

## **CHANGES OF BODY COMPOSITION DURING WEIGHT REDUCTION PROGRAM BASED ON THE DIET AND PHYSICAL EXERCISES AND LONG TERM EFFECTIVENESS OF THIS THERAPY IN OBESE ADOLESCENTS**

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**Abstract.** This study investigates to what extent long term effectiveness of weight reduction program in obese adolescents depends on the body composition before therapy and its changes during therapy. Studies were conducted on 78 obese adolescents aged 12-16 years, who participated in a 4-week weight reduction program, which consisted of low energy diet (5.47 MJ per day, 18% protein, 26% fat, 56% carbohydrate) and physical exercises. Body weight (BW) and body composition (fat mass – FM, lean body mass – LBM) were measured using bioimpedance method before and during therapy as well as six months later. After 4-week BW, FM, LBM decreased significantly ( $p < 0.001$ ). Six months after termination of therapy the mean BW increased, but mainly due to LBM. Mean changes FM (0.29 kg  $\pm$  3.93) were not significant however in 50% of population FM increased. Correlation between loss of LBM during therapy and FM gain after six months was statistically significant. FM after six months correlated with BW and FM before therapy and changes BW during therapy. Effectiveness of the program could be well predicted by BC before therapy and its changes during therapy. Results permitted to formulate detailed recommendations for weight reduction program for obese adolescents regarding the individual degree of obesity and BC.

**Key words:** obesity, adolescents, fat mass, lean body mass, diet, physical activity, bioimpedance

### **INTRODUCTION**

The obesity of children and young people is an essential reason of the development of the obesity in the adult age with all consequences. The child who is becoming involved in the adolescence overweight, has only, according to Kaplan and Mamel [1995]

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25% chances of reaching the correct body weight in the adult age, however if with the obesity he is becoming involved in the maturity, the probability of reducing the body weight to the norm is only 3%.

Children who are overweight experience physiological consequences similar to those of overweight and obese adults. Risk factors for chronic diseases such as heart disease and cancer are prevalent in overweight children, increasing the likelihood of disease development early in adulthood.

For them an excess of the body weight is larger all the more disadvantageously an obesity influences to the organism of the child. Although the majority of the examined obese children do not sense the complaint it is possible for them to state the different degree of the change in the bone-muscular arrangement and greater burden for the cardiovascular system [Dietz 1998, Freedman et al. 1999, Krebs et al. 2003, Reilly et al. 2003].

Even though the youthful obesity is connected with many risk factors of chronic diseases of the adult age, the most adverse influence concerns the psychosocial sphere [Dietz 1998]. Obese children and teenagers often suffer because of the low self-assessment, psychological disorders and discrimination by peers. Treatment of the obesity of children is a difficult and long-term, requiring the patience and understanding process. It is a source of stress for both the child and parents. Therefore early awareness both of the family and the child of the need to control the problem is essential to the physical development, correcting the diet and the lifestyle what will be assured by effective action with the child [Napler 1993].

Recommended [Epstein et al. 1998, Gately et al. 2000, Reguła and Jeszka 2004, Reguła et al. 2007] form of therapy in obesity, where apart from the diet and the physical activity, alongside with developing appropriate habits, is weight reduction program in sanatorium for children and young people. Weight reduction programs organized during summer holidays for obese children and adolescents were reported as an effective method of obesity treatment. The effectiveness of such treatments, the maintenance of the fall, next further lowering of the body weight depends on patients who should systematically watch the diet established for them, supported by surrounding [Epstein et al. 1998]. Holding lowered fat mass in consecutive years of living after finishing the treatment is an essential element of the slimming therapy. In Poland there are few of examinations discussing about long-term effects of weight reduction program and elements indeed influencing these effects. This study investigates to what extent long term effectiveness of weight reduction program in obese adolescents depends on the body composition before therapy and its changes during therapy.

## SUBJECTS AND METHODS

78 obese adolescents aged 12-16 years, participated in a 4-week weight reduction program during summer holidays, which took place in a pediatric sanatorium. Patients characteristics are given in Table 1. All the individuals included in the study and their parents agreed to participate in the investigations and the protocol of the experiment was accepted by the Ethics Commission at the University of Medical Sciences in Poznań.

