THE EFFECTIVENESS OF DIFFERENT TRAINING PROGRAMS IN REDUCING BODY WEIGHT

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CERTIFICATE

This is to clarify that the dissertation entitled

"THE EFFECTIVENESS OF DIFFERENT TRAINING PROGRAMS IN REDUCING BODY WEIGHT"

Is the bona fide record of research work done by

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During the period from October 2013 to **JUNE 2014**

Under my supervision

THE EFFECTIVENESS OF DIFFERENT TRAINING PROGRAMS IN REDUCING BODY WEIGHT

By

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ABSTRAK

KEBERKESANAN PELBAGAI PROGRAM LATIHAN SENAMAN DALAM MEMBANTU MENURUNKAN BERAT BADAN

Tujuan kajian dijalankan adalah untuk mengenalpasti program latihan senaman yang berkesan dalam membantu menurunkan berat badan. Seramai 36 orang subjek, pelajar Universiti Sains Malaysia (Kampus Kesihatan) yang mengalami masalah berat badan (BMI $\geq$25) dan menjalani kehidupan yang tidak aktif berumur dalam lingkungan 20 hingga 25 tahun secara sukarela menyertai. Mereka dibahagikan secara rawak kepada Kumpulan Latihan Kekuatan (n=7), Kumpulan Latihan Ketahanan (n=10), Kumpulan Latihan Gabungan (n=7) dan Kumpulan Kawalan (n=12) dengan median BMI ialah 33.6 kg/m^2, 30.55 kg/m^2, 27.90 kg/m^2 dan 31.50 kg/m^2 bagi setiap kumpulan secara turutan. Dalam tempoh 8 minggu tempoh intervensi, Kumpulan Latihan Kekuatan (ST) terlibat dalam program latihan kekutan berdasarkan berat badan sendiri selama 8 minggu, Kumpulan Latihan Ketahanan (ET) terlibat dengan program latihan senaman berasakan aerobic seperti jogging, berjalan laju dan memanjat tangga selama 8 minggu, Kumpulan Latihan Gabungan (SET) pula terlibat dengan dua-dua jenis program latihan secara bergilir-gilir berdsarkan minggu latihan dan Kumpulan Kawalan (C) melakukan aktiviti seharian mereka seperti biasa. Kesemua program latihan mengambil masa selama 60 minit termasuk 5 hingga 10 minit waktu untuk sesi memanaskan dan menyejukkan badan. Program latihan kekuatan termasuklah tekan tubi, 'dart', 'plank', 'hip-up', sit-up, 'dip', bulatan tangan dan 'lunge'. Selepas 8 minggu, kesemua subjek menjalani post-ujian untuk mengukur komposisi badan. Keputusan menunjukkan bahawa, dengan mengikuti program senaman latihan selama 8 minggu dalam apa jua bentuk senaman memberi kesan kepada perubahan berat badan ($p<0.05$).

Selain itu, kumpulan ST juga menunjukkan perubahan yang ketara kepada kepada ukur lilit pinggang, manakala kumpulan SET menunjukkan perubahan yang ketara kepada ukur lilit pinggul. Kesimpulannya, program senaman memberi kesan kepada penurunan berat badan dalam kalangan pelajar perempuan yang mengalami masalah berat badan (BMI $\geq$ 25)

ABSTRACT

THE EFFECTIVENESS OF DIFFERENT TRAINING PROGRAMS IN REDUCING BODY WEIGHT

The purpose of this study was to determine the type of exercise which was effective in reducing body weight. A total of 36 overweight (BMI ≥25) and sedentary female subject from Universiti Sains Malaysia's students (Health Campus) age range between 20 to 25 years old were divided randomly into Strength Training Group (n=7), Endurance Training Group (n=10), Combine Training Group (n=7) and Control Group (n=12) with median of Body Mass Index (BMI) of 33.6 kg/m^2, 30.55 kg/m^2, 27.90 kg/m^2 and 31.50 kg/m^2 respectively. During 8 weeks of intervention period, Strength Training Group (ST) participated in the intervention program of body weight strength training for 8 weeks, Endurance Training Group (ET) participated in the intervention program of aerobic exercise training type such as jogging, brisk walking and stair climbing for 8 weeks, Combine Training Group (SET) participated in both strength and endurance training exercise alternately also for 8 weeks and Control Group (C) had their owns activities. All training program exercise protocol was to perform 60 minutes of exercise 3 days per weeks. Each session included 5 to 10 minutes of warm-up and cool-down. Strength training program included; push-ups, darts, prone plank, hip-ups, sit-ups, dips, arm circles and lunges. After 8 weeks, all subjects underwent post-test to measure their body composition. The finding revealed that, engage in 8 weeks of any exercise training resulted in significant changes of body weight ($p<0.05$). Besides, ST group show significant changes in waist circumferences and SET group show significant change in hip circumferences. The results show that exercise training program does

