

Physiological Features of Obesity in Children and Adolescents

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Abstract:

Purpose. This paper intended to reveal the physiological features and benefic effects of the hygienic-dietetic regime and practicing of a sustained physical effort during the prevention period and the obesity period as well in children and adolescents. *Methods.* A study was conducted for this purpose from February 2015 to September 2017, using the database of “Grigore Alexandrescu” Emergency Clinical Hospital for Children of Bucharest. This study included 52 obese children –the experimental group and 15 normal weight children - the control group, with ages ranging from 7 to 18 years. The following elements were used on this occasion: anthropometric data, clinical examination (systolic blood pressure, diastolic blood pressure) and para-clinical data (complete blood count; lipid, hepatic and pancreatic profiles; glycaemia). *Results.* By implementing the multi-factorial therapeutic methods joined with hygienic-dietetic regime, sustained physical effort, psychological assessment and support and an effective treatment with Omega-3 fatty acids, the body weight of the obese children decreased, their body mass index improved, the abdominal circumference diminished, the blood pressure values got smaller and the lipid profile had significant changes. The echography images proved that the number of patients with high risk of developing hepatic steatosis decreased by 49% approximately. *Discussion.* The specialized literature highlights the concerns about overweight and obesity in children aged 2 to 18 years, the body mass index, the higher intake of calories, fats, carbohydrates and sugar from the fast-food meals, the scientific evidence regarding the negative impact of the sedentary behavior on the health, a subsequent relationship between the sedentary time and the incidence of cancer, cardiovascular diseases and diabetes, the metabolic syndrome which is also defined by high blood pressure and hypertriglyceridemia, the properties of leptin as possible therapeutic neuroprotective agent etc. *Conclusions.* The continuously increasing prevalence of pediatric obesity entails severe complications such as high blood pressure, diabetes mellitus type 2, cardiovascular diseases, osteoarthritis and hepatic steatosis. It is recommended to use a multi-factorial treatment including hygienic-dietetic regime, organized physical effort, psychological evaluation and counseling leading to significant results in terms of clinical parameters (weight, BMI, abdominal circumference, systolic blood pressure, diastolic blood pressure) and para-clinical parameters too (lipid, hepatic and echographic profile).

Key Words: obesity, lipid profile, endocrine profile, metabolic syndrome, hygienic-dietetic regime.

Introduction

The obesity of the child and adolescent is frequently associated with bad eating habits, lack of exercising, family history of obesity, endocrine or neurological disorders, depression or other emotional problems. The overweight is a major risk factor for many chronic diseases such as the dyslipidemia, high blood pressure, diabetes mellitus type 2, cardiovascular diseases, osteoarthritis and some forms of cancer.

The definition of obesity in children was initially based on the definition used for subnutrition. The weight-for-age and weight-for-height indicators help to identify the excess body fat in children. The assessment of nutritional condition is essential for clinical, epidemiological and research purposes. The better knowledge of the nutritional state definition (involving also growth references) will lead to the necessary comparisons and to the identification of the factors responsible for the high ratio of obesity in children (Rolland-Cachera, Akrou, & Péneau, 2015).

The prevalence of obesity is higher and entailed a significant burden for public health. Thus it is important to identify the factors that prevent the weight increase. A favorable motor balance and an active life will lead to a healthy lifestyle, will significantly decrease the risk of obesity, enhance the cerebral activity and facilitate the child's integration into society (Criste, 2009).

