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Original Article

Effects of High Intensity Training on Body Composition in Recreationally Active Women

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Abstract

The aim of the study was to determine the effects of high intensity training on body composition in recreationally active women. The sample included 27 recreationally active women, experimental group (n = 13; age: 34.6 ± 1.7) and control group (n = 14; age: 34.2 ± 1.9). Nine parameters were measured: body weight, body height, body mass index, adipose tissue in%, adipose tissue in kg, muscle tissue in%, muscle tissue in kg, lean body mass in%, lean body mass in kg. Statistically significant effects on the final measurement were determined in the following tests: body weight in kg, body mass index, adipose tissue in%, adipose tissue in kg, muscle tissue in%, lean body mass in% and lean body mass in kg, at the level of statistical significance $p<0.05$. The results confirmed that intensive training of high intensity ≥80%-90% HR_{max}, was effective and lead to statistically significant changes in body composition.

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1. Introduction

Body composition is a fitness component that is closely related to the relative values of muscle, fat, water, bone as well as other vital parts of the human body (Andreoli, Garaci, Cafarelli, & Guglielmi, 2016). Body composition is represented by fitness components that are focused on three specific indicators: body mass index, sum of 5 points of subcutaneous adipose tissue and waist circumference (Campa, Toselli, Mazzilli, Gobbo, & Coratella, 2021). Changes in the structure of body composition that result in obesity are considered to be one of the most significant public health problems of modern times, and according to the assessment and frequency, this problem is the second leading cause of mortality (Lee et al., 2023). In order to achieve the maximum positive impact through exercise, it is important to know the basal consumption, energy consumption through training or physical activities, health condition and abilities of a person (Schilling, Schmidt, Fiedler, & Woll, 2023). Also, it should be mentioned that the success in maintaining the correct body composition largely depends on the correct diet.

The importance of regular physical exercise in the function of preserving and improving health has been confirmed in many studies (Perry, Heigenhauser, Bonen, & Spriet, 2008; Whyte, Gill, & Cathcart, 2010; Liu et al., 2017; Bjelica, Milanović, Aksović, Zelenović, & Božić, 2020; Andrade, 2023; Qiu et al., 2023; Bódis et al., 2024), because the modern way of life and work is such that technological development has forced man to focus less on physical activities (Bjelica et al, 2022). Due to the very nature of high intensity exercise and its impact on fitness components, its effectiveness on body composition has been determined (Sultana, Sabag, Keating, & Johnson, 2019).

Perry et al. (2008) showed that body fat oxidation or fat burning, as well as carbohydrate oxidation, is higher after 6-week interval training compared to a continuous training. Whyte et al. (2010) have confirmed that a high-intensity training program leads to an increase in both aerobic and anaerobic fitness parameters. Also, a high intensity training program in inactive recreational athletes leads to an improvement in aerobic endurance more than continuous sub-maximum load training (Laursen, & Jenkins, 2002).

In addition, high intensity training achieves better results than continuous running when it comes to reducing body composition and body fat in both men and women, despite the fact that much lower overall energy expenditure in this type of training (Trapp, Chisholm, Freund, & Boutcher, 2008).

Recent studies have shown that cardiovascular adaptations that occur during high intensity training are similar, and in some cases even better, than continuous aerobic training (Wisløff, Ellingsen, & Kemi, 2009; Hussain, Macaluso, & Pearson, 2016).

The aim of the study was to determine the effects of high intensity training on the body composition in recreationally active women. Therefore, it is expected that there are high intensity training will be effective, and lead to changes in the body composition of recreationally active women.

2. Material and methods

Participants

The sample included 27 recreationally active women, divided into two groups, experimental and control. The experimental group consisted of 13 women (age: 34.6 ± 1.7; BH = 165.8 ± 4.1 cm; BW = 57.6 ± 2.3 kg; BMI = 20.4 ± 1.4 kg/m^2). The control group consisted of 14 women (age: 34.2 ± 1.9; BH = 164.2 ± 3.8 cm; BW = 59.1 ± 5.5 kg; BMI = 21.8 ± 2.6 kg/m^2).

All subjects were healthy, without any chronic diseases, without injuries to the locomotor system that would affect the test results. During the experiment, they did not participate in any other physical activity, and it was advised to continue with daily life activities and a normal diet.

Both groups voluntarily agreed to participate in the research.

