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RESEARCH ARTICLE

IS CROSSFIT EXERCISE SUITABLE FOR OVERWEIGHT MIDDLE-AGED WOMEN (A CINDY MODEL STUDY)

Mehmet Soyler [1], Raif Zileli [2]

[1] Cankiri Karatekin University, Yaprakli Vocational School, Cankiri, Turkey.
[2] Bilecik Şeyh Edebali University, Faculty of Health Sciences, Bilecik, Turkey.

ORCID: M.S. 0000-0002-6912-4218; R.Z. 0000-0003-4178-5468

Address for Correspondence: Mehmet Soyler, **E-mail:** mehmetsoyler@karatekin.edu.tr
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ABSTRACT

Purpose: In this study, it was aimed to examine the effects of the 16-week CrossFit Cindy exercise model on some physical and physiological fitness parameters.

Methods: In this study; mean age 39.87±8.21 years, average height 164.07±9.16 cm, body weight averages 87.40±12.05 kg, BMI averages 30.71±4.79 kg/m^2 and during the last 6 months 15 overweight middle aged women who did not regular exercise participated voluntarily. Participants were applied CrossFit exercise (cindy method) 4 session a week for 16 weeks regularly. Participants' body composition, cardiovascular fitness and physical physiological fitness parameters were measured before and after exercise period. Variance homogeneity of the data was performed using Levene's Test and normal distribution analyzes were performed with Shapiro-Wilk Test. Paired Sample T Test was used in the analysis of all parameters. Significance was determined at the level of p> 0.05.

Results: As a result of exercise interventions in overweight middle aged women, statistical changes were observed in the body composition, resting heart rate, oxygen consumption maximal strength and flexibility values of the participants.

Conclusion: The findings suggest that CrossFit Cindy model can be used an alternative high intensity exercise methods that cause positive changes in the body composition and physiological parameters of overweight middle aged women.

Keywords: Crossfit, Cindy, High Intensity Exercise, BMI, Overweight

INTRODUCTION

Today, physical inactivity rapidly causes health problems and chronic diseases. When we look at the literature, there is an intense relationship between the increase in obesity due to inactivity and metabolic diseases. These days, the prevalence of obesity is very much related to the age factor (1). Even though, the women increasingly desire to look physically well, physical inactivity increases day by day among women (2). Negative effects of the technological developments come among the factors which cause this increase. Individuals have become less mobile due to the facilities brought by technology (3).

Sedentary lifestyle which is parallel with the technological developments is one of the biggest dangerous diseases faced by an individual in the civilized world (4). A sedentary lifestyle, which is described as the disease of our age and causes many

health problems, has a very high incidence of many diseases such as obesity, muscular weakness, diabetes, especially cardiovascular diseases, in sedentary individuals (5).

Physical inactivity is a leading risk factor for the above-mentioned health problems and today, exercise is accepted as the fundamental principle of healthy life. Guthold et al., (2020) reports that the global physical activity target of World Health Organization (WHO) for 2025 would not be accomplished if this present tendency related to the physical inactivity goes on. Likewise, WHO set a target to reduce the insufficient physical activity for 2030 among adults within More Active People for a Healthier World global action (6). Recently, there has been an increased interest in high-intensity exercises such as high-intensity interval training (HIIT) as an alternative to classical fitness exercises, as it increases time economy and motivation. (7). The results of Dominski et al., (2021) show that high-intensity modalities have significant growth among various groups which include obese and healthy individuals (14). The expectation to reduce the amount of body fat, especially in the participation of sedentary women in exercise programs, is of great importance for exercise selection (8,9).

CrossFit, which is one of the training models that has become widespread recently, is a training practice consisting constantly changing, high-intensity, multi-jointed movements. The main target of this training model is to create a broad, common, and very comprehensive training method (10). The content of CrossFit is also described as combined training and is recommended in terms of strength and power training to use the time efficiently (11). CrossFit consists of exercises based on a new and extremely popular physical activity, which are perpetually changing aimed at performance. It is carried out at high intensity, covering many functional movement patterns in a single training session.

