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BOJAN BJELICA, NIKOLA AKSOVIĆ, BORISLAV CICOVIĆ, LJUBICA MILANOVIĆ, RIDVAN COLAK, MILAN ZELENOVIĆ

EFFECTS OF DIFFERENT PHYSICAL ACTIVITIES ON THE BODY COMPOSITION OF MIDDLE-AGED PEOPLE

ABSTRACT: The aim of the systematic review was to determine the effects of different physical activity programs on the body composition of women and men aged 40–65 based on collected data and analyzed papers published between 2000 and 2020. Literature research was performed using the following search databases: MEDLINE, Google Scholar, PubMed. The papers were selected on the basis of the following: type of study, intervention, results and age group of participants. The combination of physical activities and reduced caloric intake achieves the best effects on reducing fat deposits and total body weight. Aerobic activities performed 3–4 times a week in time period of 12–16 weeks with activity duration of 50–60 minutes are the most effective means of changing body composition. Moderate physical activity for middle-aged people combined with reduced calorie intake has a positive effect on body fat and weight loss.

KEY WORDS: Exercise - Body composition - Fat - Muscle mass - Middle Age

INTRODUCTION

Physical activity (PA) is a very important segment in the protection and development of health (Moon 2013). Physical inactivity is considered a global health problem of a nation. Physical inactivity in middle-aged people leads to changes in the structure of body composition, which result in obesity and are considered one of the most significant public health problems of modern times. According to the estimate and frequency, this problem is another cause of death that can be successfully prevented (Aksović *et al.* 2017). The research (Barry *et al.* 2014) showed that the increase of PA provides comprehensive health benefits and reduces mortality associated with any cause, regardless of body mass index (BMI). PA has positive relations with health and longer life expectancy (Lustyk *et al.* 2004). Also, regular PA reduces fat deposits and

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maintains body weight (Blair *et al.* 2004, Haskell *et al.* 2007, Garber *et al.* 2011, Golubic *et al.* 2012, Can *et al.* 2014, Clark 2015, Liu *et al.* 2018, Can *et al.* 2019).

Body composition can be defined as the absolute and relative amount of muscle, bone and adipose tissue composition that make up total body mass (Heyward 1991). When defining body composition, authors often mention two components: fat mass (FM) and fat-free mass (FFM). Aerobic training of moderate intensity (walking, running) is the most adequate way to reduce body composition due to high caloric expenditure during each individual training where the largest percentage of energy is obtained from body fat (Jorgić *et al.* 2011). 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 in case of continuous moderate-intensity running, but that the share in the total is sufficient to reduce the body composition of women and men (Trapp *et al.*2008, Burgomaster *et al.* 2008, Jorgić *et al.* 2011). By comparing high-intensity interval and aerobic training (Bruseghini *et al.* 2015) a statistically significant reduction in body weight and body fat in both groups without significant differences between groups was found, while aerobic training, compared to high-intensity training, resulted in better reduction of lean body mass and LDL cholesterol.

PA has been shown to reduce the risk of many associated chronic unhealthy conditions with high body fat (Buchowski *et al.* 1997). With aging, physical barriers and medical limitations compared to younger people increase. Therefore, the intensity of exercise must be controlled and adjusted to the abilities of the elderly (Kallinen, Markku 1995, Taunton *et al.* 1997). Fat-free body weight is stable until the age of 40, after which it decreases by about 6% in men and 10% in women aged 60 to 80 (Holloszy, Kohrt 1995). Monitoring energy consumption through training or PA is very important because in this way exercise has a positive impact on the body, health and physical abilities of the person (Kostić 2009). The activities of middle-aged people (aged 40–65) mostly come down to walking (Ashe *et al.* 2009). It should also be noted that the success in maintaining body composition largely depends on proper nutrition. In addition to the effects on body composition, regular PA leads to an increase in both aerobic and anaerobic parameters (Pilch *et al.* 2016), reduces the harmful effects of the disease of people with diabetes (Maltby, Day 2001), helps people with cardiovascular issues (Nystoriak, Bhatnagar 2018, Pinckard *et al.* 2019), increases bone density and reduces osteoporotic changes (Warburton *et al.* 2001, Carter, Hinton 2014).

