ORIGINAL ARTICLE

Effects of CrossFit training program and traditional gym training on morphological characteristics of men

Ljubiša Kićanović[1] • Bogdan Živanović[1]✉ • Mila Vukadinović Jurišić[1] • Jelena Obradović[1]

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Abstract

CrossFit is recognized as one of the fastest-growing high-intensity functional training modes in the world. The study aimed to compare the effects of the CrossFit training program and traditional gym training on anthropometric measurements in healthy, active men. The study sample consisted of 50 participants who were divided into two groups, 22 participants who practiced the CrossFit training program (CFT group; 28.64±2.04 years; body height 181.74±6.96 cm; body mass: 72.75±5.53 kg), and 28 participants who applied traditional gym training (GT group; 26.89±2.99 years; body height: 184.52±7.80 cm; body mass: 74.86±8.48 kg). A total of ten anthropometric measurements (Body height, Body mass, BMI, Subscapular, Abdominal and Triceps skinfolds, Chest, Forearm, Upper arm, and Thigh circumferences) were monitored before and after twelve weeks. The Shapiro-Wilk test was used to test the normality of distribution. The multivariate analysis covariance (MANCOVA) and analysis of covariance (ANCOVA) were used to analyze the data. The results of this study indicated that there were statistically significant differences between groups in the Circumference of the upper arm (p=0.02), Thigh circumference (p=0.00), Chest circumference (p=0.03), and Subscapular skinfold (p=0.00). The findings of this study demonstrated that healthy, active males who participated in the 12-week CrossFit training program improved their anthropometric measurements more than those who trained in the traditional gym training.

Keywords Skinfolds • Body circumferences • BMI.

✉ bogdanzivanovic97@gmail.com

[1] University of Novi Sad, Faculty of Sport and Physical Education, Novi Sad, Serbia

Introduction

CrossFit (CF) training is high-intensity functional training that combines aerobic and anaerobic exercises which are performed quickly and contain multiple repetitions with or without a pause between series (Feito, Burrows, Tabb, Ciesielka 2020). The CF training is often characterized by the execution of exercises integrating large muscle groups (i.e., squat, push, press, etc.) or more specifically resistance training with free weights or body mass performed with high intensity with short rest intervals (Weston, Taylor, Batterham & Hopkins, 2014). Initially, this program was designed for people whose work required a certain level of physical form as well as muscle strength, like soldiers, policemen and firefighters (Weisenthal, Beck, Maloney, DeHaven, & Giordano, 2014). Because the CF training includes weightlifting (squats, deadlifting, power snatch, power clean) with a large number of repetitions during a short period, gymnastic movements (pull-ups, hand-walking, push-ups on the wall), and aerobic exercises (running, swimming, rowing) (Longe, 2012). However, in the last few years, CF training has also been applied to physically healthy boys of 16-17 years (Petrova, Bala, Masliak, & Mameshina, 2022), overweight men aged 21.6 ± 1.6 years (Dehghanzadeh Suraki, Mohsenzade, Tibana, &

Ahmadizad, 2021) and healthy active men aged 20.8 ± 2.0 (Özbay, 2019).

The basic principle of CF training is based on the uniform application of modalities that include weightlifting, gymnastics, and metabolic conditioning (Crawford, Drake, Carper, DeBlauw & Heinrich, 2018). The CF program aims to choose methods that will have an impact on the partial segment improvement and which will later improve overall fitness development. thehe Each complex in CF training is referred to as "training of the day", which is short for WOD ("Workout of the Day"). Most of these complexes bear a certain name (late soldiers, policemen, firefighters). These complexes are considered as official CF training and their number is steadily increasing (Crossfit, 2016). Since CrossFit is a relatively new group exercise program, there are a few longitudinal types of research that scientifically and statistically indicate its effects. Eun-Ju, Wi-Young, and Taikyeongm (2017) reported that 14 weeks (two times per week) of CF training improved the body composition of male students.

Barfild and Anderson (2014) concluded that the CF program was effective for raising aerobic endurance levels, but it did not have significantly better effects on muscle endurance, flexibility, and body composition in comparison to Olympic weightlifting. Based on that, previous studies (Eun-Ju et al., 2017; Barfild et al., 2014) showed that CF training improves aerobic endurance level and body composition of male population. On the other hand, resistance training is a modality of exercise that has grown in popularity over the past two decades, particularly for its role in improving athletic performance by increasing muscular strength, power and speed, hypertrophy, local muscular endurance, motor performance, balance, and coordination (Kreamer et al., 2000). Additionally, Maksimović, Vukadinović, Rakonjac, Obradović, and Barišić (2016) reported that 12 weeks of heavy resistance training effect on the morphological characteristic of young males.

