PHYSICAL FITNESS LEVELS AMONG COMMUNITY-DWELLING ELDERLY IN ONGKHARAK, NAKHON-NAYOK

A THESIS

BY

JINTANA TANYONG

Presented in Partial Fulfilment of the Requirements for the

Doctor of philosophy Degree in Physical Therapy

at Srinakharinwirot University

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AN ABSTRACT

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Aging reduces levels of physical fitness leading to disability among the elderly and appropriate exercise programs are advantageous in reducing the risk of immobility. This study evaluated the effects of prescribed individual home-based progressive exercise programs in community-dwelling elderly participants in the Ongkharak district of the Nakhon-Nayok Province and was composed of three phases. Phase one involved the investigation of the test-retest reliability of the modified Senior Fitness Test (SFT) Thai-version including 1) arm curl test; 2) chair stand test; 3) six-minute walk test (6MWT)/two-minute step in place test (2MST); 4) back scratch test; 5) chair sit and reach test; 6) eight-feet up and go test; and 7) body mass index. A high test-retest reliability for all tests (ICC 0.89-0.98, n=10) was also found. Evaluations of reliability of 2MST, ten-meter 6MWT (6MWT-10m) and thirty-meter 6MWT (6MWT-30m) for assessing cardiopulmonary endurance among the elderly showed a high test-retest reliability (ICC 0.91-0.93, n=30). In terms of validity, there was a moderate to high correlation ($r=0.71$-0.86, $p<0.1$) in the percentage of heart rate reserve (%HRR) but only a moderate correlation for a rating of perceived exertion (RPE) ($r=0.40$-0.58, $p<.01$) to 6MWT-30m were found. In Phase two, the results from the one hundred and ninety participants (one hundred and twenty one females, 64.2 ± 2.6 year) showed significant gender effects in all tests ($p<0.05$) except the arm curl test. In Phase three, sixty-one participants from Phase two who were ranked in the seventy-fifth percentile and lower in cardiopulmonary endurance and lower body strength physical fitness levels were included and randomly assigned to two groups. The exercise group completed an eight week individual home-based progressive exercise programs including strength, endurance, flexibility, and balance exercises. The results indicated that the exercise group achieved significantly higher results compared to the control group in the arm curl test, the chair stand test, the 2MST and the chair sit and reach test. In conclusion, the eight-week individual home-based progressive exercise prescribed based on physical fitness levels were shown to be effective in improving strength, cardiopulmonary endurance and lower body flexibility. Further studies are required to promote physical fitness in elderly, especially for the purpose of dynamic balance.

ระดับสมรรถภาพร่างกายของผู้สูงอายุในชุมชน อำเภอองครักษ์ จังหวัดนครนายก

บทคัดย่อ

โดย

จินตนา ตันหยง

เสนอต่อบัณฑิตวิทยาลัย มหาวิทยาลัยศรีนครินทรวิโรฒ เพื่อเป็นส่วนหนึ่งของการศึกษา

ตามหลักสูตรปรัชญาดุษฎีบัณฑิต สาขากายภาพบำบัด

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ผู้สูงอายุที่มีสมรรถภาพร่างกายลดลงจะนำไปสู่การเคลื่อนไหวที่ผิดปกติ ซึ่งโปรแกรมการออกกำลังกายที่เหมาะสมจะทำให้สามารถลดความเสี่ยงต่อความพิการของร่างกายได้ การศึกษานี้ประเมินผลของโปรแกรมการออกกำลังกายเฉพาะบุคคล ที่บ้านในผู้สูงอายุในชุมชนอำเภอองครักษ์ จังหวัดนครนายกประกอบด้วยการศึกษา 3 ระยะ การศึกษาระยะที่ 1 ศึกษาเกี่ยวกับความเที่ยงของการวัดซ้ำของการประเมินสมรรถภาพร่างกายจาก Senior Fitness Test ฉบับภาษาไทย ประกอบด้วย 1) arm curl test, 2) chair stand test, 3) six-minute walk test (6MWT)/2 minute step in place test (2MST), 4) back scratch test, 5) chair sit and reach test), 6) 8-feet up and go test, 7) body mass index พบว่าวิธีการประเมินสมรรถภาพทุกการทดสอบมีค่าความเที่ยงในการวัดซ้ำในระดับสูง (ICC 0.89-0.98, n=10) ผลการประเมินความเที่ยงของการวัด 2MST และ 6MWT ระยะทาง 10 เมตร (6MWT-10m) เทียบกับ 6MWT ระยะทาง 30 เมตร (6MWT-30m) ที่ใช้ประเมินความทนทานของของหัวใจและปอดในผู้สูงอายุพบว่า มีความเที่ยงในการวัดซ้ำที่สูง (ICC 0.91-0.93, n=30) สำหรับการทดสอบความตรงของค่าอัตราการเต้นหัวใจสำรองของการทดสอบพบว่าอยู่ในระดับปานกลางถึงสูง (r=0.71-0.86, $p<.01$) แต่สำหรับระดับความเหนื่อยจะมีความตรงของการวัดอยู่ในระดับกลาง (r=0.40-0.58, $p<.01$) เมื่อเทียบกับการวัด 6MWT-30m การศึกษาระยะที่ 2 ในผู้สูงอายุจำนวน 191 คน (เพศหญิง 121 คน อายุ 64.2±2.6 ปี) พบว่าเพศมีความแตกต่างกันในทุกการทดสอบ ($p<0.05$) ยกเว้น arm curl test ในการศึกษาระยะที่ 3 ผู้สูงอายุจำนวน 61 คน ที่เข้าร่วมงานวิจัยได้มาจากการศึกษาระยะที่ 2 ที่มีความทนทานของหัวใจและปอด และความแข็งแรงของขาต่ำกว่า 75 เปอร์เซนต์ไท ผู้สูงอายุจะถูกแบ่งออกเป็น 2 กลุ่ม โดยในกลุ่มออกกำลังกายจะได้รับโปรแกรมการออกกำลังกายด้วยตนเองที่บ้านแบบมีการปรับความหนักเพิ่มขึ้นในด้าน ความแข็งแรง ความทนทานของหัวใจและปอด ความยืดหยุ่นและการทรงตัว เป็นระยะเวลา 8 สัปดาห์ พบว่ากลุ่มออกกำลังกายมีระดับคะแนนของการทดสอบ arm curl test, chair stand test, 2MST และ chair sit and reach test เพิ่มขึ้นเมื่อเทียบกับกลุ่มควบคุม สรุปผลการศึกษา การออกกำลังกายในผู้สูงอายุที่ได้รับโปรแกรมการออกกำลังกายด้วยตนเองที่บ้านแบบเฉพาะ โดยมีการปรับความหนักเพิ่มขึ้นบนข้อมูลการประเมินสมรรถภาพของแต่ละบุคคล เป็นระยะเวลา 8 สัปดาห์มีประสิทธิภาพในการเพิ่ม ความแข็งแรงของกล้ามเนื้อแขน-ขา ความทนทานของหัวใจและปอด และความยืดหยุ่นของขา ควรมีการศึกษาเพิ่มเติมในอนาคตเกี่ยวกับการส่งเสริมสมรรถภาพร่างกายในผู้สูงอายุในด้านการทรงตัว

The dissertation titled

"Physical fitness levels among community-dwelling elderly in Ongkharak, Nakhon-Nayok"

by

Jintana Tanyong

has been approved by the Graduate School as partial fulfillment of the requirements for the

Doctor of Philosophy degree in Physical Therapy of Srinakharinwirot University.

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December , 2017

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Jintana Tanyong

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CHAPTER 1
INTRODUCTION

Background

The proportion of the elderly population to the world population is continuously growing. In 2012, out of the total population of 7,058 billion, there were 565 million people aged 60 years or older, representing 8 percent of world population[1]. Furthermore, advancements in the areas of medicine and public health care have been helping prolong life in elderly people, thus greatly widening the ratio of the aging population, as compared to other demographic groups. As the result, the number of elderly was projected to increase nearly three times during a 30-year period from 6 million (10%) in 2005 to 16 million people (25%) in 2035[1].

Biologically, aging reduces one's physical fitness, leading to the decline in functions of body systems (such as the cardiovascular system, respiratory system, musculoskeletal system, and nervous system) and the increase of comorbidity (metabolism disease, heart disease and lung disease) and sedentary lifestyles[2]. In addition, the major health problems faced by the elderly is the decreased in physical functions [1, 3]. Typically, physical functions depended on muscle strength, muscle flexibility, exercise endurance, agility/dynamic balance, and body composition[4]. Accordingly, there is a critical need for periodic assessments of basic health data of the elderly in order to promote the health condition among these individuals. Moreover, the lower physical activity levels of a person aged 53 years or older is statistically associated with the higher rate [5].

One of the most essential components of elderly's independent functioning in daily life is physical fitness. This includes both simple and complex daily life activities such as walking, climbing stairs, standing up from the floor, performing tasks of daily living (such as combing hair, putting on socks and shoes) [6]. To ensure that an elderly person receives a comprehensive physical fitness, Senior Fitness Test (SFT) is used for tests in upper/lower body strength, cardiopulmonary endurance, upper/lower flexibility, agility/dynamic balance and body mass index (BMI)[6]. SFT has been shown to be a good reliable and valid assessment of exercise effectiveness among elderly [6]. The SFT for the upper and lower body strength is performed through the arm curl test and 30-s chair stand test, respectively. For upper and lower flexibility tests, the back scratch test and chair sit-and-reach test are performed, respectively. The agility/dynamic balance is performed via 8-ft up-and-go test. The body mass index is calculated from one's weight and height. And the cardiopulmonary endurance is conducted through the six-minute walk test (6MWT) or the alternative cardiopulmonary endurance test, 2-minute step in place test (2MST), if space is limited [6]. The measurement of cardiopulmonary endurance is important as it associates directly with the endurance to perform daily activities, and the poor test result can indicate the poor physical fitness in other areas, such as lower body strength and agility/dynamic balance. As a standard, the 6MWT utilizes walkways of different lengths, e.g. 20 meters, and 30 meter [7]. Ng et al. (2013) found that there is no significant difference between the lengths of walkway (10, 20, and 30 meter) in terms of Rating of Perceived Exertion (RPE) and heart rate (HR) in elderly [8]. However, the 2MST may be more appropriate for elderly due to the use of repetition movements. Therefore, the present study was investigate the heart rate, Rating of Perceived Exertion, and blood pressure among community dwelling elderly during the 6MWT-10m, the 6MWT-30m, and the 2MST.

In Ongkharak district (in 2013), there are 7,438 people who are over 60 years old (12% of total population) with more than 70% of them having comorbidity [9]. Examples of comorbidity in elderly are hypertension, diabetes mellitus, dyslipidemia, and chronic lung diseases. Therefore, an appropriate physical performance test is required to assess the level of physical activity in order to maintain and improve the physical fitness and health conditions specific to this group of population. In addition to having high reliability and validity, the physical fitness test must properly take into account of the availability and limitation of facilities, equipment, and other resources. And most importantly, the test must cover the physical fitness components of the elderly. Therefore, the aims of study was investigate appropriate physical fitness test in community dwelling elderly, and evaluate physical fitness of elderly, consequently design appropriate exercise program to maintain or increase health of elderly.

Research question

Phase I

Is the 2MST and 6MWT-10m reliable, and valid in community-dwelling elderly?

Phase II

What is the physical fitness level of community-dwelling elderly in Ongkharak district determined by SFT?

Phase III

Does the community-dwelling elderly who performs 8 weeks home-based progressive exercise program have a physical fitness level different from the control group?

Objectives of the study

Phase I

Primary objective:

To investigate percent heart rate reserve and dyspnea level responses to 2MST compare to 6MWT-10m and 6MWT-30m in community-dwelling elderly.

Secondary objectives:

1. To investigate test retest-reliability of Senior fitness test.
2. To investigate test retest-reliability of 2MST, 6MWT-10m and 6MWT-30m in community-dwelling elderly.

Phase II

Primary objective

To determine physical fitness level of the community-dwelling elderly in Ongkharak, Nakhon-Nayok and subsequently categorize the elderly to below-average and average from above average physical fitness based on 25th and 75th percentile as suggested by Rikli and Jones (1999).

Secondary objective:

To determine gender and age effect of physical fitness level of community-dwelling elderly in Ongkharak, Nakhon-Nayok.

Phase III

To determine changes in physical fitness level community-dwelling elderly who performed 8 weeks individual home-based exercise program.

Hypotheses of the study

Phase I

1. The validity of percent heart rate reserve and RPE level have higher than 0.7 in 2MST compare to 6MWT-10m in community-dwelling elderly using 6MWT-30m as a reference test.

2. Modified SFT Thai-version has high test retest-reliability (ICC>0.8).

3. 2MST, 6MWT-10m and 6MWT-30m have high test retest-reliability (ICC>0.8)

Phase III:

1. The physical fitness level in community-dwelling elderly who performed 8 weeks individual home-based progressive exercise program is improved.

Significance of the study

This study will investigate appropriate the physical fitness test in community-dwelling elderly and will receive information of physical fitness level of elderly in Ongkharak districts by SFT. This physical fitness level can be used as a guideline for individual home-based progressive exercise program in elderly, therefore, design appropriate exercise program to maintain or increase health of elderly.

Keywords

Senior fitness test, reliability, validity, community-dwelling elderly, individual home-based progressive exercise program

Conceptual Framework

The conceptual framework of this study is presented in figure 1. This conceptual framework is composed of three groups categorized by independent level of Ongkharak elderly in Nakhon-Nayok Province, factor affecting the decline of physical performance, five component of functional test, and R1, R2, and R3 that are first, second, and third research questions.

