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The relation between antioxidative ability and the diet of young swimmers

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Abstract

Purpose: **The comparison of nutrition of children with high level of physical activity in dependence on antioxidative efficiency expressed in Ferric Reducing Ability of Plasma – FRAP adapted for saliva.**

Material and methods: **The group consisted of 74 pupils (43 boys and 31 girls) from swimming classes of Sport Championship School in Kraków. FRAP was measured in saliva with the use of colorimetric method and was presented in calculation per 1 gram of proteins.**

Three groups were separated on the basis of FRAP/ /protein (g) values distribution of 15 and 85 percentile. In each group the comparison of particular nutritional components was done with taking into consideration the 24 hour nutritional recall.

Results: **The statistically significant differences in nutrition were observed only in girls group in dependence on the FRAP values. These differences concerned energy and carbohydrates intake. Fats always provided more then 30% of energy, especially among children with high FRAP/ protein (g) value – 34.3%. The shortage of proteins was not observed. The mean intake of calcium, and zinc was below and phosphorus, vitamin A and C intake was above the recommended level.**

Conclusions: **Non-enzymatic mechanisms of antioxidative efficiency (FRAP) are partially being modified by nutritional factors.**

Key words: antioxidative ability (FRAP), children, physical activity, diet.

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Introduction

Raising the level of physical efficiency in the adolescent period and keeping it in the middle age results in better health in the older age, what is being rescheduled for better efficiency of the respiratory and cardiovascular system. In addition people leading the active style of life are less threatened of the occurrence of a number of diseases like arteriosclerosis, the coronary artery disease, hypertension, diseases of the respiratory system [1-3]. Published data inform of profitable impact of the physical activity on antioxidative system ability [4-6]. However, it is important that physical exercises are being executed regularly since only this form of physical effort is influencing profitably the efficiency of antioxidative system [7-9]. In case of excessive burdening with exercises of the organism that is not accustomed to the regular training some disorders of the balance of oxidative-antioxidative system [10] may occur. The sudden increase in demand for oxygen results in production of large quantities of reactive oxygen species, which with the fall of antioxidative capacity leads to the development of oxidative stress [11-13]. The organism is protected from the excess of reactive oxygen species by antioxidative mechanisms. The most important internal antioxidative mechanisms are: enzymatic intracellular line (catalyze, glutathione peroxidaze) which is effective at the correct level of such microelements like copper, manganese, iron, selenium; antioxidants in the blood serum (albumins, transferin, laktoferin, bilirubin, urinary acid); “free radicals sweepers” i.e. low-particle antioxidants like vitamins: A, C, E. Nutrition has a major impact on cellular levels of the “free radicals sweepers”. It is important that the diet is rich in fresh fruit, vegetables and fish which are the outstanding source of insatiable fatty acids which are necessary for correct absorbing and the usage of vitamins soluble in fats. Taking under active remark physical activity, it is also important to preserve correct proportions, both in quality and quantity of food components [14,15].

The purpose of presented studies was to compare the methods of feeding in children who are burdened with the physical

Table 1. **The mean level of energy and main nutrients intake in daily nutritional ration depending on FRAP values and gender**

A. **Girls**

Nutrients	Units	I group		II group		III group		p< 0.05
		mean	SD	mean	SD	mean	SD	
Energy	kcal	2898.01	559.81	2361.15	577.66	2382.31	468.65	I : II
Proteins (total)	g	99.81	13.34	83.78	16.44	91.92	12.73	NS
Fats	g	93.18	17.48	89.02	24.73	80.36	12.35	NS
Saturated Fatty Acids (SFA)	g	34.99	5.66	32.92	9.47	32.98	6.13	NS
Polyunsaturated Fatty Acids (PUFA)	g	12.48	5.18	12.85	4.99	8.78	1.70	NS
Cholesterol	mg	395.09	53.64	427.99	137.38	423.29	71.03	NS
Carbohydrates	g	439.25	111.19	325.17	90.20	339.65	88.95	I : II
Fibre	g	28.35	9.99	21.28	6.97	20.03	6.63	NS

B. **Boys**

Nutrients	Units	I group		II group		III group		p<0.05
		mean	SD	mean	SD	mean	SD	
Energy	kcal	2261.39	296.53	2441.30	603.44	2547.10	732.94	NS
Proteins (total)	g	87.37	20.86	89.73	20.52	88.10	24.61	NS
Fats	g	83.61	16.55	83.87	22.51	109.31	38.33	NS
Saturated Fatty Acids (SFA)	g	30.44	8.08	31.43	10.22	41.16	16.32	NS
Polyunsaturated Fatty Acids (PUFA)	g	11.60	3.38	11.78	3.08	15.76	7.98	NS
Cholesterol	mg	441.75	148.73	363.90	154.95	455.07	268.79	NS
Carbohydrates	g	306.88	23.93	352.11	100.68	324.13	94.62	NS
Fibre	g	19.40	2.60	23.34	7.42	23.40	6.67	NS