According to the author's knowledge, no study examined the effects of CF training programs and traditional gym training on anthropometric measurements of men. Therefore, the purpose of this study was to compare the effects of the CF training program and traditional gym training on anthropometric measurements in healthy, active men.

Method

Participants

The study included 50 healthy, active men who volunteered to participate in the survey and were members of the Sports Society "Sportagora" from Čačak. These 50 participants met the following criteria: (i) all participants had to train CF in 'Sportagora' from Čačak for at least 6 months; (ii) this study included only the male population; (iii) age between 18 to 30 years. Exclusion criteria were: (i) injury before or during the study (N=5); (ii) supplementation (N=7). They were divided into two groups. The experimental group consisted of 22 participants (CFT group; 28.64±2.04 years; body height: 181.74±6.96 cm; body mass: 72.75±5.53 kg) who trained the CF training program, and the other experimental group included 28 participants (GT group; 26.89±2.99 years; body height: 184.52±7.80 cm; body mass: 74.86±8.48 kg) who exercised traditional gym training program. Both groups had one-hour training sessions three times a week, for 12 weeks.

Measuring instrument

The following anthropometric measurements were taken: Body height and Body mass, body mass index (BMI), four circumferences (Chest circumference, Circumference of the forearm, upper arm and thigh) and three skinfolds (Subscapular, Abdomen, and Triceps). The BMI was calculated using a formula and the categorization of the feeding condition was taken according to Harrison's scale (Harris, Bradlyn, Coffman, Gunnell & Cottrell, 2008). Body height was determined by Martin's anthropometer (GPM, Switzerland), skin folds were measured using a John Bull's caliper (British Indicator Ltd, UK) with an accuracy of 0.2 mm, and circumferences were measured with a centimeter tape with an accuracy of 0.1 mm. Training program

Procedure

Anthropometric measurements were tracked for 12 weeks. The first testing was conducted at the beginning of the program, while the final testing was carried out after 12 weeks of CF training intervention and the traditional gym training program. The experimental group practiced CF workouts in the presence of coaches, and the other experimental group went to the traditional gym training. The study was conducted at the Sports Society "Sportagora" from Čačak. The participants were asked not to perform any intense physical activity the day before

the testing, and not to consume food or drink for at least 3 hours before it. The testing was performed in the morning, and the same examiners took the same anthropometric measurements on the initial and final testing, in the same order.

Following the principles of CF training, the CFT group applied three training complexes. Each complex consisted of three pieces of training performed in one week (Table 1). For 12 weeks, these complexes took turns every week. Each training was followed by a 48-hour rest period to allow participants to recover and prepare for the next training.

The workout began with a warm-up, after which participants did one of the complexes that lasted for 20 to 30 minutes, and the training was finished with static stretching.

Table 1. Training program for CFT group

Complex 1			
Name	"Cindy"	"Barbara"	"Ralph"
	AMRAP 20'	5 rounds for time:	For time:
	5 pull-ups	20 pull-ups	8 deadlifts
	10 push-ups	30 push-ups	16 burpees
	15 air squats	40 sit-ups	3 rope climbs
		50 air squats	600m run
Complex 2			
Name	"Angie"	"Helen"	"Kelly"
	For time:	3 rounds for time:	5 rounds for time
	100 pull-ups	400m run	400m run
	100 push-ups	21 kettlebell swing	30 box jumps
	100 sit-ups	21 pull-ups	30 wall ball
	100 air squats		
Complex 3			
Name	"Annie"	"Loredo"	"Donny"
	For time:	6 rounds for time	21-15-9-9-15-21 reps
	50-40-30-20-10	24 air squats	For time:
	Double-unders / single unders	24 push-ups	deadlifts
	sit-ups	24 walking lunges	burpees
		400m run	

Legend: AMRAP – As many repetitions as possible

In the GT group, all participants followed the same resistance training for twelve weeks (3 days/ weeks; 3-4 sets of 10-12 repetitions, resting between repetitions in the series 2-3 minutes, between exercises 4-5 minutes). The load ranged from 80-95% of the 1 repetition maximum. Participants were trained three days per week. There were three different training sessions. Briefly, the first training involved chest and biceps musculature and included six different exercises; the second training involved back and triceps musculature and included six different exercises; the third training involved shoulder and leg musculature included six different exercises. The total time of one training session for each participant was approximately 90-120 min.