bring benefits in reducing body weight among overweight and obese female student (BMI $\geq$ 25).

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Overweight and obesity has become epidemic due to world growth in industry, economy, urbanization and globalization (Mustafa *et al.*, 2013). Therefore, obesity been recognized as a major public health concern due to lack of physical activity and sedentary lifestyle (Ayiesah *et al.*, 2013). According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Specifically, overweight is defined as an individual having body mass index (BMI) equal or more than 25 kg/m2, while obesity is defined as an individual having BMI equal or more than 30 kg/m2 or individual that has waist-hip ratio (WHR) of more than 1:0 for male and more than 0:85 for female .

According to Global Health Observatory Data Repository, 46.3% of Malaysians females are being overweight (BMI $\geq$ 25) in 2008. A study that had been done in one of the hospitals in Malacca recorded that 59% of the respondent from the aged between 21 to 59 years old are obese, 24% are overweight and only 17% have an ideal weight (Ayiesah *et al.*, 2013). With that, one-fifth of Malaysian primary school children are overweight, showing that Malaysia in worrying state. Studies have often identified sociodemographic factors, level of physical activity, individual and family health status, and lifestyle behaviors as determinants of obesity risks (Naidu *et al.*, 2013).

Consequently, obesity risks in Malaysia are affected by gender, education level, family history, health conditions, smoking status, and ethnic backgrounds. Specifically, female (5.3%) in Malaysian are more likely to be obese and those with history of families' illness (4.8%) (Tan *et al.*, 2011). Obesity among females is a significant health concern in Malaysia compare to men. Kee et al, who examined the nationwide NHMS III data, reported 26% of woman at higher risk compare to men (7.2%) (Kee *et al.*, 2008). It shows that, female at higher risk than male in being overweight or obese.

According to Malaysia Clinical Practice Guidelines, lifestyle modification is the main initial approach to lose weight and to combat obesity. Cut down the amount of calorie intake important during weight loss therapy. The amount of calorie intake depends on the category of obesity. For instance, a very low calorie diet is for individual with BMI> 30kg/m2. Surgery is an option in selected patient with morbid obesity (BMI >40 kg/m2 or between 35 kg/m2 to 40 kg/m2, with major weight related comorbidities). Consequently, limit the energy intake and increase physical activity are the easier choice to lose weight and preventing obesity.

Physical activity is important in weight loss therapy and weight maintenance. According to National Institute of Aging (NIS), 45 to 60 minutes of moderate physical activity per day or less duration for vigorous activity are recommended. Physical activity contributes to weight loss by altering energy balance and favorably changes body composition, also decrease risk for disease, and improves quality of life. There are four basic categories of exercise and physical activities which are endurance, strength, balance and flexibility (NIA, 2011).

Increased in practicing physical activity or exercise is a recommended strategy to reduce and manage body weight effectively (McDonald *et al.*, 2012). Usually, aerobic-type activities like walking, biking and swimming are tend to caloric expenditures. Studies suggest that strength exercise also play an important role in reducing weigh through different mechanism. Although strength training is getting more popular among general population, there is still lack of interest among female to take strength training as part as their exercise program. There is a misconception about strength training by practicing it can get bulky and too muscular. Female hormones do not have high level of testosterone hormone which primary function for muscle growth. Therefore, changes to get bulky are low unless it been advised to overload the strength training.

1.2 Objectives of the study

The general objective of this study is:

- To study and investigate which type of exercise is effective in reducing body weight in overweight individuals.

