, providing optimization of eating behavior (6). The import value is attached to nutrition of preventive direction. Such food ration allows limiting influence of risk factors influenced on the person. It is reached by enrichment of food ra-

tion with natural antioxidants and adaptogens (7). Such food ration is characteristic of Korean ethnic cuisine as one of the healthiest in the world. It is determined that keeping of national cuisine traditions promoted higher antioxidant status. It is emphasized that in the conditions of oxidative stress just healthy nutrition couldn't provide the high antioxidant status. It is also necessary the additional enrichment of food ration (8).

It is necessary to enrich food ration with antioxidants for prophylaxis of health problems. In this case the essential value has the level of such microelements as Se, Cu and Zn (9). Important risk factors of digestive disorder system are oxidative stress and inflammation. Therefore giving of antioxidant direction to food ration by means of enrichment with vitamins and amino acids allows decreasing the level of oxidative stress (10).

It is important to study balance of oxidants – antioxidants for the prognosis for illness development in children's and adult age. Study of oxidative stress is offered for early diagnostics. It allows revealing intermediate states between health and illness (11). In turn, enrichment of food ration with antioxidants is recommended as a factor of protection from oxidative stress and complications caused by it (12). It is distinguished vitamin C, vitamin E, Se and vitamin A among significant antioxidant factors of nutrition. Such elements give corresponding direction to food ration. This is achieved by prophylaxis of many illnesses (13).

There are quite certain connections between level of carotenoids consumption and children body structure in 2-18 year old. It is confirmed that decrease of carotenes level in food ration is risk factor of chronic illnesses development and also causes overweight (14). The negative correlation between antioxidant activity and markers of overweight is also determined. It proves that the level of oxidative stress is closely connected with overweight development (15). In other research groups with excess weight / overweight had much lower average doses of critical microelements necessary for body growth in comparison with normal children (16). Authors specify that low average consumption of critical microelements among all age groups from 2 up to 18 year old indicates the need of adequate interferences for solution the problem of food insecurity and undernutrition. Other authors determined that un-

dernutrition among children is the main problem of public health care in developing countries (17). These problems are especially characteristic of schoolchildren living in regions with intense ecological situation (18).

Mode of life and behavior in social environment are distinguished among many factors of overweight development in youth. The mode of life of children with excess weight / overweight and teenagers influences on efficiency of treatment (19). Authors determined that family multidisciplinary approach is effective in the short term in health condition improvement, eating habit and physical indicators in children and teenagers. In other researches was revealed that decrease of general physical activity and increase in consumed food is closely connected with mode of life (20, 21). It is necessary to recommend to teenagers to practice sport actively to avoid consequences of abdominal overweight (22, 23). At the same time the physical activity of schoolchildren has to have pedagogical control (24). It is also necessary to use various approaches to assessment of risks of excess weight and overweight (25).

Saturation of food ration with antioxidants allows decreasing negative impact of many adverse factors: influence of toxic metals, ionizing radiation, stress, digestive disorder. Researches (26) confirmed the increased tension of antioxidant protective systems in conditions of influence of toxic metals, in particular, of Cd. Authors developed and proved the diet of protected direction which is characterized by the high level of antioxidants. Its application has allowed decreasing toxic influence of Cd on organism. In other research (27) the oxidative and antioxidative statuses were analyzed in children with various levels of protein and energy insufficiency. Undernutrition led to decrease in level of antioxidant enzymes and increase of concentration of lipids' peroxidation. Special methodical recommendations were developed for improvement the children from Chernobyl disaster zone (1986, Ukraine) (28). They are based on the principle of increase in adaptation potential of organism. It is reached by use of the developed complex of improving actions. The nutrition with antioxidant direction is a part of this complex.

*The purpose* of the research was determination of antioxidant direction of nutrition of schoolchildren in the recreational period and assessment of its efficiency.

## Materials and Methods

### *Participants*

It was studied nutrition features of 221 schoolchildren in 7-15 year old in children's recreational institution.

### *Study design*

The design of research presupposes study of nutrition features of schoolchildren in recreational period and assessment of dynamics of indicators characterizing vitamin and antioxidant status as criteria of efficiency of food ration.