The aim of the study was to collect relevant data on the effects of physical activity, as well as to clarify whether there were positive effects of different physical activity programs on the body composition of women and men.

METHODS

A systematic review of the papers is shown according to methodological instruction and in accordance with the consensus of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-PRISMA (Moher *et al.* 2009).

The database sources and the research strategy

The following databases were searched in the electronic research of papers: MEDLINE, Google Scholar, PubMed, as well as other relevant literature that could provide answers to the set problem. Papers published in the period 2000–2020 were analyzed. The search was performed by a combination of keywords, primarily related to aerobic activities and body composition, then to the age category determined by the topic. The keywords used to search the databases are: "exercise", "body composition", "fat", "muscle mass", "middle age". For the purposes of the research, a descriptive method was used.

The criteria for inclusion

Type of study:

Only longitudinal studies were analyzed, transversal ones were excluded for further analysis. Papers that were published in English were included in the study.

Sample of participants:

The study included men and women aged 40–65 (middle age) regardless of their lifestyle (active and sedentary population) and health status.

Type of intervention:

The papers whose experimental program lasted longer than two weeks were singled out.

Type of results:

The primary search result was body composition after an aerobic training, while the secondary result was the age category to which the problems of the concepts of the degree of nutrition (obese, normally nourished), blood pressure, cholesterol, diabetes and the like were related.

The criteria for exclusion

The type of study: 1) studies without experimental or control group; 2) studies written in a language other than English; 3) duration of the study that is less than two weeks; 4) inadequate framework of analysis in the period 2000–2020; 5) studies applied to subjects under 40 and over 65.

RESULTS

An initial search of the databases found 204 potential papers. After deleting duplicates and eliminating papers based on titles and abstracts, 55 studies remained. The remaining papers were reviewed in detail. Based on the inclusion criteria, additional 33 papers failed to meet the criteria for further procedure, while 22 studies met the pre-defined criteria and were included in the systematic review. The total number of participants included in this study was 1,873, of which 762 participants were male, and 1,111 were female. Six studies (Reseland *et al.* 2001, Cox *et al.* 2003, Delecluse *et al.* 2004, Freitas *et al.* 2017, Mohammadi *et al.* 2018, Do-JinKim *et al.* 2020), included male participants. In eight studies (Brill *et al.* 2002, Grant *et al.* 2004, da Silva *et al.* 2006, Irving *et al.* 2008, Sillanpää *et al.* 2009, de Mendonça *et al.* 2014, Hsu *et al.* 2015, Hernández-Reyes *et al.* 2019), the sample consisted of female participants.

Seven studies involved a combination of male and female participants (Hays *et al.* 2004, Layman *et al.* 2009, Hottenrott *et al.* 2012, McTiernan *et al.* 2012, Benito *et al.* 2015, Emerenziani *et al.* 2018, Yu *et al.* 2020).

