

Original Article

Effects of flexi bar training model to health-related physical fitness in overweight adults

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Abstract. [Purpose] The purpose of this study was to assess the effects of flexi bar training model and moderate running exercise on health-related physical fitness in overweight adults. [Participants and Methods] Forty participants were randomly assigned to an experimental (20 participant performing flexi bar training model (FBT)) and control (20 participant performing moderate running exercise (MRE) group. The participant in both groups then underwent program training 50 min/day, 3 times a week, for 12 weeks. The main outcome measures were health related physical fitness (HRPF). [Results] The result showed significant differences between FBT and MRE group. After 12 weeks FBT showed improve HRPF variable. [Conclusion] flexi bar training model can improvement health related physical fitness in overweight adults.

Key words: Flexi bar training, Health related physical fitness, Overweight

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INTRODUCTION

Overweight or being heavier than standard criteria is generally based on Body Mass Index or BMI. It can be calculated by dividing weight (kg) by height² (m²). BMI of the overweight was ranged between 25.00 to 29.99 kg per square meter¹⁾. According to BMI information, WHO conducted the research and found that Asian people have smaller physical sizes than American, European, and African people. It is needed to adjust BMI to be appropriate for Asian physical structures. Therefore, the BMI of Asian people was ranged from 18.50 to 22.99 kg/m². Meanwhile, those who have BMI ranged from 23.00 to 24.99 kg/m² were considered overweight. In 2017 World Health Organization reported the effects of overweight on chronic disease, stroke, blood pressure, and diabetes type 2 tended to increase for both men and women. To decrease the rate of having health problems in overweight adults, it is focused on promoting appropriate physical behaviors, physical activities, having healthy nutrition, and regular exercises²⁾. There are various models of exercises for losing fat such as aerobic dance³⁾ walking^{4, 5)} running^{6, 7)} and cycling⁸⁾. These activities need moving big muscles in different parts together which increase oxygen consumption and basal metabolism rates in overweight adults⁹⁾. Vibration exercise an alternative exercising activity to increase lean body mass¹⁰⁾ increasing efficiency of muscle contraction^{11, 12)} increase muscle mass^{13, 14)} and providing positive effects on blood vessels and blood circulatory system¹⁵⁾ since exercising with vibration will stimulate increasing of muscles to correspondingly work as well as increasing of basal metabolism rate¹⁶⁾. Flexi bar exercising is an exercise with vibration equipment and is designed to have low frequency rate at 5 Hz, to vibrate 270 times per minute, with the size of 1.53 m long, 710 g, and 9.5 mm for circumference (Flexi bar). The experiment was taken place in a laboratory of research and technology, Munich University, Germany and it is certified and tested for the quality of the equipment by National Association of German Back Schools (AGR) that flexi-bar under the brand of Flexisport, Munich is appropriate and safe for exercise¹⁷⁾ because of having been manufactured from high-flexibility fiber glass. While vibrating flexi-bar, the vibration

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is generated along small amplitude of movement. There is resistance or intensity against vibration along the bar where the weight at both ends were the scale to control the weight of vibration timing. The trainers need to keep the vibration timing rate stable. In this case, the device can maintain stability of force constantly¹⁸). Vibration generated by flexi bar will stimulate core muscle functioning¹⁹⁻²¹) to generate reaction with the change of cross-sectional area of muscles and increase muscle activate throughout the body²²⁻²⁴). For core muscles in human body, training with flexi bar can help encourage the functioning system of nerve muscles to perform reaction faster^{25, 26}). This condition, body can retrieve energy to be used by burning out energy faster that affects in increasing the rate of more and faster energy expenditure than normal exercises such as brisk walking, running, cycling and etc.²⁷) There are research reports studying on the function of the group of core muscles in group of healthy people, however, the benefits gained after training have not been found reported indicated about a comparison study between active vibration using the flexi bar that has no ground reaction force and general exercise by running, both of which are under the condition of aerobic exercise and control the heart rate intensity during exercise at the same level throughout training period. This can link to the change in the variables in different physiological aspects. Consequently, the researcher hopes that this research will be able to provide advantageous information for health promotion and beneficial for the choice as another effective exercise for people with overweight.

