THE ANALYSIS OF NUTRITIONAL PREDICTORS OF ANEMIA COMBINED WITH OBESITY IN PRIMARY SCHOOL-AGE CHILDREN

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ANALIZA NUTRITIVNIH PREDIKTORA ANEMIJE I GOJAZNOSTI KOD DECE MLAĐEG ŠKOLSKOG UZRASTA

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ABSTRACT

The consumption and amounts of a variety of food products used in a diet affect the incidence of anemia and different levels of nutritional status among school-age children. The prevalence of food intake comprised of fats, carbohydrates and sodium (salt) is a significant contributing factor to the incidence of excessive weight. Apart from nutrition, a leisure-time physical activity and the time spent in front of the TV or computer may contribute to an increase in anemia and obesity rates. The objective of this paper was to examine nutritional status, dietary habits and anemia among school-age children in the central Serbia region (the city of Kragujevac). It was established that 47.3% of the surveyed children fell into the normal weight group, 24.5% of the children are considered to be at risk of being overweight, 21.4 % of the children are considered as obese, whereas 6.8% of the children fell into the under-weight group. The incidence of anemia was noted in 10.8% of the cases, whereas anemia in obese children was observed in 21.6% of the cases (n=114; during the school year of 2014-2015). The obtained results show a statistically significant correlation between an increase in the consumption of fast food and anemia in children, whereas the amount of time children spend in front of the TV is also associated with the higher percentage of anemia and obesity.

Keywords: *anemia, obesity, school children*

SAŽETAK

Upotreba i količina različitih vrsta namirnica u ishrani utiče na pojavu anemije i različitih stanja uhranjenosti kod osnovnoškolske dece. Učestalost uzimanja hrane koja je puna masti, ugljenih hidrata i soli značajno utiče na pojavu prekomerne težine. Osim navika u ishrani na pojavu gojaznosti utiče i stepen fizičke aktivnosti, vreme koje deca provedu ispred ekrana, kao i navike koje propagiraju u ishrani. Cilj ovog rada je bio da se proceni učestalost anemije, nutritivni status i navike u ishrani dece iz osnovnih školi u Kragujevcu, centralnoj Srbiji. Ovim istraživanjem utvrđeno je da 47,3% anketirane dece spada u grupu normalno uhranjene, 24,5% je predgojazno, 21,4% ih je gojazno, a 6,8% pripada grupi pothranjene dece. Podaci pokazuju da se učestalost anemije među decom školskog uzrasta javlja u 10,8% slučajeva, dok se anemija kod gojazne dece pojavljuje u 21,6% slučajeva (n=114; period školske 2014/2015. godine). Studijom je utvrđena statistički značajna povezanost između povećane upotrebe brze hrane i anemije kod dece, dok je vreme provedeno kraj televizije povezano i sa većim procentom anemije i gojaznosti.

Ključne reči: *anemija, gojaznost, deca školskog uzrasta*

INTRODUCTION

Bad eating habits, inadequate amounts of physical activity and excessive media use (such as: watching television, and viewing computer screens) may have a significant effect on the incidence of anemia and obesity. The most common cause of nutritional anemia is iron deficiency. Therefore, the recommended daily iron intake from foods is 6 mg/day in children aged 7–10 years (1). As regards the relationship between micronutrient deficiencies and children's cognitive functioning, iron deficiency have been associated not only to cognitive deficits but potential long-term behavioral changes as well (2). Examples of bad eating habits are: the consumption of higher calorie-density of foods, eating meals in front of the TV screen, breakfast skipping, lack of physical activity (3, 4). Over the course of the past few years there has been a trend toward decreased physical activity that plays a significant role in the

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regulation of body mass, compared with excessive energy intake which is a contributing factor to childhood obesity (5). Worldwide, there has been a startling increase in rates of obesity. It has an epidemic-like nature (6). Currently 10% of school-age children worldwide are overweight, one in four children are obese, whereas approximately two thirds of the USA developing population are either overweight or obese (3). In Europe, one in five school-age children are overweight (6). Nutritional deficiency disorders are associated with a variety of health problems of children, and they can also lead to the onset of many age-related diseases (7). Obesity can thereby increase the risk of the development of the major noncommunicable diseases such as hypertension, type 2 diabetes, coronary artery diseases and certain types of cancers (8).