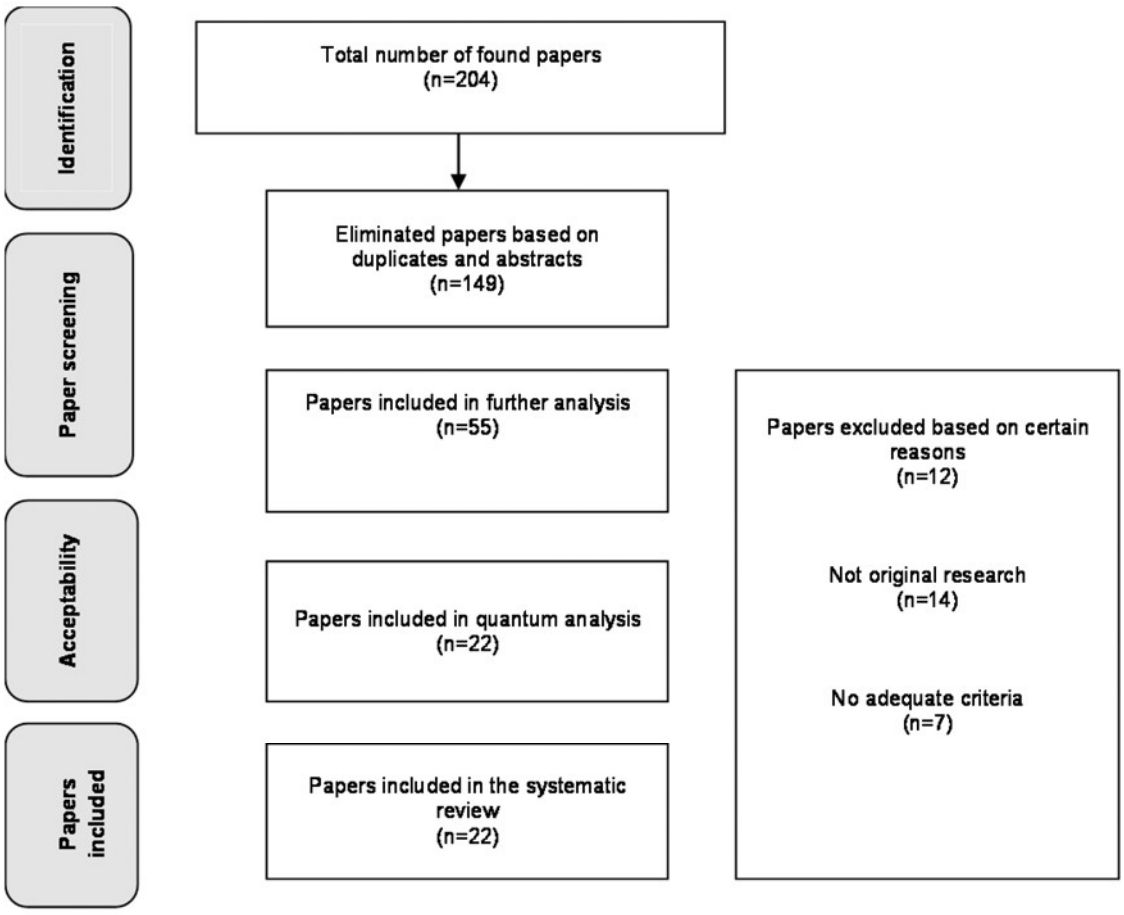

FIGURE 1: Schematic representation of collection and analysis of papers.

TABLE 1: Systematic review of papers: Influence of physical activities on the body composition of middle-aged men and women. Legend: AT aerobic training, AEXC aerobic exercise, ABG all body group, AWGR after work group, BM body mass, BF body fat, FM fat mass, BMM body muscle, BCY bicycle, CG control group, CE control exercise, CD cardiorespiratory, CR chair rise, CEND combined endurance, DG diet group, D diet, ERG ergometer, EXC exercise, END endurance, FFM free fat mass, FW fast walking, FX flexibility, GR group, HPD hight protein diet, HYG hydrogymnasics, HC hight consistency, HIEXC high intensity exercise training, HBEXC home based exercise, IAF intra abdominal fat, INT intervention, IN intensity, IE intensive exercise, IEXC individual exercise, IT interval, JG jogging, LC low consistency, LRT low resistance training, LM lean mass, MM muscle mass, MRT moderate resistance training, ME moderate exercise, MXS maximal speed, MOV movements, MWK moderate walking, PMIX programs mix, p/w per week, PLO pull over, RST resistance, RG recommendations group, SF subcutaneous fat, SLA standard life activity, STE strength and endurance, ST strength training, TM total mass, TBM total body fat, TRA training, TG training group, TCP triceps, UAG up and go, VF viscelar fat, WK walking group, WGR weekend group, WUP warm up, Wwalking, WLP weight loss program, ↓ statistically significant discrease $p<0.05$, NS no statistically significant changes $p>0.05$, ↑ statisically significant increase $p<0.05$.

