

COMPARISON OF DIFFERENT EXERCISE MODALITIES IN IMPROVING METABOLIC SYNDROME RISK FACTORS AMONG OBESE FEMALES

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(Received 9 December 2017; accepted 28 May 2018; published online 3 July 2018)

To cite this article: Norizzati M. I., Sarina M. Y., Maisarah S., & Raja Nurul Jannat R. H. (2018). Comparison of different exercise modalities in improving metabolic syndrome risk factors among obese females. *Malaysian Journal of Movement, Health & Exercise*, 7(2), 135-144.

<https://doi.org/10.15282/mohe.v7i2.193>

Link to this article: <https://doi.org/10.15282/mohe.v7i2.193>

Abstract

Background: There is compelling evidence of an obesity phenomenon worldwide and interest in structured physical activity in improvement on overall health. Moderate to high levels of cardiorespiratory fitness and muscular strength resulting from aerobic and strength training appears to be protective against diabetes, CVD, and metabolic syndrome. Aerobic and strength training have also been shown to have beneficial effects on metabolic syndrome risk factors by improving in glucose metabolism, lipids profile, blood pressure, and abdominal obesity via different physiological pathways. Therefore, this study aims to investigate the effects of different modes of training on metabolic syndromes risk factors among obese females. A total of 52 participants (22.71 ± 1.53 years old) participated in this study. Participants were randomly assigned into aerobic (n=13), strength (n=13), concurrent (n=13), and control (n=13) groups. Intervention groups (aerobic, strength and concurrent) engaged in training 3 times weekly for 8 weeks, with approximately one hour per session at moderate intensity (aerobic; 50-70% of heart rate reserve, strength; 50-70% 1 repetition maximum). The concurrent training group spent 30 minutes of aerobic exercise, followed by 30 minutes of strength exercise. Triglycerides (TG), high density lipoprotein (HDL), fasting blood glucose (FBG), resting blood pressure (RBP), and waist circumference (WC) were measured in this study. A significant improvement ($p < 0.05$) was observed in fasting blood glucose (FBG), resting blood pressure (RBP), and waist circumference (WC) in intervention groups. It can be summarized that regular involvement in exercise was associated with a reduction in most metabolic syndrome risk factors among obese females.

Keywords: Metabolic syndrome risk factors, obesity, aerobic, strength, concurrent

Introduction

Obesity prevalence had grown dramatically all around the globe with nearly threefold since 1975 to 2016. Overall, 650 million adults aged 18 and older were obese. This includes up to 13% of the adult population worldwide. Interestingly, the incidence of obesity is highest among females, with females outnumbering males by 15% to 11% (WHO, 2017). The availability of easy access food such as fast food high in fat is the main driving force for the rising prevalence of obesity. Additionally, development and modernization and domestic mechanization has facilitated the continuous decline in energy expenditure required for daily living which leads to increase in sedentariness (WHO, 2017; Wiklund, 2016). Obesity itself is a causative factor in the development of several non-communicable chronic diseases such as cardiovascular disease, diabetes mellitus, cancer and musculoskeletal disorder (Afshin et al., 2017; Nigatu, Reijneveld, de Jonge, van Rossum, & Bültmann, 2016).

Obesity, however, is highly avertable through decrease in energy intake and increase in energy expenditure via regular exercise. Numerous studies have revealed aerobic and strength exercise substantially promote overall health, weight loss as well as improve metabolic syndrome risk factors (Lira et al., 2010; Nybo et al., 2010; Pollock et al., 2000; Strasser, Siebert, & Schobersberger, 2010). There are several definitions of metabolic syndrome risk factors (Kaur, 2014). To date, the most common accepted consensus definition of metabolic syndrome risk factors includes abdominal obesity, elevation in blood pressure, triglycerides, and glucose, and reduction in high density lipoprotein (Grundy, 2016).

In addition, most of the obese people having a perspective of exercise is not enjoyable. Therefore, they rather choose to live in sedentary life instead of being physically active. (Ruby, Dunn, Perrino, Gillis, & Viel, 2011). In addition, exercise also is viewed as time consuming and too tiring among females university students and this excuses become the greatest perceived barrier for them not to exercise (Lovell, El Ansari, & Parker, 2010). Combined exercise, also known as concurrent training, which combines both aerobic and strength training in one session could be applied to this population to conquer this exercise barrier. This training might produce synergistic benefits towards metabolic syndrome risk factors (Eklund et al., 2016). Therefore, the current study is interested in observing the effectiveness of different mode of training (aerobic, strength, and concurrent training) in improving metabolic syndrome risk factors among obese university female students.

