

ANALYSIS OF THE EFFECTS OF A THREE-MONTH LONG WEIGHT LOSS PROGRAMME ON OVERWEIGHT WOMEN

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Abstract

The study examined the effects of a three-month long weight loss programme (consisting of aerobic and strength exercise and nutrition) on changes in body composition of twenty healthy middle age overweight women, aged 38 to 55 (average 45,8), who led sedentary lifestyle. Data was analysed with *t*-test (*t*-paired) in order to compare individual variables before and after the weight loss programme. Training consisted of 30 min of cycle ergometry at 60–70% maximal heart rate, 3 times weekly for 3 months, followed by strength exercises for all muscle groups. The results showed the reduction of body mass (in average 8 kg - 0.6 kg per week) and fat percentage (more than 4%). Body mass index has decreased by nearly 3 units. Skin fold values have been reduced by approximately 20% with the most noticeable decrease of circumferences in the torso area (hips and waist). The programme should be continued until body mass index values drop below 30 and consequently body weight to normal value.

Key words: weight loss, obesity, body mass, nutrition, exercise, women

Introduction

Obesity and overweightness are conditions and predicament, spreading in the modern society. Increasingly more people face obesity and health problems, caused by it, on a daily basis. Every day, more people wish to lose excess weight and live a healthier and more satisfied life. The World Health Organisation has confirmed the obesity as becoming a disease of modern times (WHO 1995; 2000; 2004). Obesity is caused by metabolic disorder, which is characteristic of every increase in fat tissue. Obesity is predominant in 10-23% of Europeans and 20-30% of American population. At the moment, more than 300 million people around the world are overweight. According to the data by Montignac (2005), 64% of American people are overweight, compared to 28% of French people. The number of overweight men in Europe has increased from 33 to 43 % between 1980 and 1993, whereas the proportion of overweight women increased from 24 to 30%. In the same studied period, the percentage of obese men grew from 6 to 13% and in women from 8 to 16%. Women are more prone to obesity than men are as female body stores fat more efficiently. Ideal proportion of body fat is 25% in women and 15% in men (Mihelač, 2006). Presumably, increased worldwide spreading of obesity can be expected in future as a result of improved living conditions, easier access to food and lesser physical activity. The results of studies throughout the world show that about 80% of the population is insufficiently physically active and that over 50% of the adult population is overweight in most developed countries (Ostojic et al., 2003). According to the data of Ministry for education and sport (2006), 54.6% of adult population in Slovenia are overweight and 15% are obese. The situation is also worrying in children and youth, signifying the future: among youth, 17% of boys and 15% of girls are overweight and 6% of boys and 4% of girls are obese.

Among children, 18% of boys and 21% of girls are overweight and 9% of boys and 8% of girls are obese. The characteristics of obesity as a disorder are crucial in the processes of development, progress and occurrence of complications in some other most common non-contagious chronic diseases: cardio-vascular diseases, diabetic diseases (Hunter, Chandler-Laney, Brock, Castro, Fernandez, & Gower, 2010); some types of cancer, types of chronic pulmonary diseases, osteoporosis and other diseases of skeletal-muscular system (Kuczmarski, 1992; Fontaine, Redden, Wang, Westfall, & Allison, 2003). Doctors more often warn of serious health problems of overweight people, particularly diabetes, increased blood pressure, increased levels of fat in blood, various hormonal disorders etc (Arsenault, Lachance, Lemieux, Alméras, Tremblay, Bouchard, et al., 2007; Poulriot, Despres, Nadeau, Moorjani, Prud'Homme, Lupien, et al., 1992; Despres, 1993; Peiris, Sothmann, Hoffmann, Hennes, Wilson, Gustafson, et al., 1989; DeNino, Tchernof, Dionne, Toth, Ades, Sites, et al., 2001), also as they are getting older. On the market there are too many food products, making it difficult to sustain correct amount and choice. People eat too much and incorrectly (Pospisil, Schwandt, & Richter, 2004). Approximately 80% of plentiful intake of calories derives from industrially processed and enriched food. Most of them partially or completely lack nutrients, such as vitamins, minerals, fibres and microelements. As a result, it happens that people despite excess food do not receive life important nutrients, with potential consequences being decreased resistance and metabolic disorders (Pospisil, et al., 2004). Increased consumption of whole-grain foods, like cereals and legumes, may protect against obesity, but concerns has been expressed that refined-grain intake may directly contribute to increase in obesity (Koh-Banerjee, & Rimm, 2003).