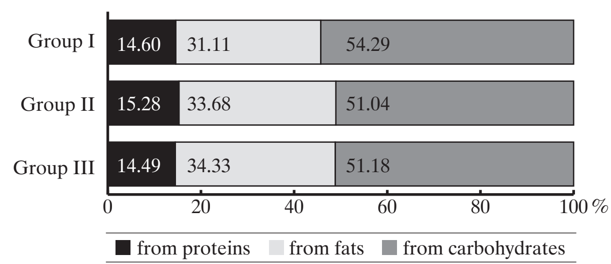
effort and have different levels of FRAP (non-enzyme determinant of antioxidant efficiency).

Material and methods

Seventy-four students were included into the study (43 boys and 31 of girls) from the swimmers classes of Krakow's School of the Sports Championship. Average age was 10.57±0.32 years. Total antioxidative status was measured in saliva on the basis of Ferric Reducing Ability of Plasma (FRAP). FRAP was being measured with the colorimetric method in the saliva and expressed in mmol/l and its values were compared with total amount of proteins per gram. The median, standard deviation, 15 and 85 percentiles were calculated. All studied children were divided into three groups: group I – children with FRAP values below 15 percentile, group II – children with FRAP values in the interval between 15-85 percentile, group III – children with FRAP values above 85 percentile. The comparison in above mentioned groups in the field of received substantial components was made. The evaluation of actual food consumption in the groups was done using 24-hour nutritional recall. The recall was gathered for 2 week days and weekend day in accordance to the one recommended in Poland, prepared by The National Food and Nutrition Institute in Warsaw "Album of products and meals portions". The mean energy value and the levels of basic food components (proteins, fatty acids, carbohydrates) and chosen vitamins (A, C, B1, B2, PP) and minerals (calcium, phosphorus, magnesium, iron, zinc) were calculated without taking into account technological loses. These values were compared with recommended level of intake for Polish children [16].

All statistical calculations were made using the Microsoft™ Excel 2003 PL. The differences between the groups were calculated using the Kolmogorow-Smirnow non-parametric test.

Figure 1. **The participation of proteins, fat and carbohydrates in daily energy intake in all examined groups**



Results

Average FRAP values for groups: I group (<15 percentile): 34.47 μmol/g of proteins (6 girls and 6 boys); II group (15-85 percentile): 80.98 μmol/g of proteins (20 girls and 31 boys); III group (>85 percentile): 410.26 μmol/g of proteins (5 girls and 6 boys). The analysis of daily nutrition rations allowed to assess the mean intake of main nutrients (*Tab. 1*) and their share as an energy source in each group (*Fig. 1*).

The intake of proteins calculated from the recalls was 10-30% above the recommendation (recommended value for 10-12 years old Polish girls and boys is about 75 g/day). The amount of energy derived from proteins was about 15%. The smallest percentage was in the group III and the biggest in group II. Fats always provided more then 30% of energy,

Table 2. **The mean intake of minerals and vitamins in daily nutritional rations among girls and boys with different FRAP/protein (g)**

A. **Girls**

Vitamins & minerals	unit	I group		II group		III group		p<0.05
		mean	SD	mean	SD	mean	SD	
Calcium	mg	983.30	272.92	801.97	247.91	791.18	256.74	NS
Phosphorus	mg	1591.84	251.01	1363.79	282.54	1414.20	144.29	NS
Magnesium	mg	343.30	72.52	273.80	76.27	267.14	60.21	NS
Iron	mg	14.88	3.95	11.28	3.23	10.91	1.48	I : III
Zinc	mg	12.16	2.26	9.70	2.35	9.82	1.58	NS
Vitamin A	μg	1818.88	1508.36	1495.99	915.22	1436.13	1017.43	NS
Thiamine	mg	2.10	0.72	1.38	0.46	1.46	0.34	NS
Riboflavin	mg	2.11	0.27	1.88	0.49	1.80	0.36	NS
Niacin	mg	21.36	6.30	16.48	6.13	20.74	2.98	II : III
Vitamin C	mg	183.39	123.77	166.55	92.54	128.76	72.99	NS

