Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

Original scientific article

Determining the Effects of a 12-Week Moderate Intensity Circuit Exercise Program on Body Composition and Physical Fitness among Overweight Women of Working Age

Sarocha Namboonlue[1ABCDE], Ananya Dechakhamphu[1ABCD] and Monthicha Raksilp[1ABCD]

[1]Ubon Ratchathani Rajabhat University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Monthicha Raksilp, e-mail: monthicha.r@ubru.ac.th
Accepted for Publication: June 3, 2024
Published: June 30, 2024

DOI: 10.17309/tmfv.2024.3.09

Abstract

Objectives. The study aimed to examine the effects of a 12-week moderate-intensity circuit exercise program on body composition and physical fitness among overweight women of working age.

Materials and methods. Twenty-nine overweight women of working age were divided into two groups: the control group (CG, n = 14) had a normal daily life, and the moderate intensity circuit exercise group (MICE, n = 15) underwent training that included 3 sessions of MICE (40–50 seconds followed by 60 seconds of rest for each exercise and 90 seconds of recovery between sessions at 64–76% of maximum heart rate). The training was conducted for 60 minutes per day, three days per week. Body composition and physical fitness were measured before (2 days prior) and after (2 days post) a 12-week training period.

Results. After the 12-week training, the MICE showed a considerable improvement in a number of key health indicators, including body weight, BMI, fat mass, skeletal muscle mass, visceral adipose tissue, total energy expenditure, resting energy expenditure, waist circumference, and waist-to-hip ratio (-0.65%, -0.73%, -2.16%, 2.53%, -7.12%, 10.85%, 0.71%, -3.13%, and -2.67%, respectively, $p < 0.05$) when compared to the CG. Similarly, the MICE demonstrated a significantly larger improvement in the sit and reach test, the back extension test, the hand grip strength of the right hand, hand grip strength of the left hand, leg strength, the 60-second chair stand test (also known as sit-to-stand test), and the maximum oxygen consumption (18.98%, 16.53%, 10.69%, 7.68%, 9.97%, 26.25%, and 8.87%) compared to the CG (-4.10%, -1.19%, -0.26%, -1.53%, -1.44%, 0.24%, and -0.70%), respectively.

Conclusions. Moderate-intensity circuit exercise has been found to have positive effects on improving body composition and physical fitness in overweight working women. Thus, the implementation of MICE with appropriate sessions, resting, duration, and training periods can achieve maximum benefit.

Keywords: body composition, moderate intensity circuit exercise, overweight, physical fitness, women of working age.

Introduction

The epidemic of overweight continues to increase among the adult population, especially working-age women (Sadali et al., 2023), which may affect daily life or result in the risk of various non-communicable diseases (NCDs) and come with behaviors that have a negative effect on health conditions such as smoking and alcohol drinking (Farhat et al., 2010). It also increases the risk of diabetes, coronary heart disease, and cancer by 58%, 21%, and 42%, respectively (WHO, 2020), and leads to breast cancer among women (Hu, 2003). Sarcopenia also occurs during adulthood and decreases even more in the elderly, leading to various chronic diseases and impaired adipose tissue that affect the cardiometabolic risk (Bosy-Westphal & Müller, 2021).

Exercise plays an important role in preventing and treating overweight and obesity. Proper exercise training will help develop physical fitness and lead to changes in good health behaviors (Bandura, 1977). Changes in body composition and the proportion between fat mass and muscle mass, improved resting blood pressure and heart rate, and increased cardiorespiratory fitness are generally found (Irene-Chrysovalanto et al., 2021). The intensity of exercise is determined by the force required to perform the physical

ТМФВ
ТОВ ОВС

activity. The American College of Sports Medicine (ACSM) defines moderate exercise intensity at 64-76% of maximum heart rate (MHR) (Medicine, 2018), 46-64% of maximum oxygen consumption (VO_2max), and the Borg's scale at the levels of 12-13 and 50-70% of repetition maximum (RM) (Thompson et al., 2013). Moderate-intensity exercise also improves aerobic capacity, develops emotions, or has a positive effect on psychology (Lox et al., 2019).