Obesity is a major issue for the public health and affects more than one billion people worldwide. Insulin resistance (IR) associated with obesity contributes to the development of the metabolic syndrome and is an important risk factor for diabetes mellitus type 2 (Harishankar, Kumar, Sesikeran, & Giridharan, 2011). Childhood obesity is related to an abnormal lipid profile similar to the one noticed in adults, which could contribute to the development of cardiovascular diseases years later. The pathogenesis of the atherosclerosis starts from childhood and is related to the high concentration of total cholesterol, of the LDL-C and also low values of HDL-C. A small activity of serum amylase was observed in the obese adults with NAFLD. The poor activity of the enzyme was correlated with a high risk of metabolic anomalies, with the metabolic syndrome and the diabetes mellitus (Cook & Kavey, 1999). Diet is an important component of the therapeutic approach to the pediatric obesity. The General Principles of Obesity are the result of an energetic unbalance in a child with one or several factors of risk. Therefore, the therapeutic approach should aim at helping the child / adolescent and his/her family to gradually repair the unbalance between the food consumption and energy consumption (sedentary life style, physical activity), taking into consideration the psychological and social context (Birch, Fisher, Grimm-Thomas, et al., 2001).

Physical inactivity can lead to severe health implications. Over the years, evidence revealed the fact that the sedentary life has a stronger impact on the obesity than the diet (Mitchell, Mattocks, Ness, et al., 2009). The models of the nutritional profile classify foods depending on their nutritive composition for reasons related to the prevention of diseases and health promotion. Such models of profile could be used for regulating the food advertising to children by identifying the foods that should or should not be promoted for children (Weiss, Bremer, & Lustig, 2013).

The polyunsaturated fatty acids (PUFAs) n-3 and n-6 are the 2 main classes that contain essential fatty acids. Omega-3 fatty acids are mainly included in the seafood, in the fatty fish (Kalupahana, Claycombe, Newman et al., 2010). The administration of docosahexaenoic acid (DHA) provides a considerable protection and improves the neuronal affection by the beta-amiloid ($A\beta$) and diminishes the oxidative stress by reducing the lipid peroxidation in the cortical and hippocampus nervous tissues (Hashimoto & Hossain, 2011).

The preferred physical activities that focus on family members and friendship should be encouraged, with an emphasis on explorations, toys and having fun. The pre-school kids should participate in non-organized playing on flat surfaces, with a few variables and limited instructions. It is also possible to initiate organized games (football, baseball) but with flexible rules and short instructions, focusing on the joy of playing not on the competition. These children have a limited capacity for learning the team strategy. As the prevalence of the obesity reached the proportions of an epidemic, the medical profession will not be able to solve this serious health issue on its own. The promotion of a low caloric intake and the increase of energy expenditures must be clearly put in the balance (D'Haese, Cardon, & Deforche, 2015). The regular physical activity is also benefic in terms of psychology for all adolescents regardless of weight. It is associated with an increase of the self-esteem and a decrease of anxiety and depression (Calfas & Taylor, 1994).

Purpose. This paper is meant to highlight the physiological characteristics and benefic effects of the hygienic-dietetic regime and sustained physical effort practicing throughout the prevention and obesity period in children and adolescents.

Hypothesis. The increasing prevalence of pediatric obesity can be stopped by using a multi-factorial treatment which includes a hygienic-dietetic regime, organized physical effort and psychological evaluation and counseling. The results will be significant in terms of improvement of the clinical parameters (weight, BMI, abdominal circumference, systolic blood pressure, diastolic blood pressure) and paraclinical parameters (lipid, hepatic and echographic profile).

Material & methods

The retrospective and descriptive study will also demonstrate other benefic effects of Omega 3 fatty acids for the hepatic function (prevention of fatty liver), pancreas function (prevention of pre-diabetes and fatty pancreas).

Participants

Following up the initial assessment, the obese children with hereditary diseases (Down syndrome, Prader-Willi syndrome etc), chronic hepatic diseases (hepatitis B, hepatitis C, Wilson's disease), neurological disorders, autoimmune diseases and chronic inflammatory diseases were excluded and finally a number of 52 obese children (experimental group) were included in this study, along with other 15 children of normal weight (control group). The medical records of the hospital archives for this period were used to collect the necessary data. The obese children aged from 7 to 18 years (average age 11.55 years) were compared with 15 normal weight children aged also from 7 to 18 years (average age 12.6). The distribution by age subgroups and by gender was uniform in each group. The control group included 7 boys and 8 girls (2 pupils aged 7 years and 9 years and 11 months; 10 pre-pubertal children with ages from 10 years old to 15 years and 11 months and 3 pubertal children aged from 16 years to 17 years and 11 months). The group of obese children was formed of 23 boys and 29 girls, as follows: 16 pupils (aged from 7 years to 9 years and 11 months), 28 pre-pubertal children (aged from 10 years to 15 years and 11 months) and 8 pubertal children (with ages ranging from 16 years to 17 years and 11 months).