It consists of a circuit that is done as group exercises and called "Exercises of the Day", which continues in continuous combination with short rest intervals with little or no rest intervals. This combination is called "Workout of the Day (WOD)". Although there are differences and variations depending on the content and structure of all training sessions, training periods include a unique warm-up, skill technique and strength training, with an average of 60-90 minutes (12). Typically, the WODs are prescribed using training types to perform as many repetitions as possible (AMRAP) in a given period of time or as a set of tasks to be completed in the shortest possible time ('for time') (48).

CrossFit exercises consist of power lifting (such as bench press, deadlifts and presses), calisthenics (such as pull-ups, lunges, knees to elbows, handstand push-ups, push-ups, and sit-ups), and aerobic exercise (such as running, rowing and swimming) (13).

Some WODs which are more often used include 'Nancy, 'Fran', 'Cindy', 'Fight Gone Bad', 'Filthy 50', 'Helen' and 'Grace'. These workouts include a combination of aerobic (i.e., 'Nancy', 'Fight Gone Bad', 'Filthy 50', 'Helen'), body weight (i.e., 'Fran', 'Cindy', 'Fight Gone Bad', 'Filthy 50', Helen') and weightlifting (i.e., 'Nancy', 'Fran', 'Fight Gone Bad', 'Filthy 50', 'Helen,' 'Grace') exercises; vary in time domains from a few minutes (i.e., 'Fran,' 'Grace') to over 20 min (i.e., 'Filthy 50'); and are performed 'for time' (i.e., 'Nancy', 'Fran', 'Filthy 50', 'Helen', 'Grace') or for as AMRAP (i.e., 'Cindy', 'Fight Gone Bad') (48).

The CrossFit exercise method is now making new and positive contributions for sedentary and athletes in terms of positive adaptation, health and performance. ACSM (American College of Sports Medicine) suggests sedentary people to use the high intensity interval exercise method for 3 to 7 days a week, in 30 seconds to 2 minutes and at 80% heartbeat rate (HBR) and rest until 40-45% heartbeat rate in 3-5 repetitions (15). This model which has been in the top five every year since 2014, was listed as number two trend in 2020 (16). Based on this, Cindy exercise model appears to be an exercise model in CrossFit that includes resistance and endurance models to improve physical fitness parameters such as power, strength, and endurance in an exercise program (17).

CrossFit Cindy Model is equivalent to vigorous exercise according to the ACSM for beginners (47). It is important to investigate the effect of the commonly used CrossFit Cindy exercise model on some physical and physiological fitness parameters in sedentary women. This study predicts that exercise with CrossFit Cindy Model increases performance in physical - physiological parameters. When the literature was examined, no study was found on the effects of Crossfit Cindy Model in Turkish overweight middle-aged women. Within the frame of this hypothesis, this study examines the effects of the 16-week CrossFit Cindy training model applied to

Table 1. Exercise Program

Weeks	Warm Up-Cool Down	Demo Application	CrossFit Program (20 min.)	Repetition (mean)	Total Min
1-4	**WU:**15 min.	15 min.	**Half Cindy**	5.00 10.00 13.18	60 min
	CD:10 min.		5 Assisted Pull up Machine 10 Knee Push up 15 Squat		
5-8	**WU:**15 min.	-	**Half Cindy**	5.00 9.68 12.00	45 min
	CD:10 min.		5 Assisted Pull up Machine 10 Knee Push up 15 Squat		
9-12	**WU:**10 min.	-	**Cindy**	5.00 9.81 12.52	40 min
	CD:10 min.		5 Assisted Pull up Machine 10 Knee Push up 15 Squat		
13-16	**WU:**10 min.	-	**Cindy**	5.00 10.00 14.73	40 min
	CD:10 min.		5 Assisted Pull up Machine 10 Knee Push up 15 Squat		
	WU= warm up, **CD**=cool down, **min**=minute				

overweight middle-aged women on some physical and physiological fitness parameters.

MATERIAL AND METHODS

Participants

Fifteen healthy, overweight middle-aged women (average of age 39.87±8.21 years, height average 164.07±9.16 cm, body weight average 87.40±12.05 kg, and BMI average 30.71±4.79 kg/m^2) who are members of a sports center voluntarily participated in this study. Participants who had general health problems, were in the menopause process and participated in an exercise program below 80% were determined as the exclusion criteria of the study. The study was approved by the Bilecik Şeyh Edebali University Ethics Committee (Date: 29.06.2020, Decision no: 27) and was conducted in accordance with the World Medical Association Declaration of Helsinki. After all the volunteers were verbally informed prior to the study, their written informed consents were obtained.