Methodology

Participants

Fifty-two female university students were recruited in this study through poster distribution around the campus area. All participants involved in this study completed a thorough health screening, including body composition, resting electrocardiogram, medical history, non-fasting glucose, and resting blood pressure assessment. The participants selected in this study were healthy individuals (free from cardiovascular

diseases, hypertension (blood pressure > 140/90 mmHg), diabetes mellitus, musculoskeletal injuries, and medication, absent of menstrual cycle for six consecutive months and does not physically impaired), aged between 18-25 years old, classified as obese (BMI: 30.0-39.9 kg/m², body fat percentage: ≥ 35%) according to World Health Organization (WHO), and practicing a sedentary lifestyle which had not involved in any structured physical activity for the past six months. This study was approved by the Ethics Committee of Universiti Teknologi MARA Shah Alam Campus, 600-RMI (5/1/6).

Experimental Approach

All participants engaged in eight weeks of an exercise training program. Participants underwent one day of pre-intervention test, three days a week for eight weeks of exercise training, and one day of post-intervention test. Pre- and post-intervention sessions were conducted on three consecutive days. Participants were matched based on body mass index (BMI) and body fat percentage and randomly assigned into aerobic (n=13), strength (n=13), concurrent (n=13), and control group (n=13) following to pre-intervention test. Exercise training consists of aerobic, strength, and concurrent training. All exercises were performed under supervision of a researcher and qualified trainers. Participants were advised to maintain their dietary intake and physical activity levels throughout the study.

Training Program

All participants in the training groups were trained approximately 60 minutes in each exercise session, with a warm up and cool down before and after each exercise session. Participants in the aerobic training group performed brisk walking or jogging on a treadmill at the intensity of 50 to 70 % of heart rate reserve (HRR). Participants' HRR were increased every two weeks (week 1-2: 50-55% HRR, brisk walk; week 3-4: 55-60% HRR, brisk walk/jogging; week 5-6: 60-65% HRR, jogging; week 7-8: 65-70% HRR, jogging).

Participants in the strength training group engaged with eight exercise routines including body weight and machine exercise, 3 sets of 8-12 repetition of exercise, and 1-minute rest interval between set and exercise. Exercise targeting the total body, including upper and lower body and the abdomen. Intensity was set at 50-70% of predicted repetition maximum (1-RM) and increased every two weeks by manipulating the load and repetitions of 1-RM.

For the concurrent training group, participants engaged with aerobic (30 minutes) followed by strength training (30 minutes). The exercise routine and intensity for concurrent exercise is similar with the exercise routines and intensity implemented for aerobic and strength training alone. For strength training in concurrent training, participants performed six exercise routines with 8-12 repetitions for 2 sets, start with upper body followed by lower body, and abdominal. The rest interval between set was 1 minute.

Outcome Measures

Data collections for pre- and post-test were conducted at 8.00 in the morning. The participants were asked to fast at least for eight hours the night before for blood sampling

and body composition analysis. Prior to body composition measurement, height was determined using a bodymeter (SECA206, Germany). Participants stood upright under the body meter. The measuring tongue was lowered down until it touched the head and the measurements were recorded at a measurement sensitivity of 0.1 cm. The data was later used for body composition measurement.

Body composition, body weight, body mass index (BMI), and body fat percentage were assessed using bioelectrical impedance analysis (InBody120, Korea). Participants asked to wear light clothes and step on the machine barefooted. Height and identification was keyed-in in the software and participants maintained the upright position for about 20 seconds. Ergonomic circumference measuring tape (SECA201, Germany) was used to measure waist circumference. The measurement was taken at the end of normal expiration at the accuracy of 0.1 cm. The measurement was taken approximately at midpoint between the lower margin of palpable rib and the top of the iliac crest. The measurements were taken twice and the average value was recorded. Manual desk mercury sphygmomanometer was used to measure resting systolic and diastolic blood pressure. The measurement was taken at left arm after participants had rested comfortably on a chair with a backrest for 10 minutes. An arm cuff was wrapped firmly and the stethoscope diaphragm was firmly placed onto the skin over the brachial artery in the antecubital space. The cuff was inflated and deflated to listen to the first and last Korotkoff sound. For biochemistry analysis, six milliliters of venous blood were drawn from participants via an antecubital vein through a venipuncture procedure by qualified medical personnel. The blood was collected into two vacutainers tubes which were yellow top with K2EDTA for blood lipid and grey top with potassium oxalate and sodium fluoride for fasting blood glucose. The blood samples were sent to hematology laboratory to be analyzed using standard laboratory procedures. TG, HDL, and FBG were analyzed using Siemens Advia 2400 automated analyzer (Siemens Healthcare Diagnostics, Deerfield, Illinois, USA).