Sample of variables

Nine parameters were measured, two tests to assess anthropometric characteristics: body weight (BW) and body height (BH), and seven parameters to assess body composition: body mass index (BMI), adipose tissue in % (BF%), adipose tissue in kg (BFKG), muscle tissue in % (MM%), muscle tissue in kg (MMKG), lean body mass in % (LBM%), lean body mass in kg (LBMKG). Out of a total of nine parameters, eight were included in further analysis and statistical data processing because body height was not expected to change statistically significantly in the subjects over a 12-week period.

Body composition was measured with a Tanita BC-418 digital scale (Tanitatm BC 418 MA Segmental Body Composition Analyzer, Tanita Corp., Tokyo, Japan). Body height was measured with an accuracy of 0.1 cm using a portable SECA Stadiometer 282 (SECA GmBH, & Co, Hamburg, Germany).

Procedures

The experimental group conducted high intensity training, three times a week for 12 weeks, in the form of walking and running on a treadmill, riding a static bicycle, depending on the degree of physical fitness so as to meet the set load targets of ≥80%-90% HR_{max}. Heart rate control was performed with Polar pulse meters (Polar Electro, Kempele, Finland). Each training lasted 60 minutes.

The structure of the training in the experimental group was three part, so that the main part was preceded by a 10-minute warm-up, and the main activity was followed by a 10-minute cooling of the body and returning the cardiovascular system to its initial level. The designed training program was in line with ACSM recommendations (Stine et al., 2023).

The control group did not have any kind of organized exercise, she has already resumed her usual daily activities. A detailed description of the experimental group exercise program is shown in Table 1.

Table 1. *The exercise program of the high intensity training in experimental group*

Training	Activity	Duration
Introductory part preparatory	1) Light jogging 2) Dynamic stretching 3) Progressive running	4 min 4 min 2 min
Main part	Running, walking or driving static bicycle, interval character, 4x8 minutes with a break of 2 minutes in between each exercise interval	40 min
Final part	1) Light jogging 2) Static stretching	5 min 5 min

Statistical analysis

Data processing used basic descriptive parameters: range (Range), minimum value (Min), maximum value (Max), arithmetic mean (Mean), standard deviation (SD). The significance of the differences between the mean values of the initial and final measurements of the experimental and control groups was determined using a t-test (paired samples test). The effects on the final measurement were determined using the analysis of covariance (MANCOVA/ANCOVA). The data obtained by the previously described procedure was processed with the SPSS 20 statistics program (v20.0, SPSS Inc., Chicago, IL, USA).

3. Results and Discussions

The results of the descriptive analysis and differences between initial and final measurements of experimental and control groups are presented in Table 2.

The results of measurements after the realized experiment, for the examinees of the experimental group with parameters indicate statistically significant differences in all parameters in relation to the initial measurement at the level $p<0.05$ (Table 2). Body weight (BW) decreased by 2.9 kg (57.60 kg-54.70 kg), body mass index (BMI) by 1.05 (20.95-19.90), adipose tissue (BF%) by 1.26% (26.78%-25.52%), fat tissue (BFKG) by 1.46 kg (15.47 kg-14.01 kg), muscle tissue (MMKG) by 0.71 kg (20.68 kg-19.97 kg), lean body mass (LBMKG) by 1.44 kg (42.12 kg-40.68 kg), while muscle tissue (MM%) increased by 0.62% (35.96%-36.58%) and lean body mass (LBM%) by 1.27% (73.21%-74.48%).

In the control group that did not have any type of organized exercise, after 12 weeks, there were changes in four of the eight parameters compared to the initial measurement at the level of $p<0.05$. Muscle tissue (MM%) decreased by 2.57% (33.77%-31.20%), muscle tissue (MMKG) by 1.3 kg (18.58 kg-17.28 kg), while adipose tissue (BF%) increased by 0.42% (19.95%-20.37%) and adipose tissue (BFKG) by 0.32 kg (9.69 kg-10.01 kg). Body mass index (BMI) and lean body mass (LBMKG, LBM%) decreased, but the values were not at a significant level.

Table 2. *Descriptive analysis and differences between initial and final measurements of experimental and control groups*

