# EVALUATION OF PHYSICAL ACTIVITY MONITOR (PAM) ON HEALTH AND FITNESS IN SEDENTARY INDIVIDUALS

BY

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**Evaluation of Physical Activity Monitor (PAM) on Health and Fitness in Sedentary Individuals**

## ABSTRACT

The purpose of this study was to evaluate the effectiveness of Physical Activity Monitor (PAM) on health and fitness amongst sedentary adults in Kelantan. PAM is a computer system designed to enhance physical activity level and further promote healthy lifestyle among the sedentary population. 202 sedentary males (M) and females (F) participated in this study. They were randomly assigned into the PAM Intervention group (*PAM/M*; *PAM/F*) or Control group (*Control/M*; *Control/F*). All the groups underwent anthropometric, body composition, health and fitness assessments before and after the 3-month programme. Height (HT) and body weight (WT) were measured using a Seca® bodymeter 208 and Tanita® TBF-410 (Japan), respectively. Body Mass Index (BMI) was then calculated from the HT and WT measurements ($WT.HT^{-2}$). Regression equation for percent body fat (%BF) prediction was used. Waist and hip circumferences were measured, which then determined the Waist-Hip Ratio (WHR) ($W.H^{-1}$). Systolic (SBP) and diastolic (DBP) blood pressures were measured with a GO-II® mercury sphygmomanometer (Japan). Fasting blood glucose (GLU) and total cholesterol (TC) were analyzed after a 12-hr over night fast. The 20-m shuttle-run test was carried out to obtain the total run, which was subsequently used to estimate the $VO_{2max}$ by means of a sample-specific regression equation. Two-way mixed ANOVA with repeated measures was used to determine the differences between groups over time. There was a non-significant decrease in WT in *PAM/F* and increase in WT in *Control/M*;

whereas WT in *PAM/M* and *Control/F* remained unchanged. BMI and %BF of all the groups remained unchanged after 3 months. There was a non-significant increase in WHR in *PAM/M*; whereas other groups remained unchanged. SBP of the *Control/M* and *Control/F* did not show any significant changes. However, there was a decrease in both *PAM/M* and *PAM/F,* but not significant. All the groups showed non-significant decrease in DBP at post-test. Estimated $VO_{2max}$ in *PAM/M* and *PAM/F* showed improvement at post-test (pre: 40.8 $\pm$ 6.3 $ml.kg^{-1}.min^{-1}$; post: 42.2 $\pm$ 7.5 $ml.kg^{-1}.min^{-1}$, $p<0.05$; pre: 33.7 $\pm$ 4.4 $ml.kg^{-1}.min^{-1}$; post: 34.1 $\pm$ 5.1 $ml.kg^{-1}.min^{-1}$, $p>0.05$, respectively). Whereas both Control/M and Control/F showed deterioration in estimated $VO_{2max}$ after 3 months (pre: 40.2 $\pm$ 5.8 $ml.kg^{-1}.min^{-1}$; post: 39.5 $\pm$ 6.2 $ml.kg^{-1}.min^{-1}$, $p>0.05$; pre: 31.7 $\pm$ 3.9 $ml.kg^{-1}.min^{-1}$; post: 30.8 $\pm$ 4.2 $ml.kg^{-1}.min^{-1}$, $p<0.05$, respectively). There were no significant changes in GLU and TC for all groups at post-test. The overall findings revealed that PAM did not significantly facilitate all the heath variables at the end of programme. However, it significantly improved the fitness in both genders. Therefore, it is concluded the current version of PAM can facilitate physical fitness of sedentary adults. It is suggested that a newer version of PAM to be designed with the inclusion of dietary component to produce more significant health effects.