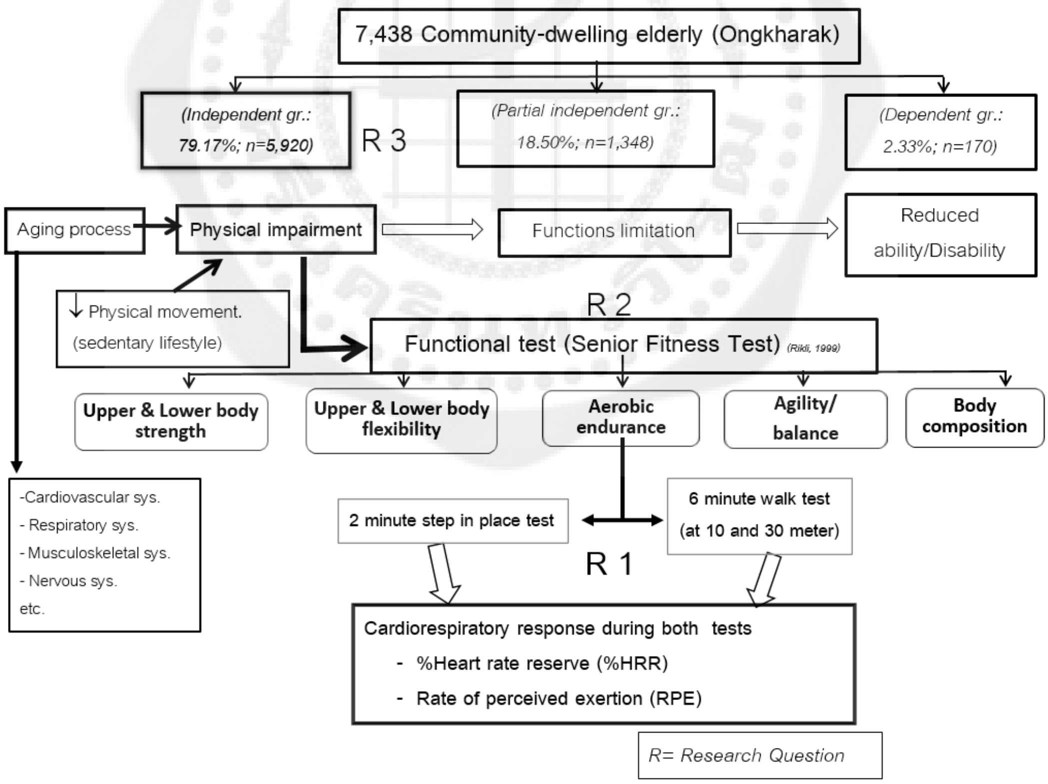


FIGURE 1 CONCEPTUAL FRAMEWORK

CHAPTER 2

REVIEW OF THE LITERATURE

Systematic change in elderly

The reductions in age-related physical fitness are often attributed to the decline in functions of the body systems, the increased in comorbidity, and the sedentary lifestyles. The body system which likely suffer the declined in major functions due to aging include the cardiovascular system, the respiratory system, the musculoskeletal system, and the nervous system [2, 10].

Cardiovascular system

Alterations of the heart decrease stroke volume, cardiac output, and muscle contractility. They are also responsibility for the degeneration of the conduction system, cardiac hypertrophy, and inability to control of vasoconstriction. These changes may induce dysrhythmias and reduced blood flow to the coronary arteries, thus, causing dizziness on light-headedness when standing up (impaired blood pressure response to standing) [11, 12].

Respiratory system

As a result of aging, the respiratory tract and lung tissue become less elastic. Along with mucus accumulation and reduced cilia activities, these conditions often lead to the lower rate of airflow. The respiratory muscles also weaken and undergo atrophy, thus, reducing the ability to breathe deeply. Moreover, shortness of breath and fatigue can occur more frequently due to a ventilation/perfusion mismatch (decreased gas exchange) and a decreased in the oxygen partial pressure (PO_2). In elderly, the vital capacity can decrease approximately 50% while there is a 1% decrease in maximum oxygen uptake (VO_2 max) per years, resulting in limited exercise capacity and increased exertion [2, 10].

Musculoskeletal system

The number of blood vessels, myoglobin, and mitochondria decrease with age, affecting the ability of slow fiber muscle function and, in turn, reducing the endurance for physical activities. Additionally, an elderly may suffer from the loss of muscle mass, size, and strength. To further worsen the condition, this generalized atrophy of all muscles is often replaced by fat deposits. Furthermore, when calcium is lost and bones become less dense, osteoporosis and a reduction of weight bearing capacity are likely to occur, ultimately leading to the possibility of spontaneous fracture [10].

Nervous system

A person of old age may suffer the alterations in central and peripheral nervous system, consequently, having an effect on body functions. The decline in the nervous system includes decrease of the total number of neurons, brain shrinkage, reduction of neurotransmitter level, loss of myelin, and autonomic nervous system dysfunction. There can also occur major impairments in memory, hearing, balance, vision, and smell [2, 10].

The decline of these body systems may limit functions and lower the physical fitness. As the level of physical activities among elderly tends to decrease due to the sedentary lifestyles and comorbidity, maintaining and improving physical activities are of prime importance not only to reinforce physical fitness of an aging person but also to help reduce medication use, when viewed from a social perspective.

Physical fitness test for elderly

There are many physical fitness tests in elderly, but, in order to have the tests appropriate to the elderly in any given community, one must consider the level of difficulty, the cost, and the duration required. The tests should also include assessments of the physical fitness performance in these five areas: muscle strength, flexibility, cardiopulmonary endurance, agility/dynamic balance, and body composition measurements [4].

In order to effectively assess physical function for elderly, Rikli and Jones (1999) developed a functional ability framework indicating a progressive relationship between physiological performance, functional performance, and activity goals (figure 2) [13]. Failure to achieve an appropriate level of physical performance (muscle strength, cardiopulmonary endurance, flexibility, agility/dynamic balance, and body composition) can result in a physical impairment which can lead to a functional limitation (such as walking, stair climbing, and standing up from a chair) and a decrease in common activities (such as personal care, shopping, and housework) or a disability in the long run.

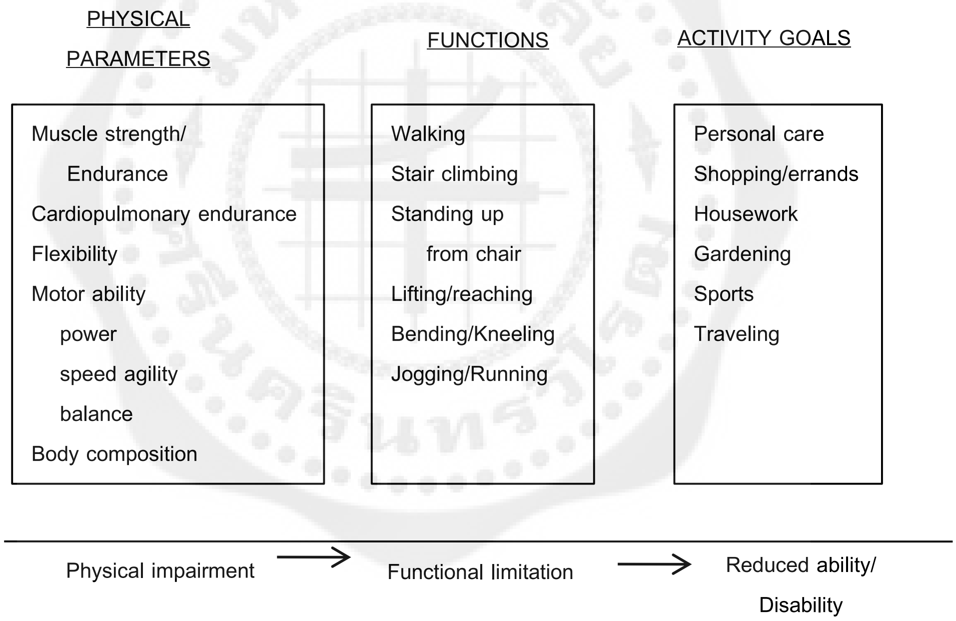


FIGURE 2 FUNCTIONAL ABILITY FRAMEWORK [13]

Based on the functional ability framework above, Rikli and Jones (1999) developed the Fullerton Fitness Test as a recommended SFT to evaluate the physical performance in elderly. The SFT consists of 30-second chair stand, arm curls, chair sit-and-reach, back scratch, 6MWT or 2MST, 8-ft up-and-go and height and weight measurements (Table 1) [14].

TABLE 1 SENIOR FITNESS TEST ITEM SELECTED [14]

Physical fitness parameter	Test items
1. Body strength	
Upper body strength	Arm curl
Lower body strength	30-s chair stand
2. Cardiopulmonary endurance	6-min walk test
Alternative cardiopulmonary endurance	2-min step test
3. Body flexibility	
Upper body flexibility	Back scratch
Lower body flexibility	Chair sit-and-reach
4. Motor agility/dynamic balance	8-ft up-and-go
5. Body mass index	Height and weight

Each of the five physical fitness performance is reviewed in order to explain its importance toward health, evaluate measurement tools other than SFT, and determine the exercise to improve the physical fitness as followed:

1. Cardiopulmonary endurance in elderly

Cardiopulmonary endurance is the capacity to perform heavy muscle and dynamic activities for a prolonged period [15]. Natural aging in humans is associated with a progressive decrease in cardiopulmonary endurance, which contributes to decline in daily activities. Cardiopulmonary endurance depends on the functional state of the respiratory, cardiovascular, and skeletal muscle systems. It is measured by VO_2 max, which indicates the ability of cells to take up and utilize oxygen in energy production during maximal activity [15]. The VO_2 max can be evaluated by direct and indirect methods.

Measurement of cardiopulmonary endurance

Gas analyzer is the direct method and the gold standard of cardiopulmonary endurance measurement. However, this method has several shortcomings as it is expensive and time consuming. And, most of all, the gas analysis may not be appropriate for elderly because it is required to be conducted during a maximal exercise test. On the other hand, an indirect method involves a submaximal exercise test, which incorporates several tests, such as walking, cycling, and step tests. It can easily be seen that the walk test (6 minute walk test) and step test (2 minute step in place test) are appropriate for elderly in a community [14] because they are simple, safe, inexpensive, and easy to conduct [14].

The 6MWT is a simple, useful and objective to measure the functional capacity [7]. The test requires a subject to walk as far as possible in six minutes. It was modified from the 12-minute walk test (12MWT), which was developed for testing lung disease, in a study by Butland et al. (1982). The study found that walking for six minutes has better correlation with 12-minute walk than that of any other duration [16].

In 2002, American Thoracic Society (ATS) issued guidelines for the 6MWT in order to minimize errors and ensure safety. ATS recommended 6MWT as an evaluation of the physical capacity in patients with lung or cardiac disease during the pre- and post-treatment, healthy elderly, and those with predictive mortality risk. Specifically, ATS advised the use of the 30-meter standard walkway and the total time of not more than 15 minutes, which includes the time to perform 6MWT, to rest, and to measure vital signs (blood pressure, whole body fatigue, blood oxygen saturation, dyspnea, and heart rate) before and after the walk test [7].

The test-retest reliability when comparing 2-day, 1-week, and 2- week 6MWT in healthy elderly was found to have high reliability intraclass correlation coefficients (ICC) ranging from 0.91 to 0.96 [3, 17, 18]. In addition, test-retest reliability of 6MWT in patient with heart failure was also high (ICC = 0.88-0.91) [19].

The setup and pattern of 6MWT can vary depending on the course, the walkway length, the number turn, the instruction, the encouragements, and the number of trials required. Ng et al. (2013) found that the walkway length (10 m., 20 m., and 30 m.) had a significant effect on the distance achieved in 6MWT [8]. Encouragements also played a crucial role in increasing the distance [20]. However, the turning direction and walkway length had no significant effect on the post-test heart rate, RPE, and oxygen saturation [8]. Moreover, the shape of walkway, whether it be rectangular, elliptical, or circular, also did not yield any effect on the results of 6MWT [3, 18, 21-24].

As a substitute for 6MWT, the two-minute step-in-place test (2MST) was recommended by Rikli and Jones (1999). The test was originally developed for an exercise endurance assessment in elderly and included as a part of Fullerton's Functional Fitness Test or SFT. 2MST is appropriate to be performed by an elderly because of its repetitive movements, in which induce less anticipation in elderly. In addition, 2MST requires a simple protocol and smaller area, thus, making this test suitable for a facility whose space is limited. The only movement of 2MST to be performed is to step in place for two minutes, in which the height of each step is indicated by a mark on the wall, where the raised kneecap aligns horizontally with the iliac crest. Moreover, the subject with a balance disability is allowed to hold on to a chair or a rail for support while performing the test. The number of times when the right knee reaches the mark in two minutes is then recorded as the result of the test [6, 14].

The intraclass reliability of 2MST ranges from 0.90 to 0.95 in elderly [14, 25]. The criterion validity of 2MST shows a moderate correlation (r= 0.73) correlation with one-mile walk time in 24 male and female elderly subjects (mean age = 69.6, SD=6.5) [26]. Moreover, there is also a moderate correlation (r=0.74) between 2MST scores and incremental treadmill test in 25 male and female elderly subjects (mean age = 72.1, SD=6.2), with the exercise capacity measured at 85% maximum heart rate on the incremental treadmill test [27].

Rikli and Jones (1999) evaluated 2MST in the community-dwelling elderly who had no symptoms of chronic heart failure, chest pain, dizziness, angina during exercise conditions, and severe hypertension, i.e. having blood pressure above 160/100 mm Hg. The study measured the normal range of 2MST in the elderly aged between 60 and 94 years old. It was found that the cardiopulmonary endurance in male was higher than that of female in the same age range, while the cardiopulmonary endurance decreased with increasing age[22].

Johnston (1998) found that the average RPE during 2MST was 13.9, while that of the 6MWT was 13.6 [27]. However, in the study of 32 hypertensive elderly females (65.4$\pm$5.4 year old) by Perosa and Holanda (2009), there was a low correlation (r=.36) between the number of steps in 2MST and the distance walked in 6MWT [28].

Although Rikli and Jones (1999) recommended 2MST as an alternative exercise endurance test [6], there has not been any study investigating the heart rate, dyspnea, and blood pressure response between 10-meter and 30-meter 6MWT and 2MST.

2. Muscle strength (Lower body strength and Upper body strength)

The loss of muscle strength in elderly is an effect of a generalized atrophy of muscle tissues whose mass is being replaced by fat deposits due to prolonged inactivity. As the muscle strength is reduced due to aging, so is the agility and the ability to balance [29], often leading to falling [30], and, ultimately, the risks of disability [31]. Generally, the isometric, concentric, and eccentric strengths start to decline at the age of approximately 40 years old and quickly deteriorate after the age of 65-70 years old. The lower body strength tends to decrease at a faster rate than the upper body strength. In addition, the muscle power declines faster than the muscle strength [32]. However, strength trainings can help increase neural adaptation after 1-2 weeks and skeletal muscle hypertrophy after 3-4 weeks [33-35].

Measurement of muscle strength

There are numerous instruments that can be used as tools for the muscle strength assessment in elderly, such as chest press, dumbbell, elastic bands, handheld dynamometer, isokinetic dynamometer, leg press, pull down, and manual muscle testing. These instruments measure either upper or lower muscle strength with different reliability and validity [36]. For the elderly in the community, the functional fitness tests recommend the 30-second arm curl test [22] for the upper body strength and the five times chair stand test [37] and the 30-second chair stand test for the lower body strength [22].