Exercise Intervention

Participants practiced in the CrossFit practice area of a private sports center, 4 session a week for 16 weeks, and 20 minutes a day. The Cindy training protocol was done between 6 p.m. and 7:30 p.m. as given in Table 1. In the present study, the "Cindy" model was chosen as the WOD consisting of 5 assisted pull-ups, 10 knee push-ups, and 15 air squats as many reps as possible in 20 minutes. Participants had twenty minutes to complete as many rounds and repetitions as possible. Total rounds and repetitions were scored and converted to total number of repetitions in 20 minutes for the analysis. Warm-up included jogging, then calisthenics and post-exercise stretching intervention as suggested by literature (18, 49, 50).

Participants were practically informed about the movements of the training program, demonstrating the movements them in practice one week before the beginning of the study.

Measurements

Participants cardiovascular fitness, body composition and physical physiological fitness parameters were measured at the beginning and at the end of the exercise period as pre-test-post-test model. Both measurements were taken in the morning, between 8:30 a.m. and 11:30 a.m. The whole test program was administered by the same researcher at the sports center. The participants were asked not to consume excessively fatty foods or engage in strenuous activities. Participants were not given any specific nutritional program or food restriction during their trainings.

1. Body Composition Measurements

1.1 Height Measurement: The participants was measured in cm with a Holtain (UK) stadiometer with a sensitivity of 0.01 m in a standing upright position, with barefoot, feet together with the heels, head upright and eyes facing forward (19).

1.2. **After the height measurement, participants were taken to body composition measurement:** The measurement consists of Skeletal Muscle Ratio (kg), Body Mass Index-BMI (kg/m^2), Body Fat Ratio-BFR (%), Body Fat Weight (kg) (Inbody 270 Japan). Bioelectrical impedance is a measurement method based on the electrical permeability difference of fat and measuring lean tissue mass (20). During the measurement, participants were asked to put off metal adornments and to be with light and comfortable training clothes. They were also asked to stand barefoot on the device and to hold the hand electrodes in a proper way as demonstrated by the researcher. The results were recorded using a computer connected to the Body Composition Analyzer. Measurements were taken on a same available day for all the participants in which all of them not in their period of menstruation (Luteal phase). They were asked to use the toilet before the measurements.

2. Cardiovascular Measurements

The cardiovascular measurements were also taken at the beginning and at the end of the exercise period.

2.1. Heart Rate Measurement: We measured Rest-HR with a Polar RS800cx watch. We transferred the data to a computer with an infrared connection and saved it. The watch is made in Finland and has two parts. One of the parts is a watch and wear to the wrist. The other part is a rubber band and wears to the heart line to surround the chest. It has options to save HR to a computer with 5, 10, or 15 seconds intervals (19).

2.2. Blood Pressures Measurement: One researcher measured the blood test of the participants as they sat on a chair in mmHg using aneroid-sphygomano-meter and stethoscope devices. This measurement was repeated three times without any gaps. The lowest value of the measurements was recorded (19).

3. Physical – Physiological Measurements

3.1. Sit and Reach Test: to measure the flexibility of the hamstrings muscle, a standard high Sit-Reach Noodle Stand, which is 35 cm long, 45 cm wide and 32 cm high, was used for muscle flexibility measurement, and the test was applied as 3 repetitions. The best result was recorded as the elasticity value (21).

3.2. Max VO_2 Measurement: Twenty-meters shuttle test was used for the maxVO_2 values of the participants (22). The 20-meters shuttle run test starts at 8.5 km/h and increases the running speed by 0.5 $km.h^{-1}$ every 1 minute. In order to determine the running speed, a standard test cassette was used. The test was terminated when the volunteer could not overlap the two signals or stopped the test. According to the results, the VO_{2max} values of the participants were calculated in ml/kg/min (23).

3.3. Leg Extension and Leg Curl Measurement (5 RPM): For Leg Extension and Leg Curl measurement, standard plates weigthing one kg / One and a half kg / two kg / two and a half kg / three kg / five kg / ten kg / fifteen kg / twenty kg were used. The maximal strength of each participant was determined by the 5-repetition method. In order to determine the weight that the participants would lift each participants made a trial lift before the measurement. As a result of this trial, maximum weight that the participant could lift for five repetition both in leg extension and leg curl was determined (24).