The analysis of nutrition was carried out by means of the calculation method providing study of the menu production records during the recreation period (not less than 7-10 days). The analysis of daily consumed food allows calculating their daily average set (7). The chemical composition and energy value of food ration is calculated on the basis of this set and with the help of chemical composition tables of food (29, 30). Recommendations of food set for children from Chernobyl disaster zone for summer recreational period was used for comparison (28).

The efficiency of nutrition was estimated on indicators of vitamin and antioxidant status in 2-3 and 22-23 days of recreation. Vitamin saturation was estimated by ascorbic acid, riboflavin and pyridoxine egestion in hour portion of urine. Level of ascorbic acid was determined by titration with Tillman's indicator. Level of B vitamins was determined by fluorometric method (31). Ascorbic acid level lower than 0,4 mg hour – was considered low; 0,4-0,69 mg hour – was considered average; 0,7 mg hour and more – was considered normal. Egestion level of riboflavin not less than 10 mkg hour is taken for norm. Egestion level of pyridoxine not less than 40 mkg hour is taken for norm. The quantity of studied participants was: for vitamin C – 42 persons; for B vitamins – 15 children in 10-14 year old.

The antioxidant status was estimated according 9 parameters of biochemiluminescence of urine on HLM1C-01 device. The spontaneous luminescence (SL) (impulse/second) was defined in urinalysis samples of 2 ml. Stimulation of luminescence were carried out with the help of fresh reagent 6% of hydrogen per-

oxide. It was determined 8 parameters of stimulated luminescence: intensity (IL), (impulse/second), initial amplitude of "flash" (IA) and final amplitude (FA) of research (relative units), indicator of activation ( $IA = IL - SL$ ), (impulse/second). It was defined average intensities of luminescence of the first (I1) and the last (I2) 10 seconds of research (impulse). It was estimated the correlation of these values (CI) and also relative value of slope ratio of chemiluminogram (TK). The research involved 39 children at the age of 10-14 year.

### *Statistical analysis*

The statistical analysis of results is carried out with use of the licensed tables of Excel. Indicators of descriptive statistics were defined: arithmetic means, standard deviations and mean values. Considering sample value, the reliability of differences in groups was estimated by means of parametrical Student's t-test. In making an assessment of levels of vitamins egestion was used nonparametric sign test. It was determined correlation by Pearson between indicators of antioxidant and vitamin statuses. Study of dependence of B vitamins level in urine and indicators of biochemiluminescence included: determination of correlation coefficient; assessment of F-test. It was estimated the reliability of the revealed dependence on the basis of F-test. Use of F-test allows to level to some extent the distortion appeared at the small sample value.

### *Ethical consideration*

The study protocol was approved by the Ethical Committee of Academy of Physical Culture. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents. A written informed consent was obtained from all participants prior to data collection. Schoolchildren were approached during mandatory course class and invited to participate in the study. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents. They had a right to withdraw from the study at any time. The study was conducted in accordance with the Declaration of Helsinki.

## Results

Data on average daily consumption of the main food products are provided in table 1. Taking into consideration need of realization of set within 7-10 days the deviation of recommended within 10% was considered reliable. The reliability of differences of main food products consumption was estimated by Student's t-test.

It is determined that in June levels of milk and dairy products consumption, meat and meat products consumption, juice and fats consumption were within reliable deviations. The content in food ration of grain and noodle products, bread and bakery, sugar and confectionery was reliably overestimated. Total consumption of vegetables and fruit was underestimated.

The consumption of milk and dairy products, vegetables and fruit, fats generally corresponded to recommendations in July. Specific weight of meat and meat products in nutrition increased. This indicator reliably exceeded the recommended level. The consumption of grain, noodle and bakery products, sugar and confectionery decreased. This indicator exceeded recommended level. Content of juice in food ration decreased. There were absence of fish, fish products and sea products in children nutrition. Also there was no additional vitaminization.

Data of chemical composition and energy value of nutrition also confirm ambiguity of effect of alimentary factor (tab. 2). According one indicators (content of total protein, total of aromatic and sulfur-containing amino acids, tocopherols etc.) food ration coincides

with recommendations. The energy value, content of sugars, Na, chlorides, B vitamins exceed level of recommendations. According to the content of proteins of animal origin, Se, ascorbic acid, I food ration is significantly in arrears of recommendations.