Research	**Subject information**			**Protocol and results**	
Reference	**Subjects Sex**	**Age**	**Duration**	**Group/Exercise program**	**Final results**
Reseland *et al.* 2001	186♂	49.2 ± 2.5	48 weeks	a) DG b) TG c) DG+TG d) SLA, TG-AT, FW, JG; 3 p/w x 60 min. c) CG	BM (kg) = a) 1.4↓ b) 1.0↓ c) 2.4↓ d) 0.1↓ BF (%) = a) 1.4↓ b) 1.0↓ c) 2.4↓ d) 0.1↓ FM (kg) = a) 1.2↓ b) 0.9↓ c) 1.1↓ d) 0.05↑
Brill *et al.* 2002	56♀	39.8 ± 7.3	12 weeks	a) WG 30 min. x 5 p/w b) WG 60 min. x 5 p/w c) DG – SLA	BM (kg) = a) 4.13↓ b) 5.75↓ c) 5.85↓ BF (%) = a) 1.02↓ b) 1,2↓ c) 2,3↓ FM (kg) = a) 2.63↓ b) 3.53↓ c) 4.41↓
Cox *et al.* 2003	59♂	42.4 ± 5	16 weeks	a) and c) 1-2 p/w x 30 min. b) and d) 3 p/w x 30 min. a) and c) CE & ME b) and d) IE (BCY) 95%	BM (kg) = a) 1.0↑ b) 3.2↓ c) 8.0↓ d) 12.2↓ BF (%) = a) 1.5↓ b) 0.1↓ c) 15.6↓ d) 15.6↓
Hays *et al.* 2004	34 14♂ 20♀	60.5 ± 2.3	14 weeks	a) HPD b) HPD + EXC c) SLA a) HPD b) 4 P/W BCY ERG 80% HR max. 45min.+D	BM (kg) = a) 3.2±1.2↓ b) 4.8±0.9↓ c) 0.1±0.6↓ BF (%) = a) 2.2↓ b) 3.5↓ c) 0.2↑
Grant *et al.* 2004	26♀	63 ± 4	12 weeks	a) EG b) SLA a) 40 min. x 3 p/w, WUP, 10 min., AEXC, 20 min., STE, 5 min., FX, 5 min. CR, timed 'UAG test, 20-m WK,lifting a 1- and a 2-kg bag on to a shelf, stair WK, S&R FX	BM (kg) = a) 1.69↓ b) 0.27↓ EX-CG = 1.96 BF (%) = a) 0.01↓ b) 1.37↓ EX-CG = 1.36
Delecluse *et al.* 2004	79♂	63 ± 2.8 55-74	20 weeks	a) END + MRT b) END + LRT (LR) c) RST as replaced by additional END d) SLA; 75%	BF (%) = a) 0.1↓ b) 0.1↓ c) 0.6↓ d) NS