B. **Boys**

Vitamins & minerals	unit	I group		II group		III group		p<0.05
		mean	SD	mean	SD	mean	SD	
Calcium	mg	757.96	284.42	802.20	269.46	710.55	193.73	NS
Phosphorus	mg	1341.90	289.92	1416.50	334.94	1404.15	373.84	NS
Magnesium	mg	259.80	37.54	296.39	84.07	295.77	87.42	NS
Iron	mg	12.49	2.16	13.08	3.24	11.93	4.15	NS
Zinc	mg	9.93	2.09	10.38	2.40	10.68	3.28	NS
Vitamin A	μg	1737.14	1152.78	1245.42	673.43	1591.03	840.62	NS
Thiamine	mg	1.59	0.30	1.75	0.53	1.41	0.59	NS
Riboflavin	mg	2.09	0.64	1.97	0.56	1.83	0.48	NS
Niacin	mg	19.34	4.89	20.28	5.91	21.97	6.27	NS
Vitamin C	mg	96.63	14.37	157.93	108.86	147.92	69.61	I : II

Table 3. **The percentage of norm realization on vitamins and minerals in daily diet in studied groups**

A. **Girls**

Vitamins & minerals	unit	Recom-mended level	I group (%RL)	II group (%RL)	III group (%RL)
Calcium	mg	1200	81.94	66.83	65.93
Phosphorus	mg	900	176.87	151.53	157.13
Magnesium	mg	300	114.43	91.27	89.05
Iron	mg	14	106.27	80.55	77.94
Zinc	mg	16	76.02	60.65	61.36
Vitamin A	μg	1000	181.89	149.60	143.61
Thiamine	mg	1.5	140.22	92.20	97.20
Riboflavin	mg	1.9	111.14	98.97	94.63
Niacin	mg	20	106.78	82.41	103.71
Vitamin C	mg	70	261.99	237.93	183.95

B. **Boys**

Vitamins & minerals	unit	Recom-mended level	I group (%RL)	II group (%RL)	III group (%RL)
Calcium	mg	1200	63.16	66.85	59.21
Phosphorus	mg	900	149.10	157.39	156.02
Magnesium	mg	300	86.60	98.80	98.59
Iron	mg	16	78.06	81.73	74.55
Zinc	mg	13	76.37	79.82	82.15
Vitamin A	μg	800	217.14	155.68	198.88
Thiamine	mg	1.3	122.44	134.52	108.59
Riboflavin	mg	1.6	130.52	123.19	114.48
Niacin	mg	18	107.46	112.66	122.03
Vitamin C	mg	70	138.05	225.62	211.32

especially among children with high FRAP/protein (g) values (34.3%). It was due to excessive intake of saturated fatty acids. The high intake of fats was concomitant with too low intake of carbohydrates. The amount of dietary fiber was always close to minimal recommended value (about 21 g/day in all examined children), excepted for girls from group I. Also girls from group I differed from the other two groups in regard of energy intake and the energy sources. It was shown that the intake of carbohydrates was higher than that of cholesterol only in group I, which was exactly opposite to situation in the group II and III. The statistical significance was only observed between group I and II (in case of group III it was very near of statistical significance) (*Tab. 1*).

The mean intake of chosen vitamins and minerals is shown in *Tab. 2* and *Tab. 3* separately for girls and boys because of different Polish recommendations for them.

In all groups very low intake of calcium, zinc and iron was noted (in case of iron statistically significant difference was found in girls from group I and III). The dietary deficit of above mentioned minerals was present without regarding the value of FRAP/protein (g). The highest deficit of dietary calcium and zinc was found in boys from the group III (59.2% of the norm) and the lowest dietary calcium deficit among girls from the group I. In case of iron, deficiency was not present only in girls from the group with the lowest FRAP values. From the remaining analyzed vitamins and minerals the oversupply (in the relation to the recommended standards) was observed. Also statistically significant differences were present in case of Niacin (girls form group II and III) and Vitamin C (boys from group I and II).

Discussion

The increase in energy demand which takes place during the intensive, repeatable physical activity must find its reflection in the increased quantities of nutrients in the diet. The energy value adapted to the needs of the organism and the suitable structure of daily rations may influence significantly personal capacity to take the desired exercise. Energy demand is dependent on the intensity, the elapsed time and the frequency of the training, e.g. the amount of energy used for running or cycling is around 15-20 times bigger than energy used up during resting. The average consumption of energy is around 0.8 kcal/kg/km during the march and is increasing to about 1.1 kcal/kg/km during the run, and ranges (depending on the style and on the speed that the swimmer wants to reach) from 2 to 5 kcal/kg/km. Moreover after the intensive effort the tissue metabolism does not return at once to the value during rest, as was shown in the studies performed on athletes. It was shown that often up to 12 hours (and sometimes over 24 hours) after the end of the physical effort, the tissue metabolism has sometimes maintained itself on the considerably higher level. Only persons trained suitably can afford such energy expenses through longer periods of time but they must also be prepared dietary suitably to take up the desired exercises [17,18].