Statistical Analysis

The Statistical Package for Social Science software (SPSS) version 21.0 was used to analyze the raw data and all values were reported in mean \pm standard deviation (SD). Normality of the data was checked using Shapiro-Wilk test. A Mixed Between-Within Subject Analysis of Variance (ANOVA) was employed to analyze pre- and post-training values within and between groups for all dependent variables. The significance value was set at .05. The magnitude of change (Δ) was also reported in this study if there was a significant difference shown in variables tested. The magnitude of change was calculated using formula below:

$$\text{Magnitude of change (\%)} = \frac{\text{Pre-intervention result} - \text{Post-intervention result} \times 100}{\text{Pre-intervention result}}$$

Results

Adherence to Training Program

No dropouts occurred during eight weeks of exercise interventions. All participants completed all 24 exercise sessions. In addition, there were no injuries reported throughout the study.

Physical Characteristics

Table 1 showed physical characteristic among groups at baseline. The results showed that the data for all four groups is normally distributed.

Table 1: Physical characteristic between groups

Variables	Aerobic (n=13) Mean±SD	Strength (n=13) Mean±SD	Concurrent (n=13) Mean±SD	Control (n=13) Mean±SD
Age (years old)	22.38±.77	22.46±1.27	23.77±1.79	22.23±1.69
Height (cm)	157.31±4.12	159.72±5.84	160.59±4.81	158.82±5.35
Weight (kg)	83.34±9.59	86.81±12.71	87.78±10.27	86.19±9.78
Body Mass Index (kg/m ²)	33.62±3.26	34.01±4.09	34.04±2.99	34.18±3.38
Body Fat Percentage	46.28±2.77	46.56±4.84	46.82±4.18	47.04±2.85

Metabolic Syndrome Risk Factors

Table 2 shows the values of metabolic syndrome risk factors at baseline and post-intervention in all groups. Based on the results, significant improvement was seen in waist circumference (p = .00), systolic blood pressure (p = .00), and fasting blood glucose (p = .02) variables between pre- and post-intervention. There were no significant differences found when comparing between groups in all variables tested (p > .05).

Based on magnitude of change, strength training elicits superior reduction in waist circumference followed by aerobic and concurrent training (-4.44%; -4.11%; -0.56%). On the other hand, systolic blood pressure was found to be most improved in aerobic group compared to the concurrent and strength training group (-6.44%; -6.30%; -4.02%). Meanwhile, the concurrent training group shown greatest percentage of blood glucose reduction (-13.16%) followed by aerobic (-5.15%) and strength (-4.81%) groups after eight weeks of intervention.

Table 2: Metabolic Syndrome Value Comparison between Pre- and Post-intervention

Variables	Aerobic	Strength	Concurrent	Control
Waist circumference (cm)*				
Pre-intervention	87.79±6.34	91.50±7.30	91.72±8.58	91.07±7.88
Post-intervention	84.18±5.63	87.44±5.46	91.21±8.76	91.65±7.27
Systolic blood pressure (mmHg)*				
Pre-intervention	124.31±12.15	122.62±12.85	124.38±11.9	127.08±10.24
Post-intervention	116.31±8.60	117.69±11.66	116.54±7.47	128.08±9.65
Diastolic blood pressure (mmHg)				
Pre-intervention	76.77±11.83	77.15±9.15	78.77±10.51	76.92±6.93
Post-intervention	74.92±7.64	73.85±9.61	76.00±8.64	78.23±6.83
Triglycerides (mmol/L)				
Pre-intervention	1.23±.56	.96±.22	1.02±.42	.95±.46
Post-intervention	1.05±.58	.92±.21	.90±.34	.99±.40
High density lipoprotein (mmol/L)				
Pre-intervention	1.25±.26	1.37±.26	1.28±.29	1.33±.25
Post-intervention	1.23±.20	1.38±.30	1.41±.34	1.30±.26
Fasting blood glucose (mmol/L) *				
Pre-intervention	4.90±.77	4.57±.44	4.90±.47	4.70±.56
Post-intervention	4.66±.90	4.36±.39	4.33±1.06	4.85±.44

