Lejla Šebić[1], Adriana Ljubojević[2], Amra Nožinović[3], Šejla Omerhodžić[1] and Dalila Kajević[1]

EFFECTS OF CIRCUIT TRAINING ON BODY COMPOSITION OF WOMEN

[1]*Faculty of Sport and Physical Education University of Sarajevo, Bosnia and Herzegovina*
[2]*Faculty of Physical Education and Sport University of Banja Luka, Bosnia and Herzegovina*
[3]*Faculty of Physical Education and Sport University of Tuzla, Bosnia and Herzegovina*

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Abstract
Body composition and fat components of the human body are of great significance in modern diagnostics and assessment of a training process when compared to other benchmarks. The basic goal of this research is to evaluate the effects of circuit training on body composition changes in female population. The sample for this research consisted of 45 female test subjects of 35 years of age in average. Eight variables were applied for body composition assessment measured through a unique and advanced double frequency technology of TANITA TBF-300 A monitor electronic scales, and the BIA technique (Bio Impedance Analysis = measuring bioelectric impedance). The test subjects had taken part in a two month long program of circuit training sessions three times a week (24 training sessions in total). Based on partial differences (t-test for dependent samples) between the initial and final testing, the results have indicated that statistically significant changes have occurred in the following variables: body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), metabolic age of a body (MTA) and body mass index (BMI). Circuit training was demonstrated to be a very efficient mean of exercise with the goal of reducing body fat in women.

Key words: **group fitness, transormation processess, body composition, recreationists**

Introduction

Modern civilization causes primarily a sedentary (sitting) way of life, and in today's modern society Homo Sapiens became Homo Sedens which has significantly deteriorated his health. Numerous studies, from around the world, indicate that a large percentage of the population is insufficiently physically active, the consequence of which is that in the majority of the developed countries, over 50% of the adult population is overweight (Ostojić, 2007; Hajmer, 2010; Hollmann & Hettinger, 2000). It is estimated that, in Europe, the lack of physical activity is responsible for over 600,000 deaths annually. Two thirds of adults in the European Union (persons over 15 years of age) fail to reach the recommended level of physical activity (WHO - Regional Office for Europe, 2006).

Hypokinesia (reduced movement, reduced physical activity) is a factor which contributes to development of many chronic diseases and imbalances, and also leads to an increase in risk factors of cardiovascular and other chronic diseases such as diabetes, obesity, hypertension, bone and joint diseases, etc. (Warburton, Gledhill, & Quinney, 2001). Physical activity is any type of movement performed through activation of skeletal muscles demanding energy consumption (Caspersen, Powell and Christenson, 1985), and it helps in achieving an optimum state of health thus reducing the risk of developing many chronic diseases (Blair, Cheng and Holder, 2001).

In 1989. year, the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) had listed the so called components of physical fitness; body composition being one of them. Body composition implies the percentages of fat, muscular and bone tissue in the overall body mass. It is important that the percentage of body fat does not cross a specific limit that jeopardises the health of an individual.

One of the most basic measurements when assessing body compositions is the Body Mass Index – BMI. The calculation of a body mass index determines a desirable body mass of a human being (Table 1). According the World Health Organization (WHO, 1998) BMI lower than 18.5 is considered to indicate insufficient weight and a state of undernourishment, eating disorder or other health problem, while BMI higher than 25 is considered to indicate obesity. These ranges in the values of BMI are only valid as statistics categories for adults.

Table 1. Categories of human body in reference to BMI (according to: Federation International of Sports Aerobics and Fitness & Belgrade Aerobic and Fitness Association, 2006)

BMI range	Weight categories
19 do < 25	Normal weight
25 do < 30	Overweight
30 do < 35	Obesity
35	Morbid obesity

Any kinesiological activity which can effectively influence recreationists' morphological characteristics and lifestyle is of great significance for social community. Group fitness program, as a form of circuit training, represents an efficient combination of resistance exercises and high intensity aerobic exercises. It unifies the basic principles of aerobic, interval training, and strengthening exercises, which intensifies calorie consumption, improves cardiovascular system function and strengthens the entire body (Perez and Greenwood-Robinson, 2009). This concept of an approach to modern fitness exercising satisfies the goals of harmonious body shaping, improvement of body posture, strengthening bone, joint, tendon and ligament segments of the locomotive system and improves general health (Furjan-Mandić, Kosalec and Vlašić, 2011). Application of various fitness programs has produced significant effects in the improvement of functional and motor abilities (Mandarić et al., 2011; Oreb et al., 2007; Park et al.,2003; Šebić et al., 2012), as well as changes in the body composition of women (Donges et al., 2010; Stasiulis et al., 2014). For most female recreationists the motive to take part in group exercising programs is shaping of their body into a generally harmonious form, with a specific accent on the reduction of the subcutaneous fat tissue (Šebić and Podrug–Arapović, 2008). The basic goal of this research was to evaluate the effects of circuit training for the duration of two months (24 training sessions) on changes in body composition in female population.