16 most characteristic indicators were chosen for specification of antioxidant direction of food ration. Data are submitted in the figure 1. Recommended consumption of nutrients according to the developed food ration is represented in the form of circle (28). Their values in percentage corresponding to content in nutrition in recreation period are represented in the form of the dispersing beams.

In our opinion, the graphic representation reflects existence of essential antioxidant direction of food ration. The majority of indicators don't significantly differ from the recommended levels. However there are significant deviations as upwards (protein, B vitamins), and downwards (Se, ascorbic acid).

The food ration was characterized by sufficient content of proteins (in June and July in 3,9% and 9,9% higher than recommended). Specific weight of proteins of animal origin decreased (in June in 20,9%, in July – in 9,6%).

Assessment of amino acid content was carried out using amino-acid score method. It allows to consider amount of amino acids of nutrition and to compare it to ideal protein. It is the most optimum way of assessment of protein full value of nutrition. The obtained data confirm the sufficient and optimum balanced content of amino acids in food ration. Thus, part of lysine is: in June – 5,4%; in July – 7,5% at recom-

**Table 1.** The average daily consumption of the main food products by schoolchildren in recreation period

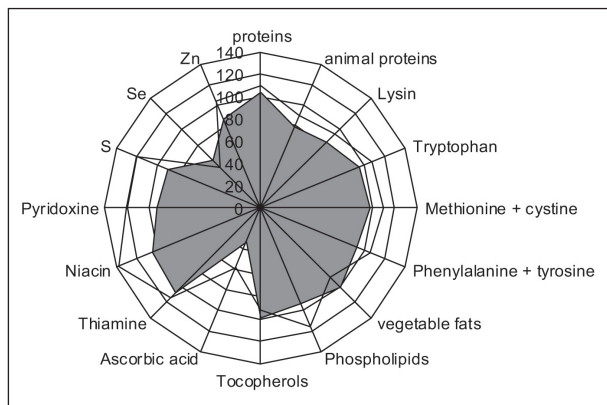
<i>Food</i>	<i>Content in food ration, g</i>		
	<i>recommended</i>	<i>June</i>	<i>July</i>
Cereals and noodle products	85	128,07±7,7 <sup>1</sup>	119,4±11,3 <sup>1</sup>
Bread and bakery	260	423,8±13,2 <sup>1</sup>	415,0±9,3 <sup>1</sup>
Vegetables and fruit	880	537,2±0,9 <sup>1</sup>	897,0±83,8
Butter and fats	50	54,9±2,3	48,8±2,0
Milk and dairy products	510	505,3±24,3	444,4±28,2
Vegetable and fruit juices	250	197,5±14,7	182,5±10,6 <sup>1</sup>
Meat and meat products	215	191,8±11,4	282,5±25,5 <sup>1</sup>
Sugar and confectionery	70	102,5±6,6 <sup>1</sup>	96,9±9,5 <sup>1</sup>

<sup>1</sup> – Differences of recommended consumption are reliable ( $p < 0,05$ ).