Procedure - The study is formed of 3 phases: *identification, comparison and intervention*.

The patients that meet the inclusion criteria and have no exclusion feature (neurological disorders, viral hepatitis, genetic malformations etc.) will be selected during the *identification phase*.

The differences between the reference values of the control group and the values of the experimental group (obese patients) will be monitored in the *comparison phase*.

The *intervention phase* will address the multi-disciplinary management, with discussions about the results pre- and post- treatment, revealing the benefic effects of a well-balanced diet, physical activity, psychological counseling and support and Omega-3 fatty acids supplements.

The following elements were used for this study:

- anthropometric data (size, weight, BMI, abdominal circumference);
- clinical examination (systolic blood pressure, diastolic blood pressure to be measured by a tensiometer at both arms;
- paraclinical data (hemogram test; lipid, hepatic and pancreatic profile; glycaemia).

The study was conducted throughout the period February 2015 – September 2017, using a data base of the “Grigore Alexandrescu” Emergency Clinical Hospital for Children of Bucharest. All the children-subjects of the study- were submitted to anthropometric measurements meant to determine their obesity level.

Data collection and analysis

All the children who participated in this study were non-smokers and took no medication during the study. The participants involved in the study as members of the control group were instructed not to change their life style (diet and physical activity) and not to use nutritional supplements. In return, the obese participants were submitted to a balanced lifestyle as hygienic-dietetic treatment, consisting of a healthy diet with 3 meals per day and two snacks at the most. They respected these dietary principles, had a physical activity specific to their age and benefited from psychological counseling if necessary. The obese children have also received a capsule with Omega-3 fatty acids every day for 3 months. The recommended treatment was monitored by phone every week. The children came to the hospital every month for a check-up. None of the children gave up the treatment. They did not have any adverse reactions. Each child and his/her parents gave their informed written agreement regarding the participation of the child in this study. The inclusion of the children in the study and the use of the biological material were governed by the European Ethical Norms. The protocol of this study was approved by the Ethics Commission of the “Grigore Alexandrescu” Emergency Clinical Hospital for Children of Bucharest.

Results

The clinical and paraclinical evaluations (biological and imagistic analyses) of the children were made before and after the recommended treatment. The results of the anthropometric measurements show the distribution of subjects depending on their average size: 152.73 cm in normal weight children and 148.4 cm – obese ones. The average height of the normal weight boys is 152.71 cm and 148.04 cm – obese boys; average height of normal weight girls – 152.75 cm and 148.79 cm – obese girls. The average weight of the normal weight children is 42.86 kg while for the obese children is 64.02 kg – with differences according to gender and age. Regarding the body mass index (BMI), the children of the control group had normal values while the others were overweight (>85 percentile BMI) or obese (>90 percentile BMI). The girls in the experimental group (adolescents) had maximum values of blood pressure, namely 150 mmHg systolic value and 80 mmHg diastolic value; the adolescent boys too had maximum values of 155 mmHg - systole and 85 mmHg - diastole. The girls and boys in the control group had the systolic and diastolic blood pressure within the normal limits. The blood samples were taken “à jeun” (the patient does not eat anything for 12 to 14 hours), in hospital, in vacationers specific to the determined markers. In this study, the lipid profile is changed related to the control group and the atherogenic risk increases. Therefore, the total cholesterol, LDL-C and the plasmatic triglycerides had higher values than in the control group, but the multi-factorial treatment reduced them significantly. The HDL-C had much lower values in the experimental group in comparison with the control group and the treatment increased the concentration of HDL-C.