The specific objectives of this study are:

1. To measure the effectiveness of strength training in reducing body weight.
2. To measure the effectiveness of endurance training in reducing body weight.
3. To measure the effectiveness of combination strength and endurance training in reducing body weight.
4. To compare the effectiveness these three type of training in reducing body weight.

1.3 Hypothesis of the study

Null hypothesis, H_o:

1. There is no significant effect of strength training in reducing body weight.
2. There is no significant effect of endurance training in reducing body weight.
3. There is no significant effect of combination strength and endurance training in reducing body weight.

Alternative hypothesis, H_A:

1. There is significant effect of strength training in reducing body weight.
2. There is significant effect of endurance training in reducing body weight.
3. There is significant effect of combination strength and endurance training in reducing body weight.

1.4 Significance of the study

The significance loss of kilograms in short time is important for female who are involved in exercise routines. Although for just one or two sessions, they already expect to loss certain weight. Most of them rarely choose strength based training as an option to lose weight but endurance based training likes jogging or brisk walking. It is important to us to examine the effectiveness of these different types of exercise routines in reducing body weight. Apart from that, this study will also help to provide a comfortable and supported environment for overweight to exercise and try to lose weight to desirable weight. This study also may help women to stay active and healthy even though had a busy schedule.

1.5 Operational definitions

1.5.1 Strength training exercise

Strength training (also called resistance training or weight training) is based on the principle that muscle of the body will work to overcome a resistance force when it is required to do so. Strength training includes free weight, body weight training, chair exercise and rubber resistance exercise. It is a weight-bearing activity that can strengthen bones, build muscle and burn calories. It is not only involves target muscles but also surrounding muscle. For example, during prone plank, target muscle is abdomen but also affected back muscle and biceps. For this study, body weight training is chosen as exercise routines. Body weight training is convenient and free.

Specific training regimen is needed to elicit the desired adaptations. Muscle adaptations occur differently based on the type of overload placed on them. In first eight to twelve weeks of practicing strength training, neural adaptations will occur such as motor learning, increase in coordination of motor unit and increase motor unit recruitment. Besides, muscular adaptations also will happen. There is an increase in muscle size called hypertrophy, which usually type II muscle fiber, due to volume of strength training and also increase in term of numbers of muscle (hyperplasia). But, increased muscle strength is not always parallel to the gains in muscle size. During strength training, it involves three types of contraction; concentric (muscle shortens when contraction), eccentric (muscle lengthens while it is contracted), and static (no change in muscle length during contraction). Energy system will help the movement of the muscle by provide ATP energy used during strength training.

1.5.2 Endurance training

Endurance training or aerobic training is long duration exercise performed at submaximal effort simply where oxygen is present and used to generate energy when the glycogen is stores in the muscles are broken down to produce glucose and hence allow muscle contraction to continue. Body energy system can use either fat or carbohydrate stores in order to produce energy. During higher level of intensity, carbohydrates are typically used more. However, with the right training, fat utilization as fuel can be use with longer bouts of exercise. For weight management exercise, thus type of exercise is recommended to reduce weight. During endurance exercise, energy for the muscle contraction from energy regenerated through mitochondrial respiration, which initially has same pathway as glycolysis. But energy system is work together to produce ATP. Through glycolysis, blood glucose or muscle glycogen is converted to pyruvate, which once produced will either enter the mitochondria or be converted to lactate depending on the intensity of exercise.

Endurance training induces many physiological adaptations both centrally and peripherally mediated. Increase in the capacity of endurance training was the result of cardiovascular adaptations by increasing the capacity to deliver oxygen (O_2) to the working muscle, primary responsible for large increase in maximal O_2 uptake capacity (VO_2max). Endurance training also induces an increase in the mitochondrial contents of skeletal muscle. Resting heart rate also decrease due to increasing efficiency of cardiovascular system and higher stroke volume. Increased stroke volume due to heart becoming stronger and blood pumped out more completely during diastole. Muscle hypertrophy also can occur but on slow-twitch muscle fibers.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Impact of strength training on body weight in overweight women

Muscle strength is the capacity of the neuromuscular system to win or to oppose the external resistance such as weight, elastic bands, the body mass and strength training machines (da Mota *et al.*, 2010). The systematic implementation of such activity is called strength training (ST) and has a positive impact on several activity of daily living. Common modes of ST include the use of barbell/dumbbells, resistive band/tubing, and various body weight exercises.