PARTICIPANTS AND METHODS

This study was performed in accordance with the ethical standards of the Helsinki Declaration and approved by the Ethics Committee in Human Research, Khon Kaen University, HE 612319. The participants were 40 individuals, participating in the health promotion project who were staff and students of Loei Rajabhat University, aged 20–45 years old with BMI ranges between 23.00 to 24.99 kg/m², BMI is set as the standard for Asian people is considered overweight. The participants were written informed consent has been obtained from each participant. The 40 samples were identified as overweight, using sample random sampling technique. Inclusion criteria consist of without any operation history or having treated with spinal surgery at least 6 months, being healthy without chronic diseases or health problems that possibly reduce readiness to exercise, evaluated from Physical Activity Readiness Questionnaire (PAR-Q) and pass in physical fitness, being healthy and strong without any affective factors obstructing exercise. Exclusion criteria were as follows having chronic diseases such as high blood pressure, heart disease, diabetes, and coronary artery diseases, etc., less than 80% participation of the flexi bar training sessions. And pregnant or breastfeeding volunteers. Other exercises and food consumption were recorded daily. Data were collected during three periods: the 1st week, the 8th week, and the 12th week of the experiment. The research instruments included twelfth active vibration with flexi bar training model. The test periods were performed for 12 weeks and included health related physical fitness. For the 1st–12th week of the experiment the participants lived their normal lives. Flexi bar training model: Twelfth active vibration with flexi bar training model has been developed into a model that is suitable for exercise in people who are overweight. Through consideration of the suitability of sports science experts with qualifications through passed the training course of certified personal trainer from American Council on Exercise (ACE) and National Academy of Sports Medicine (NASM). All participants were asked to perform the 12-week training program by doing Flexi bar training model for 50 min per time, 3 times a week on Monday, Wednesday and Friday. This program was conducted from 5 pm to 6 pm. The training program was performed at the Sports complex building, Sport and Exercise Sciences program, Loei Rajabhat University. Data were collected during three periods of the experiment. The test periods were performed for 12 weeks and included health related physical fitness in terms. Muscular strength, muscular endurance, flexibility and cardiorespiratory fitness were measured. Also, the assessment of body composition was carried out through the bioelectrical Impedance Analysis (In body 270) measurement of weight, body mass index (BMI), fat percentage (% Fat), fat mass muscle mass and basal metabolic rate (BMR). The participants' height (without shoes) was measured by a standiometre. The BMI was calculated by dividing body mass in kilograms by height in square meters (kg/m²). The waist girth was measured at the level of the umbilicus horizontally without clothing, Waist hip ratio (WHR) was calculated by dividing the waist girth by the hip girth. Muscular strength is measured including Shoulder press: Deltoid, Chest press: Pectoralis, Abs crunch: Abdominal, Back extension: Lower back, Leg extension: Quadriceps, Leg curl: Hamstring, Biceps curl: Biceps, Triceps extension: Triceps, and Lat pull down: Latissimus dorsi using weight machine from Life Fitness brand, in Kilogram. Muscular endurance is tested with sit up. The participants lie on the mat and bend their knees 90 degree with someone hold on the ankles, two feet apart, hands joined together at the chest, count the numbers of times doing sit up within 30 sec. The upper muscles of the body can be tested with push up by having the participants put their hands on the mat little wider than the shoulders, and put arms alongside their body. For males, body trunk and legs are lined together while females can kneel down on the floor doing Modified push up. The times the participants can do the push up are counted within 30 sec. Flexibility is tested with Sit and Reach test. Participants sit down bend their body forward, stretch their legs, put the soles of the feet closer to the testing device, bow down, stretch arms, and press the figure plate (cm) with finger tips. Do the test twice and record the highest score the participants can do. Procedures: Twenty overweight adult participant's active vibration with flexi bar training model (FBT). The exercise sessions were divided into three sessions; a 10 min warm up session performing static stretch following dynamic warm up with flexi bar. A 35-min workout session performing the other 12 positions, chest, balance abductor, waist, oblique, triceps, biceps, core muscle, deep back extensor, shoulder, hips, lower back and abdominals (Table 1). The Flexi-Bar (FLEXI-BAR[®]; Flexi-Sports, Germany) used in this experiment is an exercise tool having weights