Table 1. Anthropometric characteristic of obese adolescents

	Before therapy	After therapy	6 months before therapy
Height, cm		164 ±7.6 <sup>a</sup>	166 ±7.8 <sup>b</sup>
Weight, kg	77.5 ±13.0 <sup>a</sup>	73.7 ±11.9 <sup>b</sup>	76.3 ±12.9 <sup>a</sup>
BMI, kg/m <sup>2</sup>	28.6 ±3.59 <sup>a</sup>	27.3 ±3.33 <sup>b</sup>	27.7 ±3.50 <sup>c</sup>

Significant difference between column is indicated by different letters (p < 0.001).

The weight reduction program consisted of low energy diet and physical exercises. Children consumed a low-calorie diet (5.47 MJ per day) containing on average 18% protein, 26% fat, and 56% carbohydrate. The total daily energy value of meals was calculated using computer software "Dietetyk 2006".

Body weight and body composition (fat mass – FM, lean body mass – LBM) were measured before and during therapy as well as six months later and was determined using a non-invasive method of measuring bioelectric impedance with a bioanalyzer BIA 101S, AKERN-RJL. Measurements were taken at the beginning and at the end of the therapy, in the morning before the morning hygienic activities which made it possible to maintain all the conditions recommended by Lukaski and Johnson [1985].

Testing results were subjected to statistical analysis using the analysis of variance for factorial designs, the T-test for dependent samples and multiple regressions. All the calculations were performed using a software package STATISTICA™ PL 7.0 by StatSoft.

## RESULT AND DISCUSSION

The prevalence of overweight among children and adolescents has dramatically increased lately. There may be vulnerable periods for weight gain during childhood and adolescence that also offer opportunities for prevention of overweight. Overweight in children and adolescents can result in a variety of adverse health outcomes, including type 2 diabetes, obstructive sleep apnea, hypertension, dyslipidemia, and the metabolic syndrome. The best approach to this problem is prevention of abnormal weight gain. [Daniels et al. 2005] Too intensive slimming down in case of young people may lead to anorexia nervosa and bulimia, growth retardation, psychoneurological disorders and muscle weight losses. Thus, the course of the slimming therapy needs to be monitored thoroughly and systematically, to follow changes in body components. It is possible at a sanatorium, where a multidisciplinary program of body weight reduction combines a low-calorie diet, exercise and modification of behaviour through consultations with a psychologist and a dietitian [Gately et al. 2000, Reguła and Jeszka 2004, Lazzar et al. 2005, Reguła et al. 2007]. Gately et al. [2000] suggest that the use of a structured fun-based skill learning programme may provide an alternative method of exercise prescription to help children prolong the effects of the 8 week intervention. Further investigations will help identify the key factors that are necessary for long-term lifestyle

In our examinations realized during summer holiday in the sanatorium for children in all examined groups significantly lowering the body weight, BMI, fat mass – FM and the fat-free body weight was noted (Table 1, Fig. 1).

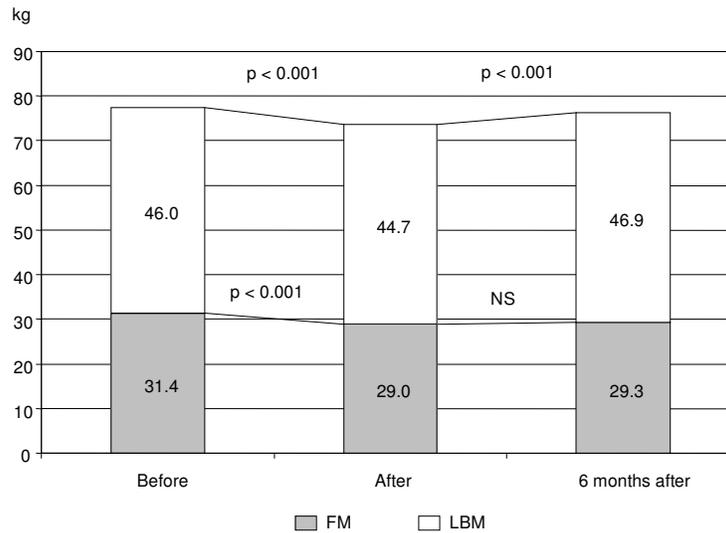


Fig. 1. Body composition during weight reduction program and 6 months after therapy: FM – fat mass, LBM – lean body mass