TABLE 1: Continued

da Silva *et al.* 2006	80♀	61.1 ± 7.3	12 weeks	3 p/w 40 min. 2 ser./11-12 reps. flying, PLO, extension table and flexor of scott thread and TCP in the pulley and elevation lateral	BM (kg) = 1.5↓ FM (kg) = 0.5↓ BF (%) = NS
Irving *et al.* 2008	27♀	51 ± 9	16 weeks	a) LRT b) HIEXC c) SLA a) WK/run IN at or below their b) WK/runMRT 65%	BM (kg) = a) 2.1↓ b) 3.5↓ c) NS BM (%) = a) 0.4↓ b) 1.7↓ c) NS FFM (kg) = a) 0.9↓ b) 0.5↓ c) NS FM (kg) = a) 1.3↓ b) 2.8↓ c) NS
Layman *et al.* 2009	130 58♂ 72♀	45.2 ± 1.2	48 weeks	a) D 1700 + EXC b) D 3400 + EXC MWK 5 p/w. Overall 100 min. p/w without differe. in GR 75%	BM (kg) = a) 8.2±0.5↓ b) 7.0±0.5↓ LM (kg) = a) 2.4↓ b) 2.2↓ BF (%) = a) 6.6↓ b) 4.9↓
Sillanpää *et al.* 2009	62♀	51.5 ± 3.1 39-64	21 weeks	a) END EXC b) ST c) combined ST d) SLA a) BCY 30 min. 1-7 p/w, 45 min. 8-14, 60 min. 15-21. b) gym, ABG, 3 BCY, 40–60% of the 1RM, 15-20 reps, 60-80% 1RM 10-12, 70-90% 6-8 c) PMIX	TM (g) = a) 1.26↓ (1.900) b) 4.3↓ (1.417) c) 943↓ (1.226) d) 196↓ (1,027) BF (%) = a) 2.1↓ (2.2) b) 0.9↓ (1.8) c) 1.9↓ (1.7) e) 0.6↓ (1.5)
Hottenrot *et al.* 2012	34 15♂ 19♀	43.4 ± 6.9	12 weeks	a) WGR b) AWGR a) 30 min. END run at 85% VLT, t-10 IT of 30 s all-out sprints, w-30 min. IN END run at 100% VLT, t-4 to 6 IT of 2 min. run at MXS, f-10 IT of 30 sec sprints, b) s-30 to 60 min. END run at 85% VLT, s-60 to 120 min. END run at 75% VLT	BM (kg) = a) 2.1↓ b) 1.8↓ TBF (%) = a) 1.5↓ b) 1.0↓ VF (kg) = a) 0.9↓ b) 0.3↓ FFM (kg) = a) 1.0↓ b) 0.7↓
McTiernan *et al.* 2012	202 102♂ 100♀	57.5 ± 3.5	48 weeks	a) W b) M The INT was facility-and HBEXC to-vigorous IN AT, 60 min./d, 6 p/w vs. CG	FM (kg) = a) 1.9↓ b) 3.0↓ BF (%) = a) 1.8↓ b) 2.7↓ IAF (cm2) = a) 5.8↓ b) 43.3↓ SF (cm2) = a) 18.0↓ b) 12.2↓
de Mendonça *et al.* 2014	89♀	41.4 ± 9.2 25-55	16 weeks	a) ST b) dance c) HYG a) gym EXC, 60 to 70% of 1RM. 3x 8–12, 2–3 min. rest = 50–60 min. b) popular dance /AT with songs of a rhythmic HR 100-165, 60-85% c) LRT 60-85%, CD EXC + MM END EXC	BF (%) = a) 1.77±0.82↓ b) 0.94±0.31↓ c) 1.19 ±0.34↓ LM (kg) = a) 1.56↑ b) 1.04↑ c) 1.09↓
Benito *et al.* 2015	120 61♂ 59♀	43 ± 2.1	22 weeks	3 x p/w; 50–60%. a) ST b) END c) CEND + END group or a PA RG d) SLA	BM (kg) = a) 9.21±0.83↓ b) 10.55±0.80↓ c) 9.88±0.85↓ d) 8.69±0.89↓ BF (%) = a) 5.24±0.55↓ b) 5.35±0.55↓ c) 4.85±0.56↓ d) 4.89±0.59↓
Hsu *et al.* 2015	180♀	57.5 ± 4.2 45-70	12 weeks	a) Circuit EXC b) tai chi GR c) SLA a) streching machine, AEXC, gym machine 60-80% b) tai chi 13 forms, 50-60% 15 + 45 min	TBM (kg) = a) 0.69↓ b) 1.61↓ c) NS LBM (kg) = a) 0.75↓ b) 1.71↓ c) NS BF (%) = a) 3.52↓ b) 2.22↓ c) NS

TABLE 1: Continued.