Sample of test subjects

The sample of test subjects for this research was composed out of 45 (forty five) attendees of the Aerobics Club LN1 from Sarajevo of 35 years of age on average (age group ranging from 25 to 45 years of age).

Sample of variables

Eight variables were used for body composition assessment: body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), fat free mass (FFM), muscle mass (MUS), bone mass (BON), metabolic age of a body (MTA) and body mass index (BMI).

Circuit training description

Circuit training created for the purpose of this research was designed to be simple, and also to improve stamina and muscle endurance. The goal of the training program was to provide for an adequate and healthy way of regulating body weight in female population. Circuit training, the overall duration of which was 60 minutes, consisted of introductory warm-up (10 minutes), preparatory stretching (5 minutes), followed by exercise stations of eight exercises that activate the entire body (35 minutes), done in a fast tempo with the use of external weights (2 kilogram dumbbells). The circuits are repeated five times. Every exercise lasts for 45 seconds. During the circuit training there is no pause between the exercises, and one circuit lasts for 6 minutes. Between each new circuit, there is a 60 second break. After the completion of all circuits there are 10 minutes of static stretching.

Table 2. Time articulation of a single training session

Part of training session	Contents	Duration
I - Introductory part	Warm-up through basic steps of hi-low aerobics	10 minutes
II – preparatory part	Dynamic stretching of large muscle groups	5 minutes
III – Main part	8 exercise circuit training	35 minutes
IV – Concluding part	Static stretching (large muscle groups)	10 minutes

Table 3. Example of the types of exercises in one circuit training session

No.	Exercise	Dominant muscle activation	Duration
I	Squat press	legs and shoulders	45 sec
II	Stiff-leg deadlift	hamstrings and lower back	45 sec
III	Alternating front lunge + dumbbell lateral shoulder fly	legs and shoulders	45 sec
IV	Bent over two dumbbell row	back	45 sec
V	Sumo squat + dumbbell butterfly	chest and legs	45 sec
VI	Bicep curl with alternating knee raise	arms and abdomen	45 sec
VII	Sumo squat with overhead dumbbell triceps extension	arms and legs	45 sec
VIII	V-ups	abdomen	45 sec

Data processing methods

The results were processed in the software package SPSS 22.0 for Windows. Central and dispersion parameters were calculated for each applied variable, and the normality of the distribution was examined based on skewness and kurtosis coefficients. The differences in body composition between the initial and the final stage were determined based on the t-test for dependent samples. Eta-sqared was used for calculating effect size in t-test for dependent samples.

Results

Central and dispersion parameters for the set of body composition variables treated in the initial testing relates to condition of the test subjects prior to the application of the circuit training program (Table 4). With the majority of the applied variables, it is clear that the results are placed within the normal distribution range and that a satisfactory homogeny of the results is visible. Variables such as fat free mass (FFM), muscle tissue (MUS), bone weight (BON) show somewhat increased result elongation values which was to be expected due to the range of test subjects' age.

Table 4. Descriptive statistics (initial) - minimum results (Minimum), maximum results (maximum), Arithmetic middle (Mean), standard deviation (Std. Deviation), skewness coefficient (Skewness), kurtosis coefficient (Kurtosis)

	N	Rang	Min.	Max.	Mean	Std. Devi.	Skewness	Kurtosis
BW	45	70.00	44.80	114.80	76.08	14.55	.522	.549
FAT%	45	42.60	7.10	49.70	33.86	7.57	-.959	2.451
MMT	45	53.90	3.20	57.10	26.67	10.21	.605	1.393
FFM	45	28.50	40.90	69.40	49.41	5.47	1.190	**2.701**
MUS	45	27.10	38.80	65.90	46.91	5.20	1.192	**2.694**
BON	45	1.40	2.10	3.50	2.49	.272	1.136	**2.764**
MTA	45	56.00	13.00	69.00	41.33	14.53	-.211	-.673
BMI	45	24.70	17.50	42.20	26.39	4.99	.926	1.419