Numerous studies have shown that obesity might also increase the risk of iron deficiency (9). Despite their excessive dietary and caloric intake, obese children and adolescents can be at risk of iron deficiency (ID), because they tend to consume unbalanced meals, particularly rich in carbohydrates and fat (6). Iron deficiency and anemia can lead to fatigue and additionally decreased exercise capacity that may create favourable environmental conditions predisposing people to weight gain (10). The widest range of nutritional deficits includes insufficient dietary intake and absorption of iron. Iron deficiency (ID) is estimated to affect 1.5 billion people worldwide. 10% of children and adolescents in the USA suffer from iron deficiency (11). 25.4% of school-age children worldwide is estimated to suffer from anemia (12). Considering the fact that children's eating patterns and food preferences are established in their early childhood, parents have a significant role in their development (3). Therefore, children's behaviour patterns directly affect not only their current but overall health state as well. In May 2004, the 57th World Health Assembly (WHA) endorsed the World Health Organization (WHO) Global Strategy on Diet, Physical Activity and Health in order to enhance and sustain health and encourage the implementation of action plans to improve diets and increase physical activity (13). The objectives of this paper were established in order to examine nutritional status, dietary habits and anemia prevalence among school-age children in the central Serbia region (the city of Kragujevac).

MATERIALS AND METHODS

The research was carried out in the 4 elementary schools in the territory of the city of Kragujevac. The study sample consisted of 114 children (56 boys and 58 girls) attending the first (55 children) and the fourth (59 children) grade. The participation of at least one parent/guardian of each student was mandatory. The research was conducted during the 2014-2015 school year, in regular classes, whereas the doctors who conducted the research were present there as well. Respondents voluntarily participated in the survey. Survey respondents were assured that their contributions would remain anonymous. The opportunity to participate in the study was denied in the cases of children with incomplete medical records, which entailed not providing sufficient information on blood hemoglobin concentration. Children diagnosed with the anemia that was not mainly nutritional in origin were also excluded from the current analysis.

The collected data were processed using G*Power software, version 3.0.10., a statistical power analysis program. In order to ensure more precise results, the study sample was examined at various levels by analysing numerous parameters such as the following: the probability of Type I error ($p=0.05$), the power of the test ($1-\beta$) of 95% and the correlation coefficient of $C=0.6$.

The data collection was done by combining surveys, anthropometric measurements and biochemical parameters. The survey (a questionnaire used in the survey) was designed in a heterogenous manner and based on open-ended and closed-ended questions, which were arranged in such a manner so that the topic should be reached gradually and selected according to their difficulty levels not only for parents but for their children as well. The parents had multiple choice questions, questions with a set of alternatives or possible answers and fill-in-the-blank questions (consisting of a numeric response box adjacent to the test item indicating where a respondent should provide his/her numeric response or of a blank line where a written response should be provided). The children involved in the survey participated by circling a letter adjacent to the answer that fitted best after reading instructions.

Research materials included questionnaires designed for parents – for family nutrition assessment, and those designed for early elementary school students (that is, first graders) – for eating habits assessment. The utilized questionnaires were formal standardised questionnaires designed according to the principle of the food-frequency approach, that is, food frequency questionnaires, ratified by the World Health Organization (WHO). A parent-based questionnaire consisted of 20 questions, whereas questionnaires for children included 10 simple questions. The forms of anthropometric measurement included children being properly measured for height-for-age and weight-for-age under adequate conditions. The obtained results were converted to body mass index (BMI) and closely aligned to the corerresponding reference values given in the charts of the WHO Child Growth Standards. The children with a BMI-for-age over the 95th percentile (age specific and gender specific) were considered obese; the children with a BMI-for-age between the 85th and 95th percentiles were classified as healthy weight or at risk of overweight; the children with a BMI-for-age between the 10th and 25th percentiles were considered to have normal healthy weight; whereas those with a BMI-for-age less than the 5 percentile were considered underweight (14). Biochemical measurements included determination of hemoglobin concentration in blood as an indicator for anemia. Anemia was considered

to be present in school-age children in the cases when hemoglobin concentration was less than 115 g/l (15). Hemoglobin values were extracted from the children's medical records kept at the Children's Department of the Health Care Center Kragujevac. The abovementioned values were obtained at the regular examinations.

After data collection, the data were entered into SPSS software version 20.0 and were analyzed using descriptive and comparative analytical/statistical methods. Descriptive statistics included measures of central tendency and variability. The results were classified according to the expected research variables, shown in this paper through the following types of visuals: charts and graphs. The analyses on categorical variables were carried out by using χ^2 - test and the findings were considered statistically significant at $p<0.05$.