3.4. One Minute Sit-up Test: For the test, participants were asked to lie back, their knees bent at a 90 degrees angle, their hands are on their neck, and their feet touching the ground. With the command, they tried to do the sit-up as many as they could in one minute. An assistant holds the participants' ankle in order to keep the feet fixed. Participants were asked to try the sit-up before the tests started. The shoulders of the participants were made sure to touch the ground in the lying position, and their elbows were made sure to touch the knees in the upright position. Number of the sit-ups were recorded into the registration form after one minute (25).

3.5. Hack Squat Test: For this measurement, fixed plate weighing one kg/ one and a half kg/ two kg/ two and half kg/ three kg/ five kg/ ten kg/ fifteen kg/ twenty kg were used. The maximal strength of each participant was determined by the 5 repet. method. In order to determine the weight that the participants would lift each participants made a trial-and-error lift before the measurement. The participants' lumbar-spine-leg posture was stabilized in the Hack Squat

Table 2: Descriptive Statistics

Variables	n	$\bar{x}$ ± sd
Age (years)	15	39.87±8.21
Height (cm)	15	164.07±9.16
Weight (kg)	15	87.40±12.05
BMI (kg/m^2)	15	30.71±4.79

machine. They were asked to lift the weight appropriately. After the successful lift, extra weight was added for the next step (24).

Statistical Analysis

SPSS 23 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis of the data obtained within the scope of the study. Normality of the data was analysed with the Shapiro-Wilk test and homogeneity of variance was analysed with the Levene test. Paired Sample T Test was used in the analysis of all parameters. Statistical significance was accepted as p<0.05. The arithmetic mean, standard deviation, effect size and development rate values are also presented.

The development rates (%) of the athletes were calculated as in the following formula:

$|PreTestScore - PostTestScore| = Difference$

$(Difference/PreTestScore) \times 100$ Development Rate%

The sample size was calculated with the GPower 3.1.9.4 programme. Accordingly, the sample size was described as 15 participants with an alpha (mistake) rate of 8% and 90% power with the medium effect size for dependent t-test.

RESULTS

Body composition, cardiovascular fitness and physical-physiological fitness parameter measurement values of the participants are presented below. Table 2 shows that the mean age, height, body weight and BMI of participants (n: 15) are 39.87±8.21 years, 164.07±9.16 cm, 87.40±12.05 kg, 30.71±4.79 kg/m^2, respectively. The striking finding of the descriptive data above is that the participants can be classified as young but obese.

Table 3 shows the statistical analysis of the participants pre-test and post-test values. According to the results, Body Weight (t = 8.59, p <0.05), Body Fat Ratio (t = 10.74, p <0.05), Body Fat Weight (t = 12.30, p <0.05), Body Mass Index (t = 8.74, p <0.05) and Skeletal Muscle Weight (t = -9.61, p <0.05) parameters were found to be statistically significant.

Table 4 presents the statistical analysis of the participants pre-test and post-test values. Results show that there is a statistically significant difference in Resting Heart Rate (t = 5.27, p <0.05), Diastolic Blood Pressure (t = 5.13, p <0.05), Systolic Blood Pressure (t = 5.70, p <0.05).

When we look at Table 5, statistically significant difference was found in the flexibility (t = -7.00, p <0.05) parameter between the pre-test and post-test values of the participants. On the other hand, there is no statistically significant difference HBR max (t = 0.15, p> 0.05) and $VO_{2\ max}$ (t = -0.58, p> 0.05) parameters.

Pre-test and post-test values of the parameters show that there is statistically significant difference in 5 RPM Leg Ext. (t = -11.77, p <0.05), 5 RPM Leg Curl (t = -8.74, p <0.05), 1 min Sit-up (t = -3.13, p <0.05), Hack Squat (t = -7.09, p <0.05).

DISCUSSION

Fifteen healthy, overweight middle-aged women between 18 and 54 years old participated in this study. The group applied Cindy model exercise which is one of the CrossFit training models for 16 weeks, 4 session a week. The effects of the exercises were measured in terms of some physical and physiological parameters at the beginning and at the end of the exercise period.

