

THE EFFECTIVENESS OF THE LOW ENERGY DIET IN OVERWEIGHT AND OBESE ADULTS

*Beata Całyniuk¹, Elżbieta Grochowska-Niedworok¹, Małgorzata Muc-Wierzoń²,
Ewa Nowakowska-Zajdel², Marcin Osowski^{1*}*

¹Faculty of Public Health, Department of Human Nutrition, Medical University of Silesia, Zabrze, Poland

²Faculty of Public Health, Department of Internal Diseases, Medical University of Silesia, Bytom, Poland

ABSTRACT

Background. Excess body weight is one of the most common health and economic problems of the contemporary world. According to the assessments of the World Health Organization (WHO), almost billion adults are overweight and at least 300 million were diagnosed with clinical obesity. Health consequences of overweight are: ischemic heart disease, congestive cardiac failure, hypertension, arteriosclerotic vascular disease, diabetes mellitus type 2, tumours, degenerative joint disease and many more.

Objective. The aim of the study was to evaluate the effectiveness of the low-energy diet used in the period of 5 months by women and men treated from overweight or obesity in the diet centre.

Material and Methods. The research included 296 overweight or obese patients, treated in the diet centre: (1) 104 women without co-morbidities, between 18 to 61 years old; (2) 58 women with the accompanying insulin resistance between 19 to 61 years old; (3) 49 women additionally suffering from hypothyroidism, between 19 to 61 years old; (4) 85 men without co-morbidities, between 19 to 62 years old. Treated patients were recommended the use of the low-energy diet, where 20% of energy came from protein, 30% of energy from fat and 50% of energy from carbohydrates. The energy content of the diet was considered to be dependent on the individual daily demand that was estimated taking into consideration the physical activity and that was reduced with 1000 kcal. Patients applied suggested reductive diet for 5 months.

Results. The use of diet in each group brought positive results. In all groups, body fat decreased significantly after 5 months of dietary treatment. It has been shown to increase the average percentage of water content in the body of subjects. There was also an average reduction in total cholesterol, LDL, TG, glucose levels and increasing HDL for each group.

Conclusions. Diet proceedings consisting in reduced energy value of the diet has a beneficial effect on reducing body mass, metabolic age, reducing BMI and influences the percentage change in body fat, causing its reduction, change in percentage of water content, leading to a slight increase in its levels in the body. In addition, favourably nutritional proceedings influenced the changes in blood levels of lipid indicators, thus reducing risk factors for coronary heart disease.

Key words: *low-energy diet, overweight, obesity, metabolic age, biochemical parameters*

STRESZCZENIE

Wprowadzenie. Nadmierna masa ciała, to jeden z najczęściej występujących problemów zdrowotnych i ekonomicznych współczesnego świata. Według szacunków Światowej Organizacji Zdrowia, prawie miliard osób dorosłych ma nadwagę, a u co najmniej 300 mln występuje otyłość kliniczna (BMI \geq 40). Następstwami zdrowotnymi otyłości są m.in. choroba niedokrwienna serca, niewydolność mięśnia sercowego, nadciśnienie tętnicze, miażdżycy, cukrzyca typu 2, nowotwory, choroby zwyrodnieniowe stawów.

Cel. Celem badań była ocena skuteczności niskoenergetycznej diety stosowanej przez 5 miesięcy przez kobiety i mężczyzn z nadwagą i otyłością leczonych w poradni dietetycznej.

Material i Metody. Badaniem objęto 296 pacjentów z nadwagą lub otyłością, leczonych w poradni dietetycznej: (1) 104 kobiety bez schorzeń towarzyszących, w wieku od 18 do 61 lat; (2) 58 kobiet chorujących z towarzyszącą insulinoopornością, w wieku od 19 do 61 lat; (3) 49 kobiet chorujących z dodatkowo występującą niedoczynnością tarczycy, w wieku od 19 do 61 lat; (4) 85 mężczyzn bez schorzeń towarzyszących, w wieku od 19 do 62 lat. Badanym osobom zalecono stosowanie diety ubogoenergetycznej, w której 20% energii pochodziło z białka, 30% z tłuszczu, 50% z węglowodanów. Wartość energetyczną diety uzależniono od indywidualnego dziennego zapotrzebowania, które obliczono uwzględniając aktywność fizyczną i pomniejszono o 1000 kcal. Pacjenci stosowali zaproponowaną dietę redukcyjną przez 5 miesięcy.