Circuit exercise consists of 9-12 exercise stations, focusing on improving muscle strength, muscular endurance, and stimulating cardiorespiratory endurance simultaneously (Adamson, 1959). Moreover, circuit exercise saves on exercise time but is highly effective in improving physical fitness. When combined with body weight exercise, it will use less equipment, which is easy and convenient to start exercising (Klika & Jordan, 2013). A previous study by Paoli et al. (2013) compared three types of training: high-intensity circuit training, low-intensity circuit training, and endurance training, which were performed 3 times/week for 50 minutes each. After a 12-week training, it was found that the high-intensity circuit training can improve diastolic blood pressure. The reductions in fat mass and arterial cholesterol were significantly different. The low-intensity circuit training group experienced the greatest changes in systolic blood pressure. Also, all these three training programs had a significant effect on body weight changes. It was effective in improving BMI and body composition in adults (Paoli et al., 2013). Irene-Chrysovalanto et al. (2021) used a moderate-intensity intermittent circuit training program among obese and overweight individuals, with the intensity at 50-60% of maximum heart rate, 2 times/week. A total of 10 exercise stations were repeated for a total of 2 circuits. After the 8-week training, significant improvements were found in body weight, body mass index, body fat, lean body mass, systolic blood pressure, resting heart rate, and cardiorespiratory fitness. It can be concluded that moderate intensity circuit training is as effective in improving physical fitness as high intensity circuit training (Irene-Chrysovalanto et al., 2021). Furthermore, a moderate-to-high-intensity circuit training program can affect changes in muscle performance. In particular, there is an increase in upper and lower muscular strength (Marcos-Pardo et al., 2019). These basic strengths are important indicators for working-age women to maintain their muscular fitness to prevent muscular disorders and the risk of injury to bones and joints (Nelson et al., 2007). Moderate-intensity exercise can help reduce cell damage or inflammation compared to high intensity exercise over a long period of time, which has a greater negative effect on cellular inflammation (Cerqueira et al., 2020). A systematic review by Ramos-Campo et al. (2021) revealed that resistance circuit-based training can improve body mass index, fat mass, and muscle mass significantly among middle-aged and elderly women. VO_2max, maximum aerobic speed, and the strength of the upper and lower extremities also significantly improved (Ramos-Campo et al., 2021). Previous studies reported beneficial effects of circuit training among women of working age and other age groups, as it can improve the cardiorespiratory system and prevent cardiovascular diseases (Ballesta-García et al., 2020; Beqa Ahmeti et al., 2020). In this study, the researchers considered the safety during the training of the samples, who were working-age women with sedentary behavior. If they begin to practice a high-intensity circuit exercise program, they may be at risk of injury during exercise training. Therefore, the exercise intensity was set at a moderate level of 64-76 % MHR throughout the 12-week exercise training period. The researchers have recognized the importance of applying a moderate-intensity exercise program to improve body composition and enhance physical fitness, which can be the guidelines for health care, prevention, and treatment among overweight working-age women.

Materials and Methods

Study Participants

Twenty-nine working-age participants, overweight women from Ubon Ratchathani Rajabhat University (mean age 42.66 ± 4.19 years), volunteered for this study. The inclusion criteria were as follows: participants measured and reported as overweight (BMI = 25.0-29.0 kg/m^2), likely to be untrained, no training for aerobic and resistance exercise programs within the past 3 months, and no contraindication for circuit exercise. The exclusion criteria included having tendons, joints, and muscle injuries or other complications, such as heart disease, and participating in the research project for less than 80% of the training. Participants provided written informed consent after being informed about the study's details, objectives, risks, and potential of a moderate-intensity circuit exercise program. The research received approval from the Human Ethics Committee (HE662039) at Ubon Ratchathani Rajabhat University.

Study Organization

The participants were randomly divided into two groups: the control group (CG, n = 14) and the moderate intensity circuit exercise group (MICE, n = 15). The control group did not exercise and had a normal daily life. Baseline measurements were taken for all participants before the start of the training program. After twelve weeks of training, measurements were taken again, namely between two days before and after the final training session (Fig. 1).

Training Program

The moderate-intensity circuit exercise program consisted of workouts that lasted for 60 minutes per day, 3 days per week, on non-consecutive days, for a total of 12 weeks. The program was scheduled every Monday, Wednesday, and Friday, with two sessions available from 3:00 p.m. to 4:00 p.m. and 5:00 p.m. to 6:00 p.m. The exercise sessions took place at UBRU Fitness, located at Ubon Ratchathani Rajabhat University. The circuit exercises comprised nine body weight-based exercises, including jumping jacks, triceps dips, sit-ups, knee-hops, Russian twists, lunges, planks, squats, and jogging. These exercises were followed by a moderate intensity circuit exercise, during which participants wore HR monitors (Rhythm+2.0; Scosche Industries P.R.C.) on their upper forearms to monitor heart rate. The target pulse range was set at 64% to 76% of maximum heart rate (MHR) (Cerqueira et al., 2020) throughout the training period.