RESULTS

The mean age of the respondents was 8.75 ± 1.58 years. 56.9% of the children had normal weight, 20.8% of the children were at the risk of being overweight, 16.7% were classified as obese, whereas 5.6% were classified as underweight (Figure 1). The prevalence of anemia among school-age children in the total sample size was 10.8%, whereas 21.6% of the obese children had anemia (Figure 2).

The study showed the cause-effect relationship between the number of daily meals and the occurrence of anemia. Consequently, the occurrence of anemia was reported in 100% of the noted cases of children having more than 5 meals per day, whereas not a single case of anemia was reported in the cases of children who had only 3 meals per day (Figure 3).

The highest level of obesity was found in the children who had 4 or 5 meals during one day. The children who had 3 daily meals (11.6% of the sampled children) were most likely to be found underweight. On the other hand, the children having more than 5 meals during one day were not found to be underweight. However, the prevalence of nutritional deficiency disorders was not statistically significant compared with the number of meals the children had on a daily basis. $\chi^2= 2.503$, DF=2, p >0.05.

The occurrence of anemia and nutritional status were studied concerning the variety of food included in a family diet, methods of food preparation and eating habits (Table 1).

The obtained results showed that anemia was most frequently present in children who had fish once a week (14%). The percentage of normal-weight group of children was observed in the case of those eating fish once a week (55.2%), whereas the greatest percentage of those at the risk of being overweight (66.7%) and obese children (33.3%) were observed in the case of not having any fish in children's diet.

The highest percentage of the occurrence of anemia was observed in children not having nuts in their diet, whereas 50% of the sampled children who occasionally ate nuts were found to be obese.

The study found the correlation between the anemia prevalence rates and a higher intake of sweets and snacks. The highest percentage of children diagnosed with anemia (55.2%) occasionally ate sweets and snacks, whereas 45.8% of the children included in the study consumed that kind of food every day. In the under-weight group, the highest percentage of the sampled children consumed sweets and snacks every day.

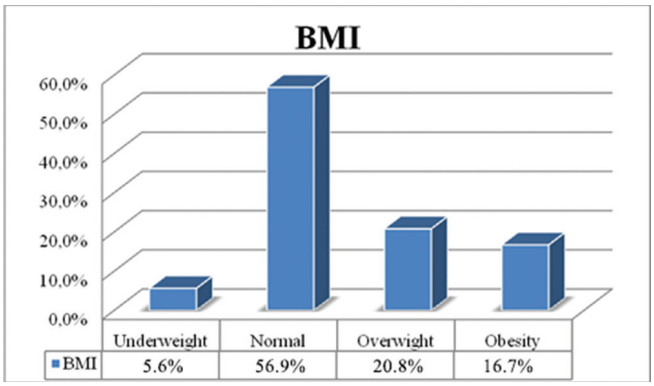


Figure 1. Distribution of the nutritional status of the sampled children

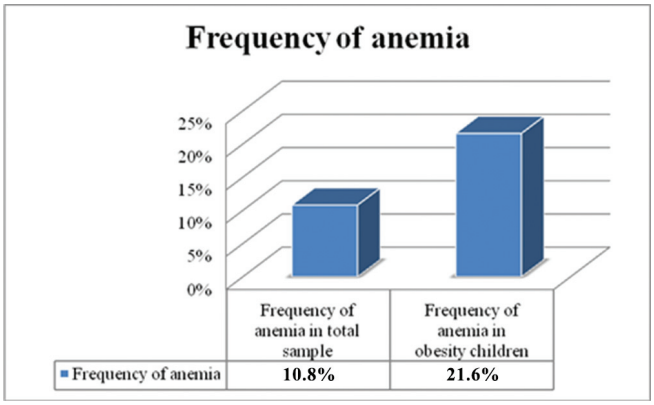


Figure 2. The prevalence of anemia in children

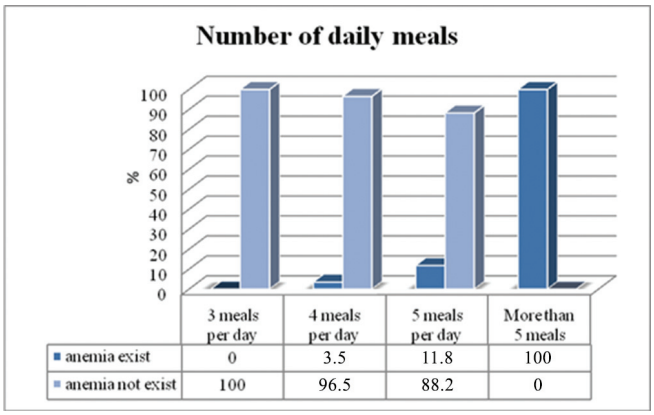


Figure 3. The relationship between the anemia prevalence rates and the number of family meals on a daily basis

Table 1. The relationship between anemia prevalence rates and nutritional status according to the variety of food included in a diet, methods of food preparation and children's eating habits.