Table 1. Flexi bar training model protocol

Unit of training	Active vibration with flexi bar training model position	Duration of training
Warm up	Static stretching of major muscle groups and dynamic warm up with flexi bar.	10 min
	1. Chest	
	2. Balance abductor	
	3. Waist	
	4. Oblique	
	5. Triceps	35 min
	6. Biceps	- 30 sec active vibration
	7. Core muscle	- 30 sec rests in set
	8. Deep back extensor	- 3 sets each position
	9. Shoulder	
	10. Hips	
	11. Lower back	
12. Abdominals		
Cool down and stretching	Static stretching.	5 min

at the both ends of a glass fiber elastic bar of weight 719 g and length 1.53 m. At the center part, a grip of 17.9 cm, whereas the ends consist of weighty rubber. So the hands and arms transfer approximately 5-Hz vibrations when holding the middle handle and shaking the stick. To vibrate 270 times per minute, the participant held the Flexi-Bar with both hands while standing and performed vibration exercise, each position performed its exercise for 30 sec and rested for 30 sec, continue to practice with 3 sets of each pose. Following a 5-min cool down and static stretching of major muscle groups. The control group, twenty overweight people using moderate running exercise (MRE) with continues 50 min.

Both groups control intensity 65–75% of maximum heart rate throughout the duration of each exercise. Intensity and energy expenditure while training with flexi bar and moderate running exercise. All participants put on heart rate monitor (Polar Team Pro) in which the signal was connected to the receiver (Apple iPad). The results were displayed on the screen while training including Heart Rate (bpm), Percent of Average Heart Rate (%AVG^{HR}), Percent of Maximum Heart Rate (%AVG^{HRmax}) and Energy Expenditure of Exercise in Kilocalories (Kcal). Statistical Analyses: The effect size was calculated using Cohen's. these calculations were based on Cohen's classification of a small ($0.2 < ES < 0.5$), moderate ($0.5 < ES < 0.8$) and large ($ES \geq 0.8$) effect size²⁸). A p-value < 0.05 based on two sided calculations was considered significant analysis of variance. As a result, 2 samples in this study were cut out. Therefore, forty participants were chosen for this study. The data analysis, the statistical analysis was conducted using SPSS 17.0 for Windows. Data were presented as mean \pm SD, changes within group and within-group variance of baseline data and after-training data. The baseline data were the data before the 1st week, 8th week and 12th week. The paired samples t-test was used to compare pre training and post training variables in each group (FBT or MRE). The independent samples t-test was used to compare basal variables between groups (FBT vs. MRE). The statistical significance was tested at the level of 0.05. Kolmogorov-Smirnov Test used to normality distribution of the data in both groups before the experiments. Research using one way repeated ANOVA for analysis with statistical significance level of 0.05.

RESULTS

The participant group was no baseline differences in demographic and clinical findings between the experimental and control groups. At week 12th, the FBT and MRE group were significantly different ($p < 0.05$) from baseline in body composition variable. For example, for body composition, the weight, BMI, percentage of fat decreasing while muscle mass increase significantly ($p < 0.05$). The cardiovascular variable (Table 2) were showed significantly ($p < 0.05$) decreasing after training in HR rest, systolic-diastolic blood pressure, and increase VO_2 max after training respectively.

Regarding muscular strength (Table 3) there were significant changes ($p < 0.05$) from baseline at week 8th, FBT group showed improvement biceps, triceps, latissimus dorsi, pectoralis, deltoid, grip strength and found significant difference between group in week 12th, also MRE group changes different ($p < 0.05$) in quadriceps and hamstring muscle (Table 4). Thirty second sit up muscle endurance test were showed significantly increased from baseline in FBT group, and also sit up 30 second pushes up at week 12th there were significant changes ($p < 0.05$) when compare MRE group (Table 5). In addition, all both groups there were significant changes from baseline at week 12th.