Variables	Group	Range	Min	Max	Mean	SD	t	p
BW	**EXP**	14	51	65	57.6	4.4	6.32	**.000**
	CON	21	47	68	59.1	5.3	.000	1.00
BMI	**EXP**	3.9	19.2	23.1	20.4	1.3	6.40	**.000**
	CON	5.3	19.1	24.4	21.8	1.9	4.82	.639
BF%	**EXP**	7	24.3	31.3	25.6	2.1	6.42	**.000**
	CON	6	16.2	22.2	20.1	1.8	-2.75	**.003**
BFKG	**EXP**	5.8	12.4	18.2	14.7	2.1	6.45	**.000**
	CON	6	5.8	11.8	9.85	1.6	-2.70	**.005**
MM%	**EXP**	3.9	33.3	37.2	36.2	1.2	-5.72	**.000**
	CON	11.6	28.2	39.8	32.4	3.2	9.63	**.000**
MMKG	**EXP**	3.8	19.0	22.8	20.3	1.3	6.35	**.000**
	CON	8.2	15.3	23.5	17.8	2.3	7.23	**.000**
LBM%	**EXP**	7.03	68.6	75.7	73.6	2.1	-6.42	**.000**
	CON	6.7	77.1	83.8	79.8	1.8	2.75	.117
LBMKG	**EXP**	8.3	38.6	46.9	41.5	2.7	6.05	**.000**
	CON	23.6	35.2	58.8	49.3	5.9	.604	.557

Legend: Range - range, Min - minimum value, Max - maximum value, Mean - arithmetic mean, SD - standard deviation, EXP - experimental group; CON - control group; t - coefficients of t-test; p - significance of t-test.

Table 3. *Multivariate analysis of covariance*

Wilks Lambda	F	p
0.68	3.96	**.000**

The values of the subjects of the experimental group on the initial measurement (Table 3) show that most variables have statistically different values from the subjects of the control group, and therefore the differences on the final measurement after the applied experimental treatment were determined by covariance analysis (MANCOVA/ANCOVA).

At the final measurement, statistically significant differences were obtained between groups at the multivariate level (Wilks Lambda = 0.68, F = 3.96, $p<0.05$).

Table 4. *Univariate analysis of covariance*

Variables	Adj. Mean	F	p
BW	**EXP** 55.5 **CON** 58.5	19.17	**.000**
BMI	**EXP** 20.4 **CON** 21.4	107.96	**.000**
BF%	**EXP** 21.6 **CON** 23.3	9.57	.**005**
BFKG	**EXP** 11.1 **CON** 12.2	6.97	**.003**
MM%	**EXP** 35.3 **CON** 32.1	81.64	**.000**
MMKG	**EXP** 18.8 **CON** 18.3	1.72	.095
LBM%	**EXP** 78.3 **CON** 76.6	9.57	**.005**
LBMKG	**EXP** 44.3 **CON** 46.3	9.23	**.002**

Legend: Adj. Mean - corrected mean values at the final measure from which the influence of covariates is statistically removed, F - the value of F-test to test the significance of differences of arithmetic means, p - coefficient of significance of differences of arithmetic means.

Statistically significant differences at the univariate level, between the experimental and control groups at the final measurement were found in the following tests (Table 4): body weight in kg (BW), body mass index (BMI), adipose tissue in% (BF%), adipose tissue in kg (BFKG), muscle tissue in% (MM%), lean body mass in% (LBM%) and lean body mass in kg (LBMKG), at the level of statistical significance $p<0.05$.

Based on the revised mean values Adj. Mean (from which the influence of covariates was statistically removed), the experimental group has higher values in the tests (LBM% 78.3-73.6) and (LBMKG 44.3-41.5) and lower values in (BW 55.5-57.6), (BF% 21.6-25.6), (BFKG 11.1-14.7), (MM% 35.3-36.2) and (MMKG 18.8-20.3), while the BMI values are the same (BMI 20.4-20.4). The control group has higher values intests (BF% 23.3-20.1), (BFKG 12.2-9.85), (MMKG 18.3-17.8), and lower values in (BW 58.5-59.1), (BMI 21.4-21.8), (MM% 32.1-32.4), (LBM% 76.6-79.8), and (LBMKG 46.3-49.3).

Discussions

The main purpose of this study was to determine the effects of high intensity training on the body composition in recreationally active women. After 12 weeks, there were changes in body composition in both groups. In the control group, there were changes in four of the eight parameters compared to the initial measurement.

Taking into account the fact that the control group participants did not participate in any organized form of physical activity, it is clear that no significant changes were expected. However, in some parameters there were statistically significant changes, ie there was a decrease in muscle mass (MM%, MMKG) and an increase in adipose tissue (BF%, BFKG), and the reason may be the physical inactivity of the control group.

In the experimental group, the measurement results after the realized experiment indicate statistically significant differences in all parameters in relation to the initial measurement. After high intensity training, the subjects of the experimental group reduced body weight (BW) by 2.9 kg, body mass index (BMI) by 1.05, adipose tissue (BF%) by 1.26%, adipose tissue (BFKG) by 1.46 kg, muscle tissue (MMKG) by 0.71 kg, lean body mass (LBMKG) by 1.44 kg, while muscle tissue (MM%) increased by 0.62% and lean body mass (LBM%) by 1.27%.