The main purpose of weight reduction program was the reduction of body weight in particular of fat mass as well as motivating patients for holding these beneficial results of therapy in the longer temporary horizon. In order to get the reply to the question, whether obese persons after finishing the treatment for the second time are not increasing the body weight, whether they do not face the so-called “yo-yo effect”, the anthropometrics parameters and body composition after 6 months from finishing therapy at the sanatorium were measured (Table 1, Fig. 1). We observed that after this period the average body mass of all children and young people significantly increased and did not differ indeed from the value before beginning of the treatment. However it is essential, that the body weight increase was mainly caused alongside with a significant increase of the lean body mass (LBM), in it of muscle mass and water.

However, statistically essential changes of average contents of fat mass (FM) were not registered after 6 months from finishing of the treatment, and compared with the level before the treatment this mass was significantly lower. The lean body mass significantly increased compared with value noted before therapy. But, taking into consideration the values which are not average for the entire population, but individual parameters of persons in 50% an essential increased of fat mass was observed (Fig. 3). These results are corresponding with notifications of different authors [Schwingshandl and Borkenstein 1995, Mello 2002, Reguła and Jeszka 2004, Bewick and Gately 2005, Reguła et al. 2007]. Despite the fact that the problem of the body weight and fat mass increase after finishing of the weight reduction program appears in many publications, a synonymous explanation of the factors responsible for this phenomenon is missing.

Schwingshandl and Borkenstein [1995], in examinations of children and young people at the age 9-15 years, stated that to the long-term effect of therapy a size of loss of the

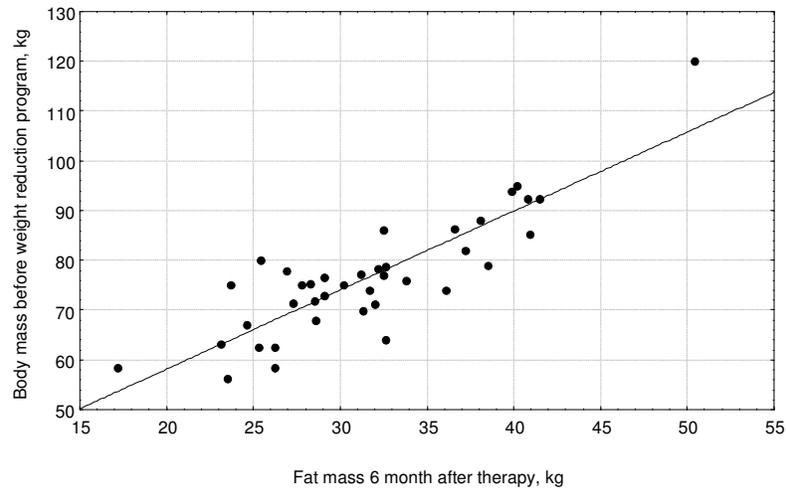


Fig. 2. Relation between the increase fat mass (FM) 6 months after weight reduction program and body weight before the treatment in the sanatorium  $r = 0.86$ ,  $p < 0.001$

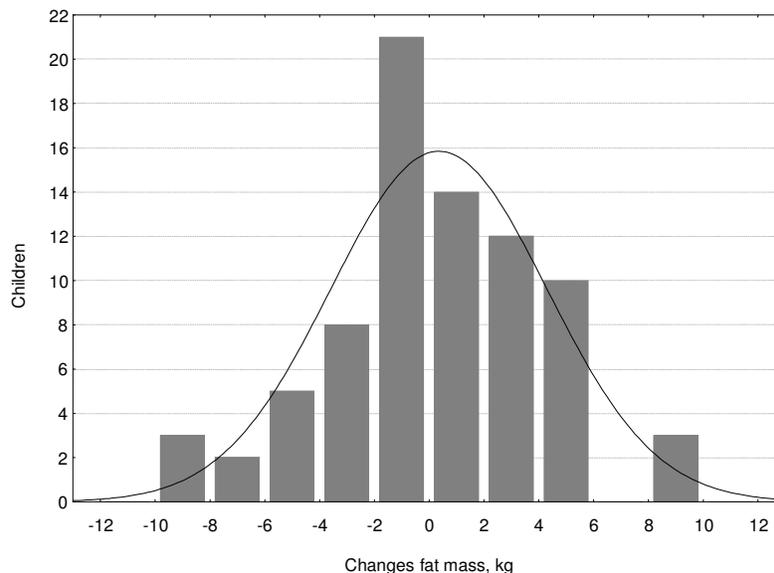


Fig. 3. Estimation of changes of fat mass in population six months after therapy

lean body mass could have an essential influence in the process of therapy. These authors after 4 months from ending of the 3-week weight reduction program judged body composition of obese children again, observed high-essential correlation between changes of the lean body mass during therapy and increase of fat mass after 4 months from its finishing.