Freitas *et al.* 2017	51♂	MA	12 weeks	a) AT and RST muscle TRA, b) incorporated breathing and stretching EXC a) WLP + EXC b) WLP + sham 68-76%	BF (%) = a) 6.8%±3.5↓ b) 3.1%±2.6↓ LM (kg) = decreased at group a); NS b)
Emerenziani *et al.* 2018	220 48♂ 172♀	48.1 ± 12.3	4/8 weeks	HR reached a value of 90% of their HR max. a) and b) WK/run OMNI-RPE-WK/IVT a) HC 3–5 p/w b) LC max. 3 p/w	FM (kg) a_1) 0,1↑ a_2) 0.7↑ b_1) 1.0↑ b_2) 0.6↓ FFM (%) a_1) 1.7↑ a_2) 2.6↑ b_1) 0.7↓ b_2) 0.1↑ FM (%) a_1) 1.7↓ a_2) 2.6↓ b_1) 0.7↓ b_2) 0.1↑
Mohammadi *et al.* 2018	57♂	50 ± 1.6 40-60	12 weeks	a) AT b) ST c) CEND d) CG a) tredmill 20-60 min. b) 10 strength MOV for the lower and upper BMM GR c) treadmill 20–30 min./2 sets of 8 strength MOV with 8–10 reps. AT 60-75%, strenght 75%–80%	BM (kg) = a) 5.1±1.5↓ b) 1±4.4↑ c) 3.2±3.2↓ d) NS BF (%) = a) 3.81±2.4↓ b) 1.74±0.5↓ c) 4.49±2.9↓ d) NS LM (kg) = a) NS b) 5.33±1.3↑ c) 8.6±0.2↑ d) NS
Hernández-Reyes *et al.* 2019	117♀	42.9 ± 10.8	24 weeks	a) low-level of PA + d ACT b) imoderate PA +d c) intense PA d)cg a) WK 5000 p/d b) WK 10000 p/d 60% c) body pump EXC+WK a,b,c) 70% of VO2max	BM (kg) = a) 3.66±2.1↓ b) 3.23±2↓ c) 0.99±4.5↓ BF (%) = a) 3.56±3.1↓ b) 10.57±3.5↓ c) 16.31±5.9↓
Yu *et al.* 2020	40 8♂ 32♀	64 ± 4.4	10 weeks	a) console for 10 weeks, 3 p/w and 50 min each time, Xbox 360 Kinect®. 10 min. of WU, 30 min. of exergame, and 10 min. of CD. Weekly leisure ACT = (9 × Strenuous) + (5 × Moderate) + (3 × Light). b) SLA, HR 100-180 p/m	BF (%) = a) 0.7±7.2↑ b) 0.14±8.2↓
Do-JinKim *et al.* 2020	16♂	53 ± 1.75	8 weeks	a) RST (1RM 80% each 1week/10 reps 2set/20min); AT (target HR 80% each 1 p/w, 20 min.); Squat, Press (bench, leg, shoulder), Leg curl, Barbell curl, Lat pull down, Lunge. b) SLA	BF (%) = a) 5.1±1.4↓ b) 0.15±2.4↑ MM (kg) = a) 2.05±4.1↑ b) 0.12±1.1↓
Correio *et al.* 2020	41 8♂ 33♀	42.3 ± 7.8	20 weeks	a) intervention consisted of two weekly sessions Pilates. Cuing, sequence, and number of reps are all predetermined.As the study progressed, and partic. mastered the IEXC. 2x p/w x 60min. b) SLA	BF (%) = a) 0.61↓ b) 0.32↑

DISCUSSION

The duration of the experimental programs had a wide range and went from 4 to 48 weeks. The most commonly applied program was the 12-week program, found in seven studies (Grant *et al.* 2004, da Silva *et al.* 2006, Hottenrott *et al.* 2012, Hsu *et al.* 2015, Freitas *et al.* 2017, Mohammadi *et al.* 2018), then the 16-week program, found in three studies (Cox *et al.* 2003, Irving *et al.* 2008, de Mendonça *et al.* 2014). The 48-week

program was also represented in three studies (Reseland *et al.* 2001, Layman *et al.* 2009, McTiernan *et al.* 2012). The remaining studies (Emerenziani *et al.* 2018, Do-JinKim *et al.* 2020) had a duration of experimental programs of less than eight weeks. The program (Yu *et al.* 2020), was 10 weeks long. There was one 14-week program (Hays *et al.* 2004), two 20-week programs (Delecluse *et al.* 2004, Correio *et al.* 2020), and one treatment in duration of 21 weeks (Sillanpää *et al.* 2009), 22 weeks (Benito *et al.* 2015), and 24 weeks (Hernández-Reyes *et al.* 2019), respectively.

When observing aerobic activities of medium or high intensity in the range of 70–85% HRmax, the average training frequency on a weekly basis was 3–5 times. In programs whose contents included activities such as walking or individual exercise programs at home, the frequency was 5–6 times during the week, and the intensity of activities was slightly lower and amounted to 60–75% HRmax. The average duration of training ranged between 40 and 60 minutes of active implementation during the applied activity.