*Corresponding author: Marcin Osowski, Faculty of Public Health, Department of Human Nutrition, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland, phone number: +48 514 002 989, e-mail: marcin.osowski@med.sum.edu.pl

Wyniki. Stosowanie diety w każdej z badanych grup przyniosło pozytywne rezultaty. We wszystkich czterech grupach zawartość tłuszczu w organizmie zmniejszyła się istotnie statystycznie po 5 miesiącach stosowania diety. Wykazano wzrost średniej procentowej zawartości wody w organizmie osób badanych. Zanotowano również obniżenie średniego stężenia cholesterolu całkowitego, frakcji LDL, TG, glukozy na czczo oraz wzrost stężenia frakcji HDL dla każdej grupy.

Wnioski. Postępowanie dietetyczne polegające na obniżeniu wartości energetycznej diety ma korzystny wpływ na obniżenie masy ciała, wieku metabolicznego, zmniejszenie wartości wskaźnika BMI oraz wpływa na zmiany procentowej zawartości tłuszczu w organizmie, powodując jego obniżenie, zmiany procentowej zawartości wody, prowadząc do nieznacznego wzrostu jej poziomu w organizmie. Ponadto wpłynęło korzystnie na zmiany stężenia we krwi wskaźników lipidowych, powodując zmniejszenie czynników ryzyka choroby niedokrwiennej serca.

Słowa kluczowe: *dieta niskoenergetyczna, nadwaga, otyłość, czynniki metaboliczny, parametry biochemiczne*

INTRODUCTION

Excess body weight is one of the most common health and economic problems of the contemporary world. According to the assessments of the World Health Organization (WHO), almost billion adults are overweight and at least 300 million were diagnosed with clinical obesity ($BMI \geq 40$) [13]. Among European countries more than 50% people are overweight and 30% were diagnosed with obesity [2, 10].

Ischemic heart disease, congestive cardiac failure, hypertension, arteriosclerotic vascular disease, diabetes mellitus type 2, tumours, degenerative joint disease, they are just some of the health-related consequences of obesity [25, 26, 38].

The excess body weight influences almost every aspect of life, therefore it is necessary to eliminate it at an early stage. The treatment of obesity is difficult. It is a result of the fact that the disease also concerns the psychological sphere. Very often bad state of mind and lowered self-esteem are observed in case of overweight patients. With regard to that, the overweight and obesity treatment should be performed under the surveillance of a physician, dietician, psychologist. Many overweight people reduce the body weight without the assistance from experts, by using various diets and diet programs, published in the magazines, newspapers or the Internet [34]. The diet therapy for people with obesity problem should first of all be based on the education of patients in the scope of the changes to the nutritional habits [12, 20, 21].

Low-energy diet, also called the reductive diet is the basis for the dietary obesity treatment [22, 28]. Every diet, also the low-energy one should be individualized. While preparing the diet, not only the anthropometrical data (body weight, height) is taken into consideration, but also other various aspects, first of all such as: age, gender, physical activity, nutritional likings and habits, associated illnesses, the type of performed work or the culinary skills.

The task of the diet is first of all broadly defined improvement of the patients health condition. Body weight loss, being the result of the diet therapy, should

influence the improvement of the metabolic parameters, and at the same time, reducing the risk factors of the cardiovascular diseases as well as maintaining the results obtained as a result of dieting [6].

The task of the low-energy diet, apart from reducing the body weight (by slow limitation of delivered energy), ensuring patient's good frame of mind (both physical and mental health) and reducing the feeling of hunger, is, when accompanied by [6, 25, 31, 38]:

- diabetes: reducing the fasting glucose concentration in the blood and at the same time reducing the need for the oral hypoglycaemic agents;
- arterial hypertension: lowering blood pressure and as a consequence reducing the need for the antihypertensive drugs;
- hyperlipidemia: reducing the fraction of the LDL cholesterol concentration in blood serum, triglycerides (TG) and the increase of the HDL cholesterol concentration;
- sleep apnoea syndrome: relieving of the symptoms;
- degenerative joint disease: increase of the movement capacity.