About the size of changes of the body weight after 6 months from a close-down of the weight reduction program, according to de Mello [2002] can also decide, apart from the initial body mass, size of its loss in the course of this program. Bewick and Gately [2005] claim that the long-term success of therapy depends on gaining correct habits by children and young people in the process of the treatment. The multidisciplinary weight reduction program applied in the sanatorium, linking low-energy diet, physical exercises, alterations of behaviours, should be introduced into everyday proceedings after finishing therapy. Best effects are obtained, if additionally, apart from the child his parents are involved in curing. Authors put forward conclusions on the basis of observation of 65 obese persons at the age of 14 years, travelling 6 months earlier at the slimming down camp.

Our examinations carried out after 6 months from finishing therapy allowed for making an attempt at determining factors having an influence on effectivenesses of therapy led in sanatorium conditions. We observed that after 6 months from finishing therapy, fat mass was significantly influence: body mass at the beginning of the weight reduction program, weight loss during therapy and fat mass at the beginning of therapy ( $r = 0.82$ ,  $p < 0.001$ ; Fig. 2).

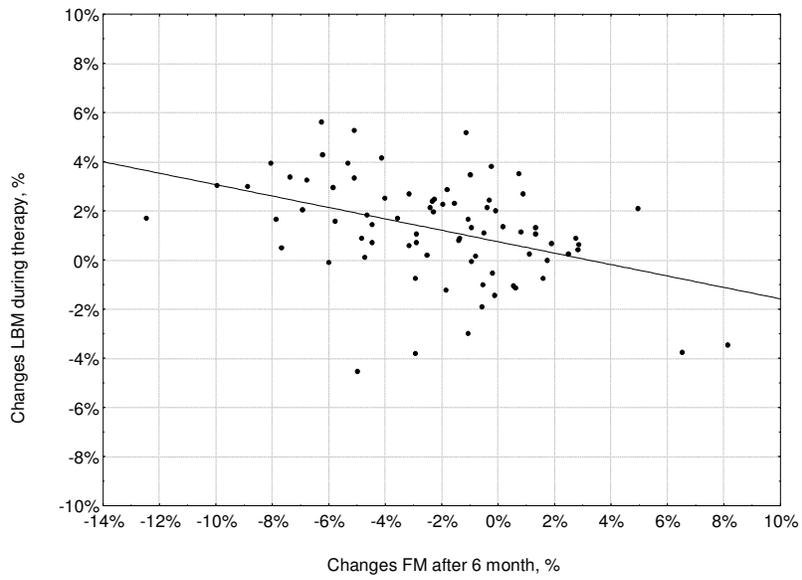


Fig. 4. Correlation between loss of LBM during therapy and changes of FM after six months ( $r = -0.41$ ,  $p < 0.001$ )