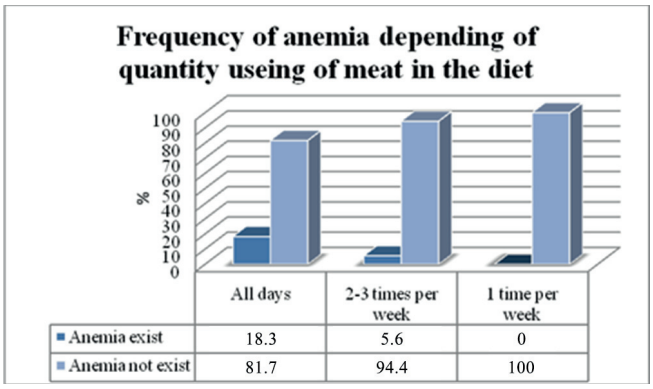
Variables		The prevalence of anemia		χ^2 тест	Nutritional status				χ^2 тест
	Number of children	Anemia is present %	Anemia is not present %	Anemia	Under-weight %	Normal-weight %	Over-weight %	Obesity	Nutritional status
Fish intake consumption in a diet									
2-3 times a week	13	0	100		19.4	36.4	27.3	18.2	
once a week	22	9	91	χ^2=1.94	0	55.2	22	21.6	χ^2= 13.45
2-3 times a month	75	14	86	DF=3	5.7	52.9	21.1	19.3	DF=9
Not eating fish	4	0	0	p>0.05	0	0	66.7	33.3	p >0.05
The consumption of nuts in a diet									
Yes	100	10	90	χ^2=16.79	6	52	24	18	χ^2=2.57
No	3	35	65	DF=2	0	75	25	0	DF=6
Sometimes	5	20	80	p<0.05	0	50	0	50	p >0.05
Sweets and snacks consumption									
On a daily basis	52	16	84	χ^2=1.08	10	45	21	20	χ^2=6.74
Sometimes	62	10	90	DF=1	3	57	23	17	DF=3
No	0	0	0	p>0.05	0	0	0	0	p <0.05
Food preparation methods									
Frying	24	15	85		0	53.8	25	21.2	
Roasting	8	30	70	χ^2=16.87	0	80	0	20	χ^2= 3.82
Boiling	81	4	96	DF=3	7.4	53.7	22.2	16.7	DF=9
Purchasing ready-cooked meals and fast food	1	100	0	p<0.05	0	100	0	0	p >0.05
Skipping a meal									
Breakfast only	30	20	80		0	50	20	30	
Lunch only	4	0	100	χ^2=2.88	0	66.7	33.3	0	χ^2=5.26
Dinner only	3	0	100	DF=3	0	44.4	33.4	22.2	DF=9
No meals skipping	77	8	92	p>0.05	8	60	18	14	p >0.05

The highest percentage of anemia was observed in children having ready-cooked meals and fast food (100%), and the least percentage of anemia was noted in children who ate home-made food (4%). The children who ate ready-made products and fast food were of healthy weight in 100% of the cases. The children who ate fried food (25%) were at risk of being overweight, and as for those who ate roasted food only 20% of them were considered as obese.

The study found that the highest percentage of anemia was observed in children who did not have breakfast in their family diet (20%), on the other hand, even 30% of the children with the same eating habits were obese. The results indicated that obesity was not found in children whose family members did not have lunch (Table 1).

The children eating meat every day were found to be underweight (10.3% of the sampled children). Obesity was most frequently found in children who had meat once a week (28.3%), consequently it was found in the children who had a daily intake of meat in their diet (21.4%). There was no statistically signficant correlation between nutritional status disorders prevalence rates and meat consumption frequency. We have established that anemia was mostly present in children who ate meat on a daily basis (18.3%). However, there was no statistical significance (Figure 4).

