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EFFECTS OF FITBALL EXERCISE ON BODY COMPOSITION, FLEXIBILITY, MUSCULAR STRENGTH-ENDURANCE AND AEROBIC CAPACITY IN OBESE WORKING-AGE WOMEN

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Abstract

The study purpose was to examine and compare the effects of fitball exercise on body composition, flexibility, muscular strength-endurance and maximum oxygen consumption (VO_2 max) in obese working-age women.

Materials and methods. Twenty-six working-age women with obesity (BMI ≥ 25.0 kg/m^2) aged between 40 to 50 years were divided into 2 groups: 1) fitball exercise group (FEG) and 2) control group (CG). The training lasted 12 weeks with sessions of 60 min/day and 3 days per week. All parameters were measured at 1 day prior to (PRE; pre-training), 1 day after 6 weeks (MID; middle-training) and within 1 day after 12 weeks (POST; post-training) of the training period.

Results. After the 6-week training, the FEG showed substantial improvement in body weight, BMI, back extension, leg strength, 60 second chair stand (60SCST) and VO_2max (-0.92%, -1.34%, 12.74%, 27.19%, 25.79% and 10.75%, respectively, $p < 0.05$) when compared to the CG. Similarly, after the 12-week training, the FEG showed a significantly larger improvement in body weight, BMI, fat mass, sit and reach, back extension, leg strength, 60SCST and VO_2max (-1.14%, -2.19%, -1.92%, 54.31%, 27.31%, 33.50%, 37.02% and 24.05%, respectively, $p < 0.05$) compared to the CG.

Conclusions. Fitball exercise training is effective in improving body composition, flexibility and muscular strength-endurance as well as increasing the aerobic capacity in female workers with obesity.

Keywords: fitball exercise, body composition, flexibility, muscular strength-endurance, exercise capacity, obese, female workers.

Introduction

Obesity can lead to numerous health problems, such as cardiovascular diseases (heart disease and stroke), type 2 diabetes, certain types of cancer, musculoskeletal disorders, and respiratory issues (Lam et al., 2023). It also places a considerable burden on healthcare systems due to the increased risk of chronic diseases and the need for medical treatment. Several factors contribute to the higher prevalence of obesity in adults, especially among working-age women (Harris, et al., 2021). These factors can include changes in lifestyle and dietary habits, reduced physical activity due to sedentary jobs and stress (González et al., 2017). Addressing the issue of obesity in working-age women requires a comprehensive approach that considers both individual behavior and broader environmental and policy changes. Encouraging physical activity, promoting healthy eating habits, and providing supportive workplace environments can all contribute to combating obesity in this population.

Aerobic exercises using a fitball (swiss ball) is an effective and safe form for working-aged women (Josaphat et al., 2019). This is beneficial because working-age women often experience limited body movement and reduced physical activity, these exercises are a valuable way to counteract sedentary lifestyles and enhance overall health and fitness (Dunsky, 2019). The movements causing impact load on the weight-bearing joints may result in excessive strain on the joints, causing injury to ligaments, joints and muscles (Howley, 2001). Previous studies revealed that exercising with fitball can improved various parameters in overweight and obese working-age women including body composition, especially body weight, body mass index and fat mass (Buttichak et al., 2022), flexibility, muscle strength and endurance, maximum oxygen consumption (Ayudthaya & Kritpet, 2015) and lower back flexibility (Sekendiz et al., 2010). In addition, fitball has incorporated into other forms of exercise such as yoga (Buttichak et al., 2022; Na Nongkhai et al., 2021), low-impact aerobic dance (Ayudthaya & Kritpet, 2015), resistance training and body weight exercise (Escamilla et al., 2016; Liu et al., 2022; Multani et al., 2019). It was also used with other equipment such as kettle bell (Wasim et al., 2023) to develop overall physical fitness including body composition, flexibility, muscular strength-endurance and maximum oxygen consumption with different testing strategies. However, other factors should be considered, such as session duration, intensity, frequency, repetitions, training time per repetition, rest times, diet and sleep to benefit health and well-being significantly.

Therefore, this study aimed to examine and compare the effects of 12-week fitball exercise training model on body composition, flexibility, muscular strength-endurance and maximum oxygen consumption in working-age subjects with obese women as an alternative treatment option to prevent and treat obesity.