**Penilaian 'Physical Activity Monitor' (PAM) atas Kesihatan dan Kecergasan di Kalangan Individu-individu Sedentari**


## ABSTRAK

Tujuan kajian ini adalah untuk menilai keberkesanan Physical Activity Monitor (PAM) mengenai tahap kesihatan dan kecergasan di kalangan orang dewasa yang sedentari di Kelantan. PAM adalah satu sistem komputer pengawalan aktiviti fizikal yang direka untuk meningkatkan tahap aktiviti fizikal dan mempromosi kehidupan sihat di kalangan populasi sedentary. Sejumlah 202 peserta yang terdiri daripada lelaki (M) dan perempuan (F) yang sedentari menyertai kajian ini. Mereka di bahagikan kepada kumpulan PAM (*PAM/M*; *PAM/F*) atau Control (*Control/M*; *Control/F*) secara rawak. Semua kumpulan menjalani ujian-ujian antropometri, komposisi badan, kesihatan dan kecergasan sebelum dan selepas 3 bulan. Ukuran ketinggian (HT) dan berat badan (WT) telah diambil dengan menggunakan Seca® bodymeter 208 dan Tanita® TBF-410 (Japan). Indeks Jisim Badan (BMI) dikira dengan menggunakan data HT and WT ($WT.HT^{-2}$). Formula regresi untuk peratusan lemak badan (%BF) digunakan. Lilitan pinggang dan punggung diukur, untuk mendapatkan Nisbah Pinggang-Punggung (WHR) ($W.H^{-1}$). Tekanan darah sistolik (SBP) dan diastolik (DBP) diukurkan dengan menggunakan GO-II® sphigmomanometer merkuri (Japan). Glukosa darah (GLU) dan jumlah kolesterol (TC) dianalisasikan selepas berpuasa semalam selama 12 jam. Ujian Shuttle Run 20-m dilancarkan untuk memperolehi anggaran maksimal pengambilan oksigen ($VO_{2max}$) dengan formula regresi kumpulan spesifik. ANOVA campuran 2-hala digunakan untuk menilai perbezaan antara 2 kumpulan PAM dan Control. Terdapat perubahan yang tidak signifikan dalam

WT untuk *PAM/F* dan *Control/M*; manakala *PAM/M* and *Control/F* tetap tidak berubah. BMI dan %BF untuk semua kumpulan tidak berubah selepas 3 bulan. Terdapat sedikit peningkatan yang tidak signifikan dalam WHR untuk *PAM/M*; manakala kumpulan lain tidak berubah. SBP dalam *Control/M* dan *Control/F* tidak menunjukkan sebarang perubahan yang signifikan, manakala terdapat penurunan dalam kedua-dua *PAM/M,* tetapi tidak signifikan. Semua kumpulan menunjukkan penurunan yang tidak signifikan dalam DBP pada ujian-pasca program. Anggaran $VO_{2max}$ dalam *PAM/M* dan *PAM/F* terdapat peningkatan (pre: 40.8 ± 6.3 $ml.kg^{-1}.min^{-1}$; pos: 42.2 ± 7.5 $ml.kg^{-1}.min^{-1}$, $p<0.05$ and pre: 33.7 ± 4.4 $ml.kg^{-1}.min^{-1}$; pos: 34.1 ± 5.1 $ml.kg^{-1}.min^{-1}$, $p>0.05$, masing-masing) pada ujian-pasca program. Manakala kedua-dua Control/M dan Control/F menunjukkan kerosotan dalam anggaran $VO_{2max}$ selepas 3 bulan (pre: 40.2 ± 5.8 $ml.kg^{-1}.min^{-1}$; pos: 39.5 ± 6.2 $ml.kg^{-1}.min^{-1}$, $p>0.05$ dan pre: 31.7 ± 3.9 $ml.kg^{-1}.min^{-1}$; pos: 30.8 ± 4.2 $ml.kg^{-1}.min^{-1}$, $p<0.05$, masing-masing). Tiada perubahan yang signifikan dalam GLU dan TC untuk semua kumpulan pada ujian-pasca program. Secara keseluruhannya, data menunjukkan PAM tidak dapat meningkatkan taraf kesihatan peserta-peserta pada akhir program dengan signifikan. Akan tetapi, ia meningkatkan kecergasan secara signifikan dalam kedua-dua jantina dalam kumpulan intervensi. Oleh demikian, adalah disimpulkan versi PAM ini berupaya meningkatkan kecergasan fizikal dalam golongan sedentari. Adalah dicadangkan versi PAM yang baru direka dengan melingkungi unsur pemakanan untuk membolehkannya meningkatkan taraf kesihatan dengan lebih berkesan.

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The human body is designed for an active life. More than four decades of epidemiological, clinical, and laboratory-based research have established regular physical activity as an important determinant of general health and fitness (King, 2001). Several prospective epidemiological studies have supported the notion that both physically active lifestyle and moderate-to-high level of cardiorespiratory fitness independently lower the risk for various chronic diseases (Blair, 1993).

With the increased prevalence in physical inactivity-related chronic diseases, United States had spent approximately 1.65 trillion dollars of health care cost in 2004 (Chen, 2004). Besides improving quality of health care service for lowering the health costs, preventing health problems before they arise is another effective way to reduce the costs. In terms of economic benefits, Gettman (1996) reported that as a result of physical activity or a worksite fitness programme, as much as 3.4 US dollars can be saved for every dollar that is spent to promote or implement it.

A study conducted by Blair *et al.* (1989) on 10224 males and 3120 females who were followed for 8 years after undergoing baseline exercise testing, showed that prevalence of all-cause mortality was higher in the lower fitness groups. They also noticed a dramatic decrease in the rate of death when comparing low fit to moderately fit people. It was therefore suggested that a relatively moderate dose of regular physical activity is all that is needed to markedly lower mortality.