In many countries national dietary guidelines recommend plentiful consumption of grain foods as the basis of healthy diet and emphasis has increasingly been placed on increasing consumption of whole grains (Williams, Grafenauer, & O'Shea, 2008). We considered their recommendations with our nutrition programme. The studies have revealed that 40% of USA adult population are not at all physically active with another 40% who are active only occasionally (Francis, & Francis, 1996). In the research of Slovenian public opinion 1999 – 2004, 54.5% of interviewed subjects have declared that they did not to participate in sport and recreation, whereas another 5.1% of population participated in sport only a couple of times per year (Toš, 2004).

According to the data of the Ministry of education and sport (2006), only 32% of Slovenian population are physically or sportingly active for at least 30 minutes per day; in contrast, 16% of Slovenian population are completely sportingly inactive. Data has also been supported by the study of sports-recreational activities from the year 2000, revealing that almost 60% of Slovenian population are sportingly inactive, a quarter of population is only occasionally active, whereas considerably less than 20% of population are active regularly at least twice a week. Longitudinal analysis of physical (motor) activity of adult Slovenian population has revealed that with age participation in sports recreation gradually reduces; furthermore, significantly more women than men are inactive (63.2% to 44.1%). Body composition and physical appearance are changing under the influence of exercise. Strength development is generally accompanied by increasing muscle mass, while increased aerobic endurance is often accompanied by a reduction of subcutaneous adipose tissue (Stojilkovic, Djordjevic-Nikic, & Macura, 2005). Changes in body composition can be even more important, when the appropriate diet is applied along with the specially programmed exercise (Stojilkovic, Djordjevic-Nikic, & Macura, 2005).

Methods

Sample of measured subjects

Measured subjects (20 females) were visitors of the weight loss programme in personal fitness, aged 38 to 55 ($M=45,8\pm 8,3$). Their initial weight was between 67 and 105 kg, their height was between 159 and 179 cm. Before starting the programme, their average body mass index was 30.5 points and they had in average 36% of fat body mass.

Control group consisted of 20 females of the same age, with initial weight between 70 and 105 kg, height 161 and 178 cm. Average body mass index of control group was 31 points and they had in average also 36% of fat body mass. All the participants in the programme had predominantly sedentary jobs; some of them were experienced stressful situations on a daily basis. Due to lack of time and willpower, they did not include physical activity into their daily routine.

Measured subjects were eating very irregularly, they consumed only 2-3 meals per day and they ate main meal usually in late evening hours. Their diet consisted of mostly simple carbohydrates and saturated fats; in average, their bodies contained too little water.

Procedures

A part of variables has been monitored with the use of a scale (Tanita, Innerscan body composition monitor, model BC-545), based on a six-point measuring with magnetic impedance. Data about body height, which has been previously measured with anthropometer (GPM, Sieberhegner, Zurich), age and gender of measured subjects have been entered into a scale. Data about body mass, percentage of fat, water and muscles of measured subjects have been obtained from the scale. Morphological body dimensions were measured manually: skin folds (triceps, biceps, forearm, back, stomach, supra-spinal skin fold, suprailiacis skin fold, ventral, ventromedial and dorsal skin fold of thigh, dorsal and ventromedial skin fold of calf) with calliper (Lange Skin fold Calliper, Cambridge Scientific Industries, Inc.; Cambridge, Maryland) and circumferences (circumference of tensed and relaxed upper arm, circumference of forearm, circumference of torso across and below breast, circumference of hips across spina iliaca and pubic bone, circumference of thigh underneath the gluteal crease and in the middle of thigh, circumference of calf) with measuring tape. Measured anthropometrical variables were further used to calculate the percentage of body fat (as an average of calculations according to the formula by Sloan and Weir (1970, in Bravničar, 1994) and according to the method by Durnin and Womersley (1974, in Bravničar, 1994). Body mass index has been calculated from body height and body weight data (WHO, 2000).