For WHO physical activity and for active pastime and healthy living, activities of 3 days during the week are recommended, as well as the duration of exercise of 150 minutes per week. Many factors, especially gender and age, can affect the type, frequency and duration of activities (Owen *et al.* 2010, Sitthipornvorakul *et al.* 2014). Aerobic exercise and exercise with extra load are effective for improving body weight and body composition (Heyward 1991, Arslan *et al.* 2017). Cardiorespiratory training and weight training in both men and women are effective methods for reducing body fat and weight (Heyward 1991). In addition to the above mentioned, the most effective workouts for reducing body fat are workouts with load, medium or high intensity. Such training has the effect of increasing muscle mass (Wilmore *et al.* 1994), and generally gives positive effects on body composition. However, many studies show that combined exercise programs not only increase body weight without fat deposits, but also show more effective results in reducing fat percentage (Yilmaz 2013, Rossi *et al.* 2016). This claim is supported by studies included in the systematic review (Grant *et al.* 2004, Delecluse *et al.* 2004, Irving *et al.* 2008, de Mendonça *et al.* 2014, Benito *et al.* 2015, Hsu *et al.* 2015). However, in the study by Emerenziani *et al.* (2018), there was an increase in fat deposits expressed in kilograms and percentage, probably due to poorly programmed training and lower intensity of activity than needed. Several systematic studies have shown that we can expect less weight loss from physical activity alone compared to one with an addition of diet, i.e. limiting caloric intake (Miller *et al.* 1997, Catenacci, Wyatt 2007). The caloric intake parameter was not monitored in this study, so it cannot be claimed with certainty that intensive training led to higher calorie consumption compared to other programs, thus affecting the body composition.

Gormley *et al.* (2008) concluded that modeling training programs based on volume and intensity are much better in relation to calorie consumption because participants spend the same amount of time in training that corresponds to their relative values. Ferreira *et al.* (2009) conducted a study on 14 inactive women (33–45 years old) and investigated the effects of a 10-week aerobic circuit training (3 days a week) on the body composition. The results of the study showed that there was an increase in fat-free mass, a decrease in body fat and total body weight. In some studies (de Mendonça *et al.* 2014, Mohammadi *et al.* 2018), there was a noticeable increase in fat-free muscle mass, but some other authors (Layman *et al.* 2009, Hsu *et al.* 2015), observed a decrease. It is important to point out that in previous research, a decrease in muscle mass was found (Nindl *et al.* 2006, Lucas *et al.* 2009). One of the possible reasons for this fact lies in the duration of the study, the type of program and the choice of exercises. On the other hand, the application of aerobic activities in the form of walking, brisk walking and a program conducted on a bicycle ergometer with an additional diet (Reseland *et al.* 2001, Hays *et al.* 2004, Layman *et al.* 2009, Hernández-Reyes *et al.* 2019) lead to significant changes in the body composition compared to the group that only dealt with physical activities. 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 (Wilmore *et al.* 1994).

The obtained results clearly show the benefits of aerobic training and training with extra load on the body composition of women and men. Based on the systematic review, aerobic activities performed 3–5 times a week, for 12–16 weeks, are recommended. The duration of the training should be within 50–60 minutes. In this way, an unquestionable effect on the reduction of body fat in the male and female population of the participants is achieved. This type of activity has a much better effect than training in duration of 20–40 minutes, however, such programs are safer for overweight people and in combination with a diet can be very effective and useful.

CONCLUSION

Aerobic programs and programs with extra load are effective means of improving the body composition of women and men. A very important element in this process is the application of a diet, reducing daily caloric intake and increasing physical activity. Medium or high intensity is an effective way to reduce body fat in the male and female population, however, the results may vary primarily due to the type and duration of activity, but mostly due to the sample of participants, as in the physically inactive population there may be contraindications. In physically inactive people it is necessary to apply moderate intensity and individually dose the load in accordance with their abilities. Although aerobic activities predominate in this age category, it is necessary to do strength exercises to compensate for the loss of muscle mass due to aging. In addition to all the above mentioned, physical activities are an active lifestyle that contributes to maintaining health and quality of life regardless of gender and other characteristics.

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Bojan Bjelica
Borislav Cicović
Ljubica Milanović
Milan Zelenović*
University of East Sarajevo
Faculty of Physical Education and Sport
Bosnia and Herzegovina
E-mail: vipbjelica@gmail.com
E-mail: borislav.cicovic@ffvis.ues.rs.ba
E-mail: ljubica.milanovic@ffvis.ues.rs.ba
E-mail: milanzeleni13@gmail.com

Nikola Aksović
University of Niš
Faculty of Sport and Physical Education
Serbia
E-mail: kokir87np@gmail.com

Ridvan Colak
Ardahan Üniversitesi
Physical Education and Sports High School
Turkey
E-mail: colak.ridvan@gmail.com

* Corresponding author