Regular physical activity produces physiologic improvements regardless of age (McArdle, Katch & Katch, 1996). These changes depend on several factors including initial fitness level, and the specific type of exercise. However, there is no doubt that the alterations in physiological functions associated with the aging process can be reversed and/or blunted through proper aerobic and resistance training programmes (Foss and Keteyian, 1998).

The impact of sports or physical exercise on individuals today is widespread; yet some adults, children and adolescents are not getting enough exercise (Akande, Wyk & Osagie, 2000). In the United States, more than 60% of adults do not achieve adequate levels of physical activity and 25% are not active at all (Robergs and Roberts, 2000). To date, the prevalence of physical activity participation among U.S. adults is alarmingly low (Whitt, Kumanyika and Bellamy, 2003). In Malaysia, on average, only 11% exercise regularly for at least 20 minutes, three times a week (NHMS, 1996).

Many people have enthusiastically embarked on vigorous exercise programmes at one time or another. However, most people do not sustain their participation (Robinson and Rogers, 1994). In several studies, it was found that approximately 50% of individuals who start an aerobic exercise programme stop within the first 6 months (Alexandris *et al.*, 2002; Blair *et al.*, 1989; Robinson and Rogers, 1994). Therefore, a life-long commitment towards a healthy lifestyle at an individual level to maintain and optimize health through regular exercise is important.

This commitment towards enhancing physical activity was recently evaluated through an internet-based exercise intervention programme (Mckay *et al.*, 2001). However, this study was not relevant to healthy sedentary populations as the researchers recruited sedentary participants whom were diabetics. Studies by Sirard *et al.* (2000) and Ekelund *et al.* (2001) have used a computer science application (CSA) activity monitor to quantify physical activity and found it was useful in measuring the total amount of physical activity over 7-day and 2-week trials in adults and children, respectively. However, the CSA activity monitor does not prescribe nor monitor exercise programmes for the users. In other words, the CSA only served as a physical activity quantifying device.

In a similar study, Munneke *et al.* (2001) examined the reliability and validity of a continuous ambulatory activity monitor (AM) in sedentary participants using the Dynaport®. The time spent on activities during 24 hours and the intensity of trunk movements was recorded. Test-retest reliability and validity of the AM were performed 1 week and 18 months, respectively after the pre-test. The test-retest reliability revealed that there were no statistically significant differences between first and second assessments. They also found that AM measurements were significantly associated with physical fitness, which was measured by a bicycle endurance test and isokinetic dynamometer for quadriceps muscle strength. However, the sample consisted of individuals with rheumatoid arthritis. AM also does not prescribe and monitor exercise programmes for the users.

Despite the presence of the above mentioned methods to monitor physical activity, none has used a computer-based system that can prescribe a personalised exercise plan to enhance physical activity in sedentary healthy adults. Seefeldt, Malina and Clark (2002) revealed that a successful intervention should be able to tailor programmes to individual needs, account for personal levels of fitness, allow for personal control of the activity and its outcomes, and provide for social support by family, peers and communities. The authors also claimed that previous studies, which aimed to enhance physical activity, lacked consistency in the design; analysis and reporting of interventions in the inactive or sedentary individuals have produced equivocal results.

Based on the limitations of the previous studies on exercise interventions, the Sports Science Unit, at the School of Medical Sciences of Universiti Sains Malaysia (Health Campus) developed a computer system known as Physical Activity Monitor (PAM), which takes into account the users' medical, family, social and physical activity history to design individualised exercise plans. The Sports Science Unit liased with the School of Computer Sciences of the same university to produce this user-friendly computer system (Singh *et al.*, 2002).

According to Singh *et al.* (2002), PAM is a www-based system, designed using the Win-Prolog 4.01 programming language (LPA Ltd., U.K.). It can 'intelligently' design individualised exercise plans for the users based on the summaries of the users' medical, family, social and physical activity questionnaires. Besides designing the weekly-personalised exercise plans, the system allows the users to choose their preferred exercises and edit the duration of exercises, which they had to undertake. The users then update the plans by keying in the duration for each exercise they had performed. This allows the system to monitor each user's progress and generate new plans for the following weeks. With this new system, Singh *et al.* (2002) hoped that sedentary adults would be guided in enhancing their physical activity level; improve their fitness and further promote healthy lifestyle in the Malaysian population.

## 1.2 The purpose of the study

The purpose of the study was therefore to evaluate the effectiveness of PAM in enhancing health and fitness with the prescribed exercise plans created by the system.