Materials and methods

Study participants

Twenty-six working-age subjects with obese women (aged 45.81 ± 3.39 years) from Ubon Ratchathani University volunteered for this study. The inclusion criteria were as follows: (a) measured and reported as obese (BMI ≥ 25.0 kg/m^2), (b) passing a health examination by the doctor at the government hospital only and having a medical certificate allowing for participation in a fitball exercise research project and (c) getting at least 2 doses of COVID-19 vaccination. The exclusion criteria included (a) having muscle, bone, ligament and joint injuries or other complications such as heart disease and high blood pressure and (b) participating in the research project less than 80% of the training. Before participating in this study, all participants were informed of the experimental protocol. Written consent was obtained after explaining the objectives, risks and potential of fitball exercise program in the study. The consent form was approved by Ubon Ratchathani University Human Ethics Committee (UBU-REC-95/2022).

Study organization

The participants were randomly divided into two groups: control group (CG, n = 13) and fitball exercise group (FEG, n = 13). The study duration was 12 weeks of training. All outcome variables were measured at 3 times points consisting of pre-tests (PRE; pre-training or week 0), middle-tests (MID; middle-training or week 6) and post-tests (POST; post-training or week 12) of the 12-week of the intervention period, as shown in Fig. 1.

Training program

The fitball exercise program was used as a medium for teaching exercises. The total experimental period was 60 min/day, 3 days/week for 12 weeks, every Monday, Wednesday, and Friday from 5:00 p.m. to 6:00 p.m. at the activity field of the ILC 204 exercise room, Faculty of Liberal Arts, Ubon Ratchathani University. The instruments were 4 fitball exercise plans with a rest period of 2 seconds per pose changing. The fitball exercise program consisted of 4 phases (a) 1st to 3rd week: the familiarization phase; (b) 4th to 6th week: the skill development phase; (c) 7th to 9th week: the progression phase; and (d) 10th to 12th week: the final phase. The 20 fitball poses training protocol consisted of 3 phases: (a) 10-minute warm-up phase, (b) 40-minute fitball exercise training phase and (c) 10-minute cool-down phase (a total of 120 minutes/week or 1,440 minutes over 12 weeks) (Table 1).

Measures

Body composition measurement

Body composition (body weight, body mass index, fat mass and skeletal muscle mass) was measured by using the bioelectrical impedance analysis machine (TANITA model; MC-980 MA, Japan).

Sit and reach test

Sit and reach test was measured the flexibility of the hamstring and lower back muscles using a standing trunk

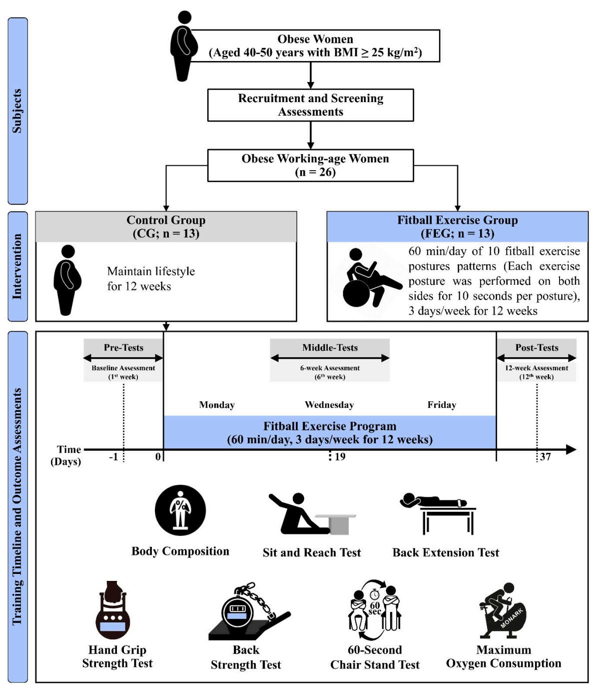
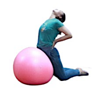


Fig. 1. Outline of training and testing schedule. Abbreviations: CG, control group; FEG, fitball exercise group

Table 1. Fitball exercise training protocol

(a) Warm up phase: Methods: 10-min walk (easy pace) and 4 fitball poses for static stretching of major muscle groups. (2 × 10 sec)			
(A) Moon salutation	(B) Downward facing dog	(C) Cat pose	(D) Matsyasan
			
Note: The fitball exercise training program at warm up phase; 3 days per week: for 1st to 3rd week (2 sets of 2 repetitions), 4th to 6th week (2 sets of 3 repetitions), 7th to 9th week (2 sets of 4 repetitions) and 10th to 12th week (2 sets of 5 repetitions).			
(b) Fitball exercise phase: Methods: 40-min fitball exercise postures consisted of 12 fitball poses, focusing on tensing muscles in a fixed position. Each pose must be held for 10 seconds and the rest time after each pose was 10 seconds. The body must be moved slowly in a continuous rhythm. It consisted of the following fitball poses.			
(E) Mountain pose	(F) Pigeon pose	(G) Cobra's pose	(H) Bow pose
			