Central and dispersion parameters for the set of body composition variables treated in the final testing, after the completion of the of the training content application process, shows to what extent the goals of the test subjects' transformation have been met (Table 5). Unlike in the initial measurements, greater result homogeneity is noticeable in the final measurements, and there are no significant deviations, other than in the body fat percentage (FAT%) variable where there is a somewhat increased kurtosis value; yet as the body fat percentage is directly dependant on height and weight of the test subject's body, these results were to be expected. Pertaining to the basic descriptive data, it can be concluded that the distribution of the results is set within the normal distribution, that the body composition of the test subjects during their final measuring is satisfactory and that it falls within the reference values consistent with healthy individuals (according to Egger, Champion and Bolton 1999).

Table 5. Descriptive statistics (final) - minimum results (Minimum), maximum results (maximum), Arithmetic middle (Mean), standard deviation (Std. Deviation), skewness coefficient (Skewness), kurtosis coefficient (Kurtosis)

	N	Range	Minimum	Maximum	Mean	Std. Dev.	Skewness	Kurtosis
BW	45	62.50	43.90	106.40	72.368	12.232	.462	.609
FAT%	45	39.80	5.70	45.50	31.335	7.439	-.888	**2.077**
FTM	45	45.10	2.50	47.60	23.471	8.863	.417	.700
FFM	45	17.40	41.40	58.80	48.897	4.078	.348	-.362
MUS	45	16.50	39.30	55.80	46.417	3.868	.346	-.362
BON	45	.90	2.10	3.00	2.480	.211	.380	-.356
MTA	45	51.00	12.00	63.00	37.222	14.111	-.096	-.960
BMI	45	20.60	17.60	38.20	25.104	4.119	.960	1.408

With regard to the basic descriptive data, it can be concluded that the test subjects' body composition during their final measurement was statistically significantly better compared to their initial state. The arithmetic middle of the body fat percentage value for the test subjects at the beginning of the testing was 33.86, which meant that the test subjects were in the overweight category. The result of the final testing of the arithmetic middle was 31.33 which speaks for the effects of circuit training, because the test subjects are now in the moderate body weight category.

During the initial measurement, the average body mass index (BMI) of the test subjects was 26.39, which indicates increased body weight or obesity, while, during the final measurement, the average value of the BMI was 25.104 which places them in the upper line of normal weight category.

The insight into values of t-test for dependent samples of the body composition arithmetic means between the initial and the final measurements, shows that there have occurred statistically significant changes in variables of

body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), metabolic age of the body (MTA), and body mass index (BMI) where statistical significance is P=0.00 (Table 6). The eta-squared results have indicated that the effect size is big in all variables where statistically significant changes have occurred between the initial and final measurements.

Table 6. T-Test for dependent samples

		Paired Differences		t	df	Sig. (2-tailed)	ETA SQARED
		Mean	Std. Deviation				
Pair 1	BW-BW2	3.720	3.121	7.996	44	**.000**	**0.59**
Pair 2	FAT%-FAT%2	2.528	3.545	4.784	44	**.000**	**0.34**
Pair 3	FTM-FTM2	3.206	3.673	5.855	44	**.000**	**0.44**
Pair 4	FFM-FFM2	.513	3.269	1.053	44	.298	0.02
Pair 5	MUS-MUS2	.497	3.108	1.074	44	.289	0.02
Pair 6	BON-BON2	.0155	.1650	.632	44	.531	0.00
Pair 7	MTA-MTA2	4.111	5.753	4.793	44	**.000**	**0.34**
Pair 8	BMI –BMI2	1.293	1.137	7.629	44	**.000**	**0.57**

Discussion

It is possible to make an insight into a current state of a body as well as to monitor changes and evaluate the real effects of the applied training process through body composition analysis. It is apparent that the applied circuit training program has caused significant changes within the important women body composition parameters. Performing regular physical activity for the duration of two months (three times a week), has contributed to body weight reduction in test subjects. The applied circuit training form has activated their entire body in a quality way and in a short period of time, has led to acceleration of metabolism, increased calorie consumption and thus led to body weight reduction in women.