* p < .05 for time effect in ANOVA test

Discussion

Our study was intended to observe the effectiveness of eight weeks of different mode of training on potential changes in metabolic syndrome risk factors. The results following eight weeks of exercise interventions demonstrated positive significant changes in waist circumference, systolic blood pressure, and fasting blood glucose in all training groups. The results of this study are aligned with other previous findings on waist circumference which also showed increasing physical activity levels among this group of population resulting in a reduction in waist circumference (Melam, Alhusaini, Buragadda, Kaur, & Khan, 2016; Pantelić, Milanović, Sporiš, & Stojanović-Tošić, 2013). The current study indicates that any exercise training, whether it is categorized as aerobic, strength or combining both aerobic and strength (concurrent), conducted 3 times per week for eight weeks, with moderate intensity is proven to reduce waist circumference. Many previous studies have suggested that aerobic exercise is the best type of exercise for total body fat loss (both visceral and subcutaneous adipose tissue) including for the abdominal region (Ali, El-Refay, & Ali, 2015; Okura, Nakata, Lee, Ohkawara, & Tanaka, 2005). However, this is contradicted by the results gathered in this study which surprisingly showed strength training group demonstrated greatest improvement in waist circumference based on the magnitude of changes as reported in results compared to other intervention groups. Even though the percentage was different between strength and aerobic groups, they did not differ much. Interestingly, this study found that strength training in this study controverted

the conventional findings on the positive relationship of aerobic exercise and waist circumference improvement. This might be due to the sufficient exercise prescription given throughout 8 weeks of training. Volume of training plays a key role in relation to the effects of strength training on weight loss. Adequate volume of training promotes further decrement of fat mass (FM) and FFM at the particular group of muscles involved during training, which is known as localized fat loss due to increased muscle activation (Howley, 2001; Ogwumike, Arowojolu, & Sanya, 2011).

Even though the findings failed to identify which group is superior in improving resting systolic blood pressure, yet, the aerobic group produced the greatest reduction in systolic blood pressure among other training groups. This finding is aligned with the general consensus in the literature that aerobic/endurance training elicits greater impact in blood pressure and recent guidelines recommend that everyone should engage in regular aerobic physical activity, such as brisk walking, jogging, with at least 30 minutes per session, most days of the week, as a means to lower blood pressure (Cornelissen & Fagard, 2005; Fagard, 2006; Pescatello et al., 2004). The possible underlying mechanisms responsible for these changes is due greater improvement in vascular resistance, and sensitivity of the aortic baroreceptors which increased in vascular endothelium-derived nitric oxide (NO) biosynthesis and lead to increase of vasodilator capacity of the skeletal and myocardial muscle tissue. Thus, it cause an increment in vessel diameter (Cornelissen & Fagard, 2005; Nuttamonwarakul, Amatyakul, & Suksom, 2012). Chronic adaptation to aerobic training (above eight weeks duration) might offer further decrement of total peripheral resistance due to the changes in vascular structural tissue. The changes include vascular remodeling to increase length, cross sectional, and diameter of arteries and veins, or new growth of blood vessels (Medicine, 2010).

Fasting blood glucose showed significant decreased after eight weeks of aerobic, strength, and concurrent training. However, no significant reduction in fasting blood glucose was observed when compare between groups. Although no significant main effect was found via statistical analysis, concurrent group showed large differences in magnitude of change (8%) when comparing with other training groups. This may be due to the combination of aerobic and strength exercise routines in concurrent training group produce greater physiological adaptations compared to aerobic and strength training alone. Aerobic exercise improves the insulin sensitivity of muscle due to an increase in the number of insulin receptor in the muscle which increases insulin binding to monocyte sites. This allows muscle to utilize glucose efficiently, especially during exercise, thus decreasing glucose levels (MacArdle, Katch, & Katch, 2010; Nayak, Maiya, & Hande, 2005). On the other hand, strength exercise that involves isolated, brief activity of single muscle groups results in increase the number of insulin receptors and protein GLUT-4 due to increase in muscle mass (Clark et al., 2003). This was supported by Sigal et al. (2007), who also found greater improvement in glycemic control in combined aerobic and strength training than either aerobic or strength training alone. Hence, it can be concluded that concurrent exercise in this present study offers great benefits for obese people to stabilize blood glucose levels and this will help in the prevention of diabetes mellitus and other health problems among obese individuals.

Conclusion

The findings of the current study have demonstrated eight weeks of regular involvement in physical exercise regardless exercise modality (aerobic, strength, and concurrent) produce significant changes in improving metabolic syndrome risk factors among obese university female students. Therefore, the choices of exercise is depends of individual preferences. It is interesting to note that concurrent exercise could be an alternative preferred exercise regime for obese people who wants to gain both benefits from aerobic and strength training at the same time which offer less time consuming, more enjoyable, and less tiring that can facilitate an active lifestyle.

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