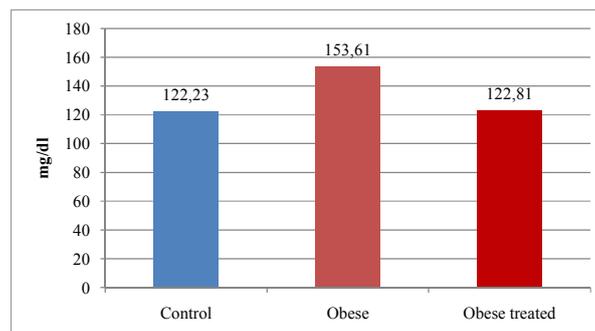


Fig.1. Values of the cholesterolemia in the children and adolescents of the study

The results of the lipid profile analyses highlight an important improvement of the total cholesterol level: the great majority of the subjects have normal values. Thus the benefic effects of Omega-3 fatty acids can be easily seen after an administration of only 3 months. The decrease of the total cholesterol is statistically significant and has a value of 7.9%.

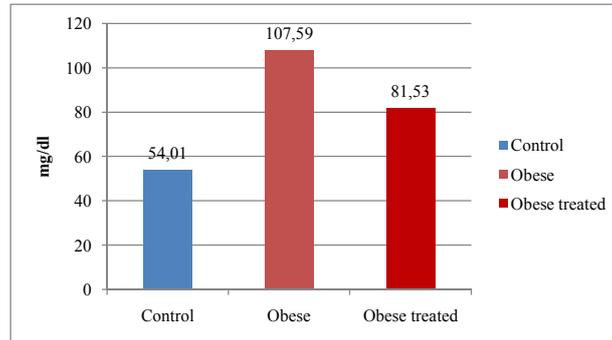


Fig. 2. Values of the triglyceridemia in the children and adolescents of the study

The obesity is associated to various metabolic imbalances, out of which the dyslipidemia is one of the most frequent, affecting more than a half of the obese children and adults.

A statistically significant modification is noticed after the treatment, namely 7.5%.

The childhood obesity is associated with a particular type of dyslipidemia: the triglyceridemia is high and the values of the HDL-C are low. This type of dyslipidemia increases considerably the risk of metabolic syndrome, because both parameters meet the criteria of metabolic syndrome. The metabolic syndrome is also characterized by high blood pressure and hyper triglyceridemia. The general factor for the metabolic syndrome is the insulin resistance. The obesity and sedentary life too increase the risk of metabolic resistance.

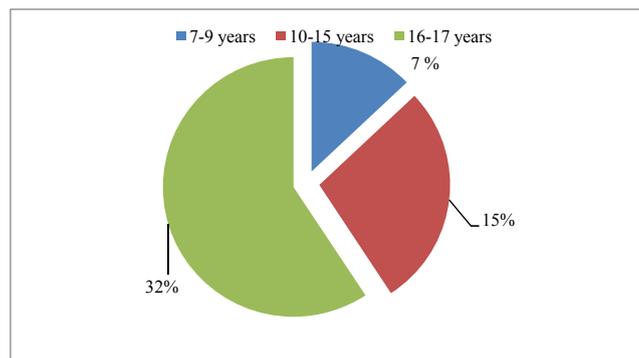


Fig. 3. Percentage of the patients who suffer from metabolic syndrome

In the group of obese patients, the subjects belonging to the subgroup 7-9 years old 7%, 10-15 years old 15% and 16-17 years old 32% suffer from metabolic syndrome. This type of dyslipidemia leads to a high risk of atherosclerosis because is associated with small and dense LDL. These lipoproteins have an extended half-life and a low affinity for receptors; they penetrate easily the vascular inner coat, contributing to the creation of foam cells which are a preamble to atherosclerosis (Paolicchi, Emdin, & Passino, 2006). The effect of Omega-3 fatty acids, EPA especially, in terms of diminution of the plasmatic concentration of triglycerides is due to the capacity of these ones for inhibiting the hepatic enzyme diacylglycerol aciltransferaza which catalyzes the final reaction of the triglycerides synthesis (Kalupahana, Claycombe, & Moustaid-Moussa, 2011).