## 1.3 Objectives of the study

1.3.1 To evaluate the changes in health variables after 3 months of intervention

1.3.2 To evaluate the changes in fitness variables after 3 months of intervention

1.3.3 To determine the effectiveness of PAM in enhancing health and fitness variables of the participants

## 1.4 Terminology

Physical Activity - Is defined as 'any body movement produced by muscles that result in increased energy expenditure' (McArdle, Katch & Katch, 1996, p.635) or 'as being physically active to the extent that there is a significant increase in energy expenditure during work, routine activities of daily living, or leisure' (Foss and Keteyian, 1998, p.376).

Exercise - Is defined as 'physical activity that is planned, structured, repetitive, and purposeful' (McArdle, Katch & Katch, 1996, p. 635). Exercise also can be defined as 'a subtype of physical activity, which is usually performed during leisure time with the intention of improving one's physical fitness.

It involves a specific, planned routine of bodily movements' (Foss and Keteyian, 1998, p.376).

Physical fitness - Is 'a set of attributes that relate to the ability of people to perform physical activity' (McArdle, Katch & Katch, 1996, p. 635), or 'a set of attributes that people have or have achieved that relates to the ability to perform physical activity' (ACSM, 2000, p.57).

Regular exercise - 'Is 30 minutes or more of accumulated moderate-intensity physical activity on most, preferably all, days of the week' (ACSM, 2000, p.137), or 'an exercise prescription for health purposes, which is carried out daily; at moderate intensity (50-70% maximal heart rate); at least 30 minutes or more and which uses major muscle groups (Foss and Keteyian, 1998, p.388).

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Excess body weight is a risk factor for morbidity and mortality (Haffner *et al.*, 1991). It is related to a number of diseases including diabetes, coronary heart disease, psychological disturbances, kidney disease, hypertension, stroke, liver ailments, and biomechanical ailments (particularly back and foot problems) (Foss and Keteyian, 1998). It was also shown that even mild to moderate overweight can increase the risk of coronary heart disease in middle-aged women (Manson *et al.*, 1990). It is suggested that a genetic predisposition combined with lower physical activity patterns may be the possible causes for obesity (Tuten *et al.*, 1995).

### 2.1.1 Obesity

Obesity is defined as an excess accumulation of body fat. It is also defined as a Body Mass Index (BMI) [body weight in kilograms divided by height in meters squared] of at least 30 $kg.m^{-2}$ (Table 2.1) or an amount of body fat of 25% or more of total body mass for men and 32% or more for women (Frankenfield *et al.*, 2001; Pi-Sunyer, 2000) (Table 2.2). In obesity, body composition is characterized by a high-to-very-high body fat percent (%BF), while in severe obesity, the body can consist of more than 50-60% body fat (Deurenberg and Yap, 1999). According to Pi-Sunyer (2000), fat in a central or upper body (android) distribution is most related to health risk.

Another indicator of obesity that is commonly used is waist-hip ratio (WHR) where a high ratio indicates high intra-abdominal or central fat distribution. A high WHR indicates high risk of hypertension, type-2 diabetes, hyperlipidemia, coronary artery disease and premature death compared with individuals who are equally fat, but have more of their fat on the extremities (ACSM, 2000). The increase in health risk with WHR varies with age and gender. The relative risk is very high for young men if their WHR is more than 0.94, and for young women, more than 0.82. For veterans aged between 60 and 69 years, the relative risk is as high as that for young men and women if their WHR values are greater than 1.03 and 0.90 for males and females, respectively (ACSM, 2000).

Table 2.1 Classification of health risk based on Body Mass Index (BMI) for males and females

| BMI classifications ($kg.m^{-2}$) | | Health risk relative to BMI | |
|---|---|---|---|
| | | Males | Females |
| Underweight | <18.5 | No risk | No risk |
| Normal | 18.5-24.9 | No risk | No risk |
| Overweight | 25.0-29.9 | Increased | High |
| Obesity 1 | 30.0-34.9 | High | Very high |
| Obesity 2 | 35.0-39.9 | Very high | Very high |
| Obesity 3 | ≥40.0 | Extremely high | Extremely high |

Adapted from ACSM (2000)

Table 2.2 Classifications of health status based on Percent Body Fat (%BF) for ages 18 and above in males and females

| %BF | | Classifications |
|---|---|---|
| Males | Females | |
| 5% and below | 8% and below | Unhealthy range (too low) |
| 6-15% | 9-23% | Acceptable range (lower end) |
| 16-24% | 24-31% | Acceptable range (higher end) |
| 25% and above | 32% and above | Unhealthy range (too high) |

Adapted from Nieman (2003)