Table 3: Comparison of the Pre-test and Post-test Values of Body Weight, Body Fat Ratio, Body Fat Weight, Body Mass Index, Skeletal Muscle Weight

Variables (n=15)	Pre-test $\bar{x}$ ± sd	Post-test $\bar{x}$ ± sd	t	p	Cohen d	Development Rate %
Weight (kg)	87.40±12.05	77.10±12.49	8.59	0.01*	0.83	-11.78
Body Fat (%)	34.65±5.18	28.99±5.35	10.74	0.01*	1.07	-16.33
Body Fat Weight (kg)	30.56±5.67	24.23±4.91	12.30	0.01*	1.19	-16.33
BMI (kg/m^2)	30.71±4.79	25.90±4.22	8.74	0.01*	1.06	15.66
Skeleton Muscle (kg)	21.35±1.86	24.71±1.70	-9.61	0.01*	1.88	15.73

*p<0.05**

Table 4: Comparison of the Pre-test and Post-test Values of Resting Heart Rate, Diastolic Blood Pressure, Systolic Blood Pressure

Variables (n=15)	Pre-test $\bar{x}$ ± sd	Post-test $\bar{x}$ ± sd	t	p	Cohen d	Development Rate %
RHBR (beat/min.)	77.80±3.69	74.87±3.50	5.27	0.01*	0.81	-3.77
DBP (mm/hg)	82.80±3.21	80.53±2.44	5.13	0.01*	0.79	-2.74
SBP (mm/hg)	125.27±5.33	122.00±4.50	5.70	0.01*	0.66	-2.61

**RHBR: Resting Heart Beat Rate *DBP: Diastolic Blood Pressure* Systolic Blood Pressure:SBP*

Body Weight (t = 8.59, p <0.05), Body Fat Ratio (t = 10.74, p <0.05), Body Fat Weight (t = 12.30, p <0.05), Body Mass Index (t = 8.74, p <0.05) and Skeletal Muscle Weight (t = -9.61, p <0.05) parameters were found to be statistically significant. When pre-test and post-test results analyzed, body weight (-11.78%), body fat percentage (-16.33%), body fat weight (-16.33%), and body mass index values decreased (15.66%). On the other hand, musculoskeletal weight values of the participants increased (15.66%) between pre-test to post-test (Table 3).

Perna et al. (2017) conducted a study in which they compared CrossFit and high intensity swimming among 24 people (14 females, 9 males) with a mean age of 31.74 ± 7.46 during 8 weeks and 3 days a week and 60 minutes a day (26). They reported that Cross Fit is more effective on body composition parameters. Reilly et al. (2009) found significant differences in body composition among 10 sedentary men and 10 sedentary women in 16-week HIIT exercise (27). Dilber & Doğru (2018) carried out a study with 30 sedentary men with mean age of 23.62±5.39. The participants were given CrossFit exercise for 12 weeks and 4 days a week. They reported that the body fat percentage of the participants decreased while back and leg strength increased (28). Segal et al. (2004) examined the effects of 6-month strength-resistance exercises on body composition with 42 healthy women. Even though, BMI and body weight values were not statistically significant, they reported that there were positive improvements in BMI and body weight values (29). Similarly, Smith et al. (2013) found out that 10-week CrossFit exercise caused significant improvements in maximal aerobic capacity and body composition of 23 men and 20 women (30). Gregory et al. (2017) carried out a study with 27 individuals who are between 18 and 60 years old (mean age, 34.58±9.26). They divided the participants into two groups as low carbohydrate ketogenic diet (LCKD) (9 women and 3 men) and control (13 women and 2 men). They prescribed low carbohydrate ketogenic diet and scheduled CrossFit combination for the LCKD group and prescribed usual diet and scheduled CrossFit combination for the control group. BMI (0.07±0.43,-1.13±0.70kg/m^2), body weight (0.18±1.30,-3.45±2.18kg), body fat percentage (0.01±1.21,-2.60±2.14%) and fat percentage (0.06±1.12,-2.83±1.77kg) of the LCKD group significantly decreased. Though increase in both groups was observed, performance of the LCKD group increased more when compared with the control group (31). Another study reports that there is a significant increase in total lean mass in 10 weeks of resistance training (32). Significant decreases are observed in BMI values in studies using resistance training method and CrossFit training. Murawska-Cialowicz et al. stated that three months of CrossFit training given to 15 young women significantly decreased the body fat percentage (33). Schjerve et al. (2008) presented a decrease (from 36.6±1.2 kgm^2 to 36.0±1.2 kgm^2) in BMI in adults who were given CrossFit training. This 2% decrease is worthy of notice. In particular, the inclusion of CrossFit resistance training programs for the lower and upper extremities has increased the effectiveness of this change (34). The findings of our study show a significant decrease in body weight, body fat ratio,