(I) Cobra pose	(J) Camel pose	(K) Bridge pose	(L) Crescent lunge
			
(M) Lizard pose	(N) Upward facing dog pose	(O) Rabbit pose	(P) Chair pose
			
Note: The fitball exercise training program at fitball exercise phase; 3 days per week: for 1st to 3rd week (2 sets of 2 repetitions), 4th to 6th week (2 sets of 3 repetitions), 7th to 9th week (3 sets of 3 repetitions) and 10th to 12th week (3 sets of 4 repetitions).			
(c) Cool-down phase: Methods: 10-min walk (easy pace) and 4 fitball poses for static stretching of major muscle groups (2 × 10 sec). It was the practice of the basic and simple fitball postures (2 × 10 sec).			
(Q) Child's pose	(R) Standing forward fold	(S) Downward facing dog	(T) Dolphin pose
			
Note: The fitball exercise training program at cool-down phase; 3 days per week: for 1st to 3rd week (2 sets of 2 repetitions), 4th to 6th week (2 sets of 3 repetitions), 7th to 9th week (2 sets of 4 repetitions) and 10th to 12th week (2 sets of 5 repetitions).			

flexion meter (Flexion-D Takei physical fitness test; T.K.K. 5403, Japan). The subject was asked to sit with the legs straight and put the feet under the meter with both feet flat to the floor and close together. The soles of the feet must be placed flat against the box. Then the subject had to slowly bend forward so that the hands were on the meter until it was unable to continue bending and hold that position for 2 seconds or more while the distance in cm was recorded. The test was performed twice. The best value was used.

Back extension test

Back extension test was conducted to measure the flexibility in the trunk muscles using a trunk extension meter (Extension-D Takei physical fitness test; T.K.K. 5404, Japan). The subject stretched the trunk and back muscles and lied down on the floor with two arms crossed at the back at the waist. If the arms or hands cannot be crossed, try to keep the arms as close as possible to the back. The test assistant grasped the subject' ankle or thigh, depending on suitability. After that, the subject had to lift the upper body as high as possible and hold the head up for about 3 seconds. Distance was recorded in cm. The test was performed twice. The best value was used.

Hand grip strength test

Hand grip strength test was administered to measure the strength of the arm muscles using a grip strength dynamometer (Grip-D Takei physical fitness test; T.K.K. 5401, Japan). The handle of the dynamometer must be adjusted to fit the subject' hand to be measured. The subject held the dynamometer in the hand to be tested with the arm at right angles and the elbow by the side of the body and squeezed the dynamometer with all possible force. The test was performed twice. The best value was used. The test results were recorded in kilograms and divided by the subject's body weight.

Leg strength test

Leg strength test was done to measure the muscular strength of the leg muscles using a back strength dynamometer (Back-A Takei physical fitness test; T.K.K. 5002, Japan). The dial must be reset to zero. The subject had to stand on the dynamometer, bend the knees while grasping the handle of the dynamometer, adjust the angle of the knees to the ready position and pull as hard as possible on the chain until the maximum value was obtained. The test was performed twice. The best value was used. The test results were recorded in kilograms and divided by the subject's body weight.

60 seconds chair stand test (60SCST)

It was administered to measure the muscular strength and endurance of the leg muscles. A chair for the standing-sitting test must be placed against a smooth wall to prevent it from moving. The subject must be seated in the middle of the chair (not close to the backrest to make it easier to stand up) with both feet placed on the floor approximately shoulder-width apart at an angle slightly back from the knees and back straight. Arms were crossed at the wrists and held against the chest. When hearing the "Start" signal, the subject had to stand up from the chair, stand straight with legs stretched, and then sit down in the starting position. This was counted as 1 repetition. The number of repetitions was recorded for 60 seconds, the participants stood up and sat down correctly on a chair as many times as possible.