Table 2. Characteristic differences of participants

Characteristic	Participants		p
	Flexi bar training (FBT=20)	Moderate running exercise (MRE=20)	
Gender (males:females)	10:10	10:10	-
Age (years)	24.3 ± 7.3	24.1 ± 7.8	0.977
Height (cm)	164.2 ± 4.2	164.5 ± 4.7	0.828
Weight (kg)	67.6 ± 5.9	66.5 ± 6.5	0.622
BMI (kg/m ²)	24.1 ± 0.7	24.1 ± 0.7	0.921

Mean ± SD.

Table 3. Differences of body composition and physiology variable

Health related physical fitness	Flexi bar training (FBT=20)			Moderate running exercise (MRE=20)		
	Pre test	8th week	12th week	Pre test	8th week	12th week
Body composition variable						
Weight (kg)	67.6 ± 5.9	67.1 ± 6.0	66.6 ± 5.7*	66.5 ± 6.5	66.4 ± 6.6	65.7 ± 6.3*
BMI (kg/m ²)	24.1 ± 0.7	23.9 ± 0.8	23.8 ± 0.8*	24.1 ± 0.5	24.0 ± 0.5	23.9 ± 0.4*
Fat (%)	20.9 ± 2.2	20.4 ± 2.3	19.9 ± 2.4*	20.1 ± 1.2	19.9 ± 1.1	19.7 ± 1.0*
Fat mass (kg)	15.1 ± 2.3	14.9 ± 2.4	14.6 ± 2.6	15.2 ± 2.1	14.8 ± 1.9	14.8 ± 1.9
Muscle mass (kg)	40.6 ± 15.0	40.9 ± 15.3	41.3 ± 15.1*	40.7 ± 10.9	39.8 ± 10.4	39.4 ± 10.1
WHR (inch)	0.86 ± 0.5	0.85 ± 0.5	0.85 ± 0.5	0.85 ± 0.5	0.85 ± 0.5	0.85 ± 0.5
BMR (Kcal)	1,688 ± 71.1	1,690 ± 88.6*	1,693 ± 86.3*†	1,694 ± 67.7	1,691 ± 66.6	1,687 ± 68.2
Cardiovascular variable						
HR rest (bpm)	73.0 ± 11.9	70.8 ± 13.3	69.4 ± 6.37*	71.6 ± 13.4	70.2 ± 11.4	69.4 ± 10.2*
Systolic (mmHg)	129.5 ± 8.2	129.1 ± 9.2	126.4 ± 4.9*	128.2 ± 7.2	127.1 ± 7.1	127.0 ± 7.1
Diastolic (mmHg)	74.1 ± 8.2	73.9 ± 8.2	73.5 ± 7.1	74.4 ± 9.0	73.8 ± 8.7	72.7 ± 7.4*
VO ₂ ^{max} (mL/kg/min)	39.4 ± 4.5	40.3 ± 3.1	41.1 ± 3.8*	38.5 ± 3.1	39.3 ± 2.2	40.5 ± 1.5*

Mean ± SD. *Compared the difference within group, *p<0.05.

†Comparing the difference between experimental groups, p<0.05.