### 2.1.2 Prevalence of Obesity

The prevalence of obesity appears to be increasing despite numerous public health campaigns to reduce it, including the best efforts of many governmental agencies as well as the medical, nutritional, agricultural and pharmaceutical industries (Bouchard, 2000). There have been attempts in losing weight seen in the communities, regardless of age, gender, or ethnicity. However, obesity remains a major public health problem in the United States (Williamson *et al.*, 1992; Blumenthal *et al.*, 2002), as well as in Asian countries (Jia *et al.*, 2002, Lee *et al.*, 2002, Yoshiike *et al.*, 2002). Based on a telephone survey conducted in the United States in 2000, 42.8% had been advised to lose weight amongst the obese participants. However, only 17.5% followed the recommendations to eat fewer calories and increase physical activity to more than 150min.week$^{-1}$ (Mokdad *et al.*, 2001).

In the United States, the prevalence of obesity increased from 13% to 27% from 1990 to 2000 (Freedman *et al.*, 2002; Mokdad *et al.*, 2001). Currently there are about 50% of United States adults and 25% of United States children who are overweight (French *et al.*, 2001). A study in California revealed that 14% of high-school seniors (boys and girls) were obese (Foss and Keteyian, 1998). On the other hand, Flegal *et al.* (2002) reported that 2 in 3 United States adults were classified as overweight or obese in 2002, compared with less than 1 in 4 in the early 1960s. Besides the United States, Asian countries such as China (Zhou *et al.*, 2002) and Hong Kong (Lee *et al.*, 2002) have also showed an increasing trend in the prevalence of obesity.

In Malaysia, prevalence of obesity and overweight in the adult population (18 years and above) about 8 years ago was 4.4% and 16.6%, respectively (NHMS, 1996). A later study on overweight Malaysian adults from the rural communities showed that the prevalence of pre-obesity (BMI ≥ 25.0-29.9kg.m$^{-2}$) was 19.8% for men and 28.0% for women (Khor *et al.,* 1999). Khor *et al.* (1999) reported that the prevalence of obesity in Malaysian men and women (≥ 30.0kg.m$^{-2}$) was 4.2% and 11.1%, respectively. The highest prevalence of pre-obesity and obesity in men was found in the age group of 30-49 years, while for women, in the 40-49 years age group. The prevalence of pre-obesity and obesity was higher in women than in men for all age categories. This indicated that overweight was on the increase in rural communities, especially among Malaysian females (Khor *et al.,* 1999). An overall comparison with NHMS (1996) showed the prevalence of overweight and obesity in the Malaysian population is increasing.

Prevalence of obesity is high in many countries all over the world and is rising (Deurenberg and Yap, 1999). Many Asian countries have followed the footsteps of the Unites States where the prevalence of overweight and obesity is worrisome (Table 2.3). As a consequence, life expectancy is significantly reduced among the obese population and it may result in a higher mortality rate (Foss and Keteyian, 1998). It is also predicted that obesity will soon surpass smoking as the leading cause of preventable death in the United States (Blumenthal *et al.,* 2002; Manson and Bassuk, 2003). Therefore, a multifaceted public health approach to address behavioural, sociocultural, and environmental factors that promote caloric intake and encourage physical activity is necessary (Blumenthal *et al.,* 2002).

Table 2.3 Prevalence of overweight (OW) and obesity amongst adults in Asian countries

| Countries | Female | | Males | |
|---|---|---|---|---|
| | OW | Obesity | OW | Obesity |
| CHINA (Jia *et al.*, 2002) | 30.7% | 5.5% | 29.8% | 2.3% |
| HONG KONG (Janus, 1997) | 33.0% | 7.0% | 33.0% | 5.4% |
| JAPAN (Yoshiike *et al.*, 2002) | 14.7% | 2.3% | 20.5% | 2.0% |
| KOREA (Moon *et al.*, 2002) | 10.3% | 1.0% | 15.7% | 1.0% |
| INDIA (north) (Reddy *et al.*, 2002) | 40.3% | 18.6% | 35.1% | 7.8% |
| MALAYSIA (rural area) (Ismail *et al.*, 2002) | 21.4% | 7.6% | 20.1% | 4.0% |

## 2.2 Physical Activity

Most people become obese because of physical inactivity (Foss and Keteyian, 1998). This is true for teenagers as well as for adults. Obesity and a physically inactive lifestyle are two of the most prevalent risk factors for common chronic diseases in the Western world. They both carry enormous health and economic costs. A physically inactive lifestyle is a risk factor for weight gain with age. Changes in weight, body fat distribution, weight gain, and the level of physical activity can all influence quality of life. In other words, the increase in weight (Bouchard, 2000) as well as having a sedentary lifestyle (Blair and Connelly, 1996) are associated with increased risk of death.