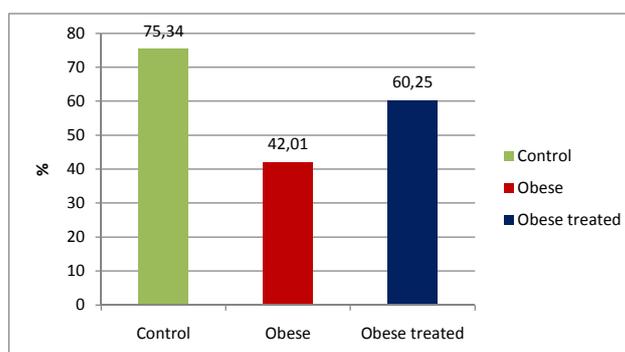


Fig. 4. Values of HDL-C in the children and adolescents of the study

EPA and DHA can increase the HDL concentration of the cholesterol and entail the growth of LDL-C particles, having antiatherogenic effect. The value of HDL-C is significantly modified in terms of statistics, with an average increase by 43%, which leads to the increase of the antiatherogenic effect.

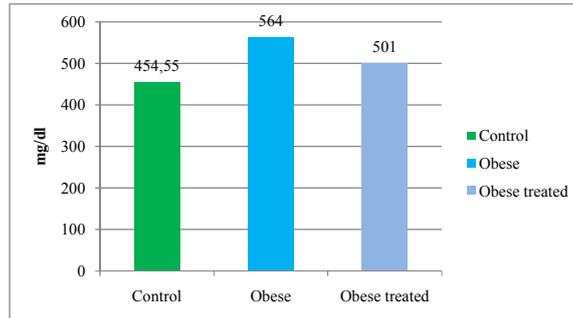


Fig. 5. Values of total lipids in the children and adolescents of the study

According to the diagram no. 5, there is a statistic significant decrease up to normal parameters.

In this study, the glycaemia values are high in the obese children compared to the normal weight children but at the end of the treatment these values decrease.

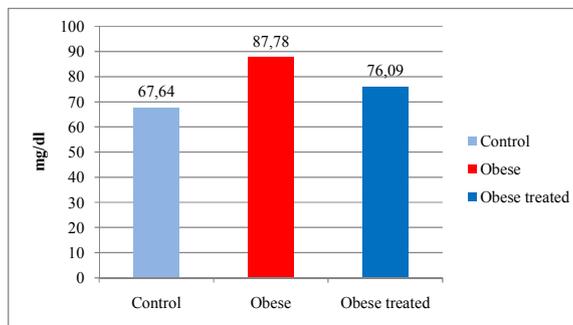


Fig. 6. Values of glycaemia in the children and adolescents of the study

About 50 % of the obese children are insulin resistant. Therefore it is necessary to implement pharmacological and nutritional solutions meant to improve the management of the insulin resistance. Omega-3 fatty acids decreased considerably the concentrations of glucose.

These results suggest that Omega-3 fatty acids Omega-3 can be useful as adjuvant treatment of children and adolescents (Juárez-López, Klünder-Klünder, Madrigal-Azcárate et al., 2013). Also, a decreased caloric intake and a consumption increased by movement help to keep glycaemia within the reference range. DHA and EPA are the most studied Omega-3 fatty acids and their effect "anti-obesity, anti-diabetes", through the improvement of the insulin sensitivity, was fully demonstrated (Li, Huang, & Xie, 2008). Among the hepatic enzymes, ALT was the only one who recorded a statistically important increase in the obese children group. The following data can be noticed after the interdisciplinary treatment:

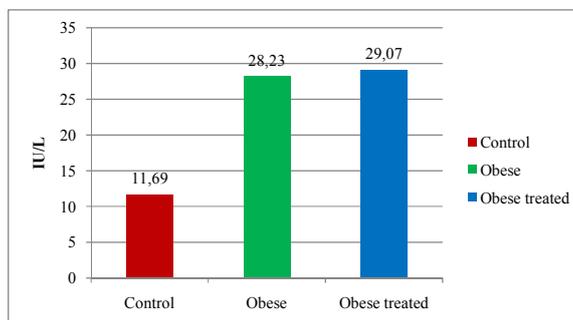


Fig. 7. Changes of ALT values

After the treatment, there is a significant decrease of ALT level which shows an improvement of the hepatic function. The echography reveals initially changes of different levels but these ones regress after treatment as follows:

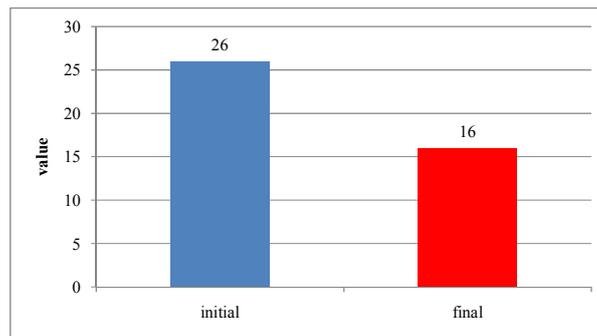


Fig. 8. Number of patients with hepatic disorders indicated by echography

At the beginning, a number of 26 patients of the experimental group (obese children) were diagnosed with hepatic disorder shown by echography (23 with rear attenuation of the hepatic image and 3 with luminosity of the echographic liver, aspect that corresponds to hepatic steatosis). After the multi-disciplinary treatment, a significant statistic decrease of the patients with echographic modifications was observed.

Discussion

In order to define the overweight and the obesity in the children of 2 -18 years old, International Obesity Task Force use as cut-off values of the obesity: the percentile curve which corresponds to cut-off BMI points of 25 (90 percentile) and 30 kg/m² (95 percentile); in 1995, World Health Organization (WHO) improved the standard of weight increase evaluation using the weight-for-height with Z score higher than 1 and higher than 2 for defining the exceeding weight and obesity in pre-school children (Gupta et al., 2012). Currently, a body mass index (BMI) of 30 kg/m² or more defines obesity, while the values of 25 and 29.9 kg/m² indicate the overweight (Misra & Shrivastava, 2013).

According to a study, the children eating fast-food are subject to the consumption of a large amount of calories, fats, carbohydrates and sugars added to a fast-food meal. It is also less probable that these children eat fibers, milk and fruit like the other children who do not eat fast food (Roizman, 2018).

The obese children with MC4R mutations have a marked hyperphagia which decreases with age. Regarding the endocrine function, hypothalamic-pituitary axis, thyroid function and reproduction, all these are normal in MC4R mutation (Dubern, Tounian, 2014). MC4R is acknowledged as the main gene mutation responsible for human obesity. The high frequency of MC4R mutation associated to obesity indicates that this one can be considered the first cause of the oligogenic obesity (Dubern, 2015).

In the last years, the scientific evidence highlighted the negative impact of sedentary behavior on health. The sedentary behavior tends to increase in early adolescence; boys are more sedentary than girls (Mitchell, Mattocks, Ness et al., 2009) as also proved by a Scottish study (Biddle, Gorely, Marshall et al., 2009). The interventions aiming at obesity prevention by diminishing the sedentary behavior in youth are promising but in the case of adults there are no proofs to that effect (Dunstan, Barr, Healy et al., 2010).