Maximum oxygen consumption assessment

It was performed to measure cardiorespiratory endurance or aerobic capacity (maximum oxygen consumption; VO_2max) following the Astrand-Rhyming test method, using a mechanically braked cycle ergometer (Monark Ergomedic 828E, Vansbro, Sweden). The subject sat in the saddle. The saddle must be adjusted to the level that the legs can be fully stretched with the knees slightly bent. The rhyme was set at 50 rpm with constant speed. The counterweight must be adjusted to 1 kp. The timer was started when the subject rides with the specified counterweight and constant speed. The heart rate was counted every 1 minute (from the 45th to the 60th second by using a stethoscope (Stethoscope professional; CK-MA601CP, Taiwan) to measure the heart rate 30 times and then compare to the table. The heart rate at the carotid artery should also be recorded for 6 minutes. If at the second minute, the heart rate is still lower than 120 beats per minute, add another 0.5 kp of weight, and add another

Table 2. Baseline characteristics of cardiovascular parameters in the control and fitball exercise group

Parameters	CG (n = 13)	FEG (n = 13)
Age (y)	45.46 ± 3.23	46.15 ± 3.65
Weight (kg)	68.75 ± 10.01	70.09 ± 7.48
Height (cm)	156.54 ± 6.62	158.77 ± 5.83
BMI (kg/m^2)	28.00 ± 2.20	27.66 ± 2.85
Resting heart rate (b/m)	77.54 ± 6.39	78.31 ± 5.82
SBP (mm Hg)	127.54 ± 4.48	129.08 ± 5.01
DBP (mm Hg)	86.62 ± 5.62	81.38 ± 8.06

Description: CG; control group and FEG; fitball exercise group; BMI; body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure. Values are mean ± SD. No significant difference was found between the two groups for any variable

Table 3. Mean changes in body composition parameters in all two groups after 6-week (MID) and after 12-week (POST) of the training period

Parameters	Time	CG (n = 13)	FEG (n = 13)	p-value
Weight (kg)	PRE (week 0)	68.64 ± 10.55	70.09 ± 7.48	
	MID (week 6)	68.60 ± 10.49	69.45 ± 7.41	
	POST (week 12)	70.01 ± 10.23	69.29 ± 7.42	
	%Changes (MID vs. PRE)	-0.06 ± 1.10	-0.92 ± 0.70*	0.019†
	%Changes (POST vs. PRE)	2.00 ± 1.38	-1.14 ± 1.60#	0.001‡
Body mass index (kg/m^2)	PRE (week 0)	28.00 ± 2.20	27.66 ± 2.85	
	MID (week 6)	28.01 ± 1.99	27.28 ± 3.05	
	POST (week 12)	28.28 ± 2.07	27.05 ± 3.23	
	%Changes (MID vs. PRE)	0.03 ± 2.54	-1.34 ± 1.59*	0.040†
	%Changes (POST vs. PRE)	1.02 ± 2.39	-2.19 ± 2.18#	0.001‡
Fat mass (%)	PRE (week 0)	39.31 ± 4.95	37.11 ± 3.96	
	MID (week 6)	39.24 ± 4.95	36.69 ± 3.79	
	POST (week 12)	39.97 ± 4.68	36.40 ± 3.94	
	%Changes (MID vs. PRE)	-0.19 ± 1.20	-1.15 ± 1.19*	0.058
	%Changes (POST vs. PRE)	1.68 ± 2.58	-1.92 ± 2.25#	0.002‡
Skeletal muscle mass (kg)	PRE (week 0)	37.61 ± 4.12	39.26 ± 2.46	
	MID (week 6)	37.65 ± 4.08	39.13 ± 2.57	
	POST (week 12)	37.53 ± 4.31	39.58 ± 2.52	
	%Changes (MID vs. PRE)	0.10 ± 1.06	-0.33 ± 0.74	0.135
	%Changes (POST vs. PRE)	-0.21 ± 1.87	0.82 ± 0.55#	0.050

Description: *Significant $p<0.05$ (PRE vs. MID), #Significant $p<0.05$ (PRE vs. POST), †Significant $p<0.05$ (%Changes MID vs. PRE), ‡Significant $p<0.05$ (%Changes POST vs. PRE)

1 minute of testing time, and measure it every minute. The average heart rate for the last 2 minutes was taken (provided that the heart rate is stable, or the difference does not exceed ± 5 bpm). The obtained heart rate was recorded, and the table was used to find the maximum oxygen consumption from heart rate and weight (in ml/kg/min).

Statistical analysis

Statistical calculations were performed using SPSS 26 (IBM Corp. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Descriptive data were shown as means and standard deviation (SD). Data normality was evaluated by using the Shapiro-Wilk test. Paired t-tests (comparisons between values obtained before, after 6-week and after 12-week training) and independent t-tests (comparisons of differences to baseline between groups) were completed. The one-way analysis of variance with repeated measures followed by the Bonferroni post-hoc test was used to evaluate differences in body composition, flexibility, muscular strength-endurance and maximum oxygen consumption between groups. P values < 0.05 was considered to be statistically significant.