Prevention of obesity results in greater success than treatment (Blair, 1993). Exercise can keep total body fat content low and may reduce the rate at which adipose cells accumulate. The primary goal of any exercise plan is its overall health benefit. Regular exercise is essential in long-term weight control (Davis *et al.*, 2001) and it is important throughout the life cycle, from childhood to old age (Shephard, 1995). It is widely believed that physical inactivity promotes the development of obesity and that active individuals are less likely to become overweight. Population-based surveys invariably showed that more active and fit persons weigh less than their sedentary and unfit counterparts (Blair, 1993). It is shown for both young and middle-aged men who exercise regularly, the time spent in activity was inversely related to their body fat level (McArdle, Katch and Katch, 1996). Therefore, physical activity plays an important role in balancing energy expenditure by burning fat (Foss and Keteyian, 1998).

Physiological and psychological benefits of physical activity are also well documented (Blair *et al*, 1989, McClaran 2002, Oja 1995). The relation of physical activity to health and disease has grown rapidly over the past few decades (Blair, 1993). Children and adolescents who exercise regularly coped more effectively with stress and had more positive identities than their counterparts who engaged in little exercise (Akande, Wyk and Osagie, 2000).

In the 1989 Framingham offspring study, investigators found that physical activity was positively related to improved cardiovascular disease risk factor profiles including greater high-density lipoprotein cholesterol, lower BMI, and less smoking (Dannenberg *et al.*, 1989). In another study led by Paffenbarger (1986), the researchers found that with or without consideration of hypertension, cigarette smoking, extremes or gains in body weight, or early parental death, alumni mortality rates were significantly lower among the physically active. The death rates in sedentary individuals were approximately twice as high as for active persons (Paffenbarger *et al.,* 1986; Paffenbarger and Lee, 1996). Other researchers also found that exercise was remarkably beneficial to individuals of all ages (Karvonen, 1996; Robinson and Rogers, 1994). Karvonen (1996) further claimed that leisure-time physical activity and fitness are each person's responsibility.

### 2.2.1 Prevalence of Physical Inactivity

The Industrial Revolution, which started in the nineteenth century, has contributed to a sedentary living. In the past 30 years, advances in computer and communication technology have continued to reduce daily energy expenditure of occupational tasks for many people (Haskell, 1996). These reductions in physical activity have then contributed to the increased prevalence of chronic diseases (Haskell, 1996). Despite the widespread dissemination of information concerning the negative health consequences associated with sedentary living, adult physical activity in many industrialized nations remained well below recommended levels (French *et al.*, 2001; Robinson and Rogers, 1994).

In fact, most American adults do not receive the health benefits of regular moderate physical activity. About 85% did not engage in moderate activity five or more days per week for 30 min., and 40% did not participate in any leisure-time physical activity (Robinson and Rogers, 1994; U.S. Department of Health and Human Services, 2000). The prevalence of physical inactivity (< 150 $min.week^{-1}$ in moderate or vigorous physical activities) in an adult southern Brazilian population was 41.1% (Hallal *et al.*, 2003). In Japan, it was reported that more than 72% of men were sedentary (Hsieh *et al.,* 1998).

In Malaysia, a survey on 17,995 living quarters selected randomly throughout the country found that the prevalence rate of 'ever exercise' (had ever carried out any type of exercise in the last 2 weeks from the date of interview) and 'adequate exercise' (had performed any type of exercise for more than 3 times a week, each lasting at least 15 minutes) were 30.9% and 11.6%, respectively. Only 37.6% of those who ever exercised did it adequately. Among those who ever exercised, the overweight and the normal BMI groups (33.9% and 32.5%, respectively) tended to engage in more exercise than the obese and underweight groups (29.0% and 29.6%, respectively). The survey also revealed that almost 70% of Malaysians did not exercise at all (NHMS, 1996).

### 2.2.2 Cost of Inactivity

In 1996, with the increased prevalence in physical inactivity-related chronic diseases in the United States, it was estimated that the health care costs had approach approximately one trillion US dollars (RM3.8 trillion) per year by the year 2000 (Gettman, 1996). Based on the 1987 National Medical Expenditures Survey in United States, Pratt *et al.* (2000) reported that the average annual direct medical costs of those who were active were about US $330/person (RM1254/person) lower compared to those who were not. It was also predicted that by increasing participation in regular moderate physical activity, the annual medical costs could be reduced by as much as 76.6 billion dollars (RM291.2 billion).

With regard to the high prevalence of physical inactivity and expensive health care costs, many health professionals are working towards the aim of promoting health and exercise from different aspects in order to reduce the population risks in chronic diseases related to physical inactivity. NHMS (1996) has targeted those who are leading a sedentary life and not engaging in any physical activity, and those who are active but engage in physical activities or exercise irregularly, to be more physically active and to exercise regularly.

