UNIVERSITI PUTRA MALAYSIA

A COMPARISON OF THE EFFECTIVENESS OF FOUR EXERCISE MACHINES IN THE DEVELOPMENT OF HEALTH RELATED FITNESS AMONG WOMEN IN UNIVERSITI PUTRA MALAYSIA

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By

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Project Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Educational Studies Universiti Putra Malaysia

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In order to compare four modes of exercise in improving health-related fitness, 119 women from Universiti Putra Malaysia (mean age = 28.77 years) were randomly assigned to control or four experimental groups. The experimental groups completed ten weeks of training frequency set at three days per week, with one group being the control, and one group each training on one type of exercise machine. The exercise machines used were the Treadmill, the Body Tone II, the Gravity Walker and the OrbiTrek.

Pretest and posttest were performed on ten measures representing the five health-related fitness components. Measures were taken on estimated VO_2 max, 1-RM bench press, 1-RM leg press, back strength, bench press repetition, leg press repetition, standing trunk flexion, trunk and neck extension, hip flexion, and percent body-fat.

Analysis of variance (ANOVA) was performed on the difference between pretest and posttest scores. This was followed by Tukey's post hoc test. F tests indicated that all four exercise machines elicited significantly higher scores than the control on all measures ($F_{4,114}$ =2.45, $p < .05$) except for 1-RM leg press, leg press endurance and percent body-fat. No significant changes were observed for percent body-fat among all groups. For the 1-RM leg press and leg press endurance, the Treadmill group did not show significant improvements when compared to the control or the other experimental groups. However significant differences were not observed among the experimental groups.

These results suggest that training on the four exercise machines was associated with significant improvement in all of the health-related fitness components with the exception of body composition. However, there appears to be no advantage of using any one of the machines over the others to improve physical fitness of previously sedentary women.

Abstrak projek yang di kemukakan kepada Fakulti Pengajian Pendidikan, Universiti Putra Malaysia sebagai memenuhi sebahagian daripada keperluan untuk ijazah Master Sains.

PERBANDINGAN KEBERKESANAN EMPAT JENIS ALATAN SENAMAN (ERGOMETER) DALAM PENINGKATAN KECERGASAN WANITA UNIVERSITI PUTRA MALAYSIA

oleh

KOK LIAN YEE

Mei 1998

Penyelia : Dr. Jabar Johari
Fakulti : Pengajian Pendidikan, Universiti Putra Malaysia

Untuk membandingkan empat jenis senaman bagi meningkatkan kecergasan berkaitan dengan kesihatan, 119 wanita dari Universiti Putra Malaysia (umur purata = 28.77 tahun) dibahagikan secara rawak kepada lima kumpulan iaitu satu kumpulan kawalan (*control*) dan empat kumpulan eksperimen. Kumpulan eksperimen berlatih selama sepuluh minggu dengan kekerapan tiga kali seminggu dengan satu kumpulan bandingan, dan setiap kumpulan lain menggunakan satu jenis alat senaman. Alat senaman (*ergometer*) yang digunakan adalah *Treadmill, Body Tone II, Gravity Walker,* dan *OrbiTrek*.

Ujian pra dan pos dijalankan untuk sepuluh pembolehubah yang mewakili lima komponen kecergasan berkaitan dengan kesihatan. Pembolehubah yang diuji adalah anggaran VO_2max, *1-RM bench press, 1-RM leg press*, kekuatan bahagian belakang,

ulangan *bench press*, ulangan *leg press*, fleksi badan semasa berdiri, ekstensi badan dan leher, fleksi pinggul, dan peratus lemak badan.