Results

The baseline characteristics of cardiovascular parameters in the control group (CG) and fitball exercise group (FEG) group are presented in Table 1. No significant differences existed among the two groups for any variables. After 6-week, the body weight and body mass index were reduced in FEG by 0.92 % and -1.34%, respectively, p < 0.05) when compared to CG. Likewise, after the 12-wks, the FEG

Table 4. Mean changes in flexibility, muscular strength-endurance, and maximum oxygen consumption parameters in all two groups after 6-week (MID) and after 12-week (POST) of training period

Parameters	Time	CG (n = 13)	FEG (n = 13)	p-value
		Flexibility		
Sit and reach test (cm)	PRE (week 0)	10.89 ± 4.99	11.69 ± 4.42	
	MID (week 6)	12.18 ± 4.85	16.15 ± 4.99	
	POST (week 12)	12.07 ± 5.02	18.04 ± 4.75	
	%Changes (MID vs. PRE)	11.88 ± 31.26	38.17 ± 24.32*	0.063
	%Changes (POST vs. PRE)	10.88 ± 19.87	54.31 ± 20.64#	0.001‡
Back extension test (cm)	PRE (week 0)	36.21 ± 6.82	37.38 ± 6.50	
	MID (week 6)	37.49 ± 6.59	42.83 ± 6.15	
	POST (week 12)	39.66 ± 7.13	47.58 ± 6.83	
	%Changes (MID vs. PRE)	3.53 ± 8.58	12.74 ± 8.83*	0.014†
	%Changes (POST vs. PRE)	9.53 ± 10.57#	27.31 ± 17.09#	0.003‡
		Muscular strength-endurance		
Hand grip strength of right hand (kg/weight)	PRE (week 0)	0.35 ± 0.06	0.39 ± 0.09	
	MID (week 6)	0.39 ± 0.05	0.43 ± 0.10	
	POST (week 12)	0.39 ± 0.05	0.45 ± 0.10	
	%Changes (MID vs. PRE)	10.20 ± 10.14*	11.71 ± 8.15*	0.448
	%Changes (POST vs. PRE)	10.44 ± 15.47#	15.93 ± 8.18#	0.209
Hand grip strength of left hand (kg/weight)	PRE (week 0)	0.32 ± 0.06	0.36 ± 0.09	
	MID (week 6)	0.35 ± 0.05	0.40 ± 0.09	
	POST (week 12)	0.39 ± 0.05	0.42 ± 0.10	
	%Changes (MID vs. PRE)	8.75 ± 11.91	10.44 ± 7.40*	0.370
	%Changes (POST vs. PRE)	0.32 ± 33.39	16.29 ± 10.20#	0.061
Leg strength (kg/weight)	PRE (week 0)	1.30 ± 0.31	1.37 ± 0.40	
	MID (week 6)	1.38 ± 0.31	1.74 ± 0.41	
	POST (week 12)	1.33 ± 0.33	1.82 ± 0.51	
	%Changes (MID vs. PRE)	5.96 ± 11.30	27.19 ± 27.60*	0.006†
	%Changes (POST vs. PRE)	2.61 ± 16.43	33.50 ± 31.15#	0.002‡
60 seconds chair strand test (reps)	PRE (week 0)	41.77 ± 6.81	43.85 ± 9.65	
	MID (week 6)	47.46 ± 8.99	55.15 ± 5.29	
	POST (week 12)	45.38 ± 9.46	60.08 ± 5.82	
	%Changes (MID vs. PRE)	2.72 ± 1.08*	25.79 ± 26.43*	0.001†
	%Changes (POST vs. PRE)	8.66 ± 31.38	37.02 ± 31.52#	0.009‡
		Cardiorespiratory endurance		
VO_2 max (ml/kg/min)	PRE (week 0)	24.73 ± 2.40	21.71 ± 3.95	
	MID (week 6)	24.77 ± 2.75	24.04 ± 3.92	
	POST (week 12)	25.34 ± 3.23	26.93 ± 4.16	
	%Changes (MID vs. PRE)	0.15 ± 10.69	10.75 ± 11.80*	0.015†
	%Changes (POST vs. PRE)	2.44 ± 13.16	24.05 ± 20.84#	0.003‡

Description: *Significant p<0.05 (PRE vs. MID), #Significant p<0.05 (PRE vs. POST), †Significant p<0.05 (%Changes MID vs. PRE), ‡Significant p<0.05 (%Changes POST vs. PRE)