In the year 2000, United States' health professionals focused on health promotion through physical activity interventions for all ages (U.S. Department of Health and Human Services, 2000). With the aims of Healthy People 2000, the United States has targeted to increase by at least 30% the proportion of people aged 6 and above to engage in regular, preferably daily, in light to moderate physical activity for at least 30 minutes per day. For those with disabilities who engage in no leisure time physical activity, it was aimed to increase to at least 20% of the proportion of people aged 18 and older; and to at least 75% of the proportion of children and adolescents aged 6–17; to engage in vigorous physical activity for 3 or more days per week, 20 or more minutes per session (U.S. Department of Health and Human Services, 2000).

### 2.2.3 Physical Activity Programmes

Due to the increased prevalence of obesity and its related chronic diseases, there are needs for health and exercise promotion. Fitness and health centres are mushrooming in many places, especially in big cities. There are many exercise programmes with different prescriptions available in the market, but it is doubtful whether these programmes are effective for people of all levels in the population who are at different stages of their lives and who have a variety of needs.

Bryant and Peterson (1999) suggested that exercise prescription should be personalised with recommended physical activity that is designed to enhance, maintain, or restore positive health and fitness, which is result-oriented, time-efficient, and safe. It should also have specific guidelines in terms of intensity, duration, frequency, type and progression of exercise, which are integral components of a sound exercise prescription. This was further supported by Dunn *et al.* (1998) who suggested that physical activity types and amounts were unique to each person's lifestyle and stage of motivational readiness, and that it is not possible to specify the exact physical activity dose for the group as a whole.

Generally, exercise plans are either self-developed or designed by professionally trained personnel who are employed at health-fitness centres. A sound programme must be based on the individual's health and fitness status, the exercise setting, the programme's and participant's goals. Health status questionnaires are normally administered to gather information on these factors to aid in exercise planning. Periodic evaluations of an individual's health and fitness status are important in assessing his or her adaptation to the exercise regimen and to determine whether adjustments in the programme's protocol should be implemented (Bryant and Peterson, 1999).

Many studies have been done to evaluate exercise programmes, which are varied in terms of mode, duration, intensity, frequency and age of the participants (Table 2.4). Up to 2001, only 2 relevant articles were found which were done using Internet-based intervention programmes (Mckay *et al.*, 2001; Wylie-Rosett *et al.*, 2001).

Table 2.4 Summary of some exercise programmes with different designs in physical fitness

| **Authors** | **Participants** | **Training** | **Duration** | **Outcome** |
|---|---|---|---|---|
| Andersen *et al.* (1999) | 40 obese women (mean aged 42.9 yrs) | Structured aerobic exercise (3 step aerobic classes in a week led by certified instructor) vs Lifestyle activity (advised to increase PA by 30min. $d^{-1}$ on most days of the week) | 16 weeks | Structured and lifestyle programmes increased significantly ($p<0.01$) in fitness with the Lifestyle group yield to be a suitable alternative for the obese women |
| Walker *et al.* (1999) | 11 postmenopausal women vs 20 normoglycemic women (mean aged 58 yrs) | Self-paced walking for 60min.$session^{-1}$, at least 5 $times.week^{-1}$ | 12 weeks | Postmenopausal and normoglycemic groups increased in fitness with the normoglycemic women showed more significant ($p<0.005$ vs $p<0.05$) |
| Lehmann *et al.* (1997) | 20 well-controlled diabetic patients (mean aged 33 yrs) | 45min. aerobic exercise at 50-70% $VO_{2max}$, 3 $times.week^{-1}$ | 12 weeks | Increased fitness ($p<0.001$) |
| Szmedra *et al.* (1998) | 7 sedentary and overweight women (mean aged 21 yrs) | 50min. endurance training at 70% $VO_{2max}$, 3 $times.week^{-1}$ | 6 weeks | Both sedentary and overweight groups increased fitness ($p<0.01$) |
| Glass *et al.* (2002) | 29 sedentary and obese women (mean aged 36 yrs) | 30-40min. aerobic exercise at 65-75% $VO_{2max}$, 4 $times.week^{-1}$ | 13 weeks | Both sedentary and obese groups increased fitness ($p<0.05$) |

