Biology of Sport, Vol. 20 N°1, 2003

INFLUENCE OF A MONITORED AEROBIC TRAINING AND A LOW-ENERGY DIET ON SERUM LEPTIN CONCENTRATION IN OBESE WOMEN

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Abstract. The study focused on the influence of a 9-week monitored energy deficit on serum leptin level in 16 obese women. Additionally, measurements of body components and total cholesterol (CHO), HDL cholesterol (HDL) and triacylglycerols (TRG) concentration in blood were carried out, concentration of LDL cholesterol (LDL) was evaluated. Energy deficit was induced by a diet and "fat burning" type exercises. Leptin concentration in blood serum was significantly higher before (41.7±16.5 ng/ml) than after the accomplishment of experiment (24.7±16.2 ng/ml). Body mass decreased, which was mainly due to a drop in body fat (from 36.6±13.9 kg to 29.0±12.5 kg). All changes have been statistically significant at the level of P<0.001. A significant decrease of CHO (from 187.9±26.3 mg/dl to 167.1±25.4 mg/dl; P<0.001) and LDL (from 115.5±25.1 mg/dl to 102.3±21.5 mg/dl; P<0.05) concentration in blood was noticed. However, changes in HDL and TRG concentration were statistically insignificant. There was a statistically significant correlation (P<0.05) recorded between changes in leptin concentration in blood and changes in body mass, BMI and body fat (0.51; 0.58; 0.64 respectively). No correlation was observed between leptin and lean body mass, CHO, HDL, LDL or TRG.

(Biol.Sport 20:33-41, 2003)

Key words: Leptin – Diet - Physical activity - lipid profile

Introduction

Since 1994, when the obesity gene *ob* was discovered [1], numerous research studies have been carried out on its product – leptin. Studies done on mice have

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shown that it plays an important regulating role for the body energy resources and can have impact on obesity (low concentration) or lack of obesity (high concentration) [2,3,4]. This discovery gave hope for developing an effective drug that could fight obesity. However, the research carried out on people proved that the functions of leptin were much more complicated and not as obvious as in the case of mice. Obese people have a higher leptin concentration than those with a normal body mass, and a drop in body mass results in a decrease in leptin level [5,6]. So, in people, this hormone is likely to mark the body energy resources, and its high level, giving evidence of substantial energy resources, reduces the appetite [7].

In animals, the function of leptin, which manifests itself in obesity, can be handicapped by mutations of the *ob* gene or mutations in genes coding leptin-specific receptors. They are present in neurone membranes of the brain, mainly in the hypothalamus area. However, such mutations occur very rarely in people [8]. Therefore, the observations of decreased leptin concentration occurring as a result of different stimuli, such as a profound energy deficit (e.g. a diet [12]) can be quite interesting.

Indeed, a higher concentration of leptin has been noticed in women compared with men, regardless the amount of adipose tissue. The major cause of this seems to be the different distribution of adipose tissue and functions of sex hormones (especially testosterone) [9,10,11].

The aim of the study was to evaluate leptin concentration in blood serum in obese people, where the energy deficit leading to reduction of body mass was induced by physical exercise and a low-energy diet.

Material and Methods

The research was carried out in a fitness club in Warsaw. Sixteen women with overweight or obesity were selected to the research. Having undergone a sprint test on a cycle ergometer, candidates went through final qualifications done by a doctor. All participants were informed about objective and methods of the research, they provided their consent and signed a statement acknowledging a voluntary character of their participation in experiment. The characteristics of examined subjects have been included in Table 1.

Women were regularly participating in recreational training and they had to apply a low-energy diet. The experiment lasted 9 weeks.

The ”fat-burning”- type of recreational training was organised 3 times a week. Each single exercise unit lasted 60 min. The exercise intensity was monitored by the heart systole frequency of the examined and was being maintained within pulse rate range of 120-160 strokes per min (an ongoing control by a sport tester).

Table 1
Anthropological data of the examined women at the beginning of the experiment (mean values, standard deviation)

Age (years)	Height (cm)	Body mass (kg)	BMI
45.3 ±8.0	165.7 ±5.8	86.1 ±13.7	31.2 ±3.8

During the experiment and in the course of the participation in the recreational training, the examined women were reducing the amount of calories strictly according to a specific schedule (Fig. 1).