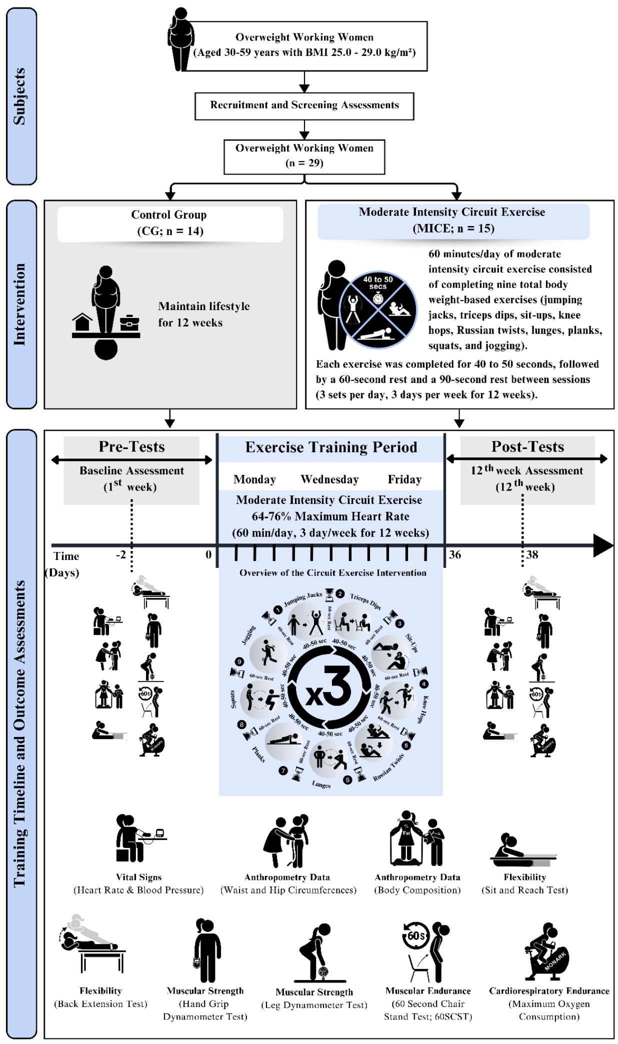

Fig. 1. Outline of the training and testing schedule

Fig. 2. Circuit exercise training protocol

Measurements

Body Composition Measurement

A bioelectrical impedance analysis device (Seca mBCA, Hamburg, Germany) measured weight, body mass index (BMI), fat-free mass, skeletal muscle mass (whole body, right arm, left arm, torso, right leg, and left leg), visceral adipose tissue, total energy expenditure, and resting metabolic expenditure while each participant stood barefoot for 5 minutes.

Anthropometric Measurement

Waist circumference (WC) and hip circumference (HC) were assessed by measuring the distance between the lower rib border and the iliac crest, as well as the level of the greater trochanter, using a flexible inch tape. The waist-to-hip ratio (WHR) was calculated using the provided measurements and the designated formula. The waist-to-hip ratio (WHR) is calculated by dividing the waist circumference (WC) by the hip circumference (HC), both measured in centimeters (cm).

Flexibility Measurement

The flexibility of the hamstring and lower back muscles was assessed using a standing trunk flexion meter (Flexion-D Takei physical fitness test; T.K.K. 5403, Japan), while the trunk muscles were evaluated using a trunk extension meter (Extension-D Takei physical fitness test; T.K.K. 5404, Japan).

Muscular Strength Measurement

The arm muscles were assessed for strength using a grip strength dynamometer (Grip-D Takei physical fitness test; T.K.K. 5401, Japan), while the leg muscles were evaluated for strength using a back strength dynamometer (Back-A Takei physical fitness test; T.K.K. 5002, Japan).

Muscular Endurance Measurement

The 60-seconds chair stand test (60SCST) was conducted to assess muscular endurance. Upon receiving the "Start" signal, the individual was required to rise from the chair, assume an upright posture with legs fully extended, and then return to the initial seated position. This was recorded as a single iteration. The frequency of repeats was documented for a duration of 60 seconds, during which the participants executed the action of standing up and sitting down on a chair with accuracy, striving to achieve the maximum number of repetitions.

Cardiorespiratory Endurance Measurement

A maximum oxygen consumption test (VO_2max) was conducted to assess cardiorespiratory endurance or aerobic capacity. Cardiorespiratory endurance was indirectly assessed using the Astrand method - rhyming, which included utilizing a cycle ergometer (Monark Ergomedic 828E, Vansbro, Sweden). The evaluation was completed under the researcher's observation.

Statistical Analysis

The statistical analyses were conducted using SPSS 25 (IBM Corp., IBM SPSS Statistics for Windows, Version 25.0; Armonk, NY: IBM Corp). The data are reported as the mean ± standard deviation (SD). The normality of the data was assessed using the Shapiro-Wilk test. The study used paired t-tests to compare data acquired before and after a 12-week training period. Additionally, independent t-tests were used to compare the variations from baseline across different groups. A P value less than 0.05 was deemed to be statistically significant.

Results

The participant's baseline characteristics of cardiovascular parameters in the control and moderate-intensity circuit exercise groups are presented in Table 1. No significant differences existed among the groups (CG and MICE) for any variable.

Table 1. Baseline characteristics of cardiovascular parameters in the control and moderate-intensity circuit exercise groups

Parameters	CG (n = 14)	MICE (n = 15)	t	p-value
Age (y)	41.86 ± 3.76	43.40 ± 4.55	0.992	0.165
Weight (kg)	72.95 ± 8.63	69.87 ± 10.16	-0.259	0.399
Height (cm)	159.15 ± 5.08	159.00 ± 5.46	-0.074	0.471
BMI (kg/m^2)	28.61 ± 3.29	27.65 ± 3.65	-0.265	0.397
Resting heart rate (b/m)	82.23 ± 12.43	81.50 ± 9.47	-0.164	0.436
SBP (mm Hg)	121.31 ± 9.12	126.75 ± 11.49	1.317	0.101
DBP (mm Hg)	81.91 ± 9.12	83.08 ± 6.84	0.351	0.365

Description: CG = control group, MICE = moderate-intensity circuit exercise group; BMI; body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure. Values are mean ± SD. p>0.05 No significant difference was found between the two groups for any variable

After 12 weeks, the body weight, BMI, fat mass, skeletal muscle mass (whole body, right arm, left arm, right leg, and left leg), visceral adipose tissue, TEE, REE, WC, and WHR were reduced in MICE by -0.65%,-0.73%, -2.16%, 2.53% (2.54%, 3.17%, 3.59%, 3.13%, and 3.35%), -7.12%, 10.85%, 0.71%, -3.13%, and 2.67%, respectively, $p < 0.05$) when compared to CG. Likewise, this increase in the MICE, changes in body composition, and anthropometrics as a result of training (baseline to post-intervention) were not significantly different in the CG (Table 2).