For the 30-second arm curl test for the upper body strength assessment, SFT modifies the procedure from that originally proposed by Osness (1996) with two changes[38]. First, the weight for women's test is changed from four pounds (1.8 Kg.) to five pounds (2-3 kg.) because the five-pound weight for women tends to be about 60 percent of that for men [39]. Second, the hand-arm position is changed from the handshake grip to the palm-up during flexion because the position is more effective in terms of the biceps tendon muscle action [38]. In addition, it was found that there are moderate to high correlations (r=0.84 for men and 0.79 for women) between the SFT's arm curl test and the combination of biceps, chest, and upper back exercises. The composite measure shows to have a significance, and the validity of the SFT's arm curl test confirms the reflection of overall upper body strength[14].

The functional performance test tool for the lower muscle strength assessment is the sit-to-stand test with the parameters of five times, ten times, and 30 seconds. The test requires a participant to stand up from a sitting position on a standard chair for a set number of times [36]. Or within a time limit. The five times sit-to-stand test (FTSST) is normally used in special conditions, such as for people after a stroke, people with arthritis, and in older adults. However, FTSST has a floor effect [6] because a subject must complete the number of times (five for FTSST) in order to receive a score [6]. Instead of setting the number of times, SFT developed the 30-second chair stand test in order to discriminate the ability of the test subject. Several studies found that the 30-second chair stand test is a good field-test assessment of the lower body strength in elderly because of the high correlation when compared to laboratory tests, such as knee extensor strength, knee flexor strength, and leg press strength [40, 41].

3. Muscle flexibility (Lower body flexibility and Upper body flexibility)

Flexibility is defined as the range of movement or motion (ROM) of a single or multiple joints. In elderly, ROM is first limited by the decline in the skeletal muscle strength and the connective tissue elasticity around the joint [32]. The decreasing ROM in both upper and lower extremities can lead to a development of a physical impairment, a reduction of the amount of daily activities, and a progression of disability [42]. The muscle flexibility is crucial in maintaining a good posture, performing tasks in daily living (e.g., putting on socks and shoes, picking up objects from the floor, rising arm on overhead, combing hair), reducing the risk of musculoskeletal injuries, and preventing falls. Poor flexibility could result in impaired mobility and functional limitation [42]. As people age, flexibility (age 70 yr.) reduces significantly in hip, spine (20%–30%), and ankle (30%–40%), especially in female [32]. In male, starting at the age of 71 years old, the decline of flexibility in shoulder abduction accelerates at the rate of 0.80 degree/year, whereas the onset of the decline (0.74 degrees/year) in female is 63 years. For hip flexion, the rate of decline is 1.16 degrees/year in male, starting at 71 years, and 0.66 degrees/year linearly in female [43].

Measurement of muscle flexibility

The most common tests for the lower body and lower back flexibility are sit-and-reach test, toe touch test, modified sit-and-reach test, unilateral sit-and-reach test, back-saver sit-and-reach test, and chair sit-and-reach test [44-47]. Most of these flexibility tests require the participant to be seated on the floor, except the chair sit-and-reach test. Since most elderly find it too difficult to stand up from the floor, SFT recommends the chair sit-and-reach test for the lower body flexibility assessment [6]. The study found that there is a high correlation (r=0.92 for men; r=0.96 for women) between the chair sit-and-reach test and the back-saver sit-and-reach test in elderly [47]. Furthermore, the test also measures the hamstring flexibility, which is a safe and socially acceptable alternative to the traditional floor sit-and-reach test in elderly [47].

The upper body flexibility is measured through a range of motion of the shoulders. In SFT, the back scratch test is used for the upper body flexibility assessment, which involves a measurement of the distance between the two middle fingers across the back, with a continuous scale being used for scoring [6, 14]. The back scratch test was developed from Apley scratch test, which requires the participant to reach behind the head with one hand and then attempt to touch the opposite scapula. Unlike the back scratch test, the distance between the middle fingers is not measured since it involves one hand at a time[48].

4. Motor agility/dynamic balance in elderly

The combination of agility (involving speed and coordination) and dynamic balance (maintaining postural stability while moving) is important for common mobility tasks, such as walking. The balance is essential in reducing the risk of falls and the loss of independence [49]. Falls are the major cause of mortality and morbidity in older adults, with approximately 40% of adults over the age of 64 suffering falls during the 12-month follow-up period [50]. In addition, 28% to 35% of falls each year occur among community-dwelling adults over 64 years. The risk of falls rise sharply with age, in which adults over the age of 80 years having the highest risk when compared to other age groups [51]. Moreover, the lower body strength also contributes to the risk factor of falls [30].

Measurement of motor agility/dynamic balance

Berg Balance Scale (BBS), timed up and go (TUG), balance screening tool (BST), and Fullerton Advanced Balance Scale (FAB) have been observed to show a good reliability, validity, and practicality for the motor agility/dynamic balance assessment in elderly[52]. However, TUG is found to be more suitable than other tests because TUG is short in duration, simple, and quick to prepare. It is also widely used as a clinical performance-based measurement of lower body functions, mobility, fall risk, and the indicated dynamic balance level (53). Statistically, TUG possesses both excellent inter-rater (ICC=0.98-0.99) [54-56] and intra-rater reliability (ICC=0.97-0.98) [3, 54, 55]. However, to increase the feasibility of conducting the agility and dynamic balance test due to the limited area, particularly in the home setting [14], SFT proposed the change from 3-meter TUG [55] to 8-foot (2.44-m) TUG. Among the community-dwelling elderly, the 8-foot TUG proves to have a good test-retest reliability (ICC = 0.94) and discriminate between the physically active and sedentary groups, as well as the male and female groups [25].

5. Body composition in elderly

Body composition consists of fat and lean body mass (such as muscle, bone and water), which is an indicator of health status. Aging decreases total body water, skeletal muscle organ mass, and bone mineral, while total body fat increases [57].

Measurement of body composition

There are several tools that can be used to measure the body composition, such as BMI, waist circumference (WC), skinfold thickness, and bioelectrical impedance analysis (BIA) [15, 58]. BMI and WC are simple and easy to apply since an extensive training is not required, and equipment used is less expensive. Evidently, BMI and WC are widely used for body composition measurement than skinfold thickness and BIA [58, 59]. Body mass index assesses body composition by calculating body weight relative to body height [58]. It is defined as a person's weight in kilograms divided by the square of body height in meters and expressed in units of kg/m^2. It is the most common measurement of obesity [15, 58, 59].

TABLE 2 CLASSIFICATION OF BMI [60]

Category	Criteria BMI
$\geq$50 kg/m^2	Obese Type III (super obese)
40.1-50 kg/m^2	Obese Type II (morbid obese)
30-40	Obese Type I (Obese)
$\geq$30 kg/m^2	Obese
25-29.9 kg/m^2	Pre-obese
23-24.9 kg/m^2	Overweight
18.5-22.9 kg/m^2	Normal
17-18.49 kg/m^2	Mild underweight
16-16.9 kg/m^2	Moderate underweight
$\leq$16 kg/m^2	Severe underweight

The high and low levels of BMI (18.5-22.9 kg/m^2) in normal person are significantly associated with increasing mortality [61, 62] , while the higher BMI in elderly is associated with an increase in functional limitations [63-65]. In addition, high BMI can also indicate the increased risk of metabolic diseases, such as hypertension, dyslipidemia, cardiovascular disease, and diabetes mellitus [66-69].

Waist circumference (WC) is a measurement of the distribution of body fat in abdomen [58], which is strongly associated with morbidity (Diabetes Mellitus, cardiovascular disease), and mortality [67, 70]. WC is measured at the level of the area between the top of the iliac crest and the lower margin of the last palpable rib in the mid auxiliary line. In South Asia, China, and Japan, the cut-off is reportedly at 80 cm and 90 cm for female and male, respectively [59].

Fitness performance scores of community-dwelling elderly

The most of the studies evaluated SFT as physical fitness tests in elderly [22, 71-73]. There are few studies evaluated tests other SFT [21] (Table 2.3).

TABLE 3 SUMMARY OF PHYSICAL FITNESS TESTS RESEARCH (NORMATIVE DATA)

Studies	Participants		Physical Fitness Tests						
	Group	Age Mean + SD or age range	Upper body strength (Mean + SD)	Lower body Strength (Mean + SD)	Cardiopulmonary endurance (Mean + SD)	Upper body flexibility (Mean + SD)	Lower body Flexibility (Mean + SD)	Agility/ dynamic balance (Mean + SD)	Body composition (Mean + SD)
Rikli and Jones 1999[22]	community-dwelling American elderly N=7,183 (Female: 5,048, Male: 2,135)	Female: 73.3 +7.6 Male: 73.4 +7.4 (60-94 years)	30-s ACT (reps.) Male: 17.9+12 Female: 14.3+4.5	30-s CST (reps. of stands) Male: 14+4.6 Female: 12+4	2MST (steps) Male: 93+25 Female: 83+25 6MWT (m.) (Rectangular course: 45 m.) Male: 536.7+118.8 Female: 485+108.8	Back scratch (cm.) Male: (-4.4) + (+4.6) Female: (-1.7) +(+3.6)	Chair sit-and-reach (cm.) Male: (-0.6) +(+4.4) Female: (+1.2)+(+3.4)	8-foot-up-and-go (sec.) Male: 5.6+1.8 Female: 6.2+1.9	BMI (kg/m^2) Male: 26.6+4 Female:25.8+4.17
Macfarlane et al. 2006 [71]	community-dwelling Chinese elderly N= 1,038 (Female =766, Male = 272)	Female: 73.6+7.1 Male: 73.6+6.7 (60-96 yrs.)	-	30-s CST (reps. of stands) Male: 11.8+ 4.3 Female: 9.9+4.2	-	-	-	-	-
Chen et al. 2009 [74]	community-dwelling Taiwanese N= 1,104 F (501) M (603)	60-92 years	grasp test (Kg.) Male: 29.2+7.5 Female: 18.1+5	30-s CST (stands) Male: 13.9+4.7 Female: 12.9+4.2	2MST (steps) Male: 89.8+21.7 Female: 89+21.2 3-min step tests with preset cadence (in number of steps) Male: 61.1+15 Female: 61.5+15.2	-	Chair sit-and-reach (cm.) Male: (-2.3)+(+12.9) Female: 4.9 + 9.8)	open-eye stand on right foot (sec.) Male: 14.7+16.1 Female: 13.4+15.1	BMI (kg/m2) Male: 24.1+3.1 Female: 24.4+3.5

TABLE 3 (Continues)

Studies	Participants: Group	Participants: Age Mean ± SD or age range	Physical Fitness Tests: Upper body strength (Mean ± SD)	Lower body Strength (Mean ± SD)	Cardiopulmonary endurance (Mean ± SD)	Upper body flexibility (Mean ± SD)	Lower body Flexibility (Mean ± SD)	Agility/ dynamic balance (Mean ± SD)	Body composition (Mean ± SD)
Gusi et al. 2012 [72]	community-dwelling **Spain** elderly N= 6,449 (Female = 5,610, Male = 839)	(60–99 yrs.)	Hand grip (kg.) Male: 61.6 ±16.3 Female: 40.1 ±9.5	-	6MWT (m.) (Oval course: 20m.) Male: 402.1 ±102.7 Female: 394.9 ±93.4	Back scratch (cm.) Male: (-18)-(+15.1) Female: (-11)-(+12.1)	Chair sit-and-reach (cm.) Male: (-2.9)± (+12.6) Female: (+1.4)± (+11.1)	TUG (sec.) Male: 8.42 ±3.33 Female: 8.55 ±3.02 Functional reach (cm.) Male: 27.2 ±9.2 Female: 25.8 ±8.1	BMI (kg/m²) Male: 29.56±4 Female: 30.91±4.56 WHR Male: 0.98±0.07 Female: 0.88±0.07 Body fat (%) Male: 33.9±5.9 Female: 42.1±5.6
Marques et al. 2013 [73]	independent-living elderly, **Portuguese** N= 4,712 (Female = 3,121, Male = 1,591)	(65–103 yrs.)	30-s ACT (reps.) Male: 16.7 ±6.1 Female: 15.6 ±6	30-s CST (reps. of stands) Male: 13.8 ±5.5 Female: 13.1 ±5.5	6MWT (m.) (Rectangular course: 45 m.) Male: 404.7 ±151.3 Female: 455.4 ±168.4	Back scratch (cm.) Male: (-20) ±15 Female: (-15.6) ±14	Chair sit-and-reach (cm.) Male: (-15.6)± (+14) Female: (-7.1)± (+11)	8-foot-up-and-go (sec.) Male: 8.5 ±6 Female: 9.6±7.8	BMI (kg/m²) Male: 27.4±3.8 Female: 28.2±4.5 WC (cm.) Male: 98.3±11.8 Female: 94.3±11.8
Thaweewannakij et al, 2013 [21]	community-dwelling **Thai** elderly N= 1,030	(60-90 yrs.)	-	FTSST (sec.) (Mean) Male: 12.9-14.2 Female: 13.2-17.1	6MWT (m.) (Rectangular course: 6 m. X 4m.) (Mean) Male: 306.6-389.6 Female: 256.3-366.1	-	-	TUG (sec.)(Mean) Male: 9.2- 11.9 Female: 9.9-13.4 BBS (scores) (Mean) Male: 52.2-54.7 Female: 50.1-54.1	-

Six studies evaluated physical fitness as follow: upper body strength assessment performed by 30-second arm curl test (30-s ACT) [22, 73], and hand grip [72, 74]; lower body muscle strength assessment performed by five time sit-to-stand test [21] and 30-second chair stand test (30-s CST) [22, 74]; cardiopulmonary endurance performed by 6MWT [21, 22, 72, 73], 2MST [22], and two- and three-minute step tests with preset cadence [74]; upper body flexibility assessment performed by back scratch test [22, 72, 73]; lower body flexibility assessment performed by chair sit-and-reach test [22, 72-74]; agility/dynamic balance assessment performed by 8-foot up and go test [22, 73]; 3-meter timed up and go test [21, 72], berg balance scale [21], functional reach [72], and open-eye stand on right foot [74]; and body composition assessment performed by BMI [22, 72, 73], WC [73, 74], percent body fat [72], and waist-to-hip ratio (WHR) [72].

These six studies of normative physical fitness level found that all components of the fitness level declines with aging (Table 3). Expectedly, male physically performed better than female [21, 22, 71-73]. These studies preferred to follow SFT for the assessment of the physical fitness level. However, 2MST was performed in only few studies [22, 74]. According to Chen et al. (2009) [74], three-minute step test with preset cadence was found to result in fewer number of steps than 2MST. Moreover, participants did not have any difficulty completing 2MST, while only 76-83% of the participants were able to complete the three-minute step test with preset cadence, due to the task (stair-climbing exercise) being more complicate than that of 2MST. Therefore, 2MST is more suitable for elderly than three-minute step test with preset cadence.

