ORIGINAL ARTICLE

IMPROVEMENT OF CARDIAC FUNCTION AFTER WEIGHT LOSS PROGRAM AMONG YOUNG WOMEN

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ABSTRACT
The aim: To determine the difference between body composition and hemodynamics indices at baseline and after the weight loss program.
Materials and methods: The subject of this study was 13 young women. The weight and body composition were measured by the bio-impedance method. Hemodynamics indices were measured by the method of the thoracic rheography. The measurement of body composition and indices of hemodynamics were performed at the beginning of the weight loss program and 2 months later. The participants underwent 45 minutes per day of moderate-intensity physical activity 3 times a week.
Results: The percentage of body fat decreased in 3.9±0.37% from baseline (p=0.01) and the level of visceral fat - 1.54±0.14 units (p=0.001) respectively. Indices of hemodynamics were improved after the weight loss program. Firstly, the index of cardiac output was reduced in 1.43±1.09 l/min (p=0.019) after 2 months of the weight loss program. Secondly, the indices of peripheral resistance also have been improved. Moreover, the index of workload of left ventricle has decreased from 3.56 to 2.7 kg/m/m2 (p=0.035).
Conclusions: Our results demonstrated the improvement of indices of hemodynamics due to the normalization of body composition among young women after weight loss program.

KEY WORDS: body composition; weight loss; central hemodynamics

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INTRODUCTION
Obesity continues to be a worldwide problem, which increases tremendously at the current time. Nowadays, obesity is not the only dilemma among adults, but the youth generation is also suffering from it. Ten percent of school-aged children around the world are being overweight [1]. According to the WHO data in 2016, 39% of women and 39% of men aged 18 and over were overweight [2]. In particular, obesity is associated with diabetes mellitus, cardiovascular diseases, certain forms of cancer, sleep apnea, and other breathing disorders, etc. Obesity is defined by a body-mass index of 30 kg/m^2 or greater, but it does not take into account the level of skeletal muscle and adipose tissue distribution [3]. Previous researches showed that people with different levels of skeletal muscle and intra-abdominal fat could have similar BMI, but different metabolic effects on health [4]. For instance, visceral fat has a positive correlation with the metabolic abnormalities in comparison with fat in a lower part of the body, which has a negative connection with the metabolic disturbance. That is why, people with normal weight, but with central obesity have the same high risk of cardiovascular diseases as people with obesity or overweight with central obesity [5]. Moreover, central obesity could trigger the pathophysiological mechanism of insulin resistance. As a result, the young adult will be at a high risk to suffer from diabetes mellitus [6]. A lot of evidence suggests that physical activity could reduce the deteriorating influence of visceral fat on the human body. Skeletal muscles due to the physical activity, produce myokines that have anti-inflammatory effects on the cardiovascular system. For example, interleukin -6 (IL-6), which is increased after physical activity, is responsible for increasing glucose uptake and fat oxidation in muscles. Moreover, it increases glucose production during exercise in the liver and, enhances lipolysis in the adipose tissue [7].

The intercorrelation of muscle and adipose tissue in the human body could play an important role in its physical and functional condition.

THE AIM
Firstly, the aim of our study was to determine the body weight and its composition at the baseline and after a 2-month weight loss program. Secondly, to determine the values of hemodynamics indices at the baseline and after a 2-month of weight loss program. Thirdly, to find the connection between the indices of body composition and hemodynamics ones.

MATERIALS AND METHODS
The subject of this study was 13 young women with age from 18 to 25, who studies on the medical faculty #2 of Uzhhorod national university. The participants did not have any acute and chronic diseases. Firstly, they were informed consent about the further procedures of the study. We followed all rules of the WMA Declaration of Helsinki in the research project.

The weight, body mass index (BMI, kg/m^2), the percentage of body fat (BF, %), the percentage of fat-free mass (FFM, %), and the index of visceral fat (VF, un.) were measured by bio-impedance analysis with using body-analizator Tanita BC-601.

Mean arterial pressure (MAP, mmHg), stroke volume (SV, ml/beat), stroke volume index (SVI, ml/m^2/beat) cardiac output (CO, l/min), cardiac index (CI, l/min/m^2), systemic vascular resistance (SVR, dynes-sec/cm^{-5}), systemic vascular resistance index (SVRI, dynes-sec/cm^{-5}/m^2), the workload of the left ventricle (WLV, kg/m), the workload of the left ventricle index (WLVI, kg/m/m^2) were measured by the method of thoracic rheography. 'REOKOM' is the medical device, which we used for the measurement of hemodynamics indices.