**Table 2.** The chemical composition and energy value of food ration of schoolchildren in period of recreation

<i>Nutrients</i>	<i>Content in food ration</i>		
	<i>June</i>	<i>July</i>	<i>recommended</i>
Proteins, g	117,6	124,4	113,2
among them animal proteins, g	56,6 <sup>1</sup>	64,7	71,6
Lipids, g	113,5 <sup>1</sup>	113,9 <sup>1</sup>	101,3
among them vegetable fats, g	28,2	24,5 <sup>1</sup>	27,8
Carbohydrates, g	491,9 <sup>1</sup>	494,7 <sup>1</sup>	341,1
of them sugar, g	139,0 <sup>1</sup>	141,3 <sup>1</sup>	121,7
Amylum, g	352,9 <sup>1</sup>	353,4 <sup>1</sup>	219,4
Amino acid, g			
Lysin	6,318 <sup>1</sup>	7,096	7,56
Tryptophan	1,331	1,503 <sup>1</sup>	1,39
Methionine + cystine	3,920	4,384	4,00
Phenylalanine + tyrosine	8,870	10,130	9,53
Histidine	2,694 <sup>1</sup>	3,167	3,19
Phospholipids, g	5,44	6,75 <sup>1</sup>	5,83
Polyunsaturated fatty acid (PUFAs), g	16,53	13,11 <sup>1</sup>	18,34
Saturated fatty acid (SAFA), g	48,18	47,07	44,17
Dietary fiber, g	24,19 <sup>1</sup>	27,77 <sup>1</sup>	32,86
among them pectin, g	1,95 <sup>1</sup>	3,19 <sup>1</sup>	4,25
Minerals, mg			
Na	3616,5 <sup>1</sup>	36,47,1 <sup>1</sup>	2575,1
K	4363,28	5608,7	5534,6
Ca	975,9 <sup>1</sup>	899,9 <sup>1</sup>	1210,5
Mg	485,9 <sup>1</sup>	541,8	547,2
P	1848,7 <sup>1</sup>	1983,5	2067,2
Fe	29,92	29,06	30,58
S	815,0	1090,7 <sup>1</sup>	903,4
Chlorides	4484,5 <sup>1</sup>	5418,9 <sup>1</sup>	3383,4
I, mcg	40,5 <sup>1</sup>	91,11 <sup>1</sup>	136,58
Se, mcg	17,88 <sup>1</sup>	15,23 <sup>1</sup>	29,55
Zn, mcg	13156,5 <sup>1</sup>	15825,0 <sup>1</sup>	15197,3
Vitamins, mg			
Carotenes	2,37 <sup>1</sup>	3,54 <sup>1</sup>	5,19
Retinol	0,49 <sup>1</sup>	1,42 <sup>1</sup>	4,24
Thiamine	1,97	2,08	1,82
Riboflavin	1,95 <sup>1</sup>	2,26 <sup>1</sup>	3,12
Niacin	22,47	29,53 <sup>1</sup>	21,42
Ascorbic acid	62,31 <sup>1</sup>	108,57 <sup>1</sup>	186,80
Pyridoxine	3,22	4,17 <sup>1</sup>	3,46
Cyancobalamin, mcg	4,63 <sup>1</sup>	12,70 <sup>1</sup>	32,25
Tocopherol	22,02	20,46	22,23
Folate, mcg	317,31 <sup>1</sup>	291,48 <sup>1</sup>	379,01
Choline	499,78 <sup>1</sup>	586,22 <sup>1</sup>	672,4
Energy value, kcal	3459,5 <sup>1</sup>	3501,5 <sup>1</sup>	2729,6

<sup>1</sup> – difference of recommended consumption more than 10%.



**Figure 1.** Assessment of antioxidant direction of food ration of schoolchildren in period of recreation.

mended level 5,5%. The part of tryptophan is 1,1-1,2% (recommended level – 1%). The part of phenylalanine and tyrosine is 7,5-8,1% (recommended level – 6%). The part of methionine and cystine is 3,3-3,5% (recommended level – 3,5%).

The lipid component of nutrition exceeded the recommended level in 10-12%. Specific weight of vegetable fats in June increased, and in July – decreased in comparison with recommended level. The food ration was adequately provided with phospholipids. Their contents in June wasn't differ, and in July exceeded the recommended level in 15,8%. The balance of proteins, lipids, carbohydrates on mass was: in June – 1:0,97:4,18 g; in July – 1:0,92:3,98 g (recommended level was 1:0,89:3,01 g).

Maintenance of balance of saturated fats (SAFA) and unsaturated fats (PUFAs), lipids and tocopherols is relevant for assessment of antioxidant protection of nutrition. The studied food rations were characterized by balance of SAFA/PUFAs – 0,34-0,28, (recommended level was 0,42). The content of PUFAs was below the recommended level (in June – 4,3% and in July – 3,4% of daily food energy, recommended level was 6%). The quantity of SAFA in nutrition exceeded the recommended level. The quantity of vitamin E to the level of PUFAs' consumption was rather high: 1,33-1,53 (recommended level was 1,21).