When compared the physical fitness level among population (Spain, Portuguese, and Thai populations) from different geographical areas, the American population performed better than the rest in cardiopulmonary endurance (6MWT), upper body flexibility (back scratch), and lower body flexibility (chair sit and reach test) [21, 22, 72, 73]. However, the Portuguese population performed better than the Americans in the area of the agility/dynamic balance (8-feet up and go test). For the upper body strength (30-s ACT), all populations performed at about the same physical fitness level. For the lower body strength (30-s chair stand test), Hong Kong and Chinese populations performed more poorly than the Portuguese and American counterparts. Lastly, all populations were assessed to have higher BMI than the normal range. Therefore, normative physical fitness data can yield different results depending on the race and daily activities among each population group.

For the Thai population, a study was conducted but did not cover all of the normative physical fitness parameters. The data of the parameters tested showed that the Thai population performed more poorly than the American, Portuguese, and Spanish populations. Therefore, it is interesting to conduct more comprehensive measurements of physical fitness tests among Thai elderly in the future.

For the Thai population, a study was collected but did not cover all normative physical fitness parameters [21]. The data of the parameters tested (6MWT and time up and go test) shown that the Thai population performed more poorly than the American [22], Portuguese [73], and Spainish populations [72]. Therefore, it is interesting to conduct more comprehensive measurements of physical fitness tests among Thai elderly in the future.

Exercise for elderly

The American College of Sports Medicine (ACSM) recommends the periodic assessment of physical fitness in elderly. There are five components of health related to the physical fitness: muscular strength, flexibility, aerobic capacity, balance, and body composition. This information below compares various exercise prescriptions in order to find exercises suitable for the community-dwelling elderly.

The American College of Sports Medicine (ACSM) recommends the periodic assessment of physical fitness in elderly. There are five components of health related to the physical fitness: muscular strength, flexibility, aerobic capacity, balance, and body composition (4). This information below compares various exercise prescriptions in order to find exercises suitable for the community-dwelling elderly [6, 49, 75-86].

1. Improving muscle strength

The ACSM/AHA [75] and several studies [6, 76] recommends the exercise prescriptions (Table 4) of resistance exercise to improve muscle strength for older adults. This exercise is progressive resistance training program (8–10 exercises involving the major muscle groups such as gluteus, quadriceps, hamstrings, pectorals, latissimus dorsi, deltoids, and abdominals of 8–12 repetitions each), arm curl exercise, 30-chair stand exercise, elastic exercise bands, stair climbing, standing squat, and other strengthening activities that use the major muscle groups. The exercise program consists of moderate (5–6) to vigorous (7–8) intensity (a modified Borg scale of 0-10) or 40-50% of 1 repetition maximum (1RM) (very light to light load for beginning older persons and for beginning sedentary persons) and 60-70% of 1RM (moderate to hard load for novice to intermediate adult exercisers). Progression is by increasing repetitions at first, and then by increasing the resistance. This exercise compose of 2-4 sets are recommended for strength of most elderly and 2-3 minutes of rest between multiple set training, (20-30 minutes/day) at least 2 day/weeks.

TABLE 4 EXERCISE PRESCRIPTIONS TO IMPROVE MUSCLE STRENGTH FOR THE ELDERLY

Variable	Recommendation
Mode	Arm curl exercise, 30-chair stand exercise, elastic exercise bands, weight training, standing squat[3]
Frequency	Major muscle groups should be trained 2-3 days/week with a 48-hour rest between sessions for muscle groups[2]
Duration	20 to 30 minutes

TABLE 4 (Continued)

Variable	Recommendation
Intensity (Strength)	8 to 10 exercises (major muscle, e.g. gluteals, quadriceps, hamstrings, pectorals, latissimus dorsi, deltoids, and abdominals) [1] 40-50% of 1RM or very light to light load for beginning older persons and for beginning sedentary persons[2] 60-70% of 1RM or moderate to hard load for novice to intermediate adult exercisers[2]
Repetitions	10 to 15 repetitions (RPE 5-6) [1] 8-12 repetitions to improve strength in most adults to fatigue[2] 15-20 repetitions is recommended for increased muscular endurance[2]
Sets	At least 1 set for elderly[1] Single set training for novice and older adults[2] 2-4 sets are recommended for strength of most adults[2] $\leq$2 sets for muscular endurance[2]
Progression	Increasing the number of repetitions at first, and then by increasing the resistance [1]
Rest	2-3 minutes of rest between multiple set training[2]

Note: [1](Balady, et al. 2000), [2](Garber, et al. 2011), [3](Rikli and Jones 2013), 1 RM = 1 Repetition Maximum

Muscle strength could be improved by progressive resistance strength training exercises in healthy and chronic condition in elderly [(79)]. Moreover, the yoga exercise [(80)], dancing [(81)], and dynamic exercise (Tai Chi) [(76, 82, 83)] improved muscle strength in elderly. However, these exercises are general functional exercise, required training and should be group exercise practice under supervision. Many studies showed that the individualized home-based exercises (strengthening exercise) [(87)], and functional exercise (standing and sitting on a chair, climbing stairs, and a 15-minute walk)[88] improved muscle strength for the elderly. SFT Manual recommended self-exercise which simple task, safety, and individual specific functional on daily activities exercise for component of physical fitness at home setting to improve body muscle strength, and similar to exercise prescription in Table 4 [6]. The important muscle groups for strength training exercise recommended for elderly included hip extensor, knee extensor, ankle plantar flexors, dorsiflexors, biceps, triceps, shoulder, abdominals, and back extensor muscle [6].

2. Improving cardiopulmonary endurance

The ACSM/AHA [75] and several studies [6, 76, 77] recommended the exercise prescriptions (Table 5) of exercise to improve cardiopulmonary endurance for the older adults. This aerobic exercise is walking (the most common type of activity), jogging, stair climbing, cycling, combined arm and leg ergometry, running, machine-base, dancing, and endurance game. This exercise is moderate to vigorous intensity aerobic exercise, at least 20–60 min/day, and 3-5 day/week. Progression is by increasing duration, frequency, and intensity.

TABLE 5 EXERCISE PRESCRIPTIONS TO IMPROVE CARDIOPULMONARY ENDURANCE FOR THE ELDERLY

Variable	Recommendation
Mode[#]	Walking, jogging, stair climbing, cycling, combined arm and leg ergometry, running, machine-base, dancing and endurance game.[1, 3] Continuous or intermittent exercise involving the major muscle groups of the body [1, 2]
Frequency	3-5 days/wk. at 60 to 80% HRR or 70 to 85% HRmax [1] 3-7 day/wk. for hypertension patient[1] 4-6 day/wk. or daily at low to moderate intensity for diabetes patient[1] Exercise performed at a moderate intensity should be undertaken most days of the week[1]

TABLE 5 (Continued)

Variable	Recommendation
Intensity	55/65% to 90% of MHR (40/50% to 85% VO2max or %HRR)[1] 40-70% VO2max for hypertension patient [1] 50-85% VO2max for diabetes patient [1] Moderate intensity (somewhat hard) Moderate to vigorous intensity is recommended (40-59 to 60-89% VO_2max or %HRR) [2] Pedometer step count for 2,000 – 7,000 steps per day[2]
Duration	20-60 minutes for healthy adult[1, 2] 20-30 minutes for adult with the risk of both cardiovascular and orthopedic injuries (excluding time spent warming up and cooling down) [1] 30-60 min for hypertension patients[1] 20-60 min/session for diabetes patients[1]
Progression	Gradually progression for duration, frequency and/or intensity (if reasonable), attaining desired goal[2] Increased exercise duration rather than intensity[1]

Note: [1](Balady, et al. 2000), [2](Garber, et al. 2011), [3](Rikli and Jones 2013), VO2max= Maximal Oxygen Consumption; HR=Hart Rate; HRR=Heart Rate Reserve; MHR = Maximum Heart Rate

[#]The SFT recommendation of walking for older adult, walking can be improved cardiopulmonary endurance and easy practice every day. The walking can lower body exercise and dynamic balance.

*Moderate intensity includes exercises that are light to somewhat hard, or a rating of perceiving exertion (RPE) of 12-13/20 or 3-4/10.

**Vigorous exercise includes exercises that are somewhat hard to very hard, or an RPE of 14-17.

Cardiopulmonary endurance exercise improves functions of the heart, lungs, and blood vessel, which related to physical performance of activities of daily living such as walking, jogging, and stair climbing. Interval-walking training (IWT) has been developed as a novel free-living training modality that consists of 5 or more sets of 3 minutes of low-intensity walking (40% of VO_2peak) followed by fast walking (70% of VO_2peak) for 3 minutes, that were monitored by accelerometry [(89)]. The IWT improved cardiopulmonary endurance (VO_2peak) in patients with diabetes mellitus [(89)], and decreased cardiovascular risk factors in middle age older subjects[(84, 85)]. However, these exercises required training and monitored for walking intensity by accelerometry. Another study investigated that the moderate intensity walking exercise at fairly light and somewhat hard of RPE score (11-13/20 score) improved exercise capacity in healthy adult [(90)]. The moderate intensity walking exercise is recommended by SFT manual that simple, safety, and individual specific functional exercise for component of physical fitness at home setting to improve cardiopulmonary endurance, and similarly exercise prescription in Table 5.

3. Improving body flexibility

The flexibility exercise could be performed before or after cardiorespiratory/strength training exercise. The ACSM/AHA [(75)] and two studies [(76, 77)] recommended the exercise prescriptions (Table 6) of exercise to improve muscle flexibility for older adults. This flexibility exercise is activities that maintain or increase flexibility using sustained stretches to the point of slight discomfort or feeling of tightness in muscle (static flexibility, 10 to 30 seconds) for each major muscle groups and joints, 2-4 repetitions of each stretching at least 2 day/weeks.

TABLE 6 EXERCISE PRESCRIPTIONS TO IMPROVE BODY FLEXIBILITY FOR THE ELDERLY

Variable	Recommendation
Mode	Static flexibility Exercises should be prescribed for every major joint (hip, back, shoulder, knee, upper trunk, and neck regions) [1]
Frequency	≥2-3 days/week of stretching the major muscle groups; greater gains will be attained if done daily[1,2]
Intensity	Stretch to the point of slight discomfort or feeling of tightness in muscle[1,2]
Duration	10-30 seconds of static stretching holds for most elderly[1, 2]
Pattern	2-4 repetitions of each stretching[2]

Note: [1](Balady, et al. 2000), [2](Garber, et al. 2011)

Upper and lower body flexibility in elderly were improved by Yoga exercise (80, 91, 92), and dancing (81). However, these general exercises were required training by under supervision. Many studies investigate that the functional flexibility exercises such as sit and reach (93), static calf stretching program (94, 95) improved body flexibility in elderly. SFT manual (6) recommended self-exercise to improve body flexibility, and similar to exercise prescription in Table 6.

4. Improving agility and dynamic balance

The ACSM/AHA (75) and four studies (6, 76-78) recommended the exercise prescriptions (Table 7). These exercises are walking on unstable surfaces, walking at different speeds, crossover stepping, and strength training exercises that is simple to advance exercise. The exercise program is 20-30 min/day (3 times/day) at least 2 day/weeks. Progression is by increasing the number of repetitions or duration.

TABLE 7 EXERCISE PRESCRIPTIONS TO IMPROVE AGILITY AND DYNAMIC BALANCE FOR THE ELDERLY

Variable	Recommendation
Mode	Any exercises that improve balance, agility, coordination and gait, particularly for older adults to improve/maintain physical function and to prevent falls such as walking on unstable surfaces, walking at different speeds, crossover stepping[2,3] Strength training exercises for the muscle groups required for basic mobility skills[4]
Frequency	$\geq$2-3 days/weeks[2, 4] 3 times/day[4]
Intensity	Simple to advance exercise[4]
Duration	$\geq$20-30 min/day may be needed[2]
Progression	Increasing the number of repetitions or duration[4]

Note: [1](Balady, et al. 2000), [2](Garber, et al. 2011), [3](Rikli and Jones 2013), [4](Clegg, et al. 2014)

Exercise programs (balance training, strengthening exercise, flexibility, and endurance) could be used to prevent injuries caused by falls and reduced the rate of falls leading to medical care in older adults (49). Yoga (92), and Dynamic balance exercise (Tai Chi) (76, 82, 83, 86) could improve balance control, flexibility and cardiovascular fitness in healthy elderly and patients with chronic condition. In addition, Tai Chi Chuan is effective in reducing falls and blood pressure in the elderly (83). However, these exercises were under supervised and required training by trainer. In previous studies showed that functional exercises such as the stand up and step ups (96), sit to stand practice, and weight transference and reaching (97) can improve balance and reduce the rate of falling in elderly. SFT manual (6) recommended self-exercise which individual specific functional exercise for component of physical fitness at home setting to improve agility/dynamic balance, safety, and similar to exercise prescription in Table 7.

Demographic data of Ongkharak elderly

Ongkharak is a district in the Nakhon-Nayok Province that has 7,438 elderly (over 60 years old). This district is subdivide into 11 Tambon. These subdistricts are Phra Achan (n=915), Bueng San (n=746), Sisa Krabue (n=974), Pho Thaen (n=595), Bang Sombun (n=444), Sai Mun (n=734), Bang Pla Kot (n=929), Bang Luk Suea (n=538), Ongkharak (n=150), Chum phon (n=653), and Khlong Yai (n=730). The approximate independent elderly is 79% (n=5,920) [9]. Therefore, these elderly should receive the appropriate physical fitness assessment for health promotion and prevent disability. However, the Sports Authority of Thailand[98] reported normal data of physical fitness using different protocol from Rikli and Jonse 1999 [22]. In addition, the SFT [14] was developed appropriate for elderly and useful. Therefore, the aims of the present study was investigate the heart rate, RPE, and blood pressure response during 2MST and 6MWT. Moreover, this research was study physical fitness in elderly people at Ongkharak district uses by SFT, that to guidelines select a proper exercise to improve physical fitness for the elderly at Ongkharak district.

CHAPTER 3

METHODOLOGY

This thesis is based on three studies; one methodology research (phase I), one cross-sectional study (phase II), and one randomized controlled trial (phase III). The research methodology investigates the reliability and validity of 2MST to 6MWT-10m by 6MWT-30m, which is a referent test for the elderly community dwellings. The cross-sectional study determines the physical fitness level of community-dwelling elderly people in Ongkharak district using the SFT. The randomized controlled trial evaluated changes in physical fitness level for community-dwelling elderly people who performed an 8-week home-based exercise program.