Low-energy diet should be balanced with regard to its content of protein, fat, carbohydrates, vitamins and minerals. The energy content should be simultaneously lower than individual complete energy demand.

The aim of the study was the assessment of the effectiveness of the low-energy diet used in the period of 5 months by women and men treated from overweight or obesity in the diet centre.

MATERIAL AND METHODS

The research included 296 overweight or obese patients, treated in the diet centre: (1) 104 women without co-morbidities, between 18 to 61 years old; (2) 58 women with the accompanying insulin resistance, between 19 to 61 years old; (3) 49 women additionally suffering from hypothyroidism, between 19 to 61 years old; (4) 85 men without co-morbidities, between 19 to 62 years old.

Treated patients were recommended the use of the low-energy diet, where 20% of energy came from protein, 30% of energy from fat and 50% of energy from carbohydrates. The energy content of the diet was considered to be dependent on the individual daily demand that was estimated taking into consideration the physical activity and that was reduced with 1000 kcal. Patients applied suggested reductive diet for 5 months.

All examined patients had their body weight (kg), body height (cm) established on their first visit, besides the analysis of their body composition was carried out (the proportional adipose tissue content and proportional water content were marked and the metabolic age was established). The analysis of the body content was carried out through the method of the bioelectric impedance analysis, with the use of the *TANITA SC – 330* apparatus (direct current with the frequency of 50 kHz and the impedance of 500 mA). In order to receive the reliable result of the examination of the bioelectrical impedance method, the patients were requested to abstain from drinking any liquids and eating 3 hours before the examination.

The value of the body mass index (BMI) was estimated and interpreted in accordance with the WHO recommendations [36]. The measurement of the body weight and the body composition, with the consideration of the metabolic age, were carried out every month during the follow up visit.

Examined patients who reported to the centre, already had the results of the biochemical testing performed by the order of a general practitioner: total concentration of cholesterol in the blood, LDL and HDL cholesterol fraction, triglycerides (TG) and glucose - fasting. The tests were repeated after 5 months when the treatment was finished.

In order to check the execution of the nutritional recommendations, the patients were advised to keep the nutritional diary, where they were writing up the menu from the last week before the scheduled appointment. Patients who took part in the test did not practice any additional forms of physical activity, during the slimming diet the physical activity in the examined group did not undergo a change. All obtained data was gathered in the *Microsoft Office Excel 2007* Spread Sheet. Data, gathered in the progress of carried out examination, underwent the statistical analysis through the use of the *SPSS Statistics 17.0*PL package.

In order to receive the answers for the research questions and the confirmation of the hypothesis, the univariate and multivariate (*POST HOC*) analysis of variance. The statistical relevance of the received results was estimated through the *t-Student* test. The occurrence of relevant dependences between the features was estimated on the basis of the measure of the *Pearson* product-moment correlation coefficient. Statistical significance $p < 0.05$ level was established.

RESULTS

Table 1 contains mean values of body weight (kg), BMI (kg/m^2), fat content (%), water content (%) and the metabolic age (years) at the beginning of the therapy and after 5 months of using the diet.

In Table 2 are present mean values of the concentration in the blood of total cholesterol (mg/dl), HDL cholesterol fractions (mg/dl), LDL cholesterol fractions (mg/dl), triglycerides TG (mg/dl) and glucose on an empty stomach (mg/dl) at the beginning and after 5 months of using the diet by the examined people.

Table 3 shows relations between the average body weight reduction in case of examined people and changes in the fasting concentration in the blood of the total cholesterol, HDL cholesterol fractions, LDL cholesterol fractions, triglycerides (TG) and glucose.

Table 4 shows values of relations between the average body weight reduction in case of examined people and changes to the content of fat, water in the organism, as well as the metabolic age.