The measurement of thoracic rheography requires 2 tape electrodes (one coil). One coil of potential electrodes should be placed around the neck, closer to the clavicle. Another one should be placed on the lower part of the chest, below the xiphoid process. The current electrodes should be placed around the head at the level of the forehead and above the left ankle joint. Since the rheograph is completed with double tape electrodes (coils), then in each of the four used in this case the coils will be involved only one tape [8]. Current cables of the remote unit of the RVG.1 rheograph (white marking) are connected to any of the tapes of the coil installed above the left ankle joint and to any of the tapes of the coil placed on the patient's head. Potential cables RVG.1.1 of the remote unit RVG.1 of the rheograph (red marking) are connected to the lower tape of the coil installed on the neck of the patient and to the upper tape of the coil installed on the patient's chest. The potential cables RVG.1.2 (green marking) are connected to one of the used potential electrodes using a special splitter, together with the corresponding potential cable of the first channel.

The measurement of body composition and indices of hemodynamics were performed at the beginning of the weight loss program and 2 months later. The participants underwent 45 minutes per day of moderate-intensity physical activity 3 times a week. They followed the individualized dietary strategy, which suggested a caloric deficit of 500 kcal/day.

Data were analyzed with a t-t for dependent samples and the multiple linear regression method. All statistical analyses were performed using the program Minitab.

RESULTS

Firstly, were performed the multiple linear regression to find the connection between BMI and the indices of body composition (table I).

Multiple linear regression was calculated to identify the connection between the dependent variable BMI and independent predictors BF, VF, FFM. Our regression model was statistically significant (p=0.001), the predicted R^2 for this model was 13.96%. The statistically significant connection BMI had only with VF (p=0.035). The coefficient of the visceral fat told us that increasing of visceral fat in 1 unit could lead to the increasing of BMI in 1.38 kg/m^2 (table II).

Regression Equation:

$$BMI = 20 + 0.16\ BF + 1.385\ VF - 0.10\ FFM$$

Our data showed that the average weight among participants was 79.38±12.04 kg and BMI=29.25±3.66 kg/m^2, which was identified as overweight. The body weight and body composition changes were evaluated after 2 months of weight loss program and are presented in table III. To investigate this statistically, we calculated the difference by t-test dependent samples.

Participants lost a mean of 5.49±2.02 kg (p=0.008). Furthermore, the percentage of BF decreased by 3.9±0.37% from baseline (p=0.01) and the level of VF 1.54±0.14 units (p=0.001) respectively. The data reveal significant enhancement in FFM – 4.88±0.32% (p=0.001). Also, we observed changes for hemodynamics indices after the weight loss program (table VI).

DISCUSSION

It is well known that there is a sex difference according to fat distribution. In comparison to men women have a higher percentage of body fat, which mainly deposit in the subcutaneous area. That is why the fat, which is accumulated in the gluteal-femoral area has a positive influence as in the metabolic processes as in the cardiovascular system [9]. According to our data women had increased level of visceral fat. We could predict that this happened due to the low physical activity and junk food consumption. The loss weight program helps to reduce the level of visceral adipose tissue in 1.54±0.14 units.

Our data also address that indices of hemodynamics were prone to improvement in participants. Firstly, we received the reduction of WLV in 1.65±0.27 kg/m (p=0,024) after 2 months of the weight loss program. Secondly, the CI as the CO significantly decreased in 1.29±0.56 l/min/m^2 and in 1,43±1,09 l/min respectively (p=0,031; p=0,019). Thirdly, the indices of SVR and SVRI increased significantly after the weight loss program. SVR increased in 424±36 dynes-sec/cm^{-5} and SVRI increased in 630±146 dynes-sec/cm^{-5}/m^2. These results go beyond previous reports, showing that the weight loss program, which includes aerobic exercises and dietary intervention, produced clinically important and significant improvement of body composition and hemodynamic indices [10,11].

Increased BMI, which is related to overweight or obesity (OW/OB), is associated with hemodynamic overload. As a result, people with OW/OB are likely to have higher CO, due to enlarged stroke volume and an increase of heart rate [12]. According to our data, while participant lost their weight the index of CO reduced. Firstly, our results support the previous findings that weight and adipose tissue reduction may provide with the improvement of the left ventricular function by decreasing the volume of overload and CO [13]. Secondly, we could predict that LV geometry and its workload have a connection with hemodynamic