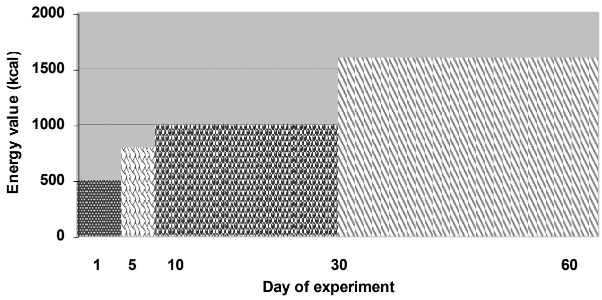

Fig. 1
Calories limitation schedule applied throughout the experiment

During the first 5 days a juice diet was applied (energy value ca. 500- 600 kcal) that finished off with a regenerating diet with gradually increasing calorie content (Fig. 1). The diet recommended for days 1-5 is a low-energy-type diet and is defined as VLED (very low energy diet). Its caloric value does not exceed 600 kcal, which constitutes approximately 25% of the daily energy requirement of women in this age group. The food consumed during the first 5 days consists only of vegetable and fruit juices prepared from fresh products and in the amount of 1-1.5 l per day. It is allowed to drink weak herbal beverages, tea and any amount of non-sparkling mineral water. The juice diet is a restrictive method of nutrition. Highly low-protein, low-carbohydrate and almost fat-free, it leads to a profound negative energy balance combined with a concurrent enrichment of the body with a substantial amount of vitamins and mineral salts. At the same time, the diet, which was recommended during the experiment, is rich in nutritive fibres that prevent the transport of triacylglycerols and cholesterol to the blood.

After 5 days of this restrictive diet, traditional nutrition was introduced. Between day 6 and 15, a revitalising diet was applied, which (compared with VLED) is richer in carbohydrates and initially has a vegetarian character (vegetable soups, bread); in subsequent days the diet is enriched with protein products (eggs, low-fat cheese, meat) and, later, with fat-containing products upon recommendation to limit animal fat. The energy value of this diet is between 800 and 1100 kcal.

In the second month of the experiment, a diet of 1000-1200 kcal was recommended along with a request to write down all products that were eaten additionally. Every examined woman was given detailed diet instructions set according to the calorie tables with appropriate nutrients' proportions. Based on the detailed menus both recommended and received from the examined it was calculated that the energy supply in the second month of the experiment amounted to 1200-1600 kcal.

Before (test I) and after (test II) two-month experiment body contents, leptin, total cholesterol, HDL cholesterol and triacylglycerols concentration in blood serum were measured and LDL cholesterol concentration was evaluated. Blood samples were taken from all subjects after an overnight fast. In order to accomplish the research objectives, following research methods were applied:

Determining serum leptin concentration: Leptin concentration was determined through immunoenzymatic method using the BIO-VENDER set (Czech Republic).

Measuring serum lipid compounds concentration (lipid profile): The concentration of total cholesterol, HDL cholesterol and triacylglycerols was measured by means of enzymatic methods using biochemical analyser ARCO PC (Italy). The concentration of LDL cholesterol was evaluated based on Friedewald formulas.

Measuring body components using the bioelectrical impedance analysis method (BIA): In the experiment a computer set equipped in the analyser BIA - RJL System NC and the Weight Manager 2a software was used. The measurements were carried out with the person lying on the back with arms stretched alongside the body. Two electrodes recording electrical resistance of particular tissues were attached on the back of the hand, half the length of the third metacarpal bone and two electrodes - on the back of the foot, half the length of the second and third metatarsal bone. Having measured the resistance and reactance, the lean body mass (LBM), body fat (FAT) and water level were examined. The experiment was twice on each subject. For the final analysis mean values were taken from the two measurements.

The statistical analysis was done using the t-test for dependent trials with help of the STATISTICA® (StatSoft) programme. The tests were approved by the Ethical Committee of Academy of Physical Education.

Results

Table 2
Changes in body mass, BMI, body fat and lean body mass and leptin concentration before and after 9 weeks of the experiment

	Test I		Test II		
	Mean	Std dev.	Mean	Std dev.	P
Body mass (kg)	86.1	13.7	77.4	11.9	<0.001
BMI (kg/m^2)	31.2	3.8	28.1	2.9	<0.001
Body fat (kg)	36.6	13.9	29.0	12.5	<0.001
Lean body mass (kg)	52.7	5.2	50.6	5.6	si
Leptin concentration (ng/ml)	41.7	16.5	24.7	16.2	<0.001

Serum leptin concentration was significantly higher before (41.7 ± 16.5 ng/ml) than after the experiment (24.7±16.2 ng/ml). Body mass decreased mainly due to a drop in body fat (from 36.6±13.9 kg to 29.0±12.5 kg). All the changes were statistically significant at P<0.001. The analysis of lean body mass (LMB) level showed lack of any significant changes during observation (Table 2). Significant drop in total cholesterol and LDL cholesterol concentration in blood was recorded, whereas, in the case of HDL cholesterol and triacylglycerols concentration, we can only speak about statistically insignificant downward trend (Table 3).