ANOVA dikira berdasarkan perbezaan antara skor ujian pra dan pos. Ini diikuti dengan ujian Tukey. Ujian F menunjukkan bahawa keempat-empat ergometer dapat meningkatkan prestasi subjek untuk semua pembolehubah yang diukur ($F_{4,114}$ =2.45, p <.05) kecuali *1-RM leg press*, ulangan *leg press* dan peratus lemak badan. Tiada perubahan signifikan diperhatikan antara semua kumpulan untuk peratus lemak badan. Untuk 1-RM leg press dan ulangan leg press, kumpulan yang bersenam menggunakan Treadmill tidak menunjukkan kemajuan yang signifikan berbanding kumpulan bandingan atau kumpulan bersenam yang lain. Perbandingan di antara kumpulan yang bersenam juga tidak menunjukkan peningkatan/kemajuan yang signifikan.

Keputusan kajian mencadangkan bahawa latihan yang menggunakan alat senaman (ergometer) boleh membawa peningkatan yang signifikan untuk semua komponen kecergasan berkaitan dengan kesihatan kecuali komposisi badan. Bagaimana pun, tidak terdapat kelebihan menggunakan mana-mana satu alat senaman berbanding dengan lain untuk meningkatkan kecergasan wanita yang sedentari.

CHAPTER 1

INTRODUCTION

Studies have established that inactivity decreases an individual's functional working capacity and deteriorates physical performance. These studies by Atomi, Ito, Iwasaki and Miyashita (1978), Burke (1977), Pollock, Cureton and Greninger (1969), have established that frequent training is important for the improvement of cardiovascular function and other health-related physical fitness components like muscular strength, muscular endurance, flexibility and body composition.

Other reports (Royal College of Physicians, 1991; Fentem, Turnbull & Bassey, 1990; Paffenbarger & Hale, 1975) showed substantial evidence that individuals or populations with higher levels of physical activity tend to have a lower prevalence of symptomatic coronary artery disease and lower death rates for cardiovascular diseases. Regular physical activity and exercise have also been found to be effective in preventing osteoporosis and in controlling other conditions like late-onset diabetes mellitus, obesity and muscle-skeletal problems.

An increase in physical activity and exercise can bring about physiological changes that may improve health-related physical fitness (Prentice, 1996; Howley and Franks, 1986) and thus help active individuals become more healthy and productive. This in turn may lead to a better quality of life.

Health-Related Physical Fitness

Physical fitness is defined by Prentice (1997) as a condition where the various systems of the body are healthy and function efficiently so as to enable the fit person to engage in activities of daily living, as well as in recreational pursuits and leisure activities, without unreasonable fatigue. For most individuals and populations regardless of age, physical health and fitness can be improved by developing the fitness components that are related to health. These fitness components are cardiovascular endurance, muscular strength, muscular endurance, and flexibility and body composition.

The American College of Sports Medicine (1995) or ACSM, defines cardiovascular endurance as the ability of the heart, lungs and circulatory system to provide oxygen to the cells of the body while they perform work for extended periods of time. Corbin and Lindsey (1991) maintain that by improving this component, individuals can lower the risks for cardiovascular disease. This is achieved through the strengthening of the heart muscles, lowering the resting heart rate, improving circulation and reducing blood lipid levels.

Muscular strength is another important component of physical fitness. Muscular strength is the ability or capacity of a muscle or muscle group to exert force against resistance. It is the muscle's ability to exert maximal force in a single effort (Prentice, 1996). Strength is needed in most work and physical activities carried out daily, and improving muscular strength better protects the body joints and this in turn, leads to fewer occurrences of lower back problems, muscle strains and muscle injury.

Muscle strength also helps individuals maintain proper posture, become more resistant to fatigue, and work more efficiently.

Wilmore and Costill (1994) defines the next component, muscular endurance, as the ability of a single muscle or muscle group to sustain high intensity, repetitive or static exercise. Muscular endurance is closely related to muscular strength. The more strength an individual possesses, the more resistant to fatigue he/she will be. This is due to the relatively less effort needed to produce repeated muscular contractions.