Apart from nutrition it is leisure-time physical activity that has its effect on anemia and obesity rates. The study demonstrated that 45% of the sampled children were physically active almost every day, although it was not part of their training, just a form of their recreational activities, whereas only 15% of the children showed their physical activity participation (2 – 3 times in a week, as part of their extracurricular activities). The amount of time children spent watching television screens was also analysed. The obtained results demonstrated that the greatest percentage of the sampled children (48%) spent more than 3 hours in front of the TV screens, whereas only 15% of the sampled children spent less than one hour in front of the TV screens (Table 2).



χ^2= 2.728, DF=2, p >0.05

Figure 4. The prevalence of anemia according to red meat consumption frequency

Table 2. Outdoor physical activities for children complete with the amount of time they spend watching television or using a computer during one day.

Variables	The prevalence of anemia		χ^2 тест	Nutritional status		χ^2 тест
	Anemia is present %	Anemia is not present %	Anemia %	Normal weight and under-weight children's group %	At the risk of being overweight and obese %	Nutritional status
Physical activity						
No physical activities	0	61.8	χ^2=14.16 DF=1	32.4	0	χ^2= 15.49 DF=1
Occasionally there are some physical activities or training	100	38.2	p<0.01	67.6	100	p<0.01
Time spent in front of the TV or computer screens						
< 3hours	0	57.8	χ^2=14.16 DF=1	83.1	0	χ^2= 12.2 DF=1
> 3hours	100	42.2	p<0.01	16.9	100	p<0.01
Number of children	12	102		71	43	

DISCUSSION

Anemia and obesity can result from unhealthy eating habits, family habits effects and environmenal factors (16). Our study results indicate that 16.7% of children is considered as obese which is approximate to the prevalence of obesity in France (14%) (17), then it is higher when compared with the study coming from Sweden (3%) (18), and less then the prevalence of obesity as depicted in the study of the USA (25%) (19). Our examination results show 10.8% of the children with anemia, which is considerably less when compared with the Ethiopian study results (39.1%) (20), and more when compared with the Brazilian study (6.3%) (21). A potential cause of the occurrence of anemia in the higher percentage of children in Ethiopia, based on the results of our particular study, is mainly related to less availability and consumption of dietary iron-rich foods, products of animal origin in particular as well as low income affecting a variety of food choices. The less prevalence of anemia observed among children in Brazil as opposed to our respondents probably resulted from the lack of a variety of food choices offered to our respondents. The number of daily meals is one of the factors relevant for maintaining energy bilance. The WHO recommended five daily meals, meaning: three main courses and two snacks. We have established that an increase in the number of daily meals is followed by an increase in anemia level. The reason for such a claim may be related to the low nutritional value of foods utilized and the consumption of inadequately prepared foods (fast food, sweets, snacks). Breakfast is considered to be the most significant meal that should provide adequate intake of carbohydrates, vitamins and minerals. Breakfast skipping increases risk of anemia and obesity development rates. Our reasearch findings indicate that anemia is mostly present in children whose family eating habits include skipping breakfast (20% of the respondents). The research of Bahaa Abalkhail and Sherine Shawky shows the presence of anemia in 27.7% of the children skipping breakfast (22). We have noted that 50% of the children classified into the excess weight gain group and obese children group would skip breakfast, unlike the results of the study Monika Arora et al. which noted 38.1% of children skipping breakfast (23).

There are numerous food preparation methods, classified into healthy and unhealthy preparation forms. Food prepared by roasting, frying or fast food has the high level of energy density, but it is not considered as the adequate source of micronutritients necessary for normal body functioning. In our study, the least percentage of anemia was present in children whose parents chose boiling as the most present food preparation form. A greater percentage of anemia was recorded among children who consumed fried and roasted food (30%). Anemia was present in all the sampled children who consumed ready-cooked meals and fast food. A frequent consumption of fast food and a frying method utilized for food preparation can be a contributing factor to obesity development. Unlike some of the previous studies Ayranci U et al. (24) and Pereira et al. (25), our study did not confirm the correlation between these bad dietary habits and the respondents' nutritional status. Only the children who had normal, healthy weight consumed fast food. The study showed that children who consumed fast food were at normal weight, probably because of the less frequent consumption of fast food or the fact that they did not consume large amounts of such food. There is also a possibility that there was sufficient physical activity that led to the expenditure of excess calories. Of the sampled children, 42% was considered to be at risk of excess weight gain or considered as obese, whereas the highest percentage of children eating fried food (58%) had a normal BMI. There were no statistically significant differences between the prevalence of anemia and nutritional status disorders compared with the food preparation method.