Table 5: Comparison of the Pre-test and Post-test Values of Hamstring Flexibility, HRR max, $VO_{2\ max}$

Variables (n=15)	Pre - test $\bar{x}$ ± sd	Post - test $\bar{x}$ ± sd	t	p	Cohen d	Development Rate %
Hamstring Flexibility (cm)	18.29±3.97	22.06±3.63	-7.00	0.01*	0.99	20.61
HBR max (beat/min)	180.67±3.52	180.47±3.52	0.15	0.88	0.05	0.11
VO_{2max} (ml/kg/min)	51.60±2.60	52.98±7.72	-0.58	0.57	0.23	2.67

*p<0.05**

Table 6: Comparison of the Pre-test and Post-test Values of 5 RPM Leg Extension, 5 RPM Leg Curl, 1 min Sit-up, Hack Squat

Variables (n=15)	Pre-test $\bar{x} \pm sd$	Post-test $\bar{x} \pm sd$	t	p	Cohen d	Development Rate %
5 RPM Leg Extension (repetition)	13.33±5.87	26.00±8.06	-11.77	0.01*	1.79	95.04
5 RPM Leg Curl (repetition)	21.00±4.70	41.00±10.38	-8.74	0.01*	2.48	95.24
1 min. Sit-up (repetition)	9.60±2.44	20.46±3.18	-13.13	0.01*	3.83	113.12
Hack Squat (kg)	14.20±6.57	31.33±10.43	-7.09	0.01*	1.96	120.63

skeletal muscle ratio and BMI values at the end of the CrossFit training period. Therefore, one can say that CrossFit resistance training has a different effect on body composition. Nindl et al. (2000) applied an exercise program consisting of a combination of resistance and aerobics to 31 healthy women for 6 months, 5 days a week. They recorded a 2.2% reduction in body mass at the end of the training period (35).

Our study represents a significant increase in muscle ratio and a significant decrease in body fat ratio. This change can be explained by the decrease in body weight.

In our study, Resting Heart Rate ($t = 5.27$, $p < 0.05$), Diastolic Blood Pressure ($t = 5.13$, $p < 0.05$), Systolic Blood Pressure ($t = 5.70$, $p < 0.05$) parameters were found to be statistically significant between pre-test and post-test values. According to these findings, resting heart rate (-3.77%), diastolic blood pressure (-2.74%), systolic blood pressure (-2.61%) values decreased from pre-test to post-test (Table 4).

Green et al. (2001) applied circular training to chronic heart patients with a mean age of 62±3 years and found a significant decrease in systolic blood pressure of participants at the end of training period (36). Kerrie et al. (2001) conducted a study among women with hypertension and examined blood pressure changes. They found out a decrease of 6 mmHg in resting systolic blood pressure after 12 weeks of exercise. They did not observe any changes in diastolic blood pressure. On the other hand, they did not report any difference in blood pressure values in the control group (37). Mensink et al. (1999) analyzed the relationship between the intensity and frequency of physical activity with cardiovascular risk factors among 5885 female participants. The participants did moderate intensity activities for 2-12 times a month and 0.5 – 2 hours per exercise. The results show that the systolic blood pressure (-1,8%), resting heart rate (-3.1%) and BMI (-3,2%) values of the exercise group was found to be lower than the control group. In terms of the light exercise (3-4.5 kcal/kg/h) done by the participants 5 or more times a week, women were found to have lower resting heart rate (-2.3%) compared to men (38). Regarding the present study, we observed a recovery among the participants with lower hearth rate and blood pressure at the end of the 16-week CrossFit period. Putting these two values together, we can assert that the heart works more productive resulting in more efficient training.