In particular, after 12 weeks of training, the sit and reach test, back extension test, hand grip strength of the right hand, hand grip strength of the left hand, leg strength, 60SCST, and VO_2max were significantly increased in the MICE (18.98%, 16.53%, 10.69%, 7.68%, 9.97%, 26.25%, and 8.87%) compared with the CG (-4.10%, -1.19%, -0.26%, -1.53%, -1.44%, 0.24%, and -0.70%), respectively (Table 3). Despite this increase in the moderate-intensity circuit exercise group, changes in physical fitness as a result of training (baseline to post-intervention) were not significantly different in the control group.

Discussion

The findings revealed significant changes in body composition and physical fitness over a 12-week period of moderate-intensity circuit exercise programs among overweight women of working age. Changes in body weight and BMI after the training may be due to the fact that the samples received an exercise program that changed the energy balance or caused energy expenditure affecting changes in body weight and BMI (Weinsier et al., 2002). Berge et al. (2021) compared the effects of a moderate-intensity continuous training (MICT) program and a combined MICT with high-intensity interval training (HIIT/MICT) program. After 24 weeks of training, both groups had a significant increase in energy expenditure during exercise (EEDE). The HIIT/MICT group showed greater reductions in body weight and BMI (Berge et al., 2021). This is similar to the present study's findings that the total energy expenditure (TEE) and the resting energy expenditure (REE) of the experimental group significantly increased and were significantly different between groups after the training. In other words, the circuit or interval exercise can influence changes in energy expenditure, affecting changes in body composition.

In addition, in this research, the waist circumference, waist-to-hip ratio, visceral fat, and body fat mass of the MICE group decreased. Similarly, a study by Berge et al. (2021) found the decrease in fat mass in the HIIT/MICT group that was different from that in the MICT group after 24 weeks of training. Changes in waist circumference after the experiment in the HIIT/MICT group were also found (Berge et al., 2021). A study of high- and low-intensity circuit training programs also revealed changes in body fat mass (Paoli et al., 2013). It can be concluded that if circuit exercise is done continuously, it will cause changes in body fat mass. The hip circumference that was not changed after the training may be because the training program in this study added exercises for the hip muscles. Therefore, the muscles in these areas may have developed, resulting in no change in hip circumference. However, changes in the waist-to-hip ratio were found. The mean waist circumference of the experimental group decreased due to exercise in the overweight and obese groups (Khan et al., 2022).

Also, an increase in muscle mass was found in all muscles of the body. This is consistent with the study of Irene-Chrysovalanto et al. (2021), which investing the effects of a moderate-intensity intermittent circuit training program among obese and overweight individuals. It was found that the leg muscles (L. Hamstring and L. Quadriceps) of the experimental group increased significantly compared to the control group after 8 weeks of training (Irene-Chrysovalanto et al., 2021). Likewise, a study by Paoli et al., (2013) found changes in fat-free mass in the group that trained with the circuit training program (Paoli et al., 2013). The present study also found that the body's muscle mass increased by 2.53%. It is possibly because the training program used body weight exercise as resistance, causing muscle development. Resistance circuit-based exercise can help improve muscle performance (Klika & Jordan, 2013).

Muscle flexibility in the MICE group increased by 18.98%, indicating an improvement in muscle performance in terms of flexibility. In the training program, resistance from body weight was used as the main exercise. Both major and minor muscles were used together through repetitions a number of times, resulting in the stretching of muscles during the movement periods. If the exercise is practiced correctly and appropriately, it will help increase muscle

Table 2. Body composition and anthropometric variables of participants in all 2 groups after 12-week training