The content of tocopherol generally corresponded to recommend. Content of thiamine, niacin and pyridoxine deviated in June, and even exceeded in July. The level of ascorbic acid consumption was above the physiological standard for children of this age, but be-

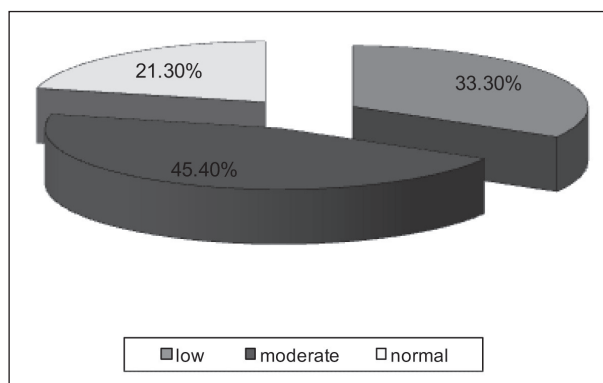
low the recommended for this category.

The disproportion of food ration caused the insufficient content of vitamin A and its precursors – carotenes. The retinol equivalent was 17,4% (June) and 39,3% (July) of the recommended quantity.

The mineral component of food ration couldn't be estimated definitely. On the one hand, the content of S, Zn, Fe, consumption of K, Mg and P was rather high (in July it generally corresponded to recommended level). The balance of Ca, P and Mg was 1:1,89:0,5 (June) and 1:2, 2:0,6 (July), the recommended level was 1:1,71:0,45. On the other hand, the absence of seafood in nutrition (as main source of I) caused its insufficient level during the observation period. Deviations from recommended daily set caused decrease of Ca level in 19-24%. The amount of Se didn't exceed a quarter of recommended level.

Results of studied status of ascorbic acid of its egestion with urine in dynamics of recreation are presented in fig. 2, 3. The third part of participants had the low level of egestion of this vitamin. Besides, all children were characterized by unsatisfactory indicators of egestion of riboflavin and pyridoxine. They was, respectively, (4,25±0,51) and (5,06±0,48) mkg/hour. It is confirmed the vitamins deficiency states among schoolchildren. Moderate level of vitamin C egestion was found in 45, 2% of examined children, normal level – in 21,7%.

Use of antioxidant nutrition influenced positively on vitamin status of children. The part of children with a low ascorbic acid egestion decreased almost by 3 times (11,9%). The number of children with



**Figure 2.** Level of ascorbic acid egestion at the beginning of recreation period

**Table 3.** Dynamics of indicators of antioxidant status of children during the recreation period

Indicator	At the beginning	At the end	Expression (%)
Spontaneous luminescence, impulse/second	9,84±0,98	4,96±0,89 <sup>2</sup>	64,1
Stimulated luminescence, impulse/second	411,88±59,53	280,73±35,47	30,8
Index of activation, impulse/second	402,63±59,25	271,93±36,17	30,8
Initial amplitude, relative units	92,00±10,76	54,90±9,40 <sup>1</sup>	25,6
Final amplitude, relative units	45,75±4,17	34,06±2,41 <sup>1</sup>	41,0
Slope of chemilumigramm	0,48±0,09	0,22±0,08 <sup>1</sup>	33,3
Initial intensity, impulse	818,50±80,17	550,18±68,29 <sup>1</sup>	28,2
Final intensity, impulse	455,07±37,62	356,42±23,55 <sup>1</sup>	43,6
Intensity correlation	2,00±0,27	1,35±0,18 <sup>1</sup>	28,2

<sup>1</sup> – differences are reliable ( $p < 0,05$ ), <sup>2</sup> – differences are reliable ( $p < 0,001$ ).

normal egestion of this vitamin increased up to 26,2%. To the end of recreation period the main part was children with moderate level of this vitamin egestion.

The similar increase in levels of egestion is revealed for B vitamins. The content of riboflavin and pyridoxine in hour portion of urine increased, respectively in 1,3 and 1,7 times. At the end of the recreational period the average level of pyridoxine egestion was (9,00±0,95) mkg/hour. This indicator was reliably higher ( $p < 0,01$ ), than at the beginning. The egestion of riboflavin was (5,56±0,49) mkg/hour. The comparison of data revealed tendency to reliability of differences ( $t = 1,85$ ,  $p < 0,1$ ). Use of non-parametric test of signs allowed to confirm the importance of differences in both cases:  $z = 1$  for pyridoxine;  $z = 3$  for riboflavin, ( $p < 0,05$ ).

The assessment of dynamics of antioxidant status was carried out by individual comparison of the studied indicators at the beginning and the end of recreation period: the part of children with expressed effect was defined. In addition, the frequency of effect expression by quantity of the changed indicators was estimated.