Phase I: Correlation of physiological response between 2MST and 6MWT-10m and 6MWT-30m in community-dwelling elderly

1. Research design

This study was an observational reliability, and validity (Methodological research) aimed to determine the test-retest reliability of SFT, test-retest reliability of cardiopulmonary endurance (2MST, 6MWT-10m and 6MWT-30m) and convergent validity of %HRR and RPE level response to 2MST compare to 6MWT-10m using 6MWT-30m as a reference test.

2. Participants

Participants was volunteers, community-dwelling elderly, living in Ongkharak district, Nakhon-nayok Provide. The Participants selected are 30 in number with age group 60 to 69 years of both sexes. Participants were admitted based on the following criteria: (1) age 60 to 70 years, (2) were male and female, (3) able to walk 6 minutes with or without the use of an assertive device (walker and cane), and (4) stable hemodynamic; resting heart rate at 60 to 100 beats/minute and blood pressure at 90/60 to 159/109 mmHg. Participants were excluded if they meet following criteria (1) have the medical diagnosis of lung diseases, heart failure, unstable angina, recent myocardial infarctions, aortic aneurysm, and aortic stenosis, (2) unstable hypertension (>160/110 mmHg), (3) severe weight-bearing pain (rated > 5/10 on the visual analog pain scale), (4) severe visual or hearing impairment, and (5) severe orthopedic problems that limited walking or marching ability. Participants were compensated healthy present for their participation.

The sample size of the community-dwelling elderly of the correlation study was calculated by the following equation [99]:

$$n = \left(\frac{Z_{\alpha} + Z_{\beta}}{Z_{(r)}} \right)^2 + 3$$

The sample size calculate for reliability study

When: $Z\alpha = 1.96$ ($\alpha = 0.05$)

$Z\beta = 0.84$ ($\beta = 0.8$)

Expecting r in the present study is set at 0.9 and error is 0.084.

Then, $P_0 = 0.9$, $P_1 = 0.9 \pm 0.084$

$$Z_{P0} = \tfrac{1}{2} \ln \left[\frac{1+0.9}{1-0.9} \right] = 1.47$$

$$Z_{P1} = \tfrac{1}{2} \ln \left[\frac{1+0.984}{1-0.984} \right] = 2.41$$

$Z_{(r)}$ was calculated from formula $Z_{P0} - Z_{P1} = 0.94$

$$n = \left[\frac{1.96 + 0.84}{0.94} \right]^2 + 3$$

$n = 11.8$

Thus, the sample size in reliability study was 12 participants. Null hypothesis r was at least 0.5. The sample size calculate for validity study.

When: $Z\alpha = 1.96$ ($\alpha = 0.05$)

$Z\beta = 0.84$ ($\beta = 0.8$)

Expecting r in the present study was set at 0.8 and error is 0.1275.

Then, $P_0 = 0.8$, $P_1 = 0.8 \pm 0.1275$

$$Z_{P0} = \tfrac{1}{2} \ln \left[\frac{1+0.8}{1-0.8} \right] = 1.098$$

$$Z_{P1} = \tfrac{1}{2} \ln \left[\frac{1+0.9275}{1-0.9275} \right] = 1.640$$

$Z_{(r)}$ was calculated from formula $Z_{P0} - Z_{P1} = 0.542$

$$n = \left[\frac{1.96 + 0.84}{0.542} \right]^2 + 3$$

$n = 29.7$

Thus, the sample size in validity was 30 participants. Null hypothesis r was at least 0.5.

Consequently, the sample size in reliability and validity studies are 30 participants. Null hypothesis r was at least 0.5.

3. Outcome Measures

3.1 Test-retest reliability for SFT

The physiologic and anthropometric measures were assessed. Systolic blood pressure, diastolic blood pressure, height, weight, and body mass index were measured for each participant. BMI was calculated as height (in meters) squared divided by weight (in kilograms).

Functional fitness was assessed using the SFT, which consisted of the total score for each test.

5.2 Test-retest reliability for cardiopulmonary endurance (2MST, 6MWT-10m and 6MWT-30m)

The physiologic and anthropometric measures were assessed. Systolic blood pressure, diastolic blood pressure, height, weight, percent oxygen saturation, chronic disease (hypertension, diabetes mellitus, dyslipidemia) and BMI were measured for each participant. BMI was calculated as height (in meters) squared divided by weight (in kilograms).

Cardiopulmonary endurance was assessed by 2MST, 6MWT-10m and 6MWT-30m for test-retest reliability, which consisted of the number of step for 2MST, distance of 6MWT. Cardiopulmonary endurance was assessed by 2MST, 6MWT-10m and 6MWT-30m for validity. Heart rate at after tests

4. Materials and research tools

The materials used in t is study included the followings.

1. Folding chair placed against a wall with a 17 in. (43 cm.) seat height
2. 5 lb (2.3 kg) and 8 lb (3.6 kg) dumbbells
3. 18 in. (45 cm.) ruler
4. Tally counter
5. Masking tape
6. Stopwatch
7. Tap measure
8. Cone
9. Automatic blood pressure
10. Pulse oximeter

5. Procedure

The aims and details of the study were read to the participants, and informed consent was obtained from each subject. Participants were interviewed and assessed for baseline demographics and health status using a questionnaire.

5.1 Test-retest reliability for SFT

Test-retest reliability for SFT were determined at the same time of day for each participant with each test scheduled 2 to 5 days apart. The tests separate to 3 time, first time for familiarly of all tests and measure SFT score at 2 and 3 time.

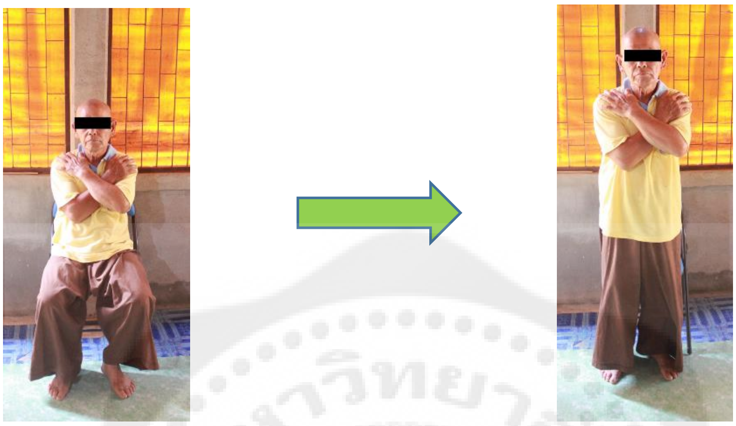
Their blood pressure, heart rate, and RPE were measured and the physical performance test [6] was administered. The protocol for this test was designed to evaluate physical fitness related to the independent functioning of upper and lower strength, cardiopulmonary endurance, upper and lower flexibility, and balance. Blood pressure, heart rate, and RPE were measured after each test for each subject. The tests were carried out as established by Jones and Rikli, 2013 details as follows:

1. The arm curl test (ACT) was designed to assess upper body strength. Participants were asked to perform as many bicep curls as possible in 30 seconds, using a 5-pound dumbbell for females and an 8-pound dumbbell for males. Scoring was based on the total repetitions completed in 30 seconds.

A B

FIGURE 3 A-B UPPER BODY MUSCLE STRENGTH ASSESSMENT (30-SECOND ARM CURL TEST)

2. The 30 second chair stand test was designed to assess lower body strength. Participants were asked to sit on the chair with arms crossed over their chest, and they were encouraged to complete as many stand-ups as possible in 30 seconds. Scoring was based on the total repetitions completed in 30 seconds.



A B

FIGURE 4 A-B LOWER BODY MUSCLE STRENGTH ASSESSMENT (30-SECOND CHAIR STAND TEST)

3. The back scratch test was designed to assess upper body flexibility. Participants were asked to touch the fingers of opposing hands behind their back. The most flexible side of an individual was used for assessment. The distance in centimeters between opposing hands' fingers was measured. A negative score was given if the fingers did not reach the opposing hands' fingers, whereas a positive score was given if fingers reached beyond the opposing hands' fingers.

FIGURE 5 UPPER BODY MUSCLE FLEXIBILITY ASSESSMENT (BACK SCRATCH TEST)

4. The chair sit and reach test was designed to assess lower body flexibility. Participants were asked to sit on the edge of a chair with the left knee bent at 90° and the left foot flat on the floor while keeping the right knee straight and the right leg extended forward. Participants were instructed to attempt to touch their toes using both hands. The most flexible side of an individual was used for assessment. The distance in centimeters between the fingers and toes was measured. Overlap of the fingers was measured in positive increments, while the distance between untouched fingers was measured in negative increments.

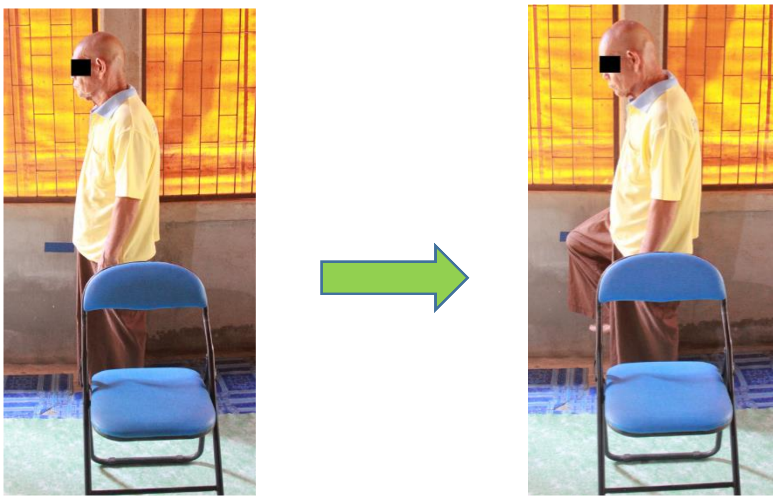
FIGURE 6 LOWER BODY MUSCLE FLEXIBILITY ASSESSMENT

(CHAIR SIT-AND-REACH TEST)

5. The 8-foot up and go test was designed to assess agility and dynamic balance. Participants were asked to sit on the chair. After a signal, the participants stood up and walked as quickly as possible around a cone set 8 feet away from the chair and then sat back down on the chair. Scoring was based on the total time elapsed to complete the test in seconds.

FIGURE 7 AGILITY/DYNAMIC BALANCE ASSESSMENT (8-FOOT UP-AND-GO TEST)

6. The 2 minute step in place test was designed to assess cardiopulmonary endurance (alternative cardiopulmonary endurance). Participants were asked to step in place, raising the knee to a height halfway between the hip bone and the kneecap. Scoring was based on the total number of times the right knee reached the proper height in 2 minutes.



A B

FIGURE 8 A-B CARDIOPULMONARY ENDURANCE ASSESSMENT (2-MINUTE STEP IN PLACE TEST)

7. The 6-minute walk test was designed to assess cardiopulmonary endurance. The tests were conducted along a straight corridor with 10 m. walkways. Colored adhesive markers were taped at each end and at 1-m intervals. The orange traffic cone was placed before the destination 50 centimeters at each end. The participants were instructed to walk as quickly as possible within 6 minutes to cover as much ground as possible. They were able to stop for rest as needed, but the time was not stopped. During the test, an assessor walked alongside the participants to ensure their safety and inform them of every minute of time left [7].

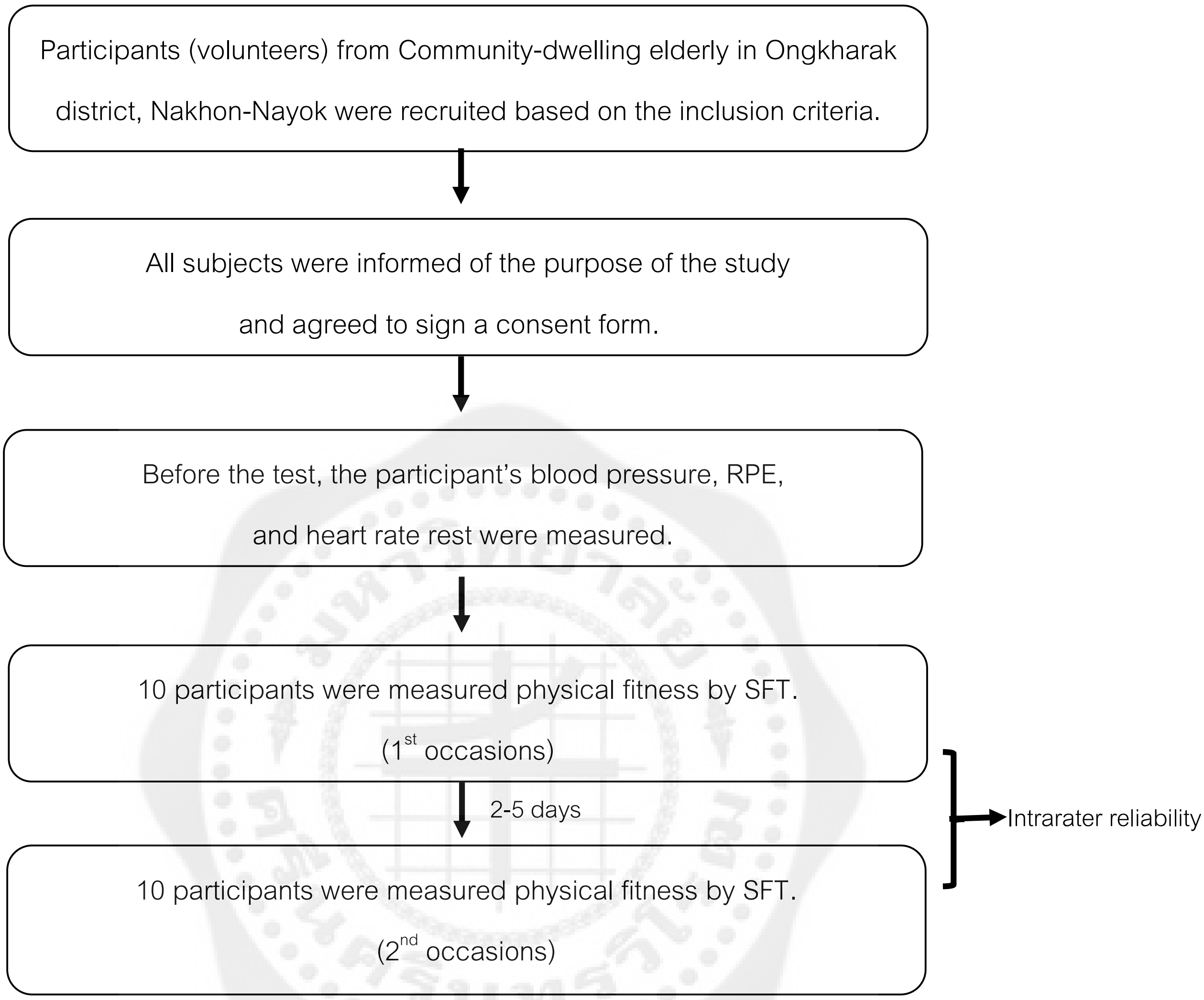


FIGURE 9 PROCEDURE OF TEST0RETEST RELIABILITY FOR SFT

5.2 Test-retest reliability for cardiopulmonary endurance (2MST, 6MWT-10m and 6MWT-30m) and validity

The procedure of test-retest reliability for cardiopulmonary endurance and validity was divide to 3 tests. Each participant performed three trials (2MST, and 6MWT-10 m and 6MWT-30m.) in a random sequence determined by simple random sampling: envelops concealed. This was to reduce random error [100]. After that, the blood pressure, heart rate, and RPE was measured before the tests.