Variables	CG (n = 14)					MICE (n = 15)				
	Pre-test	Post-test	% change	t	p-value	Pre-test	Post-test	% change	t	p-value
Body composition										
Weight (kg)	70.86 ± 9.75	71.86 ± 10.17	0.71	-1.978	0.069	69.87 ± 10.16	69.42 ± 9.96	-0.65	-2.408	0.012†
BMI (kg/m^2)	28.01 ± 3.43	28.19 ± 3.63	0.65	-1.753	0.103	27.65 ± 3.65	27.44 ± 3.64	-0.73*	-2.634	0.007†
Fat-Free mass (kg)	42.31 ± 4.51	42.73 ± 4.87	0.98	-1.909	0.083	45.49 ± 5.61	46.10 ± 5.75	1.35*	0.557	0.292
Fat mass (%)	39.35 ± 3.43	39.25 ± 3.63	-0.25	0.443	0.667	39.14 ± 3.71	38.30 ± 3.81	-2.16*	-2.539	0.009†
Skeletal muscle mass (kg)	19.31 ± 2.88	19.25 ± 2.90	-0.32	1.199	0.216	19.37 ± 3.32	19.86 ± 3.32	2.53*	4.710	0.001†
Whole body (kg)	19.31 ± 2.89	19.13 ± 2.95	-0.91	1.696	0.118	20.06 ± 4.06	20.57 ± 4.06	2.54*	4.433	0.001†
Right arm (kg)	1.06 ± 0.17	1.05 ± 0.18	-0.73	0.932	0.370	1.07 ± 0.20	1.10 ± 0.20	3.17*	3.439	0.001†
Left arm (kg)	0.97 ± 0.16	0.96 ± 0.16	-1.41	2.096	0.062	1.00 ± 0.20	1.04 ± 0.20	3.59*	4.166	0.001†
Torso (kg)	7.89 ± 1.54	7.9 ± 1.63	0.63	-0.432	0.674	7.54 ± 1.09	7.82 ± 1.06	3.65*	1.828	0.041†
Right leg (kg)	4.71 ± 0.59	4.71 ± 0.58	0.14	-0.210	0.838	4.70 ± 0.70	4.85 ± 0.79	3.13*	2.662	0.007†
Left leg (kg)	4.62 ± 0.65	4.64 ± 0.67	0.37	-0.338	0.741	4.62 ± 0.70	4.77 ± 0.79	3.35*	2.125	0.022†
Visceral adipose tissue (L)	2.29 ± 0.51	2.34 ± 0.56	1.98	-1.336	0.211	2.05 ± 0.61	1.91 ± 0.63	-7.12*	-3.490	0.001†
TEE (kcal/day)	2012.29 ± 177.65	2000.93 ± 273.97	-0.56	0.183	0.857	2130.46 ± 331.48	2361.69 ± 225.08	10.85*	2.867	0.004†
REE (kcal/day)	1418.50 ± 112.55	1419.30 ± 113.61	0.06	-0.371	0.720	1383.25 ± 79.93	1393.08 ± 84.11	0.71*	3.026	0.004†
Anthropometrics										
WC (cm)	90.67 ± 8.23	91.00 ± 8.60	0.37	-1.301	0.220	88.38 ± 8.82	85.62 ± 0.51	-3.13*	-4.206	0.001†
HC (cm)	103.27 ± 4.27	103.91 ± 4.91	0.62	-1.750	0.111	102.08 ± 5.82	101.92 ± 5.33	-0.15	-1.125	0.137
WHR	0.78 ± 0.26	0.78 ± 0.26	-0.01	0.001	1.000	0.86 ± 0.06	0.84 ± 0.06	-2.67*	-2.257	0.029†

Description: TEE = Total energy expenditure; REE = Resting energy expenditure; WC = Waist circumference; HC = Hip circumference; WHC = Waist-to-hip ratio. *Significant $p<0.05$ (pre vs post), †Significant $p<0.05$ (CG vs MICE)

Table 3. Physical fitness of participants in all 2 groups after 12-week training

Variables	CG (n = 14)					MICE (n = 15)				
	Pre-test	Post-test	% change	t	p-value	Pre-test	Post-test	% change	t	p-value
Flexibility										
Sit and reach test (cm)	11.44 ± 6.36	10.97 ± 5.74	-4.10	1.304	0.217	12.99 ± 5.10	15.45 ± 5.81	18.98*	3.602	0.001†
Back extension test (cm)	34.28 ± 6.41	33.87 ± 6.91	-1.19	0.992	0.342	33.92 ± 5.44	39.53 ± 6.88	16.53*	4.130	0.001†
Muscular strength										
Hand grip strength of right hand (kg/weight)	0.35 ± 0.07	0.35 ± 0.07	-0.26	0.199	0.846	0.40 ± 0.08	0.45 ± 0.08	10.69*	3.531	0.001†
Hand grip strength of left hand (kg/weight)	0.33 ± 0.05	0.32 ± 0.05	-1.53	1.342	0.213	0.37 ± 0.07	0.40 ± 0.07	7.68*	4.389	0.001†
Leg strength (kg/weight)	1.20 ± 0.31	1.18 ± 0.29	-1.44	1.035	0.325	1.32 ± 0.30	1.45 ± 0.27	9.97*	3.757	0.002†
Muscular endurance										
60SCST (reps)	32.15 ± 6.01	32.23 ± 5.48	0.24	-0.132	0.897	32.93 ± 9.33	41.57 ± 9.15	9.97*	4.319	0.003†
Cardiorespiratory endurance										
VO_2max (ml/kg/min)	26.04 ± 4.78	25.83 ± 4.32	-0.70	0.635	0.559	26.48 ± 7.01	28.82 ± 6.79	8.87*	5.050	0.001†

Description: 60SCST = 60 seconds chair strand test; VO_2max = Maximum oxygen consumption. *Significant p<0.05 (pre vs post), †Significant p<0.05 (CG vs MICE)

flexibility (Alizadeh et al., 2023). In the present study, sit and reach and back extension were used to test muscle flexibility, so the core and lower limb muscles were used. The training program consisted of the exercises that helped develop these muscles properly. Doing resistance training that allows muscles to work their full range of motion at least three times per week can improve flexibility (Rinaldo et al., 2017).

Changes in muscle strength performance were also found in every test result (Handgrip: L&R, Leg strength). A study by Marcos-Pardo et al. (2019) also pointed out that a 12-week resistance circuit training program can improve muscle strength in both elderly men and women (Marcos-Pardo et al., 2019). A study by Irene-Chrysovalanto et al. (2021) found changes in muscle strength in hamstring and quadriceps muscles after doing moderate-intensity circuit training (Irene-Chrysovalanto et al., 2021). Previous studies have shown the effectiveness of the circuit training program. The improvement in handgrip strength may be caused by the poses that primarily use the arm muscles. The triceps dip or other poses that use the muscles in the forearm may help develop the strength of these muscles among working-age women who tend to lack this type of exercise. The increase in leg muscle strength may be due to the fact that most training exercises involve using these muscles for movement or resistance, causing the muscles to develop strength (Marcos-Pardo et al., 2019).