Statistically significant differences between the experimental and control groups on the final measurement were found in the tests: body weight (BW), body mass index (BMI), adipose tissue (BF%, BFKG), muscle tissue (MM%), and lean body mass (LBM%, LBMKG). The reason for the greater reduction of body fat in our subjects are the higher average initial values before the experimental treatment, which provides the possibility of achieving a greater effect for a shorter period of time (Aksović, Aleksandrović, & Jorgić, 2017). Muscle tissue (MM%) and lean body mass (LBM%, LBMKG) also changed statistically significantly, and the results obtained were completely expected.

Continuous running of a moderate character is the most adequate way to reduce body composition due to high caloric expenditure during each individual workout (Lu, Wiltshire, Baker, & Wang, 2021) where the highest percentage of energy is obtained from body fat. On the other hand, research has confirmed that high intensity training is also effective because high calorie consumption occurs during high intensity intervals, with the percentage of fat in that caloric consumption being much lower than continuous moderate intensity running, but this share in the total is sufficient to reduce body composition (Gibala, & McGee, 2008), as was the case in this study.

These results are similar to previous research (Irving et al., 2008; Trapp et al., 2008; Wewege, Van Den Berg, Ward, & Keech, 2017), which had a very similar design of the training program with with the same or similar intensity and duration, so that we can state with great certainty that intensive training of high intensity is an effective in reducing the parameters of body composition. One of the main factors influencing the reduction of body composition is the total caloric consumption.

Unfortunately, this parameter was not monitored in this study, so we cannot say with certainty that intensive training led to higher caloric expenditure compared to other conventional training programs and thus affected body composition. Nybo et al. (2010) found that total caloric expenditure is limited in interval training and strength training as opposed to continuous training and that this difference directly affects body fat reduction. Also, research has shown that in physically active people the level of fat oxidation is higher both during training and during rest (Kriketos, Sharp, Seagle, Peters, & Hill, 2000). However, Nieman, Brock, Butterworth, Utter, & Nieman, (2002) have shown that fat oxidation during the recovery period or during 24-hour follow-up is lower in people who have low body fat levels. Rao, Belanger, & Robbins, (2022) indicate the influence of physical activity on the prevention of cardiovascular diseases and, the results showed that physical activity is the best means of regulating body weight.

In addition to the fact that high intensity training has a positive effect on adipose tissue (BF) and lean body mass (LBM), it also achieves positive results on the muscle mass (MM) of the participants. At the final measurement, there was an increase in the percentage of muscle mass (MM%), and as an indirect reason for the increase is a decrease in body weight (Carneiro et al., 2018). One of the key reasons is the increase in mitochondrial muscle capacity during periods of high intensity activities that affect the increase in the aerobic and anaerobic capacity of the subjects. Mitochondrial volume was found to increase by 31% after a high intensity training program (Talanian, Gallowa, Heigenhauser, Bonen, & Spriet, 2007).

Physical exercise programs, during which subjects are active for less than 30 minutes a day, three times a week, lead to little or no change in body weight and body composition. The results of 32 studies in which guidelines were set by the ACSM and used during program implementation, and indicated an average total body weight loss of 1.5 kg and a reduction in adipose tissue percentage of 2.2% (Wilmore, 1983).

Bangsbo, Hansen, Dvorak, & Krustrup, (2015) did not record changes in muscle mass (MM) and lean body mass (LBM) in both absolute and relative values, but all of these studies included subjects with a very high percentage of muscle mass (MM%) where there was no too much room for adequate change caused by a short-term training program. This actually means that it is necessary to exercise for at least 45 minutes a day, three times a week (Aksović et al., 2017).

4. Conclusions

Based on the obtained results, it can be concluded that after the realized experiment, the examinees of the experimental group, indicate statistically significant differences in all parameters in relation to the initial measurement. Statistically significant effects of high intensity training on the final measurement were determined in the following parameters: body weight in kg (BW), body mass index (BMI), adipose tissue (BF%, BFKG), muscle tissue in% (MM%) and lean body mass (LBM%, LBMKG).

The results confirmed that intensive training of high intensity ≥80%-90% HR_{max}, was effective and lead to statistically significant changes in body composition. Based on these results, it is clear that high intensity training achieves positive changes in body composition, and is recommended for daily use in fitness clubs and other places where organized exercise systems are implemented, as a program to reduce body composition, or in other words for changes in composition body of a women.

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