Heart rate was measured before and every 20 seconds for 2MST and every minute for 6MWT. The percent intensity exercise is measured using the percent of heart rate reserves (%HRR). Dalleck and Kravitz (2006) showed that %HRR is correlated with the %VO2max (*r* = 0.99) [101]. The percent of heart rate reserves of the elderly was calculated using Kavonen's Method formula [102]:

%HRR = (HR exs – HR rest) x 100 / (HR max – HR rest)

When; Maximum heart rate (HR max) = 220 – age

Exercise heart rate (HR exs) is heart rate average at 5 minute and at 6 minute for 6MWT, and at of 1 minute and 2 minute for 2MWT of steady state heart rate (steady state heart rate is two heart rate within 5 beats/min) [102].

Dyspnea and overall fatigue was evaluated using the 10 points RPE (0 = no exertion at all, 10 = maximal exertion) before, during, and immediately after testing. Zamunér et al., (2011) showed that RPE is correlated with the oxygen consumption (*r* = 0.86) and is correlated with HR (r= 0.86) [103]. Blood pressure was measured at before and immediately after testing.

6 minute walk test and 2 minute step in place test

The 6-minute walk test was designed to assess cardiopulmonary endurance. The tests were conducted along a straight corridor with 10 and 30 m. walkways. Colored adhesive markers were taped at each end and at 1-m intervals. The orange traffic cone was placed before the destination 50 centimeters at each end. The participants were instructed to walk as quickly as possible within 6 minutes to cover as much ground as possible. They were able to stop for rest as needed, but the time was not stopped. During the test, an assessor walked alongside the participants to ensure their safety and inform them of every minute of time left. After the test, the participants were measured for BP, RPE, HR and total walking distance [7].

The 2 minute step in place test was also designed to assess cardiopulmonary endurance. Participants were asked to step in place while raising their knees to a height halfway between the hip bone and the kneecap. Scoring was based on the total number of times the right knee reached the proper height. After the test, the participants were measured for BP, RPE, HR and the total number of times the right knee reached the proper height. This test follows by Jones and Rikli 2013.

The first time, the participants practiced to become familiar with the walkway, equipment, and instruction. Subsequently, the reliability study of three tests (6MWT-10m and 6MWT-30m, and 2MST) was performed on two different occasions (2 to 5 days apart) [22].

All three trials for validity were completed on the same day with a rest until the heart rate reached the same baseline (HR is different less than ± 5 bpm) [102] before each test and between trials in order to minimize any interference effect of the a previous trial.

Participants (volunteers) from Community-dwelling elderly in Ongkharak district, Nakhon-Nayok were recruited based on the inclusion criteria.

All subjects were informed of the purpose of the study and agreed to sign a consent form.

Before and after the test, the participant's blood pressure, RPE, and heart rate rest were measured.

Randomized sequence of 6MWT-10m and 6MWT-30m, & 2MST
using simple random sampling: envelops concealed
(Group A or Group B or Group C)

Group	Order of tests		
	1	2	3
A (n=10)	6MWT-30m	6MWT-10m	2MST
B (n=10)	6MWT-10m	2MST	6MWT-30m
C (n=10)	2MST	6MWT-30 m	6MWT-10m

30 participants were measured cardiopulmonary endurance (1^{st} occasions)

2-5 days

30 participants were measured cardiopulmonary endurance (2^{nd} occasions)

Intrarater reliability (step and distant)

Validity (Heart rate reserve and RPE)

FIGURE 10 PROCEDURE OF RELIABILITY AND VALIDITY FOR CARDIOPULMONARY ENDURANCE

6. Data Analysis

Results was reported as means $\pm$ standard deviation. Characteristic of participants were analyzed using descriptive statistics. The Intraclass correlation coefficient (ICCs; ICC 3,1: Intra-rater reliability) was used reliability for SFT and cardiopulmonary endurance test. This study was used Pearson product moment correlation to convergent validity the peak heart rate reserve and RPE achieved between 2MST with 6MWT-10m and 6MWT-30m. $P \leq 0.05$ was considered statistically significant.

Phase II: Study of physical fitness in community dwelling elderly in Ongkharak, Nakhon-Nayok

1. Research design

This study was a cross-sectional study aimed to investigate the physical fitness levels of SFT: arm curl test (upper body strength); 30 second chair stand test (lower body strength); 2 minute step in place test (cardiopulmonary endurance); back scratch test (upper body flexibility); chair sit and reach test (lower body flexibility); 8-foot up and go test (agility and dynamic balance) and body composition (body mass index and waist circumference) in a sample of 191 participants (60-69 years of age).

2. Participants

Participants was volunteers, community-dwelling elderly, living in Ongkharak district, Nakhon-nayok Provide. Participants were age 60 to 69 years and both male and female. The inclusion and exclusion criteria was the same as phase I. All subjects was informed of the nature and purpose of the study and sign consent form before began.

The sample size of the elderly of this phase II was calculated using following equation (Stratified random sampling) [104];

$$n = \frac{z^2_{1-\alpha/2} \sum_{h=1}^{L} [N_h^2 P_h (1-P_h)/w_h}{N^2 d^2}$$

When: n = number of samples size

$Z_{1-\alpha/2}$ = 0.05, $Z_{1-\alpha/2}$ = 1.96

Nh = Total number of population units in each stratum

Ph = The ratio of weight in each stratum

Wh = The stratum weight (Nh/N)

N = number of elderly population (5,920)

d = Errors of precision at $\pm$3 percentage

$$n = 1.96^2(1738885.50) / (5920)^2 (0.03)^2$$

$$= 3.84(1738885.50) / (35046400)(0.0009)$$

$$= 6677320.32 / 31541.76$$

$$n = 211.69$$

Calculate number of samples from this formula is 212 participants. Then sample size calculates in each stratum from allocation of a sample to strata using formula follow:

$$\boxed{n_h = \left(\frac{N_h}{N}\right) n}$$

When: n = number of samples

n_h = the sample size in each stratum

N_h = the population size in each stratum

N = the total population size

Thus from this formula is sample size from each of the elderly in 11 Tambon in the Amphoe Ongkharak [9] (Table 8).

TABLE 8 THE SAMPLE SIZE IN EACH STRATUM OF 11 TAMBON IN THE AMPHOE ONGKHARAK

Stratum	Tambon name	Populations size	Samples size (n_h)
1	Bang Sombun	314	11
2	Bueng San	611	22
3	Pho Thaen	538	19
4	Sai Mun	610	22
5	Sisa Krabue	537	19
6	Bang Pla Kot	895	32
7	Phra Achan	854	31
8	Bang Luk Suea	492	18
9	Chumphon	619	22
10	Khlong Yai	300	11
11	Ongkharak	150	5
Total		N = 5,920	n = 212

3. Outcome Measures

The physiologic and anthropometric measures were assessed. Systolic blood pressure, diastolic blood pressure, height, weight, and body mass index were measured for each participant. BMI was calculated as height (in meters) squared divided by weight (in kilograms).

Functional fitness was assessed using the SFT, which consisted of the total score for each test.

4. Materials and research tools

The materials used in this phase II study (for measure physical fitness level) included same phase I.

5. Procedure

The tests of SFT were carried out as established by Jones and Rikli, 2013 details as phase I (5.1 test-retest reliability for SFT). Physical fitness test including arm curl test (upper body strength); 30 second chair stand test (lower body strength); 2 minute step in place test (cardiopulmonary endurance); back scratch test (upper body flexibility); chair sit and reach test (lower body flexibility); 8-foot up and go test (agility and dynamic balance) and body composition (body mass index and waist circumference). Body composition was designed to assess body mass index, as an individual's weight relative to height. Waist circumference was measured between the top of the iliac crest and the lower margin of the last palpable rib in the mid-auxiliary line.

Participants (volunteers) from Community-dwelling elderly in Ongkharak district, Nakhon-Nayok were recruited based on the inclusion criteria.

↓

All subjects were informed of the purpose of the study and agreed to sign a consent form.

↓

Before and after the test, the participant's blood pressure, RPE, and heart rate rest were measured.

↓

Physical fitness level measurement

Physical fitness parameter	Test items
1. Body strength	
Upper body strength	Arm curl
Lower body strength	30-s chair stand
2. Cardiopulmonary endurance	2-min step test
3. Body flexibility	
Upper body flexibility	Back scratch
Lower body flexibility	Chair sit-and-reach
4. Motor agility/dynamic balance	8-ft up-and-go
5. Body mass index	Height and weight
	Waist circumference

FIGURE 11 PROCEDURE OF PHYSICAL FITNESS LEVELS MEASUREMENT

6. Data Analysis

Results were reported as a means ± standard deviation. Characteristic of participants were analyzed using descriptive statistics. Description statistic (percentile ≤ 25 is below-average, and percentile > 75 is above average of physical fitness) [22] evaluated the data of physical fitness tests. $P \leq 0.05$ consider statistically significant.

Phase III: Effect of physical training on physical fitness in community dwelling elderly.

1. Research design

This was a randomized, controlled. The order of this section follows the CONSORT statement for reporting randomized controlled trials [105].

2. Participants

The participants was volunteers, all live in community dwelling elderly, Ongkharak, Nakhon-Nayok. The inclusion and exclusion criteria of the present study was the same in phase II.

Participants were recruited from community dwelling in Nakhon-nayok area, Thailand. Individuals 60-69 years of age and physical fitness level of cardiopulmonary endurance and lower body strength at least 75 percentile were eligible to participate in this study, because the elderly have legs lose muscle faster arms and both performance relationship with activities of daily living.

Furthermore, individuals were excluded for this study if they had severe orthopedic problems that limit their walking or marching abilities, medical diagnosis of heart and lung diseases, unstable hypertension (>160/110 mmHg), severe weight-bearing pain (rated > 5/10 on the visual analog pain scale), and severe visual or hearing impairment.

One hundred and ninety-one participants were evaluated for eligibility. Eighty-five participants not meeting inclusion criteria were excluded. Then, 106 participants were separated by simply randomized sampling (Lottery) method that divided to exercise group

(E): 37 participants (16 males, 21 females), and control group (C): 40 participants (19 males, 21 females), respectively. Twenty-nine participants were not allocated because they did not show up on the beginning date.

Sample size was calculated from the study of Matsuda et al, 2010 that investigate effectiveness of exercise in elderly by physical fitness test [87]. The significance level was set at alpha level 0.05. The power level was set at 80%. Sample size for this study was calculated using following equation:

$$n = \frac{2(Z_\alpha + Z_\beta)^2 \sigma^2}{\Delta^2}$$

When: σ Pool variances of 30-sec. chair stand = 3.3

Δ Mean difference of 30-sec. chair stand (pre - posttest) = 2.4

α 0.05, $Z_\alpha = 1.96$

β 0.20, $1-\beta = 0.80$, $Z_\beta = 0.84$

$$n = \frac{2(1.96+0.84)^2\ 3.3^2}{2.4^2} \quad , n = 29.65$$

From above calculation, the sample size in the present study is 30 participants in each group. For this study was plus 40% dropout [87]. This dropout was calculated using following equation[106]:

$$n_{new} = \frac{n}{1-L}$$

When: n = Sample size (30 participants/group)

n_{new} = New sample size

L = %Droupout rate (40%)

$$n_{new} = \frac{30}{1-0.4} \quad , n_{new} = 42$$

Therefore, the new sample size for the present study is 42 participants in each group.

3. Outcome Measures

All subjects were informed of the purpose of the study and sign consent form. Participants were interviewed and assessed for baseline demographics such as age, sex comorbidity and health status by questionnaire. After that, the blood pressure, heart rate, and RPE were measured. Consequently, the physical performance test [107] was administered. This test protocol was designed to evaluate the physical fitness related to independent functioning: upper and lower strength, cardiopulmonary endurance, upper and lower flexibility, motor agility and dynamic balance, and body composition. Blood pressure, heart rate, and RPE were measured after each test for each subject.

Physical fitness level of participants from both groups were assessed using SFT. These tests required less time or equipment and was designed to be conducted in community settings. Participants were received instruction to before testing. The physical fitness tests were arm curl test, 30 second chair stand test, 2 minute step in place test, back scratch test, chairs sit and reach test, 8-foot up and go test, body mass index and waist circumference that details as follows phase I.

4. Materials and research tools

The materials used in this phase II study (for measure physical fitness level) included same phase I.

5. Procedure

The exercise group performed exercise to improve physical fitness item. This exercises that recommendation from guideline for elderly and performed 8 weeks individual self-home base exercise program.

Exercise group (Individual home-based exercise program)

The exercise group performed the progressive exercise program for 8 weeks. Progressive exercise involves the gradual increase of stress placed upon the body during exercise training regarding manipulation of frequency, duration, intensity, and type of exercise[102]. The 8 week progressive individual home-based exercise program that included progressive strength training, cardiovascular/aerobics, flexibility, and balance exercises three days per week. A physical therapy professional supervised the program. Participants marked the exercise dates in their diary. Details of the progressive exercise program follows by Jones and Rikli 2013 [6].

1. Muscle strengthening of upper and lower body

Progressive resistive strength training of the upper body involved wall push-up exercise and the lower body sit to stand exercise.

Wall push-up exercise (exercise to improve upper lower body strength) (Fig. 12): The participant faced the wall; distance from the wall was equal to the length of the straight-arm. The participant bent the arm and moved slowly toward the wall and pushed-up the body away from the wall [6].