Muscular endurance increased by 9.97%. Similarly, a study by Myers et al. (2015) examined the effects of circuit training on a group of young women who were physically inactive. The study revealed a significant improvement in muscular endurance after 5 weeks of training, conducted three times per week. After training, the muscular endurance of the hamstring muscles increased by 23.3% (Myers et al., 2015). In contrast to this research, the sample consisted of working-age women, potentially leading to a smaller increase in the magnitude of the change. However, the age factor may influence the change. Circuit training, on the other hand, has the potential to improve muscular endurance performance if the training program is appropriate for the subjects (Jung et al., 2019; Rinaldo et al., 2017).

The change in VO_2max in this study may be caused by the combined resistance and rest periods. As a result, the exercise had an appropriate intensity (moderate) for the samples. It was a combination of the aerobic and anaerobic energy systems in the exercise. After the training, VO_2max changed by 8.87%. It is considered to have a positive effect on the prevention of cardiovascular diseases because every 1 ml/kg/min increase in VO_2max is associated with a 9% reduction in the risk of cardiovascular diseases (Reljic et al., 2021). A study by Irene-Chrysovalanto et al. (2021) also showed an approximately 10% change in VO_2max after 8 weeks of circuit training (Irene-Chrysovalanto et al., 2021). That is, moderate-intensity circuit training can help improve cardiovascular endurance. Therefore, it can be said that a 12-week moderate intensity circuit exercise program in this study was possible to cause changes in body composition and overall physical fitness in overweight women of working age. However, the interpretation of such results needs confirmation from subsequent studies because the volunteers in this study were not restricted or controlled in their diet. Therefore, training combined with controlled or restricted food intake compared with training alone will make it possible to draw clear conclusions about these results.

Conclusions

After 12 weeks of training, moderate-intensity circuit exercise using body weight as resistance can improve body composition and physical fitness in overweight women of working age. It is an appropriate, convenient, safe, and effective exercise program that can be recommended to women with physical inactivity and those who are obese. Moreover, we recommend combining MICE with food restriction to see clear results of change, as this approach yields better results than exercising alone.

Acknowledgments

This study is supported by the Department of Health Sciences, Faculty of Public Health, Ubon Ratchathani Rajabhat University. We also extend our gratitude to the Program of Sports and Exercise Science, Faculty of Science, Ubon Ratchathani Rajabhat University, for providing the necessary equipment for this study.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Sadali, U. B., Kamal, K. K. B. N., Park, J., Chew, H. S. J., & Devi, M. K. (2023). The global prevalence of overweight and obesity among nurses: A systematic review and meta-analyses. *Journal of Clinical Nursing, 32*(23-24), 7934-7955. https://doi.org/10.1111/jocn.16861

Farhat, T., Iannotti, R. J., & Simons-Morton, B. G. (2010). Overweight, Obesity, Youth, and Health-Risk Behaviors. *American Journal of Preventive Medicine, 38*(3), 258-267. https://doi.org/10.1016/j.amepre.2009.10.038

WHO. (2020). Reducing Risks, Promoting Health Life. World Health Organization.

Hu, F. B. (2003). Overweight and Obesity in Women: Health Risks and Consequences. *Journal of Women's Health, 12*(2), 163-172. https://doi.org/10.1089/154099903321576565

Bosy-Westphal, A., & Müller, M. J. (2021). Diagnosis of obesity based on body composition-associated health risks—Time for a change in paradigm. *Obesity Reviews, 22*(S2), e13190. https://doi.org/10.1111/obr.13190

Bandura, A. (1977). *Social learning theory. Englewood Cliffs,* N.J. : Prentice Hall.

Irene-Chrysovalanto, T., Petros, A., & Stefanakis, M. (2021). Effects of Moderate-Intensity Intermittent Circuit Training in Obese and Overweight Individuals. *International Journal of Sports and Exercise Medicine, 7*(3). https://doi.org/10.23937/2469-5718/1510194

Medicine, A. C. O. S. (2018). ACSM's exercise testing and prescription. American College of Sports Medicine.

Thompson, P. D., Arena, R., Riebe, D., & Pescatello, L. S. (2013). ACSM's New Preparticipation Health Screening Recommendations from ACSM's Guidelines for Exercise Testing and Prescription, Ninth Edition. *Current Sports Medicine Reports, 12*(4), 215-217. https://doi.org/10.1249/JSR.0b013e31829a68cf

Lox, C. L., Martin Ginis, K. A., Gainforth, H. L., & Petruzzello, S. J. (2019). *The Psychology of Exercise: Integrating Theory and Practice* (5th ed.). Routledge. https://doi.org/10.4324/9780429287480

Adamson, G. T. (1959). Circuit Training. Ergonomics, 2(2), 183–186. https://doi.org/10.1080/00140135908930423