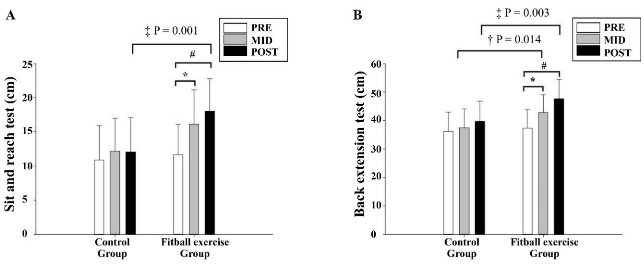


Fig. 2. Changes in flexibility (A; Sit and reach test and B; Back extension test) before (PRE), after 6-week (MID) and after 12-week (POST) of the training period. Values are present as mean ± SD. *Significant p<0.05 (PRE vs. MID), #Significant p<0.05 (PRE vs. POST), †Significant p<0.05 (%Changes MID vs. PRE), ‡Significant p<0.05 (%Changes POST vs. PRE)

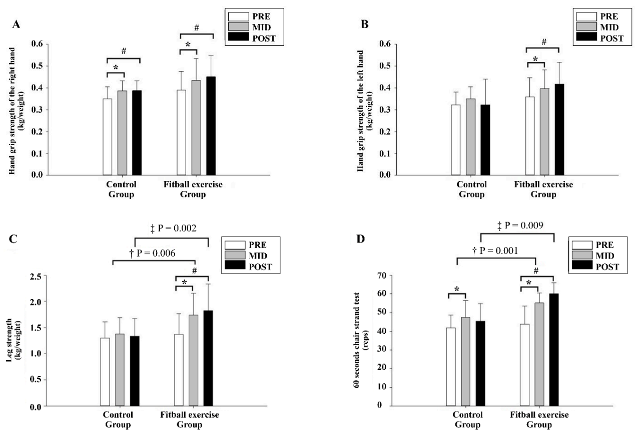


Fig. 3. Changes in muscular strength-endurance (A; Handgrip strength of right hand, B; Handgrip strength of left hand, C; Leg strength and D; 60 seconds chair stand test) before (PRE), after 6-week (MID) and after 12-week (POST) of the training period. Values are present as mean ± SD. *Significant p<0.05 (PRE vs. MID), #Significant p<0.05 (PRE vs. POST), †Significant p<0.05 (%Changes MID vs. PRE), ‡Significant p<0.05 (%Changes POST vs. PRE)

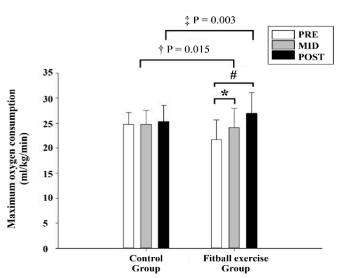


Fig. 4. Changes in maximum oxygen consumption before (PRE), after 6-week (MID) and after 12-week (POST) of the training period. Values were presented as mean ± SD. *Significant p<0.05 (PRE vs. MID), #Significant p<0.05 (PRE vs. POST), †Significant p<0.05 (%Changes MID vs. PRE), ‡Significant p<0.05 (%Changes POST vs. PRE)

showed a significantly larger improvement in body weight, BMI and fat mass (-1.14%, -2.19% and -1.92% respectively, $p < 0.05$) compared to the CG Table 3.

Table 4 shows the mean values of flexibility before and after 6 weeks of training. It was found that the FEG showed substantially improvement in back extension when compared to the CG (P = 0.014). Similarly, after 12 weeks of training, the sit and reach and back extension of the FEG were significantly improved (P = 0.001 and P = 0.003 respectively, $p < 0.05$) (Fig. 2), compared to the CG. Moreover, after the 6-week training, the FEG showed significant improvement in leg strength, 60 second chair stand test (60SCST) and (P = 0.006, P = 0.001 and P = 0.015 respectively, $p < 0.05$) when compared to the CG. In addition, the leg strength, 60SCST and VO_2max were significantly improvement in the FEG after 12 weeks of the training program (P = 0.002, P = 0.009 and P = 0.003 respectively, $p < 0.05$), when compared to the CG.

In general, after 6 weeks of training, the left-hand grip strength, leg strength, 60SCST and VO_2max were significantly improvement in the FEG (10.44%, 27.19%, 25.79% and 10.75% respectively, $p < 0.05$), compared to their baseline. In particular, after 12 weeks of training, the left-hand grip strength, leg strength, 60SCST and VO_2max were significantly improvement in the FEG (16.29%, 33.50%, 37.02% and 24.05% respectively, $p < 0.05$), compared to the before training (Fig. 3 and Fig. 4).