Generally the conviction that all athletes should receive the protein rich diet exists. It is tied with muscular mass building during the increased trainings. The insufficient supplementation of proteins may lead to the drop of the muscular mass, as well as to the impairment of regeneration processes. However, there are no studies which would suggest that increased protein supply increases the synthesis of muscular proteins. It's shown that their excess is utilized as the substratum in tissues metabolism. It doesn't mean however, that it isn't necessary in case of athletes to give bigger quantities of proteins in diet because one should remember about the increased protein oxidization during the physical effort.

Adequate supplementation of mineral components and microelements in the diet is equally important, because they are the components (co-enzymes) of numerous enzymes which catalyze biochemical reactions of the organism, and in that way influence physical efficiency. Deficiencies of iron in daily rations that take place in children and adolescents are able to lead to gentle deficits which may manifest in bad moods, pains, dizziness, sleeping and concentration disorders.

Results obtained in our study point the lack of dissimilarities in the method of feeding children with various antioxidant efficiency. Deficiencies are present in regarding the same food components in all studied subjects. So the method of feeding doesn't find reflection in FRAP/protein values (g) being one of indicators of non-enzymatic line of antioxidative efficiency of the system. Our study tied with data from world literature, let us observe worrying trends which concern young people. First significant deficiencies of substantial components of the diet were found in children who require specially balanced diet. Moreover, our data put forward the significance of correct physical development in the connection with respiratory-circulation system efficiency, which only may be reached at the training taken some more suitably, in order to reach the potential chances of the young organism.

Conclusions

Use of samples of saliva in the present study must be seen as an attempt to find out a simple, non-invasive and easy to obtain sample, suitable for frequently repeated determinations of antioxidative mechanisms. However, it seems that non-enzymatic mechanisms of antioxidative efficiency FRAP are partially being modified by nutritional factors.

References

1. Polidori MC, Mecocci P, Cherubini A. Physical activity and oxidative stress during aging. Int J Sports Med, 2000; 21: 154-7.
2. Sen CK. Oxidants and antioxidants in exercise. J Appl Physiol, 1995; 79: 675-86.
3. Sharpe PC, Duly EB, MacAuley D. Total radical trapping antioxidant potential and exercise. QJM, 1996; 89: 223-8.
4. Alessio HM, Blasi ER. Physical activity as a natural antioxidant booster and its effect on a healthy life span. Res Q Exercise Sport, 1997; 68: 292-302.
5. Brites FD, Evelson PA, Christiansen MG. Soccer players under regular training show oxidative stress but an improved plasma antioxidant status. Clin Sci, 1999; 96: 381-5.
6. Napoli C, Lerman LO. Involvement of oxidation-sensitive mechanisms in the cardiovascular effects of hypercholesterolemia. Mayo Clin Proc, 2001; 76: 619-31.
7. Kostka T, Drai J, Berthouze SE. Physical activity, aerobic capacity and selected markers of oxidative stress and antioxidant defence system in healthy active elderly men. Clin Physiol, 2000; 20: 185-90.
8. Nieman DC. Exercise immunology: nutritional countermeasures. Can J App Physiol, 2001; 26: 45-55.
9. Vina J, Gomez-Cabrera MC, Lloret A. Free radicals in exhaustive physical exercise: mechanism of production and protection by antioxidants. IUBMB Life, 2000; 50: 271-7.
10. Clarkson PM, Thompson HS. Antioxidants: what role do they play in physical activity and health? Am J Clin Nutr, 2000; 72: 637-46.
11. Liu ML, Bergholm R, Makimattila S. A marathon run increases the susceptibility of LDL to oxidation in vitro and modifies plasma antioxidants. Am J Physiol, 1999; 276: 1083-92.
12. Kanter M. Free radicals, exercise and antioxidant supplementation. Proceedings of the Nutrition Society, 1998; 57: 9-13.
13. Balakrishnan SD, Anuradha CV. Exercise, depletion of antioxidants and antioxidant manipulation. Cell Biochem Funct, 1998; 16: 269-75.
14. Schroder H, Navarro E, Tramullas A. Nutrition antioxidant status and oxidative stress in professional basketball players: effects of a three compound antioxidative supplement. Int J Sports Med, 2000; 21: 146-50.
15. Battino M, Amadio E, Oradei A. Metabolic and antioxidant markers in the plasma of sportsmen from a Mediterranean town performing non-agonistic activity. Int J Sports Med, 1997; 18: 241-5.
16. Ziemlański Ś. Normy żywienia człowieka. Fizjologiczne Podstawy. Warszawa, PZWL; 2001.
17. Rogol AD, Clark PA, Roemmich JN. Growth and pubertal development in children and adolescents: effects of diet and physical activity. Am Journ Clin Nutr, 2000; 72 (suppl 2): 521-28.
18. Fogelholm M, Rankinen T, Isokaanta M, Kujala U, Usitupa M. Growth, dietary intake and trace element status in pubescent athletes and schoolchildren. Med Sci Sport Exer, 2000; 32: 738-46.