Table 4. Differences of muscle strength

Health related physical fitness	Flexi bar training (FBT=20)			Moderate running exercise (MRE=20)		
	Pre-test	8th week	12th week	Pre test	8th week	12th week
One repetition maximum (1RM) (kg)						
Leg extension	69.0 ± 4.8	69.6 ± 4.7	72.6 ± 6.4*	70.7 ± 6.7	72.0 ± 6.0*	73.0 ± 5.3*
Leg curl	54.6 ± 11.2	55.4 ± 11.0	54.6 ± 10.8	55.2 ± 11.3	56.9 ± 10.0*	57.7 ± 10.6*
Biceps curl	29.5 ± 3.0	31.9 ± 4.4*	33.3 ± 4.0*†	29.7 ± 2.6	29.8 ± 2.0	30.0 ± 2.0
Triceps extension	34.1 ± 6.4	36.2 ± 6.8*	37.4 ± 6.7*	35.0 ± 8.2	35.6 ± 7.6	35.3 ± 7.3
Lat pull down	68.7 ± 13.1	70.0 ± 12.0*	72.2 ± 10.0*†	67.2 ± 12.4	68.6 ± 11.3	68.7 ± 11.6
Chest press	62.8 ± 13.4	63.9 ± 15.8	67.5 ± 16.1*†	62.3 ± 10.4	62.6 ± 10.2	62.5 ± 9.7
Shoulder press	53.3 ± 8.6	55.5 ± 9.4*	56.1 ± 9.8*†	54.9 ± 7.8	55.3 ± 7.5*	55.7 ± 7.0*
Hand grip dynamometer	32.9 ± 3.7	33.4 ± 3.1*	34.4 ± 3.2*†	32.8 ± 4.3	33.0 ± 3.7	32.3 ± 3.2

Mean ± SD. *Compared the difference within group, *p<0.05.

†Comparing the difference between experimental groups, p<0.05.

Table 5. Differences of muscle endurance and flexibility

Health related physical fitness	Flexi bar training (FBT=20)			Moderate running exercise (MRE=20)		
	Pre test	8th week	12th week	Pre test	8th week	12th week
Muscular endurance (times)						
30 sec push up	29.6 ± 1.4	30.1 ± 1.3	31.3 ± 1.4*	30.7 ± 1.5	30.3 ± 1.2	30.8 ± 1.4
30 sec sit up	31.0 ± 2.0	32.0 ± 2.5	33.1 ± 2.3*†	31.1 ± 2.5	31.6 ± 2.6	31.6 ± 2.6
Flexibility (cm)						
Sit and reach	13.1 ± 2.0	14.1 ± 1.2	14.7 ± 0.8*	12.9 ± 2.0	14.0 ± 1.8	14.4 ± 1.5*

Mean ± SD. *Compared the difference within group, *p<0.05.

†Comparing the difference between experimental groups, p<0.05.