Klika, B., & Jordan, C. (2013). High-Intensity Circuit Training Using Body Weight: Maximum Results with Minimal Investment. *ACSM'S Health & Fitness Journal, 17*(3), 8-13. https://doi.org/10.1249/FIT.0b013e31828cb1e8

Paoli, A., Pacelli, Q. F., Moro, T., Marcolin, G., Neri, M., Battaglia, G., Sergi, G., Bolzetta, F., & Bianco, A. (2013). Effects of high-intensity circuit training, low-intensity circuit training and endurance training on blood pressure and lipoproteins in middle-aged overweight men. *Lipids in Health and Disease, 12*(1), 131. https://doi.org/10.1186/1476-511X-12-131

Marcos-Pardo, P. J., Orquin-Castrillón, F. J., Gea-García, G. M., Menayo-Antúnez, R., González-Gálvez, N., Vale, R. G. D. S., & Martínez-Rodríguez, A. (2019). Effects of a moderate-to-high intensity resistance circuit training on fat mass, functional capacity, muscular strength, and quality of life in elderly: A randomized controlled trial. *Scientific Reports, 9*(1), 7830. https://doi.org/10.1038/s41598-019-44329-6

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera, C. A., & Castaneda-Sceppa, C. (2007). Physical Activity and Public Health in Older Adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise, 39*(8), 1435-1445. https://doi.org/10.1249/mss.0b013e3180616aa2

Cerqueira, É., Marinho, D. A., Neiva, H. P., & Lourenço, O. (2020). Inflammatory Effects of High and Moderate Intensity Exercise—A Systematic Review. *Frontiers in Physiology,* 10, 1550. https://doi.org/10.3389/fphys.2019.01550

Ramos-Campo, D. J., Andreu-Caravaca, L., Carrasco-Poyatos, M., Benito, P. J., & Rubio-Arias, J. Á. (2021). Effects of Circuit Resistance Training on Body Composition, Strength, and Cardiorespiratory Fitness in Middle-Aged and Older Women: A Systematic Review and Meta-Analysis. *Journal of Aging and Physical Activity,* 30, 725-738. https://doi.org/10.1123/japa.2021-0204

Ballesta-García, I., Martínez-González-Moro, I., Ramos-Campo, D. J., & Carrasco-Poyatos, M. (2020). High-Intensity Interval Circuit Training Versus Moderate-Intensity Continuous Training on Cardiorespiratory Fitness in Middle-Aged and Older Women: A Randomized Controlled Trial. *International Journal of Environmental Research and Public Health, 17*(5), 1805. https://doi.org/10.3390/ijerph17051805

Beqa Ahmeti, G., Idrizovic, K., Elezi, A., Zenic, N., & Ostojic, L. (2020). Endurance Training vs. Circuit Resistance Training: Effects on Lipid Profile and Anthropometric/Body Composition Status in Healthy Young Adult Women. *International Journal of Environmental Research and Public Health, 17*(4), 1222. https://doi.org/10.3390/ijerph17041222

Weinsier, R. L., Hunter, G. R., Desmond, R. A., Byrne, N. M., Zuckerman, P. A., & Darnell, B. E. (2002). Free-living activity energy expenditure in women successful and unsuccessful at maintaining a normal body weight. *The American Journal of Clinical Nutrition, 75*(3), 499-504. https://doi.org/10.1093/ajcn/75.3.499

Berge, J., Hjelmesæth, J., Hertel, J. K., Gjevestad, E., Småstuen, M. C., Johnson, L. K., Martins, C., Andersen, E., Helgerud, J., & Støren, Ø. (2021). Effect of Aerobic Exercise Intensity on Energy Expenditure and Weight Loss in Severe Obesity—A Randomized Controlled Trial. *Obesity, 29*(2), 359-369. https://doi.org/10.1002/oby.23078

Khan, S., Agrawal, R., & Memon, S. (2022). Comparison of Effect of Yoga versus Aerobic Exercise on Waist Circumference, Waist-Hip Ratio and Body Mass Index in Overweight and Obese Adult Individuals. *Kathmandu University Medical Journal, 20*(1), 38-42. https://doi.org/10.3126/kumj.v20i1.49894

Alizadeh, S., Daneshjoo, A., Zahiri, A., Anvar, S. H., Goudini, R., Hicks, J. P., Konrad, A., & Behm, D. G. (2023). Resistance Training Induces Improvements in Range of Motion: A Systematic Review and Meta-Analysis. *Sports Medicine, 53*(3), 707-722. https://doi.org/10.1007/s40279-022-01804-x

Rinaldo, N., Bacchi, E., Coratella, G., Vitali, F., Milanese, C., Rossi, A., Schena, F., & Lanza, M. (2017). Effects of Combined Aerobic-Strength Training vs Fitness Education Program in COPD Patients. *International Journal of Sports Medicine, 38*(13), 1001-1008. https://doi.org/10.1055/s-0043-112339

Myers, T. R., Schneider, M. G., Schmale, M. S., & Hazell, T. J. (2015). Whole-Body Aerobic Resistance Training Circuit Improves Aerobic Fitness and Muscle Strength in Sedentary Young Females. *Journal of Strength and Conditioning Research, 29*(6), 1592-1600. https://doi.org/10.1519/JSC.0000000000000790