Table I. Regression Summary for dependent variable BMI

Model Summary S R-sq R-sq(adj) R-sq(pred) 1.86059 80.59% 74.12% 13.96%					
Source	**DF**	**Adj SS**	**Adj MS**	**F-Value**	**P-Value**
Regression	3	129.376	43.1254	12.46	0.001
BF, %	1	0.061	0.0612	0.02	0.897
VF, un.	1	21.183	21.1834	6.12	0.035
FFM, %	1	0.023	0.0229	0.01	0.937
Error	9	31.156	3.4618		
Total	12	160.532			

Table II. Results of multiple linear regression according to the coefficients

Coefficients					
Term	**Coef**	**SE Coef**	**T-Val ue**	**P-Value**	**VIF**
Constant	20	118	0.17	0.870	
BF, %	0.16	1.19	0.13	0.897	101.61
VF, un.	1.385	0.560	2,47	0.035	2.93
FF, %	-0.10	1.25	-0.08	0.937	101.37

Table III. Comparison of indices of body composition after the weight loss program

Body composition	baseline	after 2 month	p-value
Weight, kg	79.38±12.04	73.89±10.02	0.008
BMI, kg/m^2	29.25±3.66	27.6±3.11	0.001
BF, %	37.95±4.57	34.05±4.2	0.01
FFM, %	58.78±4.32	63.66±4	0.001
VF, units	6.77±1.64	5.23±1.78	0.001

Table VI. Comparison of hemodynamics indices after the weight loss program

Indices of hemodynamics	baseline	After 2 months	p-value
MAP, mm Hg	91.67±7.11	92.2±4.33	0.746
SVI, ml/m^2/beat	44.84±14.90	40.22±15.19	0.441
CO, l/min	5.32±1.96	3.89±0.87	0.019
CI, l/min/m^2	3.00±0.97	2.29±0.41	0.031
SVR, dynes-sec/cm^{-5}	1388±418	1812±382	0.011
SVRI, dynes-sec/cm^{-5}/m^2	2415+697	3045+551	0.028
WLV, kg/m	6.31±2.59	4.66±2.32	0.024
WLVI, kg/m/m^2	3.56±1.3	2.70±0.56	0.035

components due to the Frank-Startling law and non-hemodynamic components (body composition). That is why increasing of CO and disproportional increment of body size due to the adipose tissue could lead to augmentation of the index of WLV [14].

In our findings, we observed that OW participants were likely to have lower SVR in the presence of increased CO. To some extent, this scenario has a temporary adaptive mechanism for the prevention of an increase of blood pressure, but mainly it is insufficient [15]. Other studies showed a similar association between these hemodynamics indices [16]. There is a reason to suspect, that increased level of visceral fat and subcutaneous fat in the trunk decreases artery compliance [17]. Increased CO due to the augmented blood flow leads to the rising of preload. At the same time, the overproduction of adipocytokines by visceral fat reduces NO-mediated vasodilatation, which leads to an increase in blood pressure and afterload.

After the weight loss program, SVR increased, whereas CO reduced. We could hypothesize that reducing CO, respectively, leads to the increasing in SVR. To our mind, such changes in SVR talk about the improvement of the vasomotor activity after the weight loss program. We have not received a statistically significant difference according to the index MAP (p=0.746). That is why, during the whole period of the weight loss program, women had constant MAP. The MAP was based on the increased level of CO and decreased level of SVR before the weight loss program. The same level of the MAP mainly was based on the CO, which has decreased, and the SVR, which has increased after the weight loss program. We could suppose, that the reduction of the visceral fat during the weight loss program has prevented the irreversible changes of the SVR, and has improved the vasomotor activity of the vessels.

The % of FFM mostly describes the physical person's activity. After 2-months of the weight loss program, the % FFM has been improved. The skeletal muscle pump facilitated the venous return and as a result, the myocardium requires less force for contraction [18]. Exercise training changes the geometry of the heart and improves the pump capacity of the heart [19]. Adaptive remodeling of the heart typically occurs with the preservation of the contractility function of the heart through the oxidative energy production and by omitting fat acid oxidation [20]. Steam from this, the index of WLV decreased significantly from 3.56±1.3 to 2.70±0.56 kg/m/m^2, so we could predict that the power of contraction of LV will be more economical.

CONCLUSIONS

1. According to the results of the multiple linear regression, the reduction of the visceral fat will influence on the reduction of the BMI.
2. According to our data, body composition has been improved after the weight loss program. The visceral fat has reduced in 1.54±0.14 units and FFM has increased in 4.88±0.32 %.
3. The CO has decreased in 1,43±1,09 l/min and SVR has increased in 424±36 dynes-sec/cm^5, which together have optimized the functional condition of the cardiovascular system.

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Conflict of interest:

The Authors declare no conflict of interest.

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