| | | | | |
|---|---|---|---|---|
| Dunn *et al.* (1999) | 119 sedentary and overweight women (mean aged 50.5 yrs) | Structured aerobic exercise (20-60min. exercise at 50-85% $VO_{2max}$, 5 times.week$^{-1}$) vs Lifestyle activity (advised to accumulate PA by 30min. d$^{-1}$ on most days of the week) | 24 weeks | Both structured and lifestyle groups increased fitness significantly ($p<0.005$) |
| Nishida *et al.* (2001) | 8 healthy men (mean aged 21.5 yrs) | 60min. aerobic exercise at lactate threshold intensity, 5 times.week$^{-1}$ | 6 weeks | Increased fitness ($p<0.05$) |
| Lafortuna *et al.* (2002) | 30 obese men and women (mean aged 33.9 yrs) | Non-specific (30min. aerobic exercise at 30-45% $VO_{2max}$, and 50-70min. leisure walk at 45-60% $VO_{2max}$, 5 times,week$^{-1}$) vs Individualized (35min. aerobic exercise at 50-60% individual $VO_{2max}$, 5 times,week$^{-1}$) | 3 weeks | Non-specific and individualized programmes increased fitness significantly with the individualized group showed more significant ($p<0.001$ vs $p<0.05$) |
| Suzuki *et al.* (1998) | 30 untrained women (mean aged 19.8 yrs) | 30min. aerobic exercise at 40% $VO_{2max}$, 5 times,week$^{-1}$) | 12 weeks | Increased fitness ($p<0.05$) |

PA: physical activity

However, the study by Wylie-Rosett *et al.* (2001) did not prescribe exercise plans for the participants, but only examined the changes in behaviour and lifestyle in facilitating weight loss. The researchers found that staff counselling augmented the computer intervention programme to achieve the most weight loss. They compared the 3 intervention groups over a 12-month period where 588 participants were randomized into 3 groups; there were (1) a workbook – designed as a stand-alone programme in which the participants completed self-help sheets; (2) a computer intervention – a software programme to guide participants in using the workbook and tailor behavioural goals based on the nutrition, fitness and psychobehavioral questionnaires; and (3) face-to-face staff consultation – which included 6 closed-group workshop sessions and up to 19 telephone or face-to-face consultations with a registered dietician and/or a cognitive behavioural therapist, focusing on specific activities and assignments in the workbook, and encouraging the use of the computer to identify problems and issues. Over time, they found that all of the groups achieved a statistically significant weight loss. However, the face-to-face consultation group was found to have lost significantly ($p=0.02$) more weight than the others. In addition, they also found group 3 had a significant ($p<0.01$) increase in diastolic blood pressure where the other two groups did not. In conclusion, the study revealed that the computer system was successfully used for simple problem solving and goal selection. The post-intervention survey indicated that 75% of the participants wanted an Internet-accessible system that utilized the options for greater interactivity.

The study carried out by Mckay *et al.* (2001) found that Type-2 diabetes sedentary patients derived significantly ($p<0.05$ each) greater benefits (an increase in total moderate-to-vigorous physical activity and a decrease in depressive symptomatology) using an internet-based exercise intervention when compared to controls whom only had internet information on the importance of exercise over an 8-week trial. In the intervention group, the participants were given guidelines in setting goals, planning weekly physical activity and problem solving to exercise. The researchers concluded that this internet-based intervention programme delivered a positive outcome in increasing activity levels. However, it was effective provided the users could use the Internet service with sufficient regularity.

In general, studies on exercise programme evaluation is still lacking in Asia. Many of the exercise programmes developed during the past 30 years have capitalized on fitness, but have not necessarily promoted healthy lifestyles as the main outcome (Swedburg and Izso, 1994). To date, there is no individualised cum internet-based exercise programme designed for enhancing health and fitness aimed at promoting a healthy lifestyle.

## 2.3 Health and Physical Fitness Measurements

### 2.3.1 Body Weight

It is well known that carrying excessive body weight can lead to many health problems. Many people have spent lots of money on diet products and programmes, however, the effects do not last. Weight management includes the phases of weight loss and weight maintenance (Davis and Turner, 2002). Weight control is hard work, and is considered a lifetime job because it requires commitment as well as the support from family and friends.

Williamson *et al.* (1992) reported there were approximately 25% of men and 45% of women in the United States who have attempted to lose weight. However, there are still many sedentary people in the population and a high dropout rate from exercise programmes (Weinberg and Gould, 2002). There are many studies in physical activity and exercise that have been carried out to determine the best solution to weight loss and maintenance (Dunn et al., 1998, Glass et al., 2002, Walker et al., 1999, Wylie-Rosett *et al.,* 2001).

For instance, Dunn *et al.* (1999) compared a 6-month exercise intervention programme on lifestyle physical activity and traditional structured exercise on improving physical activity. Hundred and sixteen sedentary men and 119 sedentary women were recruited into this study. They were asked to participate for 6 months either in a lifestyle physical activity (advised to accumulate at least 30 minutes of moderate-intensity physical activity on most,