Statistical analysis has shown a significant correlation (P<0.05) between changes in leptin concentration and changes in body mass, BMI and body fat (0.51; 0.58; 0.64 respectively). No correlation was observed between leptin and LBM, CHO, HDL, LDL or TRG.

Table 3
Changes in lipid profile before and after 9 weeks of the experiment

	Test I		Test II		
	Mean	Std dev.	Mean	Std dev.	P
Total cholesterol (mg/dl)	187.9	26.3	167.1	25.4	<0.001
LDL cholesterol (mg/dl)	115.5	25.1	102.3	21.5	<0.05
HDL cholesterol (mg/dl)	52.3	10.9	47.3	10.5	si
Triacylglycerols (mg/dl)	100.8	41.3	86.9	26.5	si

The largest changes in percentage terms related to leptin concentration and body fat, whereas, the smallest ones related to lean body mass (Fig. 2).

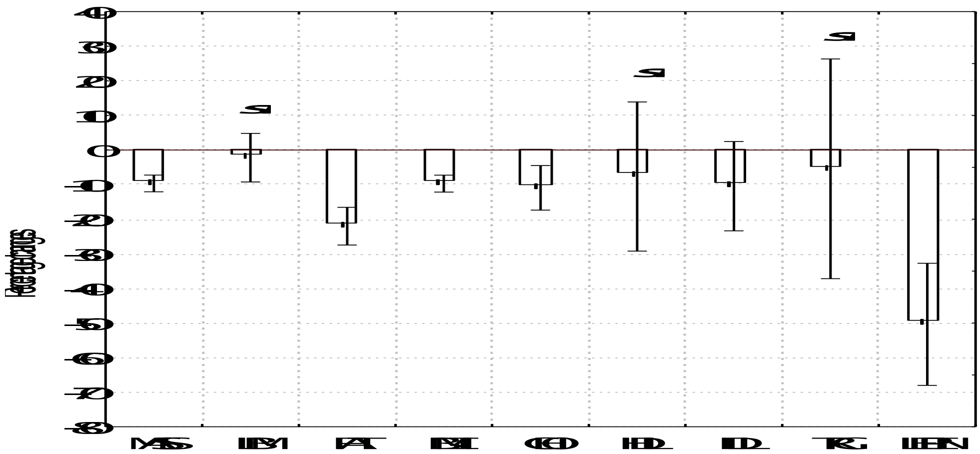

Fig. 2

Diagram showing percentage changes in body mass, lean body mass (LBM) and body fat (FAT), BMI as well as concentration of total cholesterol (CHO), HDL cholesterol (HDL), LDL cholesterol (LDL), triacylglycerols (TRG) and leptin; si – statistically insignificant changes

Discussion

No unequivocal impact of physical activity on serum leptin concentration was recorded. Thong and *et al.* [12] describe the lack of any changes in leptin concentration in obese men keeping their body mass at a constant level over a 12-week research period. Similar observations were recorded by Kraemer [13] with respect to obese women undergoing a 9-week training. However, Pasman [18] noticed that a one-year training resulted in decrease of leptin concentration and increase in aerobic power, yet regardless body mass. In young, both girls and boys, no relationship was noticed between physical activity, measured by VO_2max value, and leptin concentration [15].

However, there is a much stronger relationship of body mass and BMI changes with leptin concentration. A clear positive correlation can be noticed for men and women [6,12,17].

In our research we have acknowledged that there is a relationship between BMI and leptin concentration. What has also become clear, and at the same time has proved to be in line with the literature data, is a correlation showing that in individuals with a higher body fat level and a higher BMI index, a higher leptin concentration is recorded [5,19,20,21].

The most substantial changes noticed during the research concerned body fat and serum leptin concentration, and there was a strong correlation between their decreasing trends. No changes in lean body mass and only small changes in lipid profile can provide evidence for the dominating role of adipose tissue in regulating leptin concentration.

The decreasing leptin concentration, taking place during energy deficit, is accompanied by an increased feeling of hunger [22], which can be responsible for the “yo-yo effect” recorded in people on a diet. It could be likely that maintaining a relatively balanced leptin concentration would prevent that effect. In the event of a profound energy deficit (physical activity and low-energy diet) it may be that leptin gives the first alarming signal to the body contains a message (e.g. to appetite centre) about the energy resources going down at that particular time.

Summing up the results of research, it can be stated that a profound energy deficit (lack of food energy combined with physical activity aiming at burning fat tissue) is a strong stimulus for monitoring changes in leptin levels. Meanwhile, with a relatively stable lean body mass maintained, changes in lipid profile reflect the lipolysis process. Further observations are necessary in order to explain factors that are directly influencing leptin level.

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Accepted for publication 17.09.2002

Study financed by: Institute of Sport, Warsaw - D.3.6 and Academy of Physical Education, Warsaw - III.90