Jung, W.-S., Kim, Y.-Y., & Park, H.-Y. (2019). Circuit Training Improvements in Korean Women with Sarcopenia. *Perceptual and Motor Skills, 126*(5), 828-842. https://doi.org/10.1177/0031512519860637

Reljic, D., Frenk, F., Herrmann, H. J., Neurath, M. F., & Zopf, Y. (2021). Effects of very low volume high intensity versus moderate intensity interval training in obese metabolic syndrome patients: A randomized controlled study. *Scientific Reports, 11*(1), 2836. https://doi.org/10.1038/s41598-021-82372-4

Визначення впливу 12-тижневої програми кругових вправ помірної інтенсивності на показники композиції тіла та фізичної підготовленості жінок працездатного віку з надмірною масою тіла

Сароча Намбунлуе[1ABCDE], Ананья Дечакхампфу[1ABCD], Монтхіча Раксілп[1ABCD]

[1]Убонратчатханський університет Раджабхат

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 3 табл., 2 рис., 27 джерел.

Мета дослідження. Дослідження мало на меті вивчити вплив 12-тижневої програми кругових вправ помірної інтенсивності на показники композиції тіла та фізичної підготовленості жінок працездатного віку з надмірною масою тіла.

Матеріали та методи. Двадцять дев'ять жінок працездатного віку з надмірною вагою були розділені на дві групи: контрольна група (КГ, n = 14) дотримувалася звичайного повсякденного способу життя, та група, що виконувала кругові вправи помірної інтенсивності (КВПІ, n = 15) і проходила тренування, що включали 3 сеанси КВПІ (40-50 секунд з наступним 60-секундним відпочинком на кожну вправу і 90-секундним відновленням між сеансами на рівні 64-76% максимальної частоти серцевих скорочень). Тренування проводилися впродовж 60 хвилин на день, три дні на тиждень. Показники композиції тіла та фізичної підготовленості вимірювали до початку (за 2 дні до) та після (через 2 дні після) 12-тижневого періоду тренувань.

Результати. Після 12-тижневого тренування в групі, що займалася КВПІ спостерігалося значне покращення низки ключових показників стану здоров'я, включаючи масу тіла, ІМТ, жирову масу, масу скелетних м'язів, вісцеральну жирову тканину, загальні енерговитрати, енерговитрати у стані спокою, окружність талії та співвідношення талії до стегон (-0,65%, -0,73%, -2,16%, 2,53%, -7,12%, 10,85%, 0,71%, -3,13% та -2,67%, відповідно, p < 0,05) порівняно з результатами контрольної групи. Аналогічним чином, група КВПІ також продемонструвала суттєвіше поліпшення показників у виконанні тесту на гнучкість (спосіб вимірювання загальної гнучкості тіла при згинанні тулуба вперед, сидячи на підлозі з витягнутими вперед руками), тесту на розгинання спини, сили кистьового хвату правої руки, сили кистьового хвату лівої руки, сили нижніх кінцівок, 60-секундного тесту на оцінку сили та витривалості нижніх кінцівок, що передбачає вимірювання кількості рухів з положення сидячи та встаючи зі стандартного стільця, а також максимального споживання кисню (18. 98%, 16,53%, 10,69%, 7,68%, 9,97%, 26,25% та 8,87%) порівняно з КГ (-4,10%, -1,19%, -0,26%, -1,53%, -1,44%, 0,24% та -0,70%) відповідно.

Висновки. Встановлено, що кругові вправи помірної інтенсивності позитивно впливають на покращення показників композиції тіла та фізичної підготовленості працюючих жінок з надмірною масою тіла. Таким чином, впровадження КВПІ з відповідними сеансами, режимом відпочинку, тривалістю та періодами тренувань може досягти максимальної користі.

Ключові слова: композиція тіла, кругові вправи помірної інтенсивності, надмірна маса тіла, фізична підготовленість, жінки працездатного віку.

Information about the authors:

Namboonlue, Sarocha: sarocha.n@ubru.ac.th; https://orcid.org/0009-0007-9594-0052; Department of Health Sciences, Faculty of Public Health, Ubon Ratchathani Rajabhat University, 2 Ratchathani Road, Nai-Muang, Muang District, Ubon Ratchathani, 34000, Thailand.

Dechakhamphu, Ananya: ananya.d@ubru.ac.th; https://orcid.org/0000-0003-4001-3167; Program of Thai Traditional Medicine, Faculty of Thai Traditional and Alternative Medicine, Ubon Ratchathani Rajabhat University, 2 Ratchathani Road, Nai-Muang, Muang District, Ubon Ratchathani, 34000, Thailand.

Raksilp, Monthicha: monthicha.r@ubru.ac.th; https://orcid.org/0000-0003-4425-4638; Department of Health Sciences, Faculty of Public Health, Ubon Ratchathani Rajabhat University, 2 Ratchathani Road, Nai-Muang, Muang District, Ubon Ratchathani, 34000, Thailand.

Cite this article as: Namboonlue, S., Dechakhamphu, A., & Raksilp, M. (2024). Determining the Effects of a 12-Week Moderate Intensity Circuit Exercise Program on Body Composition and Physical Fitness among Overweight Women of Working Age. *Physical Education Theory and Methodology, 24*(3), 411-419. https://doi.org/10.17309/tmfv.2024.3.09

Received: 11.05.2024. Accepted: 03.06.2024. Published: 30.06.2024