In order to examine change of body weight during the 5 months therapy in the examined groups, the univariate analysis of variance for the dependent samples was carried out. The results for each group were significant on the $p < 0.001$ level. In conjunction with time, the statistically significant weight loss was observed (both after the first and the fifth month of the treatment). In all examined groups, each of the comparisons between successive measurements was statistically significant, on the level of at least $p < 0.01$. The biggest decrease of the body mass was observed in group of obese women and the smallest in group of women suffering from insulin resistance.

After 5 months the body mass index BMI statistically significantly lowered its value in case of examined people in all four groups ($p < 0.001$). There were statistically significant differences between the examined groups in the proportional reduction of the value of the BMI index ($p < 0.0001$). The greatest reduction of the BMI demonstrated in the group of obese women, the lowest – in the group of women suffering from hypothyroidism.

While analysing the efficiency of the diet, in connection with the level of the fat content in the organism, the univariate analysis of variance for the dependent samples was carried out in each of the groups singled out on the basis of the sex and health condition. The acquired results show that the use of the diet in each of the examined groups gave positive results (statistical significance $p < 0.001$). In all four groups the fat content in the organism was lowered statistically significantly after 5 months of using the diet. A group of men has become the largest reduction in body fat content, in contrast to group of women suffering from hypothyroidism.

Table 1. Mean values: body weight (kg), BMI (kg/m²), fat content (%), water content (%) and the metabolic age (years) at the beginning of the therapy and after 5 months of using the diet

n =296		Body weight at the beginning of the therapy (kg)		Body weight after 5 months (kg)		Mean reduction of the body weight after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	86.1	15.00	70.2	13.3	18.6	4.0
Obese women suffering from hypothyroidism	49	79.4	10.5	67.3	10.31	15.4	3.3
Obese women suffering from insulin resistance	58	91.8	17.3	75.2	16.4	18.3	6.1
Obese men	85	111.3	13.2	93.5	12.9	16.2	4.1
		BMI at the beginning of the therapy (kg/m ²)		BMI after 5 months (kg/m ²)		Mean reduction of the BMI after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	31.5	5.2	25.7	4.5	18.6	4.1
Obese women suffering from hypothyroidism	49	29.4	4.1	28.2	3.8	15.7	3.2
Obese women suffering from insulin resistance	58	33.5	6.2	27.4	5.7	18.4	6.1
Obese men	85	33.5	3.3	28.2	3.2	16.1	4.1
		Fat content at the beginning of the therapy (%)		Fat content after 5 months (%)		Mean decrease of the fat content after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	39.0	7.0	28.1	5.7	23.5	7.7
Obese women suffering from hypothyroidism	49	36.5	5.0	27.4	5.2	21.5	7.9
Obese women suffering from insulin resistance	58	41.0	8.7	29.9	6.7	22.7	6.8
Obese men	85	33.7	5.4	21.2	4.4	31.6	7.1
		The content of water at the beginning of the therapy (%)		The content of water after 5 months (%)		Mean increase of the water content after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	43.1	6.5	47.4	5.6	10.1	9.0
Obese women suffering from hypothyroidism	49	43.1	5.9	47.6	5.4	11.5	12.4
Obese women suffering from insulin resistance	58	41.5	7.4	45.9	6.8	10.8	11.8
Obese men	85	44.8	6.4	49.1	4.7	12.1	10.1
		Metabolic age at the beginning of the therapy (years)		Metabolic age after 5 months (years)		Mean decrease of metabolic age after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	49.6	14.6	42.6	14.3	14.7	9.2
Obese women suffering from hypothyroidism	49	48.8	13.7	42.5	13.7	13.5	8.9
Obese women suffering from insulin resistance	58	49.34	14.5	42.9	14.6	13.8	9.2
Obese men	85	46.2	14.6	42.2	13.9	8.7	4.9

n- number of examined people, \bar{X} - mean, SD - standard deviation,

Table 2. Mean values of the total cholesterol, HDL and LDL cholesterol fractions, triglycerides (TG) and glucose at the beginning and after 5 months of using the diet by the examined people