Suitable exercising and diet for losing weight

The weight loss programme, used in the study, combined aerobic and anaerobic exercises. The intensity of exercising has been set with the percentage of maximal heart rate; the target zone for regulation of body weight has been used (60 – 70% of maximal heart rate), whereas in a later anaerobic part – exercising with weights – 15 to 20 repetitions of single exercise in three series have been used to target the zone of anaerobic-aerobic training (70 – 85 % of maximal heart rate) (Ušaj, 2003; Petrović, Sepohar, Zaletel, Černoš, Praprotnik, & Mrak, 2005; Champion, & Egger, 1990; Febiger, 1991). In this way, beside burning fat, strengthening of muscles, increase of muscular tonus and maintaining the quality lean body mass has been achieved with simultaneous reduction of fat mass. Programme lasted three months (12 weeks), consisting of three one-hour long sessions per week. In total, programme consisted of 36 training units and has been divided in three mesocycles:

1. Adaptation of skeletal-muscular system to effort; preparation of muscles, joints, connective tissue and stabilizers of torso (dorsal and

abdominal muscles) for future more intensive stimuli (Petrović, et al., 2005). Due to increased fat mass of measured subjects, aerobic warm-up has been gradually increased from 15 to 30 minutes. In strength exercises, focus has been placed on continuous and symmetric strengthening of muscles of the entire body.

2. Increasing the aerobic part and increasing the intensity of individual exercises for strengthening the muscular system.
3. Exercises for muscular definition – distribution of exercises according to muscle groups.

The purpose of training programme was mostly reducing the percentage of body fat and emergence of muscle mass. Measured subjects and control group (who wasn't exercising) have been given the following guidelines in dietary regime:

- to eat at least 5 meals a day, eating every three hours, to drink only water or unsweetened tea during the meals, to eat fruit as an independent meal to prevent brewing in stomach, to avoid sweets; as an exception a piece of dark chocolate (with at least 70% cocoa solids), potatoes were to be avoided as much as possible, rice and pasta (whole wheat) should be consumed more often, meat/fish were to be prepared on a tea spoon of oil, even better if it is done in an oven wrapped in foil or grilled, after exercising a meal can be richer

with carbohydrates (rice, pasta, bread, crackers, energy bar...), in the evening carbohydrates were to be avoided roasted potatoes, mashed potatoes, fried steaks or fish, greasy food, desserts, white bread, cheese, pork, salami etc., to avoid alcohol (apart from a glass of red wine after lunch), three meals including meat per week were maximum, at least 4-5 meals were to be consumed with rice, the rest with pasta, at least 30 – 50g of ballast ingredients was to be consumed every day.

Measured subjects have kept a food diary throughout the programme. Diet has been monitored and controlled as well as changed if necessary by introducing novelties. Measured subjects were weighed once a week and they were supposed to be losing in average between 0.5 and 1 kg every week. In studio for dieting, body forming and healthy eating, twenty overweight women whose body mass index was above 30 had been prescribed both a dietary and exercising programmes. Prior to the preparation of programmes, measurements of body composition have been carried out; the same procedure has been followed at the end of the programme - after three months. The common goal was to reduce a percentage of skin fat by at least 5% and to lower the body mass index to »normal weight« values between 25 and 30.

Table I: Descriptive statistics and comparative t-test of differences between initial (1) and final (2) values of variables in exercise group