An intercultural study that included data from USA, Australia and eight European countries proved a significant association between childhood obesity and the advertising (24). In USA, 80% of adolescents own at least a state-of-the-art device of mass-media like the cell phone, tablet and/or personal computer (Lobstein, & Dibb, 2005). The long-chain Omega-3 fatty acids can be involved in the regulation of adiponectin secretion (Brambilla, Antolini, & Street, 2013)

Recent studies reveal the properties of leptin as possible therapeutic neuroprotective agent through the diminution of the oxidative stress and apoptosis (Macrea, Misra, & Zagrean, 2010). The leptin participates in the process of body adaptation in different conditions such as obesity, malnutrition, food disorders, late puberty, congenital cardiac diseases and hepatic diseases. A higher concentration of leptin in childhood has a predictive value for the obesity of the years to come (Savino, Liguori, & Benetti, 2013). Current research focused on the connection of the thyroid disease and NAFLD. A clinical study with overweight / obese children showed that the serum concentrations of TSH, even slightly increased, were related to a high risk of NAFLD (Radetti, Kleon, & Buzi, 2008). The adaptive immune system is a modulator of the insulin resistance. The results of the experimental studies suggest that there is a connection between the immune system and the insulin resistance in the childhood obesity (Bassols, Prats-Puig, & Gispert-Saüch, 2013). The weight for age and the weight for height indicators are recommended to identify the exceeding weight in children. The body mass indicator (BMI) too is largely used. Like in the adults' case, the BMI in children is associated to morbidity and mortality (Rolland-Cachera, 2002). Another study focusing on the obese adults demonstrated that a hypocaloric diet (only 603 kcal/day) kept along 6 weeks, reduced considerably the cardiovascular risk of the obese subjects (Hernández-Mijares A. et al, 2012). A systematic analysis highlighted that the fish oil, rich in Omega-3, has no adverse reactions and is efficient for adults and children as well (Engler, et al., 2005). Statins (HMG-CoA reductase inhibitors) are a class of drugs that reduce the lipids by the inhibition of HMG-CoA reductase enzyme which has a central role in cholesterol synthesis. The most important health associations in United States

recommended the treatment with statins for the obese children aged 8 years if diet and changes of the lifestyle are not enough for improving their health (Durden, 2017).

Children and adolescents spend a lot of time at school so their availability for regular physical activity is critical. The regular physical activity is important for losing weight and improving the insulin sensitivity of the young people with diabetes type 2. The aerobic exercises help to normalize the blood pressure of the children (D'Haese, Cardon, & Deforche, 2015). Taking into account the children's activities in the last ten years, when they stay mainly at home in front of the PC or with the tablet, several associations started to promote collective physical activities outdoors or indoors and encouraged children to practice recreational activities (Criste, 2009).

Conclusions

The implementation of the multi-factorial therapeutic method with hygienic-dietetic regime, sustained physical effort, psychological assessment and counseling and an efficient treatment with Omega-3 fatty acids led to the improvement of the following parameters:

Anthropometric parameters: the average body weight of the experimental group (obese children) decreased by 9%; the average BMI decreased from 28.25 to 25.21, value close to the normal weight; the abdominal circumference improved by 8%.

The blood pressure values decreased by 11% approximately - systolic blood pressure and by 16% - diastolic blood pressure, highlighting the correlation between the diminution of BMI and the blood pressure values considerably smaller. The changes of the lipid profile are significant: the average level of cholesterol decreased by 7.9%, the triglycerides decreased by 7.5% and the HDL-C had an average increase by 43%.

The concentration of glucose decreased by 14% and got closer to the concentration of the control group. The ALT average value decreased by 7.1%.

The echography images proved that the number of patients with high risk of hepatic steatosis decreased by 49% approximately.

In conclusion, childhood obesity is pathology with an increasing prevalence; it has serious complications like high blood pressure, diabetes mellitus type 2, cardiovascular diseases, osteoarthritis and hepatic steatosis. It is recommended to use a multi-factorial treatment formed of hygienic-dietetic regime, sustained physical effort, psychological evaluation and support and efficient use of Omega-3 fatty acids that lead to significant results regarding both clinical parameters (weight, BMI, abdominal circumference, systolic blood pressure, diastolic blood pressure) and para-clinical parameters (lipid, hepatic and echographic profile).

Conflicts of interest.

The authors declare that there is no conflict of interests.

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