n=296		Total cholesterol at the beginning of the therapy (mg/dl)		Total cholesterol after 5 months (mg/dl)		Mean reduction of the total cholesterol after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	211.1	30.2	185.1	27.9	10.9	9.3
Obese women suffering from hypothyroidism	49	203.1	22.1	184.1	25.6	8.3	7.3
Obese women suffering from insulin resistance	58	219.5	31.3	192.1	29.6	10.8	9.8
Obese men	85	216.3	30.9	190.2	27.5	10.9	8.8
		HDL at the beginning of the therapy (mg/dl)		HDL after 5 months (mg/dl)		Mean increase of the HDL after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	50.6	15.1	61.4	12.1	23.1	20.3
Obese women suffering from hypothyroidism	49	50.9	13.5	59.5	12.2	17.8	15.9
Obese women suffering from insulin resistance	58	51.1	12.1	58.7	10.1	15.9	14.0
Obese men	85	46.1	14.3	54.5	11.4	19.5	17.9
		LDL at the beginning of the therapy (mg/dl)		LDL after 5 months (mg/dl)		Mean reduction of the LDL after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	142.5	32.7	120.6	20.7	14.2	9.0
Obese women suffering from hypothyroidism	49	132.9	29.5	116.1	18.9	11.9	8.9
Obese women suffering from insulin resistance	58	144.2	27.4	124.5	21.0	12.6	9.8
Obese men	85	140.2	38.8	122.4	16.1	11.9	8.5
		TG at the beginning of the therapy (mg/dl)		TG after 5 months (mg/dl)		Mean reduction of the TG after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	142.9	110.7	110.9	48.5	20.3	12.8
Obese women suffering from hypothyroidism	49	129.7	99.8	106.5	38.9	15.5	9.9
Obese women suffering from insulin resistance	58	146.5	79.9	122.8	40.2	14.7	10.0
Obese men	85	168.0	88.0	143.1	39.9	14.0	11.2
		Glucose at the beginning of the therapy (mg/dl)		Glucose after 5 months (mg/dl)		Mean reduction of the glucose after 5 months (%)	
	n	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Obese women	104	83.0	25.1	78.2	16.5	4.9	12.0
Obese women suffering from hypothyroidism	49	79.7	21.1	75.2	10.3	4.6	12.1
Obese women suffering from insulin resistance	58	82.0	40.7	79.8	20.4	2.0	7.9
Obese men	85	81.5	23.5	77.7	16.6	4.4	11.1

n- number of examined people, \bar{X} - mean, SD - standard deviation

Table 3. Relations between the average body weight reduction in case of examined people and changes in the fasting concentration in the blood of the total cholesterol, HDL and LDL cholesterol fractions, triglycerides (TG) and glucose

n=296			↓ Total cholesterol	↑ HDL	↓ LDL	↓ TG	↓ Glucose
Obese women	↓ body weight	<i>Pearson's correlation</i>	0.32	0.22	0.32	0.32	0.02
		p	0.001	0.027	0.001	0.001	0.866
		n	104				
Obese women suffering from insulin resistance	↓ body weight	<i>Pearson's correlation</i>	0.19	-0.09	0.13	0.03	0.03
		p	0.152	0.487	0.340	0.837	0.822
		n	58				
Obese women suffering from hypothyroidism	↓ body weight	<i>Pearson's correlation</i>	-0.07	0.08	0.15	0.17	-0.11
		p	0.645	0.565	0.312	0.240	0.434
		n	49				
Obese men	↓ body weight	<i>Pearson's correlation</i>	0.40	0.36	0.33	0.24	-0.12
		p	0.000	0.001	0.002	0.029	0.291
		n	85				

n- number of examined people, p – significance

Table 4. Relations between the average body weight reduction in case of examined people and changes to the content of fat, water in the organism, as well as the metabolic age

n=296			↓ Content of fat	↑ Content of water	↓ Metabolic age
Obese women	↓ body weight	<i>Pearson's correlation</i>	0.51	0.02	0.19
		p	0.000	0.842	0.049
		n	104		
Obese women suffering from insulin resistance	↓ body weight	<i>Pearson's correlation</i>	0.38	-0.18	0.03
		p	0.003	0.168	0.842
		n	58		
Obese women suffering from hypothyroidism	↓ body weight	<i>Pearson's correlation</i>	0.13	-0.12	0.04
		p	0.380	0.423	0.798
		n	49		
Obese men	↓ body weight	<i>Pearson's correlation</i>	0.22	0.09	-0.08
		p	0.043	0.397	0.485
		n	85		

n- number of examined people, p – significance

The increase of the body water percentage in the organisms of examined people was indicated. Highly statistically significant differences were noticed in case all examined groups ($p < 0.001$).