Sit to stand exercise (exercise to improve lower body strength) (Fig. 13): The participant stood with feet one shoulder–width apart in front of a chair. The back of the chair rested against the wall for safety. The participant sat down to on the chair slowly, bringing both arms forward to balance the movement [6].

The number of repetitions for each exercise was set at the higher number tested by the arm curl test (upper body strength test) and the 30-second chair stand test (lower body strength test). Progression was increased every 2 weeks for 2 repetitions and increased by 1 set every 2 weeks [102, 108]. Participants were exercised in range of rate perceive of exertion for at 5-6/10 (participants can speak as a word)[102, 108].

FIGURE 12 WALL PUSH-UP EXERCISE (EXERCISE TO IMPROVE UPPER LOWER BODY STRENGTH)

FIGURE 13 SIT TO STAND EXERCISE (EXERCISE TO IMPROVE LOWER BODY STRENGTH)

2. Cardiopulmonary endurance training

Progressive cardiopulmonary endurance training involved marching exercise (Fig. 14)[6] similar to the 2MST. The participant stood beside a chair with feet one shoulder–width apart while holding the chair for safety. The time of the marching exercise started at 20 minutes per day at the first week [102]. Participants performed continuous marching or separate marching was performed twice for 10 minutes per day [109]. The marching time was increased by 5 minutes every 2 weeks. Participants were exercised in range of rate perceive of exertion at 5-6/10 (participants can speak as a word) [108].

FIGURE 14 MARCHING EXERCISE (EXERCISE TO IMPROVE CARDIOPULMONARY ENDURANCE) [6]

3. Muscle flexibility of upper and lower body

The flexibility exercise for the upper body was the shoulder and upper-arm stretch and for the lower body, it was the standing calf stretch exercise [6].

Shoulder and upper-arm stretch exercise (exercise to improve upper body flexibility) (Fig. 15): The participant stood with feet one shoulder–width apart and held the towel with both hands behind the back [6].

Standing calf stretch exercise (exercise to improve lower body flexibility) (Fig. 16): The participant faced against the wall and stood length of straight-arm away the wall. The participant then stepped forward and bent the knee down toward the wall while keeping the other leg straight and the foot on the floor. The participants felt stretching at the calf of the back leg [6].

This flexibility exercise was activated to maintain or increase flexibility, using sustained stretches to the point of slight discomfort, or feeling of tightness in muscles held for 15 seconds by counting 1-15 for each exercise. The participants performed this exercise 5 times per set on each side at 3 sets per day [102, 108].

FIGURE 15 SHOULDER AND UPPER-ARM STRETCH EXERCISE (EXERCISE TO IMPROVE UPPER BODY FLEXIBILITY)

FIGURE 16 STANDING CALF STRETCH EXERCISE (EXERCISE TO IMPROVE LOWER BODY FLEXIBILITY):

4. Balance training

The balance exercise was the one leg stand. (Fig. 17). The participant stood beside a chair with feet one shoulder–width apart while holding the chair for safety. The participant lifted the leg from the floor and held it up to 30 seconds [110]. From the start, to the 2nd week, the participant performed this exercise 8 times per day for each side, 1 set per day. The exercise was progressively increased 2 times every 2 weeks (8x for the 1st and 2nd weeks, 10x for the 3rd and 4th weeks) and kept at 12x for the 5th to 8th weeks [102, 108]. The time to hold the elevation of one leg depended on the ability of each participant [108].

FIGURE 17 ONE LEG STAND EXERCISE (EXERCISE TO IMPROVE BALANCE) [6]

TABLE 9 THE SUMMATION OF PRESCRIPTION FOR THE EXERCISE GROUP AND THE FOLLOW-UP

Weekly	1 wk.	2 wk.	3 wk.	4 wk.	5 wk.	6 wk.	7 wk.	8 wk.
Progression of upper body strength training*	8-20 time/set, 1 set		10-22 time/set, 2 set		12-24 time/set, 3 set		14-26 time/set, 4 set	
Progression of lower body strength training*	8-16 time/set, 1 set		10-18 time/set, 2 set		12-20 time/set, 3 set		14-22 time/set, 4 set	
Progression of cardiopulmonary endurance training	20 min/day Or 10 min/session, 2 session/day		25 min/day Or 10 min/session, 2 session/day + 5 min/sec., 1ses/day		30 min/day Or 10 min/session, 3 session/day		35 min/day Or 10 min/session, 3 session/day, + 5 min/sec., 1ses/day	
Progression of flexibility training	Using sustained stretches to the point of slight discomfort, or feeling of tightness in muscles, hold for 15 seconds by counting 1-15 for each exercise							
Progression of agility/balance training	8 time/set 1 set		10 time/set 2 set		12 time/set 3 set		12 time/set 4 set	
Follow-up	Telephone	Telephone	Telephone	Telephone	Telephone	Telephone	Telephone	Telephone
	Visit 1		Visit 2		Visit 3		Visit 4	

Note: *The number of repetitions for each exercise was set at the higher number tested by the arm curl test and the 30-second chair stand test

Control group (information heath knowledge)

Control group participants maintained their lifestyles with performed usual medical care and information about health, self-care, including knowledge about good nutrition and basic knowledge about the pathophysiology convenient for dyslipidemia, diabetes mellitus, and hypertension.

Follow-up

During the first 4 weeks of follow-up, the individual home-based exercise program was visited weekly to each subject. This visit was related to check into the prescription of exercise, and problem about exercise. During the last 4 weeks of follow-up, participants was visited at every two weeks. Participants was get a phone call once a week [111]. The total time of exercise at 8 weeks was 24 time. The dropout was recommended at less 20%. Therefore, this total time to exercise at least 20 times was conduct the analysis. The intention-to-treat was use the last observation carried forward (LOCF) method for missing data [106, 112].

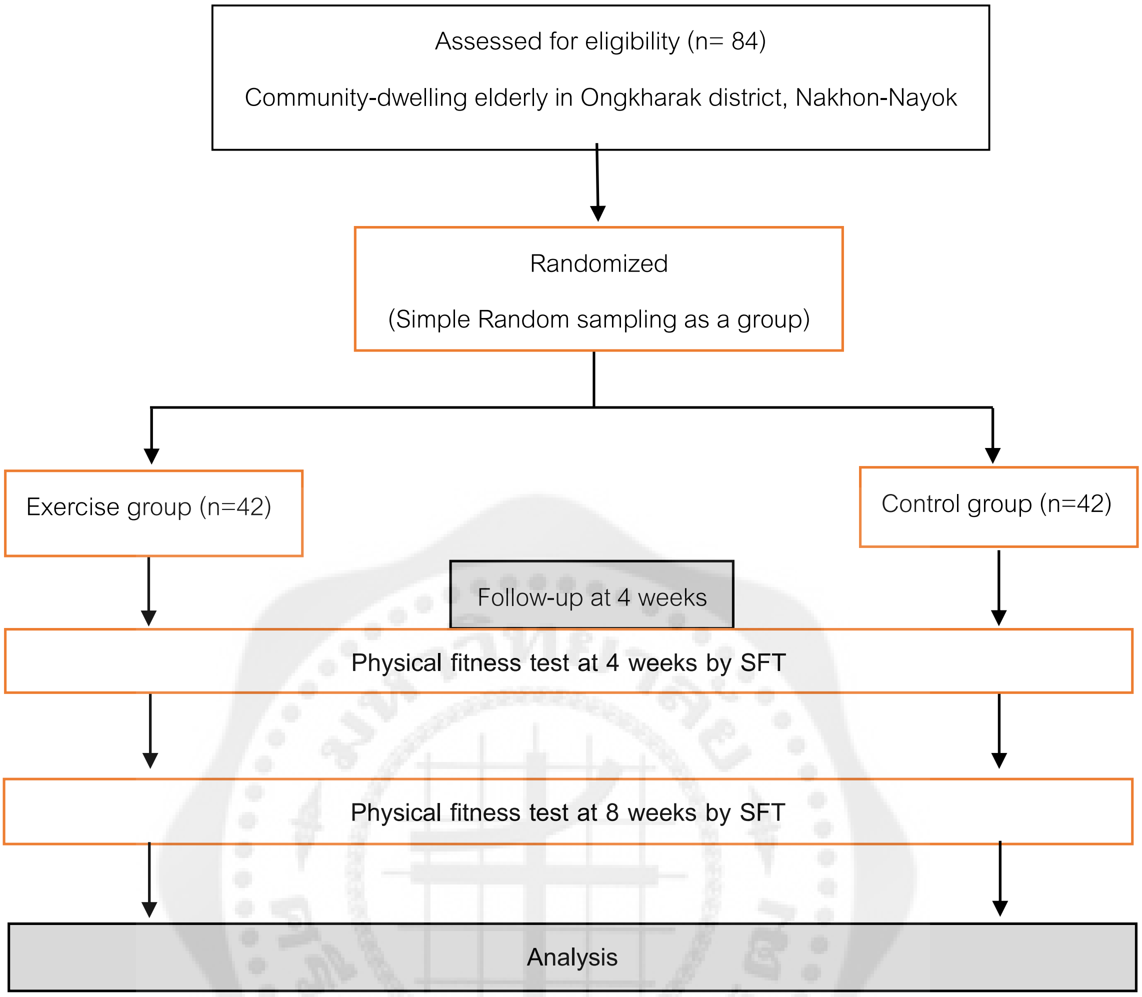


FIGURE 18 PROCEDURE OF PHASE III

6. Data Analysis

Results reported as means ± standard deviation. Characteristic of participants was analyzed using descriptive statistics. Two way ANOVA repeated was determine between groups difference in the performance of the physical fitness tests and before-after tests. $P \leq 0.05$ consider statically significant.

Ethical considerations

The study was approved by Nakhon-nayok Provincial Public Health Office institutional Review Board and informed consent, and written informed consent was obtained from all subjects.

CHAPTER 4

FINDINGS

Phase I: The percent heart rate reserve and dyspnea level responses to 2MST compare to 6MWT-10m and 6MWT-30m in community-dwelling elderly

1. Test retest-reliability of modified senior fitness test Thai-version

The analysis of test retest-reliability of modified senior fitness test Thai-version was based on 10 community dwelling older adults. Ten elderly included 2 men and 8 woman with healthy range of BMI, and normal blood pressure (Table 10).

TABLE 10 GENERAL CHARACTERISTICS OF THE SUBJECTS (N = 10)

Variables	Mean ± SD
Age (years)	67.5 ± 6.7
BMI (kg/m^2)	24.8 ± 5.4
Systolic pressure (mmHg) (at rest)	130.6 ± 16.1
Diastolic pressure (mmHg) (at rest)	80.6 ± 9.1

Seven tests of physical fitness test was high test-retest reliability (ICC = 0.89-0.98) (Table 11).

TABLE 11 TEST-RETEST RELIABILITY DATA OF PHYSICAL FITNESS TEST

Tests (n = 10)	Test day 1 (mean ± SD)	Test day 2 (mean ± SD)	Test-retest Reliability
Arm curl test (rep.)	11.5 ± 3.3	12.5 ± 2.7	0.89
Chair stand test (rep.)	12.3 ± 3.1	12.3 ± 2.7	0.91
2 Minute step in place test (rep.)	69.4 ± 14.0	72.3 ± 15.7	0.96
6 Minute walk test (10m.) (m.)	325.8 ± 105.6	304.3 ± 81.5	0.98
Back scratch test (cm.)	-8.5 ± 5.0	-8.7 ± 5.7	0.97
Chair sit and reach test (cm.)	4.0 ± 3.4	4.0 ± 2.7	0.96
8-foot up & go test (sec.)	6.9 ± 1.7	7.1 ± 1.6	0.92

2. Reliability and validity of 2MST and 6MWT

2.1 Test-retest reliability of 2MST and 6MWT

Thirty elderly subjects were recruited for the study. Demographic, anthropometric and physiological characteristics, including age, gender, BMI, vital signs and comorbidity of reliability of 2MST and 6MWT are presented in Table 12. The thirty elderly subjects included 20 men and 10 women with a healthy range of BMI, normal blood pressure and percentage O_2 saturation (Table 12). Most participants expressed having hypertension as well as hypertension with diabetes mellitus and dyslipidemia. The subject group was not found to have individual diabetes mellitus (Table 12).

TABLE 12 DEMOGRAPHIC CHARACTERISTICS OF THE SUBJECTS (N = 30)

Gender (Male: Female)	20: 10
Age (years) (mean $\pm$ SD)	64.0 $\pm$ 2.8
BMI (kg/m^2) (mean $\pm$ SD)	24.6 $\pm$ 3.8
Systolic pressure (mmHg) (mean $\pm$ SD)	133.3 $\pm$ 14.4
Diastolic pressure (mmHg) (mean $\pm$ SD)	81.5 $\pm$ 7.8
%O2 sat. (mean $\pm$ SD)	97.7 $\pm$ 0.8
Chronic disease (n)	16
Hypertension	5
Diabetes mellitus	0
Dyslipidemia	2
Hypertension+ Diabetes mellitus+ Dyslipidemia	5
Hypertension+ Dyslipidemia	4

The 2MST and 6MWT-10m and 6MWT-30m shoed very high test-retest reliability, with ICC more than 0.91 (Table 13).

TABLE 13 TEST-RETEST RELIABILITY OF 2MST, 6MWT-10M, AND 6MWT-30M

Tests	Test 1 (mean ± SD)	Test 2 (mean ± SD)	Test-retest reliability	95% CI
2MST (step)	64.1 ± 12.4	67.9 ± 14.1	0.93	0.85 - 0.97
6MWT-10m (distance)	347.5 ± 45.8	355.1 ± 44.0	0.91	0.80 - 0.96
6MWT-30m (distance)	401.6 ± 40.0	406 ± 42.5	0.93	0.86- 0.97

2.2 Validity of 2MST and 6MWT

The 2 minute step in place test showed the most average percent heart rate reserve, followed by 6MWT-30m and 6MWT-10m respectively (Table 14).

TABLE 14 %HRR (MEAN ± SD) OF 2MST, 6MWT-10M, AND 6MWT-30M

Test	Mean ± SD	Min-Max
During test		
2MST (step)	29.8 ± 9.8	15.7-51.5
6MWT-10m (distance)	18.5 ± 5.8	10.0-32.1
6MWT-30m (distance)	21.2 ± 8.0	9.4-39.0
Post-test		
2MST (step)	37.6 ± 10.5	21.4-59.3
6MWT-10m (distance)	21.2 ± 6.2	11.0-36.5
6MWT-30m (distance)	24.1 ± 7.5	13.2-38.1

The measure of percent heart rate reserve (%HRR) for 2MST and 6MWT-10m correlated positively with 6MWT-30m, both during and post-test more than 0.71(p=0.01) that post-test of 6MWT-10m was the most correlated positively with 6MWT (30-m.) (r=0.86; p=0.01) at post-test (Figure 19).