ST is typically performed for the purpose of increasing strength or muscle mass or both. The improvement of strength and muscle mass also lead to favorable changes in the area of body composition, muscular endurance, bone density, cardiac risk factors, psychosocial well-being, and metabolism (Hass *et al.*, 2001). In that case, ST also can affect body weight due to favorable changes in the area of the body composition because changing in body composition such body fat and body muscle can positively changes body weight.

Weight loss can occurs when there is a negative energy balance. Total energy expenditure (TTE) exceeds energy consumptions is one of the factors of negative energy balance. ST exercise may significantly increase total energy expenditure, but more through indirect than though direct means. ST does not affect TTE directly, but it mainly increase the resting metabolic rate (RMR) and also enhances fat loss specifically through enhanced post-exercise fat utilization, which will aid in weight loss and improved body composition (Alexander, 2002).

Body spend energy in 24 hours which relates to the amount of individual muscle mass. ST will provide muscle hypertrophy contributes to the process of weight loss (Donnelly *et al.*, 2009b). To postulated mechanism for the collaboration of the ST with weight loss via muscle hypertrophy it would be this: the increase in muscle mass create greater RMR and this, in turn, increase the TTE, thereby reducing the fat corporal (Donnelly *et al.*, 2009b). The main energy substrate used in this situation is the fat, this would be an efficient way to promote weight reduction and ultimately the body fat (da Mota *et al.*, 2010).

This study, stated that there were three components body spend energy in twenty-four hours; a) resting metabolic rate (RMR) (involve energy expenditure to maintain physiological function during sleep and in situation close to the RMR), b) thermo effect of food which is responsible for digestion, absorption and assimilation of nutrients from food, and c) thermo effect of physical activity (da Mota *et al.*, 2010).

Low caloric cost of ST may significantly affect energy expenditure, but indirectly increasing RMR and enhances fat loss specifically through enhanced post-exercise fat utilization. This will aid weight reduction and improved body composition, and at the same time increase lean body mass and decrease weight loss

People loss lean muscle mass as consequence of normal aging; the replacement of fat mass with lean muscle via strength training increase the calories burning (Laskowski, 2012). Previous study also reported, resting energy expenditure (REE) and fat free mass (FFM) decrease with aging and could also contribute to age-associated fat gains by increasingly sedentary leisure and non leisure activity pattern (Schmitz *et al.*, 2003).

Besides from the normal aging, overweight individual also increase in fat mass due to sedentary lifestyles and lack in physical activity or exercises. Consequently, due to sedentary lifestyle, resting metabolic rate and fat free mass also will decrease. By doing ST, it will increase lean muscle due to muscular adaptation from strength training. A significant and sustainable change in body composition and body power was able to produce by ST exercise (Sgro *et al.*, 2009). A review article in 2011 also concluded that ST results in favorable changes in body compositions (decreased fat mass and increased lean body mass) and effective in reducing abdominal obesity (Strasser and Schobersberger, 2011).

Schmitz *et al* (2003) in his research also reported strength training increase FFM by 1-2 kg and gain of 1kg of FFM should result in an REE increase of approximately 88kJ/kg. Another study reported that, in all age group of men and women observed REE increase in the range of 117-913 kJ/kg increase of FFM (Alexander, 2002). ST may significantly increase RMR by increasing FFM.

A studied on overweight and obese children showed significant decrease in absolute percent body fat and significant increase in lean body mass. This is due to effect of 3 day per week for eight weeks undulating periodized resistance training program. However, there were no significant changes in height, weight, body mass index, total fat mass, or bone mineral content (McGuigan *et al.*, 2009). This study consisted of total body workouts using a combination of different body weight and power exercises with variety of equipment. The program used in this study is by varying training load within each week of training as well as increasing intensity during 8 weeks.

Another studied on young overweight adults engaged in three sessions of ST per week by completing intense 1 set of 9 different exercises using load equivalent to 85-90% of 1 repetition maximum (RM) showed increasing of fat-free mass (2.7%), experienced a significant increase both resting metabolic rate and sleep metabolic rate when compared with control subjects and also there also increase in 24 hours energy expenditure and sleep respiratory quotient (RQ) (Kirk *et al.*, 2009). This decrease in RQ suggests a greater radiance on fat as fuel source. From this study, it showed a potential of high intensity, low volume of ST as role of weight management program.