The analysis of the percentage value of lowering the average metabolic age of examined people indicated the occurrence of statistically highly significant differences ($p < 0.001$) between compared groups. The

POST HOC test showed that the average decrease in the metabolic age of obese women (14.66%), women suffering from insulin resistance (13.79%) and women suffering from hypothyroidism (13.48%) was similar. Significantly smallest decrease of metabolic age in the process of 5 months was observed in case of men and it was equal on average 8.72%.

Lowering of average concentration of total cholesterol, LDL fractions, TG, glucose on an empty stomach and the increase of the concentration of HDL fraction was statistically significant for each group after 5 months of using the (p<0.05). The biggest lowering of the examined parameters was observed in the group of women without concomitant diseases of obesity. The study showed differences in lowering of the fasting blood glucose concentration between a group of women suffering from insulin resistance and all of the other groups.

The statistical analysis indicated that there were statistically significant differences on the p<0,05 level, only in the value of lowering the average TG concentration. The *POSTHOC* tests (with the correction for the unequal variances of *Games-Howell*) indicated that lowering of triglycerides in case of obese women (20.30%) was significantly higher than in case of women suffering from the insulin resistance (14.67%) or obese men (14.03%) and insignificantly higher from the result of women suffering from hypothyroidism (15.50%). In the remaining comparisons between groups, no significant differences were observed.

DISCUSSION

Obesity is a non-infectious, chronic metabolic disease. It is diagnosed in case of people belonging to all age groups [14]. In the USA it is considered to be an epidemic, in Poland the problem of overweight and obesity concerns 50% of population [2, 10, 15].

It has been noticed that the community's awareness concerning this problem is growing and the preventive measures are being undertaken [5, 21]. All around the world people are searching for the effective method to treat the obesity. The biggest results are brought by the methods connected with the change of nutrition habits, nutrition habits and the increase of physical activity [21]. According to the recommendations of WHO and scientific associations, it is necessary to use low-energy 1000-1800 kcal diets in the treatment of overweight and obesity. The content of fat in the diet should be within the limits of 23-35% of total energy, protein 15-20% and carbohydrates 50-60% [16, 25].

The analysis of obtained results allows to claim that the changes of examined parameters under the influence of using the five months slimming therapy are significant. In the examined group of 296 adults who used the low-energy diet for 5 months, the average reduction of the body weight was achieved in the group of all women with 22.98% (14.58 kg), obese women with 18.57% (15.90 kg) and in case of men with 16.16% (17.89%) (Table 1). This result was achieved only through the use of the low-energy diet.

In the similar studies carried out by *Melanson* et al. [20] with the use of therapy of low-energy diet (12

weeks), the reduction of the body weight was achieved and it was identical with the diet based on the products with low glycaemic index. In the *Melanson* et al. research [20] the examined group consisted of healthy overweight or obese adults, also using regular, group nutritional education.

Similar results of the body weight reduction with the use of the reductive diet were indicated in the study of *Krempf* et al. [18], *Andersson* et al. [1], *Ashley* et al. [4].

Hession et al. [13] analysed the research from 2000-2007 that lasted for at least 6 months and that concerned the comparison of the low-carbohydrates and high-protein diet with low-fat and low-energy diet in case of adults with the index $BMI \geq 28$ kg/m². It was stated that low-carbohydrates diet were more effective after 6 months, and after a year they are comparable to each other in the reduction of weight loss and influence on risk factors of the cardio-vascular diseases.

The study conducted among residing in the 3-week stay in a sanatorium have shown, that a short period of treatment and mismatch diet (without individual program), caused an increase in body mass and BMI, despite of increased physical activity [23].