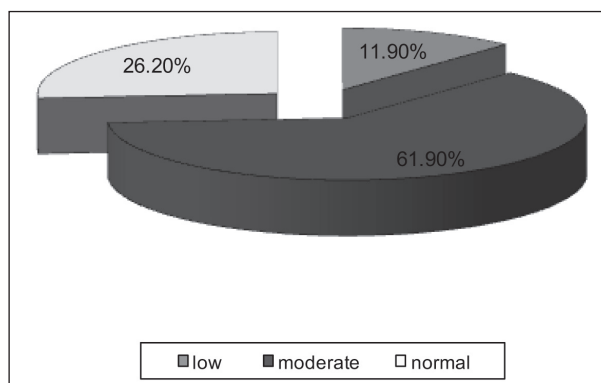
The received results confirmed favorable dynamics of the majority of parameters (tab. 3). It was expressed in decrease of super weak luminescence of urine in 25,6–64,1% of children.

Study of frequency of expression changes demonstrates the favorable dynamics: one indicator – in 41,1% of children; 2-3 indicators – in 23%; 4-5 – in 17,9%; 7-9 – in 18%. Comparison of indicators of BCL and hour egestion of vitamin C allowed to reveal existence of the inverse correlation dependence ( $p < 0,05$ ) with 4

indicators: TK ( $g = -0,36$ ), CI ( $g = -0,31$ ), I1 ( $g = -0,35$ ), IA ( $g = -0,35$ ).

It is revealed the existence of the inverse correlation dependence between pyridoxine egestion level with urine and indicators of BCL ( $g < 0,3$ ). However results weren't reliable ( $p > 0,05$ ) that could be connected with small value of sample. Feedback of weak and average power is revealed between the riboflavin level and indicators of IL ( $g = -0,52$ ), IA ( $g = -0,515$ ), IA ( $g = -0,517$ ) и I1 ( $g = -0,513$ ). Comparison of riboflavin and pyridoxine egestion allowed to reveal direct correlation of average power between them ( $g = -0,533$ ).

At the end of recreational period the interrelation of riboflavin egestion and indicators of BCL was characterized by weak inverse correlation, and with IL and IA even of average power. But the small number of observations didn't allow considering it reliable. Assessment of interrelation of BCL and pyridoxine egestion levels revealed reliable strong inverse correlation



**Figure 3.** Level of ascorbic acid egestion at the end of recreation period

dependence in IL indicators ( $t = -0,713$ ,  $p < 0,05$ ) and IA ( $= -0,711$ ,  $p < 0,05$ ). The inter vitamin dependence at the end of research was also characterized by strong direct correlation ( $g = 0,799$ ,  $p < 0,01$ ).

## Discussion

The used study of research is standard in hygiene of food and nutritional biology. Assessment of "food – is health of the person" system is based on the study of nutrition features and analysis of its efficiency of influence on health.

Nowadays the large number of techniques is applied to estimate the food ration. Some authors (12) recommend using the questionnaire of consumption frequency of certain food products for assessment of nutrition features. Other authors recommend using 24-hour dietary recalls method (32). Results of researches confirmed its efficiency in the analysis of nutrition features in middle school age children. Other authors (33) by means of 24-hour dietary recalls method studied communications between consumption of fruit and vegetables and vitamins level in blood serum of European teenagers. It is defined that normal consumption of fruit and vegetables is characterized by reliable higher levels of B<sub>6</sub> vitamins, folic acid, C, E and -carotene. The method of nutrition analysis was used in our research according to the menu production records. It is most convenient for application at the collective level. This technique allows to level fluctuations in consumption of the main food products by means of nutrition assessment during rather long period (not less than 7-10 days). Besides, it is defined the deviations in consumption of food products allow to predict deviations of the main nutrients from standards and influence of food on organism.

Our results (tab. 1) allow determining some disproportions in consumption of food. It is revealed the expressed increase in consumption of grain products (grain, noodle products and bread). It allows assuming the increased consumption of starchy complex carbohydrates, B vitamins. The lack in food ration of fresh vegetables and fruit causes deficiency of dietary fiber and water-soluble vitamins, especially ascorbic acid. This deficiency in a certain measure is leveled by suffi-

cient consumption of vegetable and fruit juices. At the same time the sufficient consumption of dairy, meat products allows to predict optimum level in food ration of essential amino acids, Ca, P, Mg, S and other minerals. Excess of recommendations in sugar and confectionery could lead to increase in consumption of monosaccharide.