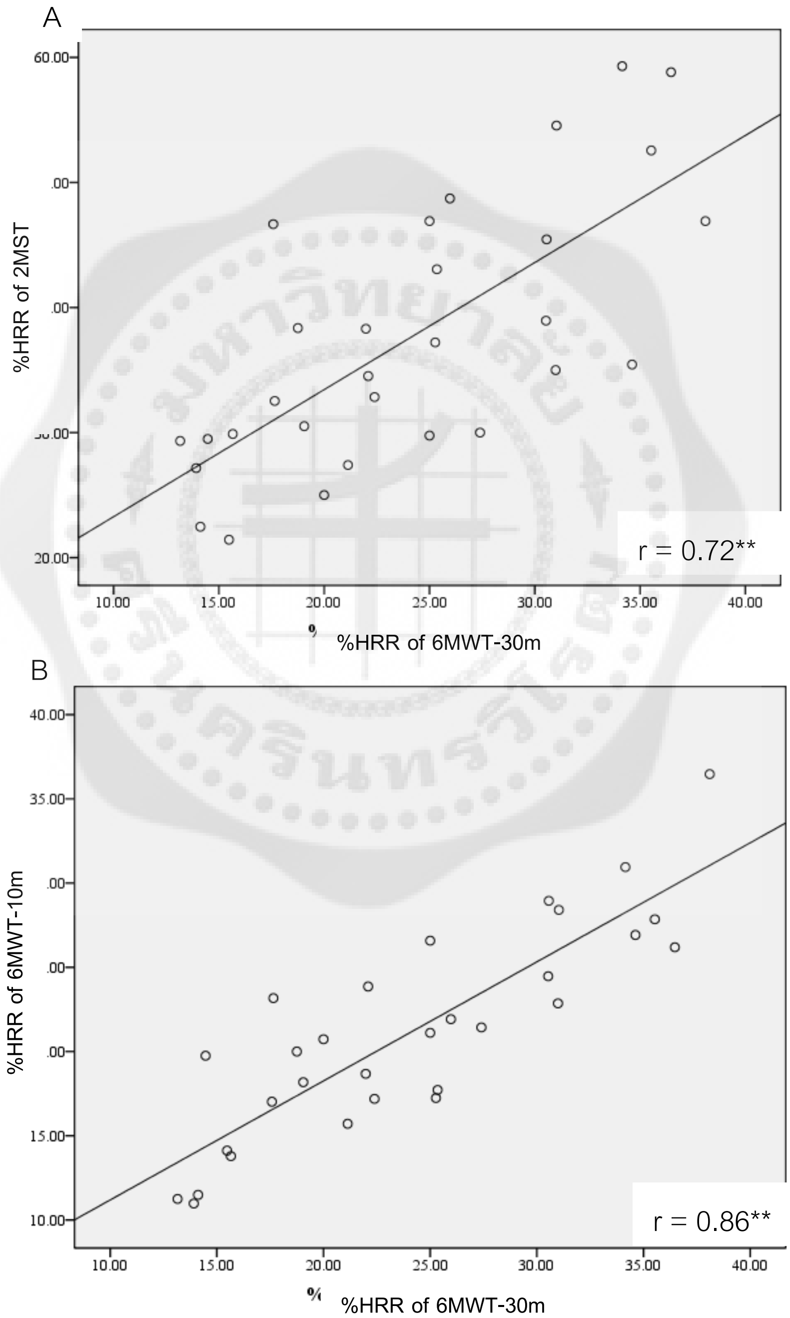


FIGURE 19 THE CORRELATION PLOTS OF %HRR FOR POST-TEST (A, 6MWT-30M AND 2MST; B, 6MWT-30M AND 6MWT-10M. (***p* = .01)

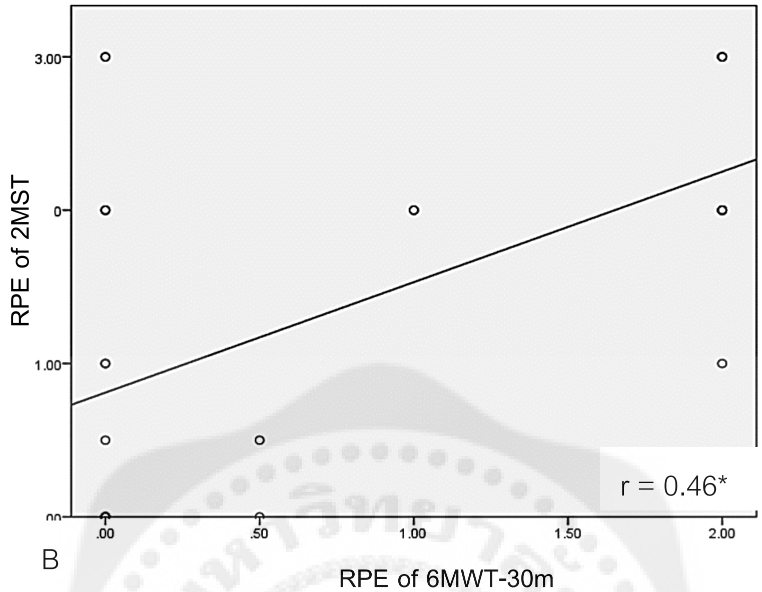
RPE for 2MST and both 6MWT ranged from nothing to weak for perceived exertion, except 2MST (post-test), which had a maximum of moderate perceived exertion. The RPE average of 2MST had low correlation with 6MWT-30m, both during testing and post-test. Further, 6MWT-10m had low correlation with 6MWT-30m both during testing and post-test (Table 15). In addition, RPR of 2MST and 6MWT-10m had low positively correlation with 6MWT-30m, both during testing and post-test (Figure 20).

TABLE 15 RPE (MEAN ± SD) OF 2MST, 6MWT-10M, AND 6MWT-30M

Test	Mean ± SD	Min-Max
During test		
2MST (step)	0.7 ± 0.8	0-2
6MWT-10m (distance)	0.2 ± 0.6	0-2
6MWT-30m (distance)	0.1 ± 0.4	0-2
Post-test		
2MST (step)	1.3 ± 1.1	0-3
6MWT-10m (distance)	0.5 ± 0.7	0-2
6MWT-30m (distance)	0.6 ± 0.9	0-2

Note: * RPE 0-10 scale

A



B

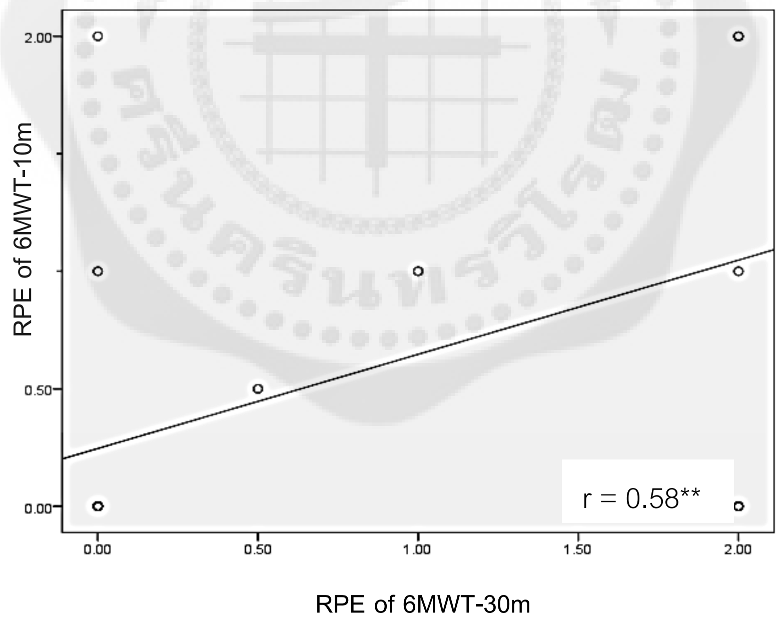


FIGURE 20 THE CORRELATION PLOTS OF RPE FOR POST-TEST (A, 6MWT-30M AND 2MST; B, 6MWT-30M AND 6MWT-10M. (*p < .05, **p = .01)

Phase II: physical fitness level of the community-dwelling elderly in Ongkharak district

Physical fitness level of the elderly

The demographic characteristics of the study sample are listed in table 16. Of the 191 participants, 63.35% and 36.65% were female and male respectively. The participants ranged in age from 60 - 69 years, separated into two groups, the 60 - 64 and 65 - 69 age. A total of 72.8%of the participants lived in a house with a partner. There were normal vital signs (blood pressure, heart rate, and %O2 saturation) but females were pre-obese and male were overweight. All participants suffered from chronic diseases composed of hypertension, diabetes mellitus, dyslipidemia, and combined diseases (hypertension, diabetes mellitus, and dyslipidemia). The group of 60 - 64 age, female and male were highest in combined diseases (hypertension, diabetes mellitus, and dyslipidemia) with pure hypertension at 22.9% and 13.5% respectively. The group of 65 - 69 age, female and male were highest in similarly in combined disease (hypertension, diabetes mellitus, and dyslipidemia) and pure hypertension at 15.7% and 18.2% respectively. The major occupation of participants was farmers with income more than 10,000 baht per month. In addition, other occupations were work as employees (labor), housekeeping, merchant, fishery, cook, and contractor. The status of participants was single, married, widowed, and divorced with the highest number married at 72.8%.

The table 17 shows age BMI, and vital signs data and means and SDs of physical fitness score for all age groups. In the 60 - 64 age group, participants were composed of female and male a 70 and 37, respectively. In the 65 - 69 age group, the participants were composed of female and male a 51 and 33, respectively. The age of the groups, female and male were 64.4+2.7 and 64.0$\pm$2.6 years old, respectively. The physical fitness scores showed significant gender difference for all tests ($p<0.05$) except arm curl test and waist circumference. However, these was no significant difference between age groups regarding in physical fitness score. The chair stand test, showed higher statistical significance of scores for males than females for both groups (14.8$\pm$3.2 and 12.9$\pm$3.1, $p < 0.001$). For the 2-minute step in place test scores, males showed higher statistical significance than females for both groups (70.5±14.3 and 62.3±15.3, $p < 0.001$). In the chair sit and reach test scores, females showed higher statistical significance than males for both groups (16.9±8.9 and 12.0±9.6, $p < 0.001$). In the back scratch test scores, females showed higher statistical significance than males for both groups (-20.6±15.0 and -14.3±12.7, $p = 0.002$). In addition, this test showed main effect of age significantly ($p<0.05$) in 60 - 64 age group. In the 8 foot up and go test scores, males showed higher statistical significance than females for both groups (7.5±1.6 and 7.0±1.1, $p < 0.05$).

Table 19 shows the 10th-, 25th-, 50th, 75th, and 90th-percentile score equivalents for each test item for men and women in all age groups. Below average physical fitness level is below the 25th percentile, while more than the 75th percentile shows above average physical fitness level, and the 25th – 75th percentile is normative data of physical fitness level[22]. The 25th – 75th percentile in the 60 - 64 age group, the chair stand test were 12.5 – 17 repetitions in males and 11 – 15 in females. The arm curl test were 12.5 – 19 and 13 – 17 repetitions in males and females, respectively. The 2 minute step in place test were 63.5 – 73.5 and 55 – 74 repetitions in males and females, respectively. The chair sit and reach test were 7.5 – 18.5 and 10.8 – 24 centimeters in males and females, respectively. The back scratch test were (-33.0) – (-14.5) and (-25) – (-2) centimeters in males and females, respectively. The 8 foot up and go scores were 7.5 – 5.9 and 8.0 – 6.3 seconds in males and females, respectively. The body mass index scores were 22.3 – 26.2 and 23.4 – 29.3 kilogram per square meters in males and females, respectively. The waist circumference scores were 81 – 93 and 84 – 96 centimeters in males and females, respectively. In addition, for the 25th – 75th percentile in the 65 - 69 age group, the chair stand test were 12 – 17 and 10 – 14 repetitions in males and females, respectively. The arm curl test were 13.5 – 16.5 and 12 – 17 repetitions in males and females, respectively. The 2 minute step in place test were 58.5 – 86.5 and 49 – 72 repetitions in males and females, respectively. The chair sit and reach test were 5.5 – 18.5 and 12 – 22 centimeters in males and females, respectively. The back scratch test were (-30.5) – (-9.5) and (-24) – (-4) centimeters in males and females, respectively. The 8 foot up and go were 8 – 6 and 8.5 – 7 seconds in males and females, respectively. The body mass index were 20.9 – 26.3 and 21.7 – 27.7 kilogram per square meters in males and females, respectively. The waist circumference were 82 – 95 and 79 – 96 centimeters in males and females, respectively.

TABLE 16 GENERAL CHARACTERISTICS OF PARTICIPANT IN PHASE II STUDY (60-69 YEARS)

variables	60-69 yrs.			60-64 yrs.			65-69 yrs.		
(mean ± SD)	Both group	Male	Female	Both gender	Male	Female	Both group	Male	Female
Age (yrs.)	64.2±2.6	64.4±2.7	64.0±2.6	62.2±1.4	62.2±1.4	62.1±1.4	66.7±1.2	66.9±1.2	66.7±1.2
BMI (kg/m^2)	25.0±4.2	24.1±3.3	25.7±4.5	25.4±4.0	24.2±3.4	26.1±4.1	24.6±4.4	23.7±3.4	23.1±4.9
Systolic pressure (mmHg)	134.2±16.2	136.2±16.1	133.1±16.2	133.3±17.1	135.1±17.3	132.4±17.0	135.4±15.1	137.5±14.9	134.1±15.1
Diastolic pressure (mmHg)	81.3±10.2	83.4±10.2	80.1±10.0	80.2±10.4	83.5±10.3	78.4±10.0	82.8±9.8	83.2±10.2	82.5±9.6
Heart rate (b/m)	78.6±10.5	77.8±10.8	79.1±10.3	78.1±10.7	77.8±11.0	78.3±10.6	79.1±10.2	77.8±10.6	80.0±10.0
%O2 sat.	97.6±0.9	97.7±0.9	97.5±1.0	97.5±1.0	97.6±1.0	97.5±1.0	97.6±0.9	97.7±0.8	97.5±0.9
Chronic disease (%)	71.2	58.6	78.5	64.5	51.4	71.4	79.8	66.7	88.2
Hypertension	13.1	15.7	11.6	12.1	13.