Figure below shows ST may have positive effect body weight consequence from some of the events effect from training exercises.

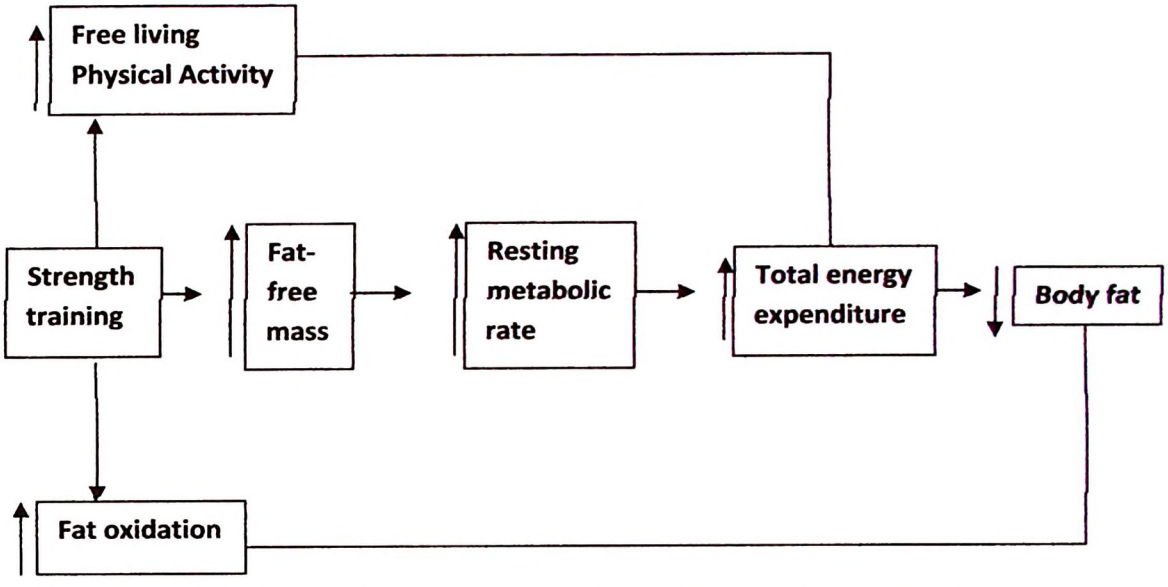

Figure 2.1: Theoretical association: (Washburn et al., 2012).

Washburn et al. explained in a theory association showed the effect of practicing strength training can alter body composition. By practicing strength training, it can affect three things; a) increase free living physical activity, b) increase fat oxidation, and c) increase fat-free mass. Increasing fat-free mass as well as explained in other study can affect resting metabolic rate. Total energy expenditure will also increase due to increase in resting metabolic rate because during resting state, body also tries to burn out energy. Increase metabolic rate and total energy expenditure resulted in loss of body fat. This also will lead to change in body weight because of loss body fat.

2.2 Impact of endurance training on body weight in overweight women

Endurance training is able to directly affect energy balance (Alexander, 2002). Exercise may influence resting energy expenditure in 3 ways: (a) a prolonged increase in post-exercise metabolic rate from an acute exercise challenge; (b) a chronic increase in resting metabolic rate associated with exercise training; and (c) a possible increase in energy expenditure during non-exercising time. By increasing energy expenditure, body weight also can be promoted.

Substantial weight loss is unlikely to occur from physical activity program unless the overall volume of ET is well above the minimum recommended levels (Swift *et al.*, 2014). An updated version of summarized of minimal requirement of physical actives (PA) stated that 150-250 minutes per weeks of moderate intensity PA will help protect against initial weight gain and engage in more than 250 minutes per weeks of moderate intensity PA can results in a "clinically significant" weight loss (Donnelly *et al.*, 2009a). 53 exercise studies principally conducted in the 1970–1980s in men and results showed overall body mass decreased with endurance training (Li *et al.*, 2014). An exercise prescription for the general population that consists of exercise of low (<50% $V\square O_{2max}$) or moderate intensity (50 to 75% $V\square O_{2max}$) does not appear to produce a prolonged elevation of post-exercise metabolic rate that would influence body-weight (Poehlman *et al.*, 1991). Aerobic exercise is associated with higher energy expenditure per unit of time and is recommended over resistance training for weight management purposes.