Flexibility is the range of motion possible about a given joint or series of joints (Prentice, 1996). It is also the capacity of an individual to move a joint through its ranges of motion. Flexibility is specific to a given joint or movement. An individual who possesses good flexibility reduces his/her chances of injury. A lack of flexibility may make movements uncoordinated and awkward and so predisposes an individual to pulls, tears, strains and stress injuries.

Body composition refers to the percentage of fat in the body relative to the percentage of all other tissues (Prentice, 1996). Body composition includes both the fat and the non-fat components of the body. The fat portion is normally calculated as a percentage of body weight and is known as percent body-fat , while the non-fat portion is referred to as lean body weight. Normal levels of body fat are 12 to 18 percent for a man, and 17 to 24 percent for a woman (Hodder, 1985). Excess fat makes more demands on the body's energy and cardiorespiratory systems. Higher percentages of body fat are also linked to high blood pressure and atherosclerosis.

Improving Physical Fitness

Physical fitness is not a single entity, but it consists of many components. Each component is critical to developing optimal health-related fitness and to achieving the benefits associated with being optimally fit (Corbin & Lindsey, 1991). Health-related fitness can be improved through regular exercise and training (Sharkey, 1990; Allsen, Harrison & Vance, 1989). However, this improvement can only be achieved by using a few basic training principles.

The principle of progressive overload is the most important principle for all fitness conditioning programs (Williams, 1990). This principle states that an individual has to perform exercise in greater than normal levels in order to gain improvement in physical fitness. If a muscle is to be stronger, it has to be worked against a load greater than normal. If a muscle is to be more flexible, it must be stretched longer than is normal. This would apply to all the other components as well. If however, the overload is less than normal for a specific fitness component, that component will decrease in its performance or capability. The usual level of exercise will maintain the current fitness level.

There are four dimensions of the overload principle that need to be considered in order to achieve fitness improvement. These four dimensions are frequency, intensity, duration and mode. All four may be adjusted in order to impose an overload.

The first dimension, frequency means the number of days per week that an individual exercises or in other words, how often. Exercise must be performed regularly to be effective. Exercise frequency depends on the fitness component to be developed. All the health-related components require an optimal frequency of three to four sessions a week (Gettman, Pollock, Durstine, Ward, Ayres & Linnerud, 1976; Crews & Roberts, 1976) with the exception of body composition. The improvement of body composition requires daily moderate exercise, though percent body fat can be lowered over a longer period with almost any frequency that results in increased caloric expenditure.

Intensity of exercise, the second dimension, is synonymous with the rate of exercise or how hard to exercise. The method for determining appropriate intensity varies with each component of fitness. Cardiovascular endurance requires elevating the heart rate above normal. Strength requires increasing the resistance, muscular endurance requires an increase in the repetitions of the resistance lifted, flexibility requires stretching the muscles beyond normal lengths, and body composition requires that the caloric expenditure be more than normal.

Duration of exercise means how long exercise is performed in a single workout session. A duration of at least 15 minutes is required for an aerobic training session to be effective because the cardiorespiratory system needs this amount of time to reach minimal threshold levels. An overload can be imposed by increasing the length of the exercise session. While longer durations are generally more effective for optimal fitness gains, it is recommended that training durations do not exceed an hour

in a single workout session. Duration of exercise is inversely related to exercise intensity – as duration increases, intensity should be decreased (ACSM, 1995).

Modes of exercise mean the types of activities that are carried out during training. The more conventional modes of exercise would be walking, jogging, bicycling, swimming, aerobic dancing, rope jumping, weight training, calistenics, basketball, soccer, netball and many others. Each mode emphasizes and develops a different combination of fitness components. An individual may need to combine a few modes to obtain development in all the fitness components. Thus modes that develop more fitness components would certainly be more effective than modes that develop fewer components. This factor needs to be given consideration when selecting modes of exercise. Choosing an enjoyable mode is also important. This is because previous research (Mortell & Tucker, 1993) has indicated that individuals are more likely to follow regular training and conditioning programs if they find them enjoyable and convenient. Other factors like personal preference, cost and accessibility also need to be taken into consideration.