Discussion

This research supports the concept of fitness training with fitball to improve body composition. The results after 6 weeks of training revealed changes in body weight and body mass index. It is consistent with the study of Buttichak et al. (2019) studying the effects of a yoga training program with fitball. It was revealed that this training program can promote changes in body composition in terms of body weight, body mass index and fat mass after 8 weeks of training (Buttichak et al., 2019). Based on this present study, after 12 weeks of training, there were prominent changes in body composition compared to the PRE and MID of the training period. In the intervention group, there were showed significant improvements in body weight, body mass index and fat mass. This is consistent with previous studies by Buttichak et al. (2019) and Na Nongkhai et al. (2021) which found changes in muscle mass after 8 weeks of training or more (Buttichak et al., 2019; Na Nongkhai et al., 2021). Liu et al. (2021) also conducted a systematic review and meta-analysis of different forms of resistance training. It was revealed that weight training exercise (fitball exercise is considered weight training exercise) can increase muscle mass. It may be because fitball exercise uses muscle sharing to stabilize body balance with body weight as resistance, causing muscles to work. Fitball exercise also tends to use stabilizer muscles more than other types of training (Liu et al., 2022). Escamilla et al. (2016) compared the training with different fitball positions to body weight training to examine muscle contractions. Fitball exercises were found to produce better muscle contractions than resistance training, especially rectus abdominis muscle and stabilizer muscles (lower-rectus abdominis, external oblique, internal oblique, etc.). Because the muscles are stimulated, their strength and size can be increased (Escamilla et al., 2016). Besides, training with fitball for a long period of time continuously can affect the metabolic process since the body will use fat as a fuel source for energy supply during exercise. This is in accordance with the study indicating that continuous exercise training on a regular basis can affect the metabolic system during aerobic training. The energy obtained from cellular metabolism is mainly the breakdown of fat in the exercising muscles. As a result, the amount of fat mass in the body of obese women decreases (Tan et al., 2012). However, recent studies support the idea that training with fitball can help improve body composition and increase muscle mass although it takes a long time to see the changes. Therefore, to achieve maximum efficiency, further study of the effects of exercise and food intake should be investigated to reduce the BMI level, and the percentage of body fat in people with obesity (Voulgari et al., 2013).

The flexibility was significantly increased in the FEG. Women were more likely to improve flexibility than men. Meanwhile, Kumar (2023) conducted a study of fitball exercises among male college students, which revealed changes in muscle flexibility. It is apparent that fitball exercise can increase the flexibility of the body in all genders and ages. This may be due to continuous fitball exercise fucuses on full-range of motion, combined with tightness and holding (Kumar, 2023). Likewise, Buttichak et al. (2022) reported that 8 weeks of yoga exercise can improved flexibility (back scratch test) in overweight elderly women (Buttichak et al., 2022). It is consistent with the study of Judy and Tamilarasi (2023) which found that fitball exercise affected the improvement of flexibility. After 12 weeks of fitball exercise, sit and reach test and back extension test were used to measure flexibility. The results of the present study, fitball exercise can improve both anterior and posterior muscle flexibility in these participants. This may be due to the similarity of the test and the training form. That is, with fitball exercises in different positions, the muscles of the shoulders, back, hips and legs are mainly stretched (Judy & Tamilarasi, 2023). Sekendiz et al. (2010) conducted a study on fitball exercise among working-age women. Significant changes in lower back flexibility were observed. This was because the exercise focused on the shoulders, back, hips and legs using different fitball exercise poses, e.g., cobra's pose, bow pose, bridge pose and downward facing dog (Sekendiz et al., 2010).

In terms of muscular strength-endurance performance, the muscular strength and muscular endurance of the FEG could improved because the training postures were in sets and reps, considered as the basis of the resistance training. In addition, in this study, the principle of overload was applied to stimulate muscle development each week in order to improve both muscular strength and size. A study by Kumar (2023) revealed that incorporating fitball into a training program can improve muscular strength. However, when compared to the group trained with the aerobic exercise program, there was no difference in the development of muscle strength. It is probably because fitball exercise can improve strength, but it may not be the best exercise compared to other forms of training (Kumar, 2023). Kamatchi et al. (2020) studied the effects of swiss ball exercise and pilates exercise on core muscle strengthening in college cricketers. It was found that both forms of training can improve muscle strength after 6 weeks of training (Kamatchi et al., 2020). In addition, a study by Wasim et al. (2023) compared fitball exercises with kettle bells. It is suggested that to develop muscular strength, fitball exercise with kettle bells works best. The samples of the study were teenagers. Compared to this research, the samples were working-age women, so they tend to have less physical activity (Wasim et al., 2023). Thus, fitball exercise may be a physical activity that can promote good health. It is also safe and suitable for obese working-age women.