According to journals published between 1966 and 1993 reported by Garrow and Summerbell in 1995 in their systematic review with meta-analysis study obtained reports on human subjects in which the effect of exercise on body composition was studied in at least two concurrent treatment groups, of which at least one group did, and one group did not, undergo an exercise programmed designed to promote fat loss. Their study showed endurance training without dietary restriction among men caused a weight loss of 3 kg in 30 weeks compared with sedentary controls, and 1.4 kg in 12 weeks among women, but there was little effect on FFM. As concluded, aerobic exercise causes a modest loss in weight without dieting. (Garrow and Summerbell, 1995)

On other systematic review with meta-analysis of randomized controlled trials on relevant databases was searched to latest November 2010 to investigate the independent and combined effects of endurance training and strength training modalities on visceral adiposity in adults for 4 weeks or more in adult humans show different result on visceral fat (VAT). These data suggest that endurance training is central for exercise programmed aimed at reducing VAT, and that endurance training below current recommendations for overweight/obesity management may be sufficient for beneficial VAT modification. The data show that when compared with a control intervention, Endurance training is effective in lowering VAT while, resistance training itself failed to induce significant reduction in VAT when compared with the control group. (Ismail *et al.*, 2012). VAT is the deep fat wrap around the inner organ and will cause negative effect to the health if there are to a large extent and drives up risk for diabetes, heart disease, stroke, and even dementia. VAT also part of body weight. Managing this type of fat will also change the body weight.

A study on 2003 about comparisons of the effects on different durations and intensities of exercise on 12-month weight loss and cardio-respiratory fitness showed weight loss was significant within all groups, but there was no significant effect of either exercise duration or exercise intensity on changes in body weight between groups. A similar pattern of change in BMI was observed (Jakicic *et al.*, 2003). These study instructed participants to exercise 5 d/wk with walking encouraged as the primary mode of exercise. Exercise intensity was prescribed both in terms of percentage of age-predicted maximal heart rate and rating of perceived exertion based on the Borg Scale.

Latest study done to examine the dose–response relationship between exercise volume and intensity with derived health benefits including volumes and intensity of activity well below international recommendations, showed low-volume exercise training (10-min brisk walking 3×/week) demonstrated improvements among fasting plasma glucose. While, larger volume exercise training programs demonstrated more consistent improvements including body composition, aerobic capacity, musculoskeletal and hemodynamic improvements (Foulds *et al.*, 2014).

The finding also support by other finding said the identification of weight loss only among larger programs supports the larger physical activity volume required for weight maintenance and weight loss (Warburton *et al.*, 2011). Another study on training method between in-place and transitional training method effect on body composition showed significant weight reduction for transitional training method involve endurance training exercise which is jogging and dynamic exercise with 65-70% of maximum heart rate-moderate intensity (Azadi *et al.*, 2014).

Another study is carefully conducted to show the issue is simply one of energy balance for control of weight and clear dose-response relationship between amount of weekly exercise and amount of weight change. Finding stated that the controls gained weight while a fairly modest amount of exercise (walking) led to weight loss and clear dose-response effect between amount of weekly exercise and decreases in measurements of central obesity and total body fat mass, reversing the observed effects in the control (non-exercising) group (Slentz *et al.*, 2004).

In non-dieting, overweight subjects, the controls gained weight, both low-amount exercise groups lost weight and fat, and the high-amount group lost more of each in a dose-response manner (Slentz *et al.*, 2004). These findings strongly suggest that, absent changes in diet, a higher amount of activity is necessary for weight maintenance and that the positive caloric imbalance observed in the overweight controls is small and can be reversed by a modest amount of exercise. Most individuals can accomplish this by walking 30 minutes every day. In 1995, the Centers for Disease Control and Prevention and the American College of Sports Medicine jointly issued a health statement recommending that "Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week." (Pate *et al.*, 1995).