The similar methodological research is conducted by other authors (34). They defined adequacy of consumption of Fe and vitamin C in children's food rations. It was studied levels of food consumption and their chemical composition. It is indicated the need of group and individual consumption levels with direction to average physiological norms of consumption. In other research (32) was defined that diets of children contained enough polyphenols in relation to the recommended values. The consumption of carotene usually exceeded the recommended retinol equivalent. Conversely, vitamin C didn't meet the requirements. The conclusion is drawn about need of increase in consumption of fresh vegetables and fruit.

Definition of average daily set of food allows calculating average chemical composition and energy value of food ration according to special reference tables. It gives the grounds for the decision of nutrition direction. The carried-out analysis confirmed competency of the made prognosis.

Thus, the level of consumption of essential amino acids is associated with processes of growth and children development. The defined balance of tryptophan and total of aromatic amino acids in the studied food rations coincides with found in nutrition of long-living persons from Abkhazia (35). Researches of authors confirmed direct dependence of this value and lifetime by means of increase in capacity of protective systems of organism.

Decrease of PUFAs' content caused some reduction of pro-oxidant features of food ration. It also has to be estimated as increase of antioxidant direction of nutrition. At the same time, the insufficient consumption of ascorbic acid has to be estimated as illustration of decrease of antioxidant potential of nutrition. Its value is confirmed by several researches (36). Authors emphasize the importance of ascorbic acid (as water-soluble antioxidant), necessary for ensuring many functions of organism. The food ration with



high level of this vitamin by means of vegetables and fruit is prophylaxis factor of many illnesses. It is connected with decrease in level of oxidative stress. Some authors (37) determined that optimum level of vitamin C consumption is 200 mg/day. It allows to maximize potential advantage of this vitamin for health and to minimize risk of adverse effects for health.

The general antioxidant protection of organism is formed by means of complex of factors. It requires complex assessment of food ration direction; this was used by us (fig. 1). In our opinion, closeness of square of figures (formed by raying) and circle confirms sufficient value of antioxidant direction of nutrition. The similar technique of assessment of direction of nutrition was developed and patented with our help (38). It was based on the planimetric analysis of square of the specified figures.

The conclusion about complex assessment of antioxidant direction of nutrition is confirmed by several researches. Authors (39) emphasize that general antioxidant activity of nutrition and blood serum are considered adequate tools of study of influence of antioxidants on health. The questionnaire of frequency of consumption of certain products was used for assessment of direction of nutrition. It was applied the correlations of indicators of oxidative stress to antioxidant activity and to the level of antioxidants in food ration As criteria of efficiency.

The competency of application of nutrients correlations for assessment of nutrition direction is confirmed by other researches (40). Authors give a row of the indicators and indexes used in the analysis of nutrition features. At the population level it is proved that food ration with the high content of antioxidants is associated with low risk of development of illnesses.

Similar correlations were applied in our research. Our results confirmed the sufficient level of antioxidant protection of food. The optimum quantity of tocopherols, their high correlation with the PUFAs level, and the optimum correlation of PUFAs/SAFA testifies to the expressed antioxidative direction of food ration.

It is repeatedly proved the efficiency of nutrition enriched with antioxidants for neutralization of action of unfavorable ecological factors. Experiments on animals (41) were confirmed the efficiency of the diet enriched with antioxidants. It allowed decreasing

effect of radiation. Tocopherols and native protein promoted decreasing of damage diaphragms and DNA by X-rays.

In other research (42) is noted that addition of antioxidants within 4 months improved antioxidant and oxidative balance and moderately improved functions of liver. It is determined reliable correlations between oxidative stress and level of inflammatory conditions of liver.

It is confirmed the sufficient antioxidant direction of nutrition of schoolchildren in recreational period by means of the content of certain nutrients and their optimum ratios. Use of this food ration allows assuming its preventive effect, positive influence on the vitamin and antioxidant status of children.