Another training principle that needs to be considered is the principle of specificity. Training adaptations are specific to the type of activity that is performed during training and also to the volume and intensity of the exercise or activity performed. To achieve improvement in cardiovascular endurance, an individual would have to perform training that will stress the cardiovascular system and not perform training that will emphasise speed

The principle of individuality is the next training principle that needs consideration. No individual is exactly the same, and heredity plays a major role in determining how the body adapts to training. Individuals are unlikely to show exactly the same training adaptations to a training program. Therefore, a program should take into consideration the needs and abilities of the individuals for whom the program is designed.

The last principle is the principle of disuse. This basically means that an individual's state of fitness will decrease to a level that only meets the demands of daily living if he or she stops training. Any previous gains from training will be lost. Therefore, it is important that a training program include a plan to maintain the fitness level that has been achieved.

Thus, with an appropriate regimen that considers a proper combination of the principles mentioned earlier, the heart and the muscles, and the various body systems will adapt to the training stimulus to improve health-related fitness and bring about physiological, psychological, and social benefits. As basic fitness improves, these same principles can help individuals improve performance in sports and physical activities too.

Exercise Machines as a Training Modality

Many different exercise modes can produce beneficial health and fitness effects; one of the most important being improved cardiovascular function. However,

some modes may elicit subtle differences in physiological responses and thus may induce more favourable effects over the course of a training program (ACSM, 1995). These differences in response may be subtle, but when accumulated over months and years of training, the physiological effect could be significant.

Using exercise machines as a mode of training has been documented only after 1980. Exercise machines were developed from ergometers, devices that allow the amount and rate of a person's physical work to be controlled (standardised) and measured (Wilmore and Costill, 1994). Ergometers were first used in research to reproduce workloads with accuracy so that work output can be quantified. Conventional ergometers like the treadmill, the cycle ergometer, the rowing ergometer, and other movement-specific ergometers like ski ergometers, arm-crank ergometers, and stair-climb ergometers have also been used in research. Most of these research concentrated on examining various physiological, biomechanical and psychological responses during acute exercise and incremental tests to exhaustion.

There is very limited literature research using ergometers as a mode of training. In these research, ergometers became known as exercise machines, exercise devices and exercise equipment. These exercise machines can be used as a mode of training for individuals who are busy a work, individuals who are at home, fitness enthusiasts, individuals and athletes who want to perform cross-training, or individuals who just simply prefer to exercise in private. Exercise machines can allow exercisers to train when weather conditions are not conducive. Even for those who exercise regularly, exercise machines can be a mode of training to add variety and thus sustain interest.

Many new exercise machines have been produced over the last ten years. However, studies on their effectiveness in improving fitness are not well documented. Advertisements on these machines claim their effectiveness in improving a few fitness components and giving the body a full and complete workout. More evidence is needed before these claims can be substantiated.

Physical Activity Levels of Malaysian Women

Urbanisation has made more Malaysians lead sedentary life-styles. Together with higher levels of automation at home and at work, the need for regular exercise to offset decreasing activity levels and prevent hypokinetic disease (diseases brought about by a lack of physical activity) becomes more urgent. The increase in automation should actually have increased the amount of leisure time for individuals. Unfortunately, excuses like the lack of time, family commitments, unsuitable time schedules and fatigue, are usually given for not participating in regular exercise.

The 1996 morbidity survey by the Ministry of Health on 60,000 Malaysians aged above 18 years showed that only 11% of the respondents exercised for at least 20 minutes three times a week. The other 89% either do not exercise at all, or so irregularly (The Sunday Star, 14 Dec. 1997). This survey also revealed that 75 percent of women, particularly housewives, do not exercise at all. Yet Malaysian women realize the importance and value of participating leisure and physical activities.