2.3 Impact of combination strength and endurance training on body weight

Haskell et al. reported that for whole-body physical fitness conditioning and exercise prescription for health, both endurance and strength training exercise should be included in training program with a frequency up to three and two times a week, respectively (Haskell *et al.*, 2007). One of the studied reported doing combination of strength and endurance training is more beneficial for weight loss and change body composition (Hendrickson *et al.*, 2010). Combined endurance and strength training may be more effective in modifying body composition by increasing lean mass and also decreased in waist circumference and total fat mass (Sillanpää *et al.*, 2009).

Kosmidou et al. reported exercise program included 3 sessions a week, each of which lasted 50 minutes those three years systematic combined strength and endurance training for healthy elderly women showed significant different in body composition and lipid profile. Significant differences were recorded between the exercise group and the control group in body mass ($p<0.01$). As conclusion, 9 months of annual training for a 3-year period induced positive adaptations in body composition and lipid profile in elderly women (Kosmidou *et al.*, 2014).

Another studied to evaluate e effects of concurrent training protocols (strength-endurance against endurance-strength), on lipid profile and body composition in overweight females for 8 weeks showed significantly decrease in body fat, body weight and increased in fat free muscle but not significantly. It also reported that there was no significant difference found between two exercise group (Ali-Mohamadi *et al.*, 2014).

Nelson et al. reported that simultaneous training (combined endurance and strength training) may inhibit the normal adaptation to either training program when performed alone. This showed in last half of the study, endurance group had significant gain in maximum oxygen consumption (VO_2max) whereas the combine group had no significant increase. The finding also showed endurance group had significant increase in citrate synthesis activity whereas combine group had no significant increase (Nelson *et al.*, 1990). The extent of interference probably depends on the nature and intensity of individual training program. But other findings in 2012 suggest that combined training performed three times a week for about 60 min in middle-age men can promote better adaptations than RT and ET isolated during this intervention period (Libardi *et al.*, 2012).

A study, purpose was to investigate the comprehensive physiological alterations that take place during the combination of bench-step aerobics (BSA) and resistance exercise training showed no significant differences were observed in either body mass or fat-free mass in any group. However, a trend for increase in fat-free mass was observed for group beach-step aerobics for 20 minutes and 40 minutes. Percent body fat decrease significantly in all group training (Kraemer *et al.*, 2001). In person with coronary artery disease, a large meta-analysis found that combined strength and endurance training was more effective than endurance training alone in improving body composition as decreasing fat mass and increasing lean muscle mass and also improving strength and some indicators of cardiovascular fitness (Marzolini *et al.*, 2011).

CHAPTER 3

METHODOLOGY

3.1 Subjects

Fifty-one female students of Universiti Sains Malaysia with body mass index (BMI) 25 and above were initially recruited into the study. Most of them were not physically active and also not engaged in any formal exercise routines with no recent injury for last three month. Each participant signed an informed consent approved by the USM Research and Ethical Committee before participation and was informed of all possible experimental risk and discomfort of participating in this study (Appendix B). As of the inclusion criteria for participation: each participant is a student of Universiti Sains Malaysia (USM), age between twenty to twenty-five years old, BMI 25 and above. Volunteers with evidence of hypertension, liver disease, kidney disease, diabetes, asthma, and/or abnormal blood value were being excluded from the study. Besides, those who are involved in other weight loss program or taking diet pills also were being excluded from the study. However, 15 of these participants did not complete the study and withdrew because of time commitments and reasons unrelated to research study. Therefore, 36 of females actually completed the study. Subjects were assigned to the four groups, and resulting group sizes were 7 in strength training group (ST), 10 in endurance training group (ET), 7 in combination of strength and endurance training group (SET), and 12 in control group (C). The study received ethics approval from USM Research and Ethical Committee.

3.2 Research instruments

Throughout this study, several of instruments were used for the purpose of data collection. All the measurements were carried out by the same person in charged. The information on each instruments are as follow.

3.2.1 Body Meter 406 (SECA)

Body Meter 406 (SECA) was used to measure the height of the subject. The reading was set to 1 decimal point.

3.2.2 Omron Karada Body Scan

Omron Karada Body Scan (Japan) was used to measure the weight and body composition (percentage of body fat and percentage of muscle) of the subjects. The scale was set to 2 decimal points.