DISCUSSION

This study aimed to investigate the effect of flexi bar training (FBT) on health related physical fitness in overweight adult compared to the moderate running exercise (MRE). There have been studies conducted a study in a passive method using full body vibration exercise equipment, while this study used a flexi-bar to apply active vibration exercise. There were three phases of this study; the pre-training period the 1st week, the 8th week, and the 12th week of the experiment. This study found that flexi bar training significantly improved body composition, cardiovascular variable, muscle strength, endurance and flexibility. The variables improvements were persisted at week 12th. According to anatomical and mechanical properties, the exposure of vibration to the skeletal muscular system causes a tonic vibration reflex (TVR)²⁹. The application of vibration to the tendon or muscle results in a TVR response, as reported previously^{30, 31}. The TVR was initially considered to be a result of frequency stimulation applied directly to a muscle or tendon for a short period. The application of local vibration to the tendon or muscle also improves muscle function^{32, 33}. From this it can be surmised that the increased effectiveness of the training also influences muscular strength and muscular endurance. Additional data include we exercise with flexi bar can activation of the core muscle and increase transvers abdominals thickness^{20, 21, 34}. Moreover, active vibration with flexi bar training can improve oxygen building muscle and yield a relevant increase energy expenditure better general exercise in the same amount of time²⁷. The active vibration with flexi bar training and moderate running exercise groups provided better body composition outcomes in terms of weight, body mass index (BMI) and fat percentage after training period. The changes in body composition were as follows; the body weight of the participants reduced significantly at the 12th week of training. This is consistent to the finding in this research that the TVR stimulation of muscles to contract by periods of low intensity vibration from flexi bar continuously, approximately 5 Hz will stimulate muscles to carry out energy for burning fat or fat metabolism, overweight and obese people more efficiently. According to principle of aerobic exercise, the active vibration with flexi bar training is a one type of aerobic exercises. To a targeted training, program with the active vibration with flexi bar training had higher energy expenditure than running group. Combination of various aerobic energy systems will provide positive effect on energy consumption from body fat and affecting fatty molecules which is lipid transported to parts of body, provides relevant results as a factor for weight and fat loss. Moreover, the activation of large muscle groups with moderately high intensity within a given time span as part of a classical flexi bar training module should at least directly correlate with distinct increases in active metabolic rate. Aerobic exercise helped increase efficiency of heart muscles. Consequently, decreasing of heart rate at rest after training of both training groups are affected by cardiovascular functioning system. When having regular exercise continuously, heart rate becomes lower since there are two types of functions. The first function is pacemaker. This is SA node relating to the amount of Acetylcholine and sensitivity of heart to catecholamine becomes lower. The second one is increasing parasympatatic vagus ability to work for heart nourishment. When sympathetic system reduces working, it also reduces heart rate at rest and helps control increasing of risk of having high blood pressure^{2, 35}. In addition, stimulates function of blood vessels and decrease pressure inside blood vessels as the key factor to reduce systolic and diastolic blood pressures, in addition increased the efficiency of maximal oxygen consumption (VO₂^{max}) after 12-week exercise. Maximal Oxygen consumption is the indicator to specify blood circulatory system and respiratory system that is relative to the increasing of gas exchange while breathing³⁶. Outstanding of continuous flexi bar training in set, practicing 30 sec for each set and 30 sec rest period simultaneously totaling 3 sets for each training posture is increasing of heart rate while exercise within short time based on the principles of training of interval training. Vibration is generated by stimulating muscles to increase rate of oxygen expenditure. This increased afferent excitation and reflexive contribution might be responsible for the improved muscle function following the application of vibration stimuli^{37, 38}. In this study showed the effectiveness of training program, by the results showed a significant increase in 8th week and 12th week respectively, muscular strength was as follows; biceps, triceps, latissimus dorsi, deltoid, grip strength, pectoralis and quadriceps. While hamstring muscle did not change in experimental group. Muscle strength increased because flexi bar training stimulated the use of force to resist vibration that affected muscular fibers to become larger or hypertrophy and

then increased muscular enzymes to perform function^{5, 29}). Same as moderate running exercise group showed a significant in quadriceps, hamstring and deltoid muscle. Hand grip at the center of handle is the center point of force from both ends to be met; therefore, the trainees will receive vibration force continuously^{18, 40}). Based on the result of this study, muscle endurance after flexi bar training increased by doing 30-sec push up and 30-sec sit up test with statistical significance when comparing with moderate running exercise group at the end of the training. Gerhardt et al.³⁹) suggested that resistance from vibration will help stimulate more blood circulatory transported for muscle and nerve cell nourishment. Moreover, repeating training postures frequently links between nerves and muscles to work together better. And then muscles become larger and muscular fiber structure change. It can be said that flexi bar training is an exercise that promotes strength and endurance of skeleton muscles as well as stability of joints^{22, 23}). It also effects to flexibility will increase length of movement of joints more efficiently⁴¹) Because the researcher set the step of stretching muscles and joints for every posture. The participants did both dynamic stretching for muscles of full body parts to stimulate muscle temperature to be ready to move in any directions and static stretching 20 sec for each round and doing it 3 set for muscle group. This study uses samples with body mass index for Asian people only. And training postures, most of which are static training, there should be applies to the training styles for various movements for the effectiveness of the training program. The patterns of flexi bar training should be appropriately adjusted for different groups of people such as children, elderly, and patients with chronic diseases. The flexi bar is a pattern of exercise designed by the researcher and proved for appropriateness by the experts based on the principles of sport science and exercise, can promote various kinds of health-related physical fitness including physical fitness components, increasing energy expenditure, cardiovascular system, flexibility, strength and endurance of muscles. This is safe for physical structure and does not cause vertical force. Therefore, flexi bar training is an alternative exercise for those who want to lose weight, strengthen physical structures and increase effectiveness of blood vessel functioning. Consequently, it should be widely promoted and furfure applied for enhancing healthiness.

Conflict of interest

The authors indicate no conflicts of interest.

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