Data analysis

Statistical data included descriptive statistics: mean (Mean), standard deviation (SD). The statistically significant differences between groups, for all analyzed variables, during the initial testing were measured by multivariate analysis of variance (MANOVA) and univariate analysis of variance (ANOVA).. To determine statistically significant differences between groups in the final testing of a given sample, a multivariate analysis of covariance (MANCOVA) and univariate analysis of covariance (ANCOVA) were used. Data were analyzed in the IBM SPSS Statistics 20.0 software package at a significance level of $p \leq 0.05$.

Results

Based on P-values (Table 2), it was concluded that there was no statistically significant difference (P=0.12) between the experimental groups in anthropometric measurements during the initial testing. In the individual analysis of each analyzed variable, it was concluded that a statistically significant difference ($p \leq 0.05$) existed in the Chest circumference, Circumference of the forearm, Circumference of the upper arm, Thigh circumference and Subscapular skinfold.

Table 2. Differences between groups in anthropometric measurements on the initial measurement

	CFT group	GT group		
Variable	Mean ± SD	Mean ± SD	f	p
Body height (cm)	181.74±6.96	184.52±7.80	1.72	0.29
Body mass (kg)	72.75±5.53	74.86±8.48	1.01	0.32
Body mass index (kg/m^2)	22.11±2.31	22.05±2.80	1.17	0.28
Chest circumference (cm)	87.35±2.90	86.18±2.75	5.29	0.03
Circumference of the forearm (cm)	23.70±0.87	23.78±1.50	5.49	0.02
Circumference of the upper arm (cm)	26.52±1.84	26.31±2.39	17.32	0.00
Thigh circumference (cm)	59.11±3.81	56.50±4.76	211.16	0.00
Triceps skinfold (mm)	100.45±23.79	104.57±33.57	0.06	0.80
Skinfold on the abdomen (mm)	133.45±55.56	125.00±48.39	0.11	0.74
Subscapular skinfold (mm)	91.64±28.26	92.29±24.12	8.32	0.00
	F=1.70	P=0.12		

Legend: f – test for univariate analysis of variance, p – statistically significant difference between the groups within one variable ($p \leq 0.05$); F – test for multivariate analysis of variance; P – statistically significant difference between the groups in a system of variables ($p \leq 0.05$)

Based on P values (Table 3), it was concluded that there was a statistically significant difference (p=0.00) between the experimental groups in anthropometric measurements during the final testing. An individual analysis of each anthropometric measurement concluded that statistically significant differences ($p \leq 0.05$) in the Chest circumference, and Thigh circumference. Statistically significant differences were not found for the remaining 8 variables.

Table 3. Differences between groups in anthropometric measurements on the final measurement

	CFT group	GT group		
Variable	Mean ± SD	Mean ± SD	f	p
Body height (cm)	181.74 ±6.96	184.52±7.80	1.72	0.20
Body mass (kg)	72.41±4.69	74.81±7.45	1.73	0.20
Body mass index (kg/m^2)	22.01±2.17	22.05±2.63	1.02	0.96
Chest circumference (cm)	87.90±2.99	86.18±2.81	4.37	0.04
Circumference of the forearm (cm)	23.89±0.94	23.80±1.52	0.50	0.82
Circumference of the upper arm (cm)	27.22±1.77	26.61±2.38	1.00	0.32
Thigh circumference (cm)	63.13±3.84	56.69±4.84	25.9	0.00
Triceps skinfold (mm)	94.59±22.70	100.25±28.58	0.58	0.45
Skinfold on the abdomen (mm)	135.86±76.73	124.75±49.45	0.38	0.54
Subscapular skinfold (mm)	86.41±27.30	90.86±23.09	0.39	0.56
	F=5.99	P=0.00		

By neutralizing the differences in the initial measurement, the respondents from the CFT group achieved better and statistically significant results than the GT group (Table 4.). Statistically significant differences were noted in Chest circumference (p=0.03), Circumference of the forearm (p=0.02),

Circumference of the upper arm (p=0.00), Thigh circumference (p=0.00) and Subscapular skinfold (p=0.00) in favor of the CFTgroup. Statistically significant differences were not found for the remaining variables (Table 4).