The Malaysian culture, like many other Asian cultures, tends to guide the women towards participating in activities that are segregated according to the sexes. Malaysian women seem to prefer physical activities and exercises that can be carried without being observed closely by the opposite sex (Zainun and Zoraini, 1996). Modes of exercise that may be more popular with them would be aerobic dancing, workouts in training gyms or health spas, swimming (swimming pools with single-sex sessions), and exercising on exercise machines.

Malaysian women also perform multi roles; they are housewives who are busy looking after their children and completing household chores, or busy career women with very little free time, or both. These reasons may make exercising at home on exercise machines a viable alternative for Malaysian women to other more conventional modes.

Theoretical Framework

The theoretical framework for this study is shown in Figure 1. The framework shows how the principles of training can be prescribed to improve physical fitness and to develop healthy lifestyles. The framework also denotes the benefits that can be obtained through physical training and how these benefits can also affect and bring about changes to an individual's lifestyle.

PHYSICAL FITNESS

Health-Related Fitness

= qualities necessary to function efficiently and maintain a healthy lifestyle.

Motor Skill-Related Fitness

= qualities that are conducive to better performance in sports and other physical activities.

Components

- cardiovascular endurance
- muscular strength
- muscular endurance
- flexibility
- body composition

Components

- speed
- power
- balance
- agility
- reaction time
- coordination

improves

TRAINING

Modes ~ jogging, walking, swimming, cycling, aerobic dancing, exercise machines, etc.

improves

Principles of Training

- Principle of progressive overload
- Principle of specificity
- Principle of individuality
- Principle of disuse

Physiological Benefits of Training

– increases endurance, strength, range of joint movements, posture, decreases risks for injury, body systems are more efficient, maintenance of body weight, increases body resistance, etc.

Changes in Lifestyle

- regular physical activity/exercise, adequate and balanced nutrition, stress relieve, weight control management.

Figure 1: Theoretical Framework

Statement of the Problem

The main purpose of this study was to compare the effectiveness of four types of exercise machines which are the Low Profile Treadmill, the Body Tone II, the Gravity Walker, and the OrbiTrek, and to determine which machine would elicit the greatest amount of improvement among sedentary women of Universiti Putra Malaysia. Specifically, the answers to the following questions are sought:

1. Does training on the Low Profile Treadmill improve cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition?
2. Does training on the Body Tone II improve cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition?
3. Does training on the Gravity Walker improve cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition?
4. Does training on the OrbiTrek improve cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition?
5. Is the improvement obtained through exercising on these exercise machines significantly higher when compared to the non-exercising group?
6. Are there differences in improvement of each fitness component between the different exercise machines?

Hypothesis

Based on the questions that need to be answered, the following hypotheses were formulated. The hypotheses were formed to test the differences between the control group and each treatment group in terms of effectiveness in improving each fitness component. H_o stands for the null hypothesis while μ_1, μ_2, μ_3, μ_4 and μ_5 refer to the population mean for the control group and each treatment group respectively. The list of hypotheses was formulated based on the five independent variables to be tested. Cardiovascular endurance has one hypothesis, muscular strength has three, muscular endurance has two, flexibility has three, and finally, body composition has one. The hypotheses that were tested are as follows:

1. Cardiovascular Endurance

   There is no significant difference in cardiovascular endurance as a result of training on the Low Profile Treadmill, the Body Tone II, the Gravity Walker and the OrbiTrek.

   $H_o 1$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

2. Muscular Strength

   (i) There is no significant difference in arm strength as a result of training on the Low Profile Treadmill, the Body Tone II, the Gravity Walker and the OrbiTrek.

   $H_o 2$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

   (ii). There is no significant difference in leg strength as a result of training on the Low Profile Treadmill, the Body Tone II, the Gravity Walker and the OrbiTrek.

   $H_o 3$: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$