The maximum oxygen consumption that refers to the exercise capacity or exercise tolerance was improved in the FEG after 6 (MID) and 12 weeks (POST) of the intervention period, compared to the CG. As working-age women in this generation tend to decrease in physical activity, fitball exercise is another good option to improve the cardiovascular system. There will be a greater exchange of oxygen in the blood and muscle cells as a result of aerobic exercise. As a result, the cardiac muscle is stronger. The heart can better pump blood to different parts of the body and cardiorespiratory system is also improved. However, it depends on the frequency, intensity, duration and type of exercise. Another factor that may increase maximum oxygen consumption in obese working-age women is fitball exercise in the form of sets and reps by focusing on total muscle use, contraction and increasing intensity by shortening rest periods. This is consistent with a study by Ayudthaya & Kritpet (2015), which found that low-impact aerobic training combined with fitball can increase maximum oxygen consumption among working-age women, similar to this present study (Ayudthaya & Kritpet, 2015). Multani et al. (2019) studied the resistance training combined with fitball at a low-weight and high-repetition. This training form can also improve maximum oxygen consumption. The main factors enabling the improvement of cardiorespiratory endurance in this study may be the intensity and the continuity of the training, that is 45 minutes or more of training, compared to the appropriate intensity for those doing exercise, so it may result in the effective improvement of VO_2max (Multani et al., 2019).

Conclusions

The 6-week (MID) fitball exercise affects the overall change of body composition, flexibility, muscular strength-endurance and maximum oxygen consumption in working-age subjects with obese women. In particular, it is more effective when continuously training for 12 weeks (POST). Therefore, it should be supported as another option to promote health and wellness that does not negatively affect tendons, joints and muscles. It is also safe and suitable for working-aged women population.

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Conflict of interest

The authors declare that they have no conflict of interest.

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ВПЛИВ ВПРАВ НА ФІТБОЛІ НА СКЛАД ТІЛА, ГНУЧКІСТЬ, М'ЯЗОВУ СИЛУ-ВИТРИВАЛІСТЬ ТА АЕРОБНУ ЗДАТНІСТЬ У ЖІНОК ПРАЦЕЗДАТНОГО ВІКУ З ОЖИРІННЯМ

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

Реферат. Стаття: 9 с., 4 табл., 4 рис., 20 джерел.

Метою дослідження було вивчити та порівняти вплив вправ на фітболі на склад тіла, гнучкість, м'язову силу-витривалість і максимальне споживання кисню (VO_2max) у жінок працездатного віку з ожирінням.

Матеріали та методи. Двадцять шість жінок працездатного віку з ожирінням (ІМТ ≥ 25,0 кг/м^2) віком від 40 до 50 років були розподілені на 2 групи: 1) група вправ на фітболі (ГВФ) та 2) контрольна група (КГ). Тренування тривало 12 тижнів із заняттями по 60 хв/день і 3 дні на тиждень. Усі параметри вимірювали за 1 день до (ПЕРЕД; до початку тренування), через 1 день після 6 тижнів (СЕРЕД; посередині тренування) і протягом 1 дня після 12 тижнів (ПІСЛЯ; після завершення тренування) періоду тренування.

Результати. Після 6-тижневого тренування ГВФ продемонструвала значне покращення показників маси тіла, ІМТ, розгинання спини, сили ніг, тесту на повторні вставання з крісла та сідання в крісло протягом 60 секунд (60SCST) та VO_2max (-0,92%, -1,34%, 12,74%, 27,19%, 25,79% та 10,75% відповідно, $p < 0,05$) порівняно з КГ. Аналогічно, після 12-тижневого тренування ГВФ продемонструвала значно більше покращення показників маси тіла, ІМТ, відсоткового вмісту жиру в організмі, тесту на нахили тулуба вперед із положення сидячи, розгинання спини, сили ніг, тесту 60SCST та VO_2max (-1,14%, -2,19%, -1,92%, 54,31 %, 27,31 %, 33,50 %, 37,02 % та 24,05 % відповідно, $p < 0,05$) порівняно з КГ.

Висновки. Тренування з виконанням вправ на фітболі є ефективним для покращення складу тіла, гнучкості та м'язової сили-витривалості, а також для підвищення аеробної здатності працівниць з ожирінням.

Ключові слова: вправа на фітболі, склад тіла, гнучкість, м'язова сила-витривалість, здатність до фізичного навантаження, з ожирінням, працівниці.

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