Research of *de Jonge* [7] indicated that the use of the low-energy and at the same time low-fat diet (carbohydrates participation 55%) lowered the body weight of the examined group below 60% of the initial values, which wasn't observed in case of people using the high fat diet.

Previously cited various studies have shown the efficiency of rationally composed low-energy diet (20% energy from protein, 30% from fat and 50% from carbohydrate) compared with alternative diets [13, 37]. It shows from own research that the use of the low-energy diet for 5 months, both in case of women and men, resulted in considerable reduction of the fat percentage content in the organism. The content of this component before using the slimming therapy in case of women amounted to 38.99%, and in case of men 33.72%, after the slimming therapy was finished the result formed appropriately at the level of 28.09% and 21.15%. The average loss of the body fat percentage content in case of the examined group of women and men amounted to 27.56% (Table 1).

In the study of *Shishkova* et al. [29] the results were similar if they were related to the similar time of using the diet. In case of those who were using the low-energy diet, after 2 weeks of the slimming therapy, the decrease of the percentage of fatty tissue was observed; it decreased from the value of 41.25% to the value of 31.3%.

Fats like carbohydrate is mainly energetic material. Unfortunately, the body reaches for adipose tissue last. Adipose tissue plays a very important role in the body. Cushions the main organs (heart, liver, kidneys), provides a protective barrier against loss of heat, it

supplies the body with vitamins, which dissolve only in its presence. In a low-energy diet, control body fat is crucial, because weight loss is not always unambiguous with a decrease in body fat. Moreover, adipose tissue is no longer regarded only as an energy storage, but also as an endocrine organ, and this impacts a large number of processes in the body, including inflammation [7].

Keeping the level of the water content in the organism is indispensable in order to ensure its correct functioning. It is also the aim of a correctly performed slimming therapy. While analysing the changes in the body content before and after the five-months long slimming therapy, favourable changes concerning the increase of the water level in the organism were ascertained in case of the examined women and men. On average the amount of water in the organism of those examined increased with 10.11%, where in case of women with 10.14% and in case of men with 12.08% (Table 1).

The weight loss at the beginning is caused by loss of water and carbohydrates. The longer it is applied the weight-reduction treatment, the greater contribution of the weight loss will be adipose tissue [30]. Also the results of other authors confirm the favourable influence of the low-energy diet on the changes to the water content in the organism [11]. In the work of *Shishkova et al.* [29] it was observed that as a result of using only 2 weeks low-energy diet, the total water content slightly decreased. The metabolic age of examined obese women and men, at the beginning of the slimming therapy amounted to appropriately: 49.60 years, 46.15 years; whereas after the 5 months of using the diet there was a decrease with 14.66% and 8.72% (Table 1). The measurement allows to establish how the hitherto prevailing style of life influenced the ageing of the body. This is a very reliable and mobilizing factor when the lifestyle changes into the healthy one.

The assessment of the dislipemia in case of overweight people was the subject of numerous studies. The most often ascertained changes include: the increase of the triglycerides concentrations, increase of the total cholesterol and the LDL fractions and the decrease of the HDL concentration in the blood serum [8, 25, 26, 38]. The literature data says that the increase of the obesity degree is the factor that enlarges the intensity of abnormalities in the scope of the lipid disorders.

In the own research, after 5 months, both in case of women and men, regardless of age, the significant decrease of the concentration of lipid indexes in the blood was observed (total cholesterol, TG, LDL cholesterol fraction) as well as the decrease of the glucose concentration on an empty stomach. On the other hand, the HDL cholesterol fractions level insignificantly increased. Mean value of the total cholesterol in the group of obese women before starting