	mean		minimum		maximum		SD		t-test	P
	1	2	1	2	1	2	1	2		
AGE	36.69		18.00		50.00		8.75		/	/
HEIGHT	1.66		1.59		1.79		0.52		/	/
WEIGHT	84.51	76.70	57.20	52.90	105.80	97.30	13.22	12.18	11.62	0.00
%FAT measured	37.92	33.37	27.70	26.00	48.40	46.50	4.95	5.63	7.68	0.00
%FAT calculated	33.54	29.54	27.74	22.87	38.81	38.81	3.88	5.29	6.73	0.00
%FAT average	35.94	31.94	29.28	25.94	43.61	41.36	3.97	5.21	8.33	0.00
% MUSCLE	45.26	47.25	34.00	36.00	57.10	55.30	13.16	4.81	-6.3	0.00
% WATER	46.42	49.71	39.20	40.40	55.70	57.00	3.94	4.13	-6.07	0.00
BMI	30.51	27.67	22.63	20.92	41.33	36.25	4.46	3.95	11.04	0.00
SF triceps	31.01	24.80	19.20	16.60	40.00	40.00	6.70	7.38	6.43	0.00
SF biceps	19.99	13.12	7.00	5.00	40.00	31.00	9.70	6.53	4.70	0.00
SF forearm	19.30	14.45	8.20	6.60	40.00	27.00	8.27	6.28	5.45	0.00
SF back	31.51	23.42	16.00	10.20	40.00	40.00	7.79	7.99	6.40	0.00
SF abdominal	32.61	27.08	20.00	12.00	40.00	40.00	7.93	9.26	5.01	0.00
SF supraspinal	35.00	30.33	26.00	15.00	40.00	40.00	5.12	8.31	4.00	0.00
SF suprailiacis	24.86	19.24	14.00	8.00	40.00	38.00	9.66	8.81	5.54	0.00
SF thigh	39.63	35.49	37.00	26.00	40.00	40.00	1.03	4.56	3.93	0.00
SF thigh D	39.72	31.05	38.00	20.20	40.00	40.00	0.68	7.56	4.68	0.00
SF thigh VM	35.00	25.99	23.00	15.00	40.00	40.00	6.22	8.71	6.23	0.00
SF calf VM	35.51	29.56	25.00	18.00	40.00	40.00	6.10	7.57	4.35	0.00
SF calf D	35.51	29.56	25.00	18.00	40.00	40.00	6.10	7.57	4.12	0.00
C upper arm relaxed	33.66	31.78	26.00	25.00	41.00	38.00	3.52	3.23	9.55	0.00
C upper arm flexed	34.59	33.14	27.00	25.00	43.00	40.00	3.67	3.38	5.06	0.00
C forearm	26.49	25.63	21.00	20.00	30.00	29.00	2.10	2.00	7.43	0.00
C chest below	92.13	85.91	75.00	70.00	107.00	96.00	7.89	6.61	8.94	0.00
C chest above	107.44	102.3	88.00	85.00	126.00	119.00	9.19	8.54	7.75	0.00
C waist	102.50	92.00	86.00	79.00	119.00	105.00	2.27	2.20	14.06	0.00
C hips supraspinal	111.81	105.4	97.00	93.00	135.00	125.00	10.23	9.86	9.56	0.00
C hips pubic bone	114.47	109.4	101.00	97.00	135.00	125.00	8.64	8.59	8.68	0.00
C thigh middle	61.36	57.75	49.00	48.00	71.00	68.00	5.73	5.69	10.14	0.00
C thigh gluteus	67.93	64.23	57.00	55.00	81.00	76.00	5.97	6.02	9.46	0.00
C calf	41.78	40.72	34.00	33.00	49.00	47.00	3.73	3.41	7.06	0.00

Data analysis methods

Formulae were used to calculate body mass index (WHO 2000; Bravničar, 1994). As a final value, values after calculations and values shown on the scale were averaged. SPSS 15 for Windows programme has been used to carry out statistical analysis of collected data. The following statistical methods were used: calculation of basic procedures of simple descriptive statistics of individual variables; t-test (t-paired) for examining differences between the initial and final status of morphological variables of measured subjects. Statistical significance has been tested on a level of 5% risk ($p=0.05$).

Results

The results revealed that in a three month period, body weight of measured subjects has been reduced in average by 7.8 kg, amounting to approximately 0.6 kg per week. The percentage of body fat has decreased; skin folds and circumferences have also decreased in individual body parts. Body mass index has decreased by 2.84 units. The percentage of fat mass has been reduced according to the scale measurements by 4.55% and on the basis of calculations by 4%. The average fat reduction (average of scale results and calculations) was 4%. In control group weight reduction was very small; in average they've lost 1,8kg and only 1% of body fat.