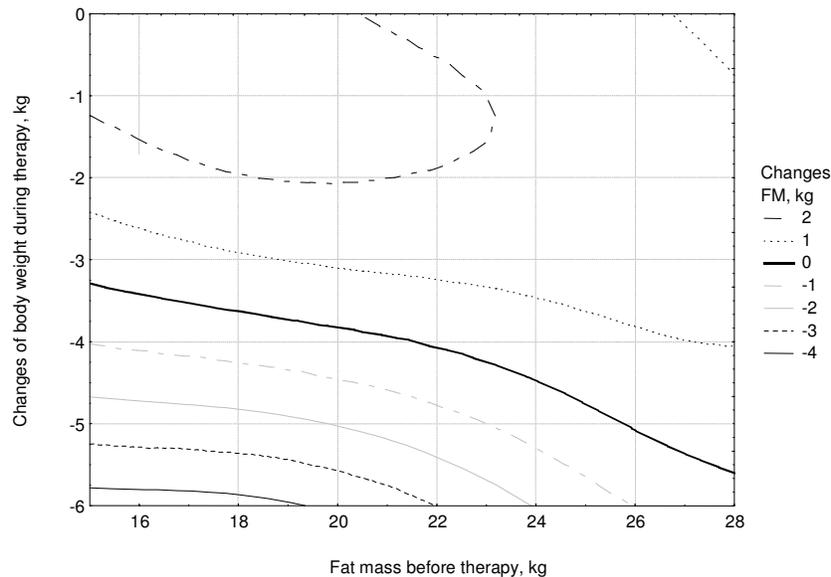


Fig. 5. Relation between changes FM after 6 months and changes of body weight during therapy and fat mass before therapy  $r = 0.79$ ,  $p < 0.001$

On Figure 5 was illustrated a relation between fat mass after 6 months from finishing of the treatment and fat mass before therapy and changes of the body mass during weight reduction program. The course of contour graphs shows, that obese persons with initial fat mass of approx. 32 kg, perhaps lowered it to ca 29 kg mass of this tissue after 6 months from the end of therapy, under the conditions in the process of therapy lost at least 4.5 kg of the body weight.

In this work we stated, that changes of the percentage content of the lean body mass during weight reduction program proportionally correlated with changes of percentage contents of the fat mass after 6 months from finishing of the treatment (Fig. 4).

Moreover, the grade of the obesity of children and young people before the treatment was received indeed to sizes of another increase in the fat mass after 6 months (Fig. 2). The greater increase in fat mass was noted when initial body weight was greater. It can attest genetically determined abilities to the adaptation of the organism, in conditions of the limitation of the consumption of food, through lowering the pace of the metabolism [Bray and Popkin 1998, Lazzer et al. 2005].

## CONCLUSION

In conclusion we state that “slimming down” of children and young people is a complex problem. Many factors are participating in this process, and their interrelation can determine the effectiveness of the entire therapeutic program.

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**ZMIANY SKŁADU CIAŁA MŁODZIEŻY OTYLEJ  
PODCZAS TERAPII ODCHUDZAJĄCEJ  
OPARTEJ NA DIETIE I ĆWICZENIACH FIZYCZNYCH  
ORAZ WPŁYW TYCH ZMIAN NA EFEKTY DŁUGOFALOWE TERAPII**

**Streszczenie.** Celem badań była ocena długofalowej skuteczności terapii odchudzającej u otyłej młodzieży w zależności od składu ciała przed kuracją i zmianami parametrów podczas terapii. Badania prowadzono z udziałem 78 otyłych nastolatków w wieku 12-16 lat uczestniczących w 4-tygodniowej terapii odchudzającej trwającej podczas wakacji w sanatorium. Program kuracji odchudzającej składał się z diety niskoenergetycznej (5.47 MJ na dobę, 18% białko, 26% tłuszcz, 56% węglowodany) i ćwiczeń fizycznych. Masę ciała (BW) i skład ciała (masa tkanki tłuszczowej – FM, masa tkanki beztłuszczowej – LBM) zmierzono metodą bioimpedancji na początku, podczas terapii oraz sześć miesięcy po zakończeniu terapii. W wyniku kuracji stwierdzono obniżenie BW, FM, LBM ( $p < 0,001$ ). Sześć miesięcy po zakończeniu terapii zaobserwowano wzrost BW, jednakże przyrost wynikał głównie ze wzrostu LBM. Nie stwierdzono istotnych zmian średniej zawartości FM, jednakże FM wzrosło u 50% populacji. Korelacja między utratą LBM podczas terapii a przyrostem FM po sześciu miesiącach była statystycznie istotna. Zawartość FM po sześciu miesiącach korelowało z BW i FM przed terapią i zmianami BW podczas terapii. Na skuteczność terapii istotnie wpływały parametry składu ciała przed terapią odchudzającą i ich zmiany podczas terapii. Rezultaty pozwoliły sformułować wytyczne dla prowadzenia programu odchudzającego u młodzieży, uwzględniając parametry wyjściowe otyłych osób.

**Słowa kluczowe:** otyłość, młodzież, tkanka tłuszczowa, tkanka beztłuszczowa, dieta, aktywność fizyczna, metoda bioimpedancji

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