The consumption of certain foods can play a role in the prevention or predisposition of anemia and obesity development rates. Red meat falls into the category of more important nutrient dense foods. Due to the chemical form of iron contained in meat, which is more easily susceptible to absorption and use, the consumption of this type of food is important for the prevention of anemia development. In our research the obtained results show that the greatest percentage of children consuming meat 2-3 times a week (5.6%), which is evidently less when compared with the data of 24.8% of the children involved (19). Obesity is mostly present in children eating meat once a week (28.3%), and the reason for stating this is probably related to the fact that types of higher nutritient-dense foods such as carbohydrates and fats are prevailing in their diet. Our research showed that anemia was not present in children who had intake of fish 3 times a week. In favour of the previous argument is the fact that anemia is less present in children who consumed fish more frequently in their diet, which is substantiated by the study results (26). Our study demonstrated that the greatest percentage of obese children did not consume fish in their diet. 19% of the obese children consumed fish in their diet at least 2 or 3 times a week, which is in correlation with the study results (27).

Nuts present excellent sources of energy, plant-based proteins, monounsaturated and polyunsaturated fatty acids, dietary fibres, magnesium, potassium, folate and vitamin E. Certain types of the nuts contain greater amounts of iron which is a necessary component in the reduction and treatment of anemia. Nuts contain a bit of natrium and they do not contain any cholesterol which can reduce the risk of cardiovascular diseases and obesity in the combination with antioxidants contained in the abovementioned nuts (28). We have detected a statistical significance between the prevalence of anemia and nuts consumption. Anemia was present in 35% of the sampled children who did not consume any nuts. Among the children who consumed nuts in their daily diets, the majority of children fell into the normal, healthy weight group

(51%), whereas the minority fell into the underweight group (7%). The study results conducted by O'Neil CE et al. were in accordance with these results. Their study indicated that those who consumed nuts were associated with a lower risk of obesity later in life (28). This particular study revealed no statistically significant difference in the prevalence of nutritional status disorders compared with the consumption of nuts. According to studies, sweets consumed by children every day are reported to have a negative impact on their health state and well-being (29). Anemia was less present (45.8%) among respondents who ate sweets on a daily basis, but there were no statistical differences. On the other hand, the results obtained in the study conducted by Crnevic and Radovic Lj. indicated less percentage of anemia present in children (12.7%) (30). One of the possible explanations may lead to sugars generally increasing the absorption of Fe. However, the consumption of sweets containing a lot of 'empty calories' distracts the intake of nutrient-dense foods with a high nutritional value, increasing the risk of obesity development (31). Our research proved that there was 19% of the obese children who consumed sweets and snacks on a daily basis, which was similar to the study data given (31).

Various types of lifestyles also have their own influence on children's development, health and well-being. The amount of time children spend in front of the TV screen is the period of their physical inactivity which is a contributing factor to childhood obesity. Anemia and obesity were present in all the children who spent more than three hours a day in front of the TV, which is contrary to the study results obtained in Cuprija, where only 0.58% of the obese children spent three hours a day in front of the TV (32).

Frequent physical activity increases total energy demands, causing fatigue and due to the inappropriate macro and micronutritients intake it creates a basis for obesity development. All children diagnosed with anemia were physically active. The reason lies in the fact that physical activity of such children along with training and insufficient intake of iron-rich foods lead to the additional expenditure of nutrients. Unlike our results, the study administered by Crncevic and Radovic Lj indicates a lower level of anemia present in this particular children group (30).

Regular physical activity shows a possitive impact on the reduction of the incidence of obesity (33). We have come to the conclusion that 67.5% of the children who were of normal were physically active every day, healthy weight or fell into the underweight group, which was twice as much comparing with the study that revealed only 28.8% of such children. The consumption of fast and unhealthy food could be one of the possible reasons.

CONCLUSION

The obtained results show a statistically significant correlation between an increase in the consumption of fast food and anemia in children, whereas the amount of time children spend in front of the TV is also associated with the higher percentage of anemia and obesity. 21.6% of obese school-age children presented anemia. Additionally, it has been established that inadequate eating behaviour patterns, including not only the continual consumption of fast food, sweets and snacks but irregular intake of fish as well, complete with excessive consumption of meat and nuts – present young children's acquired habits and food preferences mostly influenced by their parents and caregivers. Therefore, it is very important to encourage children and their parents towards a healthier lifestyle by eating well and exercising regularly, as key measures directed at the prevention and control of obesity and and anemia.

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