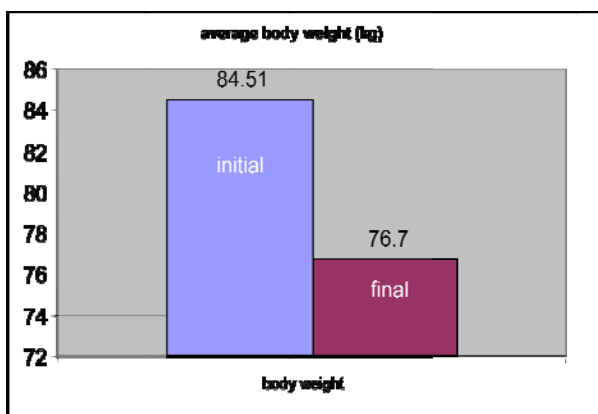


Figure 1: Changes in average body weight in exercise group

According to the calculations of fat mass, the average final percentage of fat tissue has fallen below 30 percents (29.54%). Muscle mass increased by 2%, the amount of water in body has increased by more than 3%; nevertheless, the optimal values according to Bravničar (1994) should be between 55 to 75% or according to some other studies (Tanita's internal research, 2006) between 45 to 60 % in women and 50 to 65 % in men. However, low values of water in body can be explained with correlation between the amount of fat and water in the body (Shea, 2007). Percentage of water in the body decreases in proportion with an increase of body fat or vice versa, the higher percentage of water in the body, the lower is percentage of body fat (Shea, 2007).

Measurements in the present study revealed that the percentage of fat is too high in comparison to optimal values both at initial (37.92) and final (33.37) measurements, and proportional to that is also low percentage of water with the highest value being 49.71%. All three measured skin folds of upper extremities – arms – have decreased in average by 6mm or 25.64%. Similarly, all four skin folds of torso have decreased as well in average by 5.98mm or 19.29%, amounting to approximately 0.5% per week. The largest decrease between initial and final status in the skin fold of torso has been revealed for back (by 8.09mm or 25.67%), followed by supriliacis by 5.62mm or 22.61%). Skin folds of lower extremities have in average decreased by 6.92mm or 18.61%, amounting to approximately 0.6mm per week throughout the entire three-month long weight loss programme. Circumferences of upper extremities – arms – have not decreased to such extent as skin folds; nevertheless, smaller values were recorded in all of them. Circumference of arms has in average decreased by 1.4cm. Circumference of waist has decreased the most, in average by 10.5cm. Similar result has been noticed in measuring circumference of hips supraspinal has decreased by 6.44cm and circumference of chest underneath the breasts, where the difference between initial and final status was 6.22cm. Circumference of torso has in average decreased by 5.72cm or 7.53%. In average, the circumference of lower extremities has decreased by 2.79cm or 4.62%.

Discussion

Researchers are showing positive reduction of weight when the subjects have both; influence of diet and endurance exercise programme on the other hand only dietary programme isn't enough for weight reduction (Del Coral, Chandler-Laney, Casazza, Gower, & Hunter, 2009). With the study and suitably planned exercising and diet programme, a healthy weight loss programme has been successfully carried out in the three-month period, as the measured subjects have in average lost not more than 0.6kg per week. Namely, higher weight loss would be a result of water and not fat decrease. According to the classification by WHO (1995; 2000; 2004) body mass index (BMI) value above 30.51 represents obesity of first degree and the value 27.67 indicates overweightness. Measured subjects should lose another 2.77 units – approximate decrease of their BMI in the studied period - to reach a category of normal body mass (between 18.5 and 24.9). Prescribed programmes of exercising and diet successfully reduced body fat contents to satisfactory level in the region of normal weight; although the higher values of body fat according to the scale measurements (31.94%) indicate that the programmes should be continued in order for subjects to reach values between 25 and 30%. By following the programme, muscle mass remained the same and has even increased a little, as the emphasis was more on burning of fats than on gaining muscle tissues. Time limitation also prevented muscle mass gaining.