Table 4. Multivariate analysis of covariance for examined anthropometric measurements

Variable	CFT group	GT group	f	p
	M* ± SD	M* ± SD		
Body height (cm)	72.41±4.69	74.81±7.45	1.18	0.29
Body mass (kg)	22.01±2.17	22.05±2.63	1.17	0.28
Body mass index (kg/m^2)	87.90±2.99	86.18±2.81	5.29	0.03
Chest circumference (cm)	23.89±0.94	23.80±1.52	5.49	0.02
Circumference of the forearm (cm)	27.22±1.77	26.61±2.38	17.32	0.00
Circumference of the upper arm (cm)	63.13±3.84	56.69±4.84	211.16	0.00
Thigh circumference (cm)	94.59±22.70	100.25±28.58	0.06	0.80
Triceps skinfold (mm)	135.86±76.73	124.75±49.45	0.11	0.74
Skinfold on the abdomen (mm)	86.41±27.30	90.86±23.09	8.32	0.00
Subscapular skinfold (mm)	72.41±4.69	74.81±7.45	1.18	0.29
	F=34.83	P=0.00		

Legend: M*– corrected mean

Discussion

The present study aimed at the comparison of the effects of the CF training program and traditional gym training on anthropometric measurements in healthy, active men.

During the initial testing, the differences between groups in anthropometric measurements (Chest circumference, Circumference of the forearm, Circumference of the upper arm, Thigh circumference, and Subscapular skinfold) can be observed. At the beginning of the treatment, the groups were approximately equal in terms of analyzed anthropometric measurements. The results of descriptive statistics only confirmed the facts presented by other authors in this field of group training (Hillsdon et al., 2002), that CF requires a certain level of motor skills, in addition to an adequate body constitution and physique that is above all harmonious.

The results of the final testing indicated the difference between groups in Chest circumference and Thigh circumference.

The results from Table 4. show the difference between groups in Chest circumference, Circumference of the forearm, Circumference of the upper arm, Thigh circumference, and Subscapular skinfold. After 12-week CFT group had a larger increase in body volume and reduction in adipose tissue compared to GT group. Similar results were obtained from Eun-Ju et al., (2017), who noted statistically significant changes in body composition after 14 weeks of CF training. Furthermore, Bellar, Hatchett, Judge, Breaux, & Marcus (2015) showed that CF training contains both aerobic and anaerobic activities which affected cardiovascular abilities as well as the reduction of subcutaneous fat tissue.These results support the findings that physically active adults engaged in CF training have a higher level of fat oxidation during the training (Tremblay, Coveney, Despres, Nadeau, & Prud'homme, 1992) and during the resting period (Choi, So, & Jeong, 2017). The resulting changes during the final testing in the CFT group could be explained by the body's adaptation to training with muscle load and hypertrophy. The training with load leads to muscle hypertrophy, which is reflected in increased body volume (Outlaw et al., 2014). It is assumed that during CF training the load was higher than during the traditional gym training, which led to the muscle hypertrophy which had a positive effect on the increased body volume.

In contrast to other studies (Hillsdon et al., 2002; Lyman et al. 2005)), participants from this study did not have statistically significant differences ($p \geq 0.05$) in BMI and Body weight, which could be attributed to external control of research related to the diet of exercisers that was not predetermined and controlled for 12 weeks.

This research has shown that the application of 12 weeks of CF training led to a greater improvement in anthropometric measurements in comparison to

traditional gym training in healthy active men. The strength of this study is that, according to the author's knowledge, this is the first study that investigated the effects of CF training and traditional gym training on the anthropometric characteristics of men. It is also important to note that this study compares the effects of CF training and traditional gym training on the anthropometric characteristics of men, which has not been done so far. Despite the benefits observed in this study, there are a few limitations. First, we have a small sample size. Secondly, we investigated only male participants aged between 18 – 30 years while female adults were not included. Thirdly, there was no control group. Future research ought to investigate the effects of CF training on the motor abilities (strength, power, endurance, flexibility, and speed) of male and female athletes. Also, future research should compare the CF training programs to other traditional training methods like HIIT. It can be assumed that high levels of strength, power, and agility, accompanied by low subcutaneous fat content and a larger volume of thigh muscles, forearms, upper arms, and normal nutritional volume, are required to successfully participate in CF training.

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