In our study, a statistically significant difference was found in flexibility ($t = -7.00$, $p < 0.05$) parameter for pre-test post-test values. On the other hand, there was no statistically significant difference between pre-test post-test values of HBR max ($t = 0.15$, $p < 0.05$), $VO_{2\ max}$ ($t = -0.58$, $p < 0.05$) parameters. Although not statistically significant, there was a small increase in $VO_{2\ max}$ (2.67%) in the post-test compared to the pre-test. With regards to the findings, we observed that flexibility values increased (20.61%) from pre-test to post-test, but HBR max did not change (0.11%) in exercises (Table 5).

Barfield & Anderson (2014) reported that CrossFit training did not cause any change in flexibility (39). Blake et al. (2000) gave a 14-week exercise program to sedentary obese and non-obese women. They compared exercise responses of the participants and their level of physical fitness. At the end of the study, they noted a positive change in flexibility (sit&reach) values in both groups (40). Bellar et al. (2015) found out that long periods of CrossFit WOD training period (4-10 weeks) resulted in improvement in $VO_{2\ max}$ (41). Kliszczewicz et al. (2014) suggested that CrossFit exercises result in an aerobic intensity (i.e., VO_{2max}) that meets or exceeds the minimum need to improve cardiorespiratory fitness. Kliszczewicz et al. (2014) asserted that aerobic intensity (i.e. VO_{2max}) is the

minimum requirement for the cardiorespiratory fitness and they reported that CrossFit exercises meet this requirement (17). Similarly, Murawska-Cialowicz et al. (2015) obtained significant increases in VO_{2max} after 24 weeks of CrossFit training (33). Hermans et al. (2017) stated that there was a significant improvement in flexibility after an 8-week Cindy training program (42). Hoods et al. (2011) applied treadmill exercise to determine the relationship between breathing, heart fitness and menopause level of 49 untrained women between 35 and 70 years old. Although they found VO_{2max} values to be lower as age increased, sub-max VO_2 was not found to be significant difference among age groups. The findings of this study infer that movements in CrossFit resistance trainings towards the lower and upper extremities increase the effectiveness of the changes in $VO_{2\ max}$ (43).

In our study, we observed statistically significant difference in 5 RPM Leg Extension ($t = -11.77$, $p < 0.05$, 95.04%), 5 RPM Leg Curl ($t = -8.74$, $p < 0.05$, 95.24%), 1 minute sit-up ($t = -3.13$, $p < 0.05$, 113.12%) and Hack Squat ($t = -7.09$, $p < 0.05$, 120.63%) parameters between pre-test post-test values. According to these findings, the measured maximal strength values changed from pre-test to post-test (Table 6).

Barfield & Anderson (2014) stated that CrossFit training resulted in a 22% increase in push-up movement, while it did not result any change in vertical jump movement (39). Paine et al. (2010) carried out a study of a 6-week training and reported that shoulder press/1RM (9.42%), back squat/1RM (13.41%), and dead-lift 1RM (21.11%) strength increased for the participants who completed 4 training sessions per week (46).

Study of Kalapotharakos et al. (2005) show that anaerobic exercises caused a statistically significant increase in maximal strength values (3). Gerhart and Pasternostro (2014) reported that when sedentary individuals do CrossFit resistance training, this caused an increase of 2-20% in muscle strength (44). Exercise creates significant increases in aerobic capacity and maximal strength (45). The increase in maximal strength found in our study can be thought to be a result of CrossFit exercises addressing large (main) muscle groups.

The results show parallelism with other studies in the literature. As a result of long-term regular CrossFit training with sedentary women, positive changes were observed in body composition, resting heart rate, maximal strength values and flexibility values.

CONCLUSION

Consequently, CrossFit Cindy model training for 20 minutes, 4 days a week for 16 weeks can be thought to result positive changes in the physical/physiological parameters of overweight middle-aged women. CrossFit Cindy Model exercise can be used as an alternative to traditional training methods for overweight middle-aged women, and therefore it can help improve motor competence and fat burning.

Practical Application

-The applying to aerobic exercise interventions for 2-4 weeks before the Cindy Model may positively affect the exercise response.

-Keeping muscle activation high in movements should be a prerequisite. For this reason, sessions should be used, which aim to teach the right movement forms slowly and fluently at the right movement angles.

-Cindy Model should not be applied in the precondition of high metabolic fatigue.

-Streching exercises to prevent joint range of motion, flexibility losses, injury prevention should also be applied.

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