The goal of the programme was mostly losing fat mass, indicated by lower skin fold values after final measurement. As the main emphasis throughout the entire exercising programme was strengthening of body stabilisers (muscles of back and stomach) with smaller loads (initially 30 – 40% of borderline weight, later 50-60% of borderline weight) and larger number of repetitions (Petrović, et al., 2005), the results were to be expected: less fat mass and consequently smaller skin folds of torso. The results revealed that all skin folds have been decreasing in a steady way throughout the entire 3-month weight loss programme. Initial values of skin folds of lower extremities were slightly higher in comparison to other skin folds, indicating that in legs there is more skin fat than in the other parts of the body. Nevertheless, the difference between initial and final skin fold values of lower extremities was similar to the results of skin folds of torso, which can be attributed to aerobic part of exercising (bicycle, treadmill). Circumferences did not decrease to the same extent as skin folds, which can be associated with the results of measured percentages of fat and muscle mass. Thus, the suitability of prescribed exercising and diet programmes as well as provided general recommendations on healthy dieting can be confirmed as in other studies (Donahoo, Levine, & Melanson, 2004; Elfhag, & Rosner, 2005; Esparza, Fox, Harper, Bennett, Schulz, Valencia, et al., 2000; Filozof, & Gonzales, 2000). The results of circumference of waist indicate that the majority of women suffered so-called android obesity (Montignac, 2005) with characteristic storing of fat reserves around the waist area. Although in the majority of measured subjects high values were present also at the end of programme, the changes

were good enough (reduction of waist circumference by 13% and body weight by 9%) to reduce the risk of cardio-vascular diseases, which experts attribute to this type of obesity (Lanbein, & Skalnik, 2007). The proportion between the circumference of waist and hips has been revealed as a significant factor, which influences mortality.

The lowest risk of mortality has represented a BMI 25.3 in men and 24.3 in women (Pischon, Boeing, Hoffmann, Bergmann, Schulze, Overvad, et al., 2008). In men, both too high as well as too low values of BMI represent a risk of higher mortality (Heitmann, Hills, Frederiksen, & Ward, 2009). In women, no significant correlation has been found between mortality and the percentage of fat mass or lean muscle mass. In women, physical activity has been proven to reduce mortality (Heitmann, et al., 2009).

Conclusion

In the opinion of the authors, only weight loss programmes, carried out professionally by health organisations or personal trainers, and including both dietary and exercising programmes in order to achieve desired goals, lead to permanent loss of excess body weight and change of lifestyle of individuals. Such programmes are usually less exposed to media, more expensive and less attractive, as they do not promise miraculous weight loss without denying and effort. Only expertly monitored dietary and exercising programmes can lead to long term success. A change of lifestyle and mentality, which includes both healthy eating and regular exercising, is required.

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ANALIZA EFEKATA TROMJESEČNOG PROGRAMA GUBITKA TEŽINE KOD PRETILIH ŽENA

Sažetak

Studija je ispitala učinke tri mjeseca dugog programa gubitka težine (koji se sastoji od aerobnih vježbi i vježbi snage te prehrane) na promjene u sastavu tijela kod dvadeset zdravih sredovječnih pretelih žena, dobi 38 do 55 (prosječno 45,8), koje su vodile sjedilački način života. Podaci su analizirani pomoću t-testa (t-sporenog) u vrhu usporedbe pojedinačnih varijabli prije i poslije programa gubitka težine. Trening se sastojao od 30 minuta ciklusa ergometrije sa 60-70% maksimalnog pulsa, 3 puta tjedno tijekom 3 mjeseca, praćeno vježbama snage za sve grupe mišića. Rezultati su pokazali smanjenje tjelesne mase (prosječno 8 kg – 0.6 kg po tjednu) i postotak masti (više od 4%). Tjelesni indeks mase se smanjio za gotovo 3 mjere. Veličine kožnih nabora su smanjene za otprilike 20% s najprimjetnijim smanjenjem obujma u području trupa (bokovi i struk). Program bi trebao biti nastavljen sve dok se vrijednost indeksa tjelesne mase ne spusti ispod 30 te stoga tjelesna težina na normalnu vrijednost.

Ključne riječi: gubitak težine, pretilost, tjelesna masa, prehrana, tjelovježba, žene

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