3.2.3 Tape measure

Tape measure was used to measure the waist and hip circumference of the subject. The scale was set to 1 decimal point.

3.2.4 Yoga mat

Yoga mat was used by the participants while performing pushups, darts, prone plank, hip ups, and sit ups during strength training.

3.2.5 Stopwatch

Casio Hs-30 (Japan) digital stopwatch was used to measure the time while performing jogging, brisk walking and stairs climbing during endurance training and also rest interval in between sets and exercises in strength training.

3.2.6 Heart Rate Monitor

Polar RS 100 (USA) heart rate monitor with H1 heart rate sensor was used to measure the heart rate while performing jogging, brisk walking and stairs climbing during endurance training for heart rate based training.

3.3 Research protocol

3.3.1 Testing procedures

Prior to the tests, all subjects were briefed on the experimental risks and procedures about the study. After briefing, subjects then completed and signed the participation information and informed consent form. Then, subjects went for anthropometric measurements with their height, body weight and body mass index measured. Subject who fulfilled the inclusion criterion performed the pre-test, consists of body weight, body composition analysis, and waist and hip circumference. All the thirty-six subjects were divided randomly into four groups, namely strength training group, endurance training group, combination of strength and endurance training group and control group. The exercise groups underwent training for eight (8) weeks while the control group resumed their normal lifestyle routines for 8 weeks. After 8 weeks, subjects returned back for post-test measurements (Figure 3.1).

3.3.2 Strength training procedure

All workouts started with general warm-up and included cool-down periods (i.e., stretching, etc.) of approximately 5-10 minutes. The researcher supervised all subjects so that all essential program characteristics were strictly enforced. Specifically, researcher was responsible for seeing that exercise prescriptions were properly carried out and achieved during a workout (e.g., repetitions, duration of movement, appropriate safety consideration, prescribed rest periods, and proper hydration requirements). The 8 weeks program consisted of strength training using own body weight. The exercise group performed all upper- and lower-body exercises in three training sessions per week for 8 weeks. Strength training program included; push-ups, darts, prone plank, hip-ups, sit-ups, dips, arm circles and lunges. Subjects performed 8 repetitions of each exercises for one circuit. The rest period was set to 30-60 seconds between exercises and 3 minutes between the circuits. The numbers of repetitions were increased gradually by week. Summary of the strength training was summarized in the table below.

Table 3.1: Strength training protocol

	Weeks/Repetition							
Type of exercise	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Push ups	8	12	8	10	12	15	12	15
Dart	8	12	8	10	12	15	12	15
Prone planks	8	12	8	10	12	15	12	15
Hip ups	8	12	8	10	12	15	12	15
Sit-ups	8	12	8	10	12	15	12	15
Dips	8	12	8	10	12	15	12	15
Arm Circle	8	12	8	10	12	15	12	15
Lunges	8	12	8	10	12	15	12	15
Rest between station (s)	60	60	60	60	60	60	60	60
Rest between circuit (min)	3	3	3	3	3	3	3	3
No of circuit	1	1	2	2	2	2	3	3

3.3.3 Endurance training procedure

Each session started with a general warm-up approximately from 5-10 minutes and ended with cool-down period for 10-15 minutes. The researcher supervised all subject so that all essential program characteristics were strictly enforced. Specifically for endurance training are intensity of exercise, duration of exercise and all safety consideration (e.g., rest period and hydration requirements). The 8 weeks of endurance training program was heart rate based training included jogging, walking and stairs climbing. Subjects performed 15 minutes of each exercise continuously. For first 4 weeks, the intensity of the training program was 50-60% of maximum heart rate (MHR) and continued with 60-70% of MHR for last 4 weeks.

Table 3.2: Endurance Training Protocol

	Weeks/Target Heart rate (THR) %							
Type of exercises	1	2	3	4	5	6	7	8
Jogging	50-60 % of MHR				60-70% of MHR			
Brisk walking								
Stair climbing								

3.3.4 Combination of strength and endurance training procedure

The combination of strength and endurance training group was performed both training program alternately by weeks. Subjects started training with strength training program and followed by endurance training program. Strength training program was advised done on odd weeks while endurance training on event week.