Definition of vitamin egestion with urine is considered one of the most adequate tests of assessment of nutrition efficiency (31). The preventive character of nutrition caused positive changes of vitamin status of schoolchildren. The majority of schoolchildren were characterized by moderate and normal level of ascorbic acid egestion, significant increase of B vitamins egestion. On the other hand, at the end of the recreation period were found out children with low egestion of vitamin C. The normal level of B vitamins egestion wasn't reached. It gives grounds for recommendations to increase in vitamin component of food ration by means of additional intake of multivitamin preparations.

The preventive character of nutrition assumes limitation of risk factors and neutralization of damaging mechanisms. And the most optimal of them is the intensification of free radical oxidation (43). That's why pathogenetically substantiated method of research was use biochemiluminescence for assessment of antioxidant status.

Other researches (44) confirmed efficiency of this method for assessment of free radical oxidation. Authors proved its availability and high informational content to the analysis of adaptative potential. Other authors (45) used blood chemiluminescence assessment method for the analysis of antioxidant potential of organism. The increase in consumption of strawberry decreased chemiluminescence rest level in blood and urine increased the antioxidant potential of organism. Indicators of chemiluminescence correlated with

the level of leucocytes. Decrease of chemiluminescence at rest is estimated as result of depression of oxidizers' formation and decrease of risk of systemic imbalance between oxidizers and antioxidants. Such dynamics is determined in our research. Our results testify (tab. 3), that decrease of indicator of spontaneous luminescence is the most essential. Improvement of this indicator most often met in the examined collective, and also had the most expressed dynamics. Decrease of indicators of TK and CI was observed in 33,3% and 28,2% of schoolchildren. These criteria reflect change of character of chemiluminogram and serve as illustration of improvement of balance of work of protective anti-oxidative systems of organism.

Similar processes are confirmed by dynamics of indicators of amplitudes and intensity of luminescence. Excess of initial indicators over final observed up to the end of recreation, however its expression decreases. It can be interpreted as tendency to improvement of antioxidant status.

In 30,8% of examined schoolchildren had decrease of indicators of intensity of the initiated luminescence and indicator of activation. However in this case was revealed the tendency to reliability ( $p < 0,1$ ).

Determination of correlation dependence revealed existence of reliable inverse average and strong connection between indicators of vitamin status and BCL. It confirms a potential possibility of influence on intensity of free radical oxidation in organism by means of a nutritional factor. The most interesting dependence is between TK and CI. The found interrelation confirms a possibility of influence on the anti-oxidative status by means of modification level of vitamin C in organism.

Assessment of interrelation of BCL and levels of pyridoxine egestion at the end of recreation period reflects decrease of potential ability of biological substrates to oxidation, restoration of functionality of anti-oxidative systems. It is caused by normalization of the vitamin status.

The most expressed correlation communication at the end of recreation is found for pyridoxine. Its level in urine at the end of recreational period was authentically increased. It proves that normalization of vitamin status, increase of indicators of egestion will contribute to normalization of intensity of free radical oxidation

in organism of children and teenagers.

The competency of the drawn conclusions is confirmed by the available results. Other researches (12) confirmed existence of positive association of antioxidant direction of nutrition with consumption of dietary fiber, folic acid, Mg and A, C and E vitamins. The body weight index, indicator of standard deviation of body weight index and the general body fat were connected with antioxidant direction of food ration only at patients with overweight. These data show that the antioxidant activity of nutrition could be potential indicator of risk of development of the signs connected with overweight and can be considered as a useful method at assessment of consumption of antioxidants.

## Conclusion

The received results confirm efficiency of preventive nutrition of schoolchildren in the recreational period. Use of our recommendations allowed increasing significantly antioxidant direction of nutrition of schoolchildren. The nutritional factor positively influenced the vitamin and antioxidant status of organism. Dynamics of vitamin status is characterized by increase in levels of B vitamins egestion with urine, decrease in number of children with the low level of ascorbic acid egestion. It occurs due to transition to moderate and normal levels of egestion. Indicators of antioxidant status illustrate depression of level of free radical oxidation in organism. About a half of the schoolchildren examined by us were characterized by improvement more than on one indicator of biochemoluminescence. The determined correlation dependences between indicators of biochemiluminescence and level of egestion of vitamins are confirmed by efficiency of use of nutritional factor for influence on health of schoolchildren.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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