Circuit training is a form of interval training, where a body has to adapt to rapid alternation of exercises, and where heart rate rapidly increases, than reduces, than increases again. The intervals increase oxygen level in the body, which intensifies calorie consumption not just during training session but in the rest period after workout. With this type of workout, the results can be achieved much more quickly than with standard forms of workout.

With significant body weight reduction came a significant body fat percentage loss (FAT%). Egger, Champion and Bolton (1999) suggest a criteria for classifying obesity for general population according to the body fat percentage, where women with 17% of body fat fall into the category of lean individuals, with 17-27% to individuals with an acceptable level of body fat, 27-33% of body fat to obese, and over 33% to morbidly obese category. According to their body fat percentage at the beginning of the program, the body fat percentage of the test subjects placed them into the category of the obese. After the application of the circuit training, the test subjects are now in the category of individuals with moderate body weight, that is, healthy individuals. It is well known that women must have certain percentage of body fat, primarily for normal birth function, as well as hormonal and other functions. However, it is important that their body fat percentage does not cross a specific line where the health of an individual is at risk. The upper limit of the body fat percentage for women is 30%, while the minimum values are between 5% and 17% (Mišigoj-Duraković, 2008). Assessing body composition according to the body mass index – BMI, demonstrates significant transformation under the influence of circuit training. The test subjects' BMI at the beginning of the program was an indicator of an increased body weight or obesity, while at the final stages it was a clear indicator of normal body weight.

Such changes in body composition of female recreationists (reduction of body weight, body fat percentage and body mass index), due to application of group fitness exercise program have been confirmed in similar research by Cugusi et al. (2016); Ljubojević et al. (2014); Barene et al., (2013); Donges, Duffield and Drinkwater (2010) and Stasiulis et al., (2010).

The fat free mass (FFM) of the body, also referred to as functional tissue, is composed of muscles, bones, internal organs and water. The term can refer to any type of tissue which does not contain fat. A high level of fat free mass implies a lean and healthy body. The correction of body composition is often equated with the reduction of body mass, which is wrong. Reduction of body mass does not simultaneously imply the reduction of body fat percentage, because the reduction can happen due to loss of muscle tissue, which is not good. Drastic low calorie diets, without regular exercise, have as a consequence the illusion of weight loss, while in reality the body creates the energy it needs by burning muscle mass which slows down the

metabolism because there are no muscles to burn the ingested energy. After the completion of a diet, the kilograms lost usually come back quickly and on a larger scale (the so called yo-yo effect). The essence of the applied circuit program was the improvement of body composition, that is, reduction of fat tissue with preservation or increase of muscle tissue.

With the application of the circuit training program, the final measurements showed no increase, and no reduction either, in fat free mass (FFM) and muscle tissue (MUS). It is important that no loss of muscle mass occurred during the circuit training program, and that the muscle mass was preserved. For increase in muscle mass it would have been necessary to use bigger weights and do lower number of repetitions which would make pauses between the exercises last longer.

Metabolic age (MTA) refers to measuring the real metabolic state of the body. With individuals who are not physically active and have excess fat tissue, their metabolic age is commonly much higher than their biological age. Exercise program applied in this research has contributed to reduction of metabolic age of the test subjects, to acceleration of their metabolism, and it can be said that it has rejuvenated the body the of the test subjects. The bone weight (BON) variable suffered no transformation because of the test subjects represented a mature population of women whose body growth and development has been completed. The interest of future group program effects research should be aimed towards the programs that will, along with the loss of fat tissue, simultaneously influence the increase of muscle mass in those who exercise. This research has proven positive transformation effects of circuit training, and that increased physical activity leads towards improving the health of female population. Circuit training is one of the possibilities for resolving a problem for mature age women, because it provides all assumptions necessary in the fight against fat tissue and all negative consequences of sedentary way of life.

Conclusion

Circuit training program with the duration of two months and iteration of three training sessions a week, has led to statistically significant changes in body composition of a female population. No statistically significant increase in muscle mass has occurred. In comparison with initial measurements, body weight, body fat percentage, overall fat tissue mass, body weight index and metabolic age were reduced. It is possible that the increase of muscle mass would have been achieved with prolonging the training protocol and individual choice of weights. Research results are applicable to female population. It would be good to compare the effects of the program among the male population of similar characteristics.

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Correspondence to:
Lejla Šebić, associate professor
Faculty of Sport and Physical Education
University of Sarajevo
Bosnia and Herzegovina
E-mail: lejla@ln1.ba