the slimming therapy amounted to 211.10 mg/dl and in the group of men it formed on the level of 216.34 mg/dl. After 5 months of using the diet, the concentration of total cholesterol in the blood decreased and its average amount reached in case of women 185.07 mg/dl and in case of men 190.22 mg/dl. In the discussed research, mean concentration of LDL cholesterol fractions in the blood in case of obese women amounted to 142.51 mg/dl before the slimming therapy and after 5 months it decreased its value on average to 120.60 mg/dl. In case of men it amounted to on average to 140.22 mg/dl before the slimming therapy and to 122.40 mg/dl after the therapy. The triglycerides concentration in case of obese women on average amounted to 142.95 mg/dl before the therapy and after the therapy the concentration decreased to the mean value of 110.91 mg/dl. In case of men the triglycerides concentration decreased from the mean value of 168.07 mg/dl before the therapy to 143.05 mg/dl after the therapy. In each of the examined group after the 5 months of slimming therapy, the insignificant increase of the concentration of HDL cholesterol fractions was observed. In case of obese women the concentration of the HDL cholesterol fractions amounted to 50.55 mg/dl before the therapy and after 5 months it increased to the average level of 61.36 mg/dl. In case of men the average initial concentration of the HDL cholesterol fractions amounted to 46.14 mg/dl and after the 5 months it increased to the value of 54.48 mg/dl (Table 2). Similar results concerning the concentration of lipid indexes after applying the low-energy diet were achieved in the studies carried out by *Bellou et al.* [5], *Ryan* [27], *Melanson et al.* [20], *Pinkney et al.* [24], *Aronne et al.* [3].

The research of *Trafalska et al.* demonstrated that patient with lower body mass were characterized by lower values of blood pressure, superior lipid profile parameters (regarding the level of HDL-cholesterol and triglycerides) [32]. The lack of the influence or the insignificant influence of the reduction of the body weight on the concentration of the HDL cholesterol fractions were indicated by other studies [19]. Favourable increase in the concentration of this fraction of the cholesterol was observed in the research carried out by *Ryan* [27], however, only when the diet with considerable energy deficiency was applied (after 6 months of slimming therapy).

Acquired changes in the concentrations of total cholesterol, its LDL fractions, TG, showed positive correlation with the reduction of the body weight both in the own study and in the studies of other authors (Table 3, 4). In the research of *Bellou et al.* [5] the reduction of the body weight connected to the physical activity influenced on the reduction of the concentration of triglycerides, total cholesterol and LDL cholesterol fractions.

Diverse results are the effect of differences in the degree of the fulfilment of the recommended diet, individual differences as well as methods of informing patients about the desired change of the nutrition methods [3, 24]. It shows in the carried out studies in the group of examined women and men that the glucose concentration in the blood on an empty stomach insignificantly decreased (in case of women with 3.83% and in case of men 4.43% (Table 2).

These results are convergent with the research carried out by the United Kingdom Prospective Diabetes Study [33], where the connection between the degree of the body weight loss and the decrease of the glycaemia on an empty stomach was indicated. In the research performed by the Diabetes Prevention Program [17] it was indicated that the complex non-pharmacological therapy was the most efficient way to prevent diabetes. The research carried out by Wang et al. [35] let the authors to formulate the conclusion – acute caloric restriction alters skeletal muscle insulin signalling in a way that it improves insulin sensitivity.

The time of the duration of the diet therapy is the factor that is conducive for the body weight loss and the effect also depends on the degree of obesity [20]. The results of the research presented above give the evidence for the efficiency of the changes to the nutritional methods in the prophylactics of the non-infectious, chronic metabolic disorders.

CONCLUSIONS

1. Dietary procedure, consisting in reducing the energy value of the diet has a favourable influence on decreasing the body mass, metabolic age, lowering the value of the BMI index and has influence on changes of the percentage fat content in the organism, causing its reduction, on changes of the percentage water content, leading to the slight increase of its level in the organism.
2. The use of the low-energy diet by the examined group of women and men favourably influenced the changes in the concentration of the lipid indexes in the blood causing the decrease of the risk factors of the ischemic heart disease (concentration of the total cholesterol, LDL cholesterol fractions and TG, as well as the increase of the concentration in the serum HDL cholesterol). The effect of the diet was also a slight decrease of the fasting glucose concentration in the blood in case of all examined people.
3. In case of the obese women and women suffering from hypothyroidism decreasing of the body mass was observed with the simultaneous decreasing of the percentage fat content in the body.

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Received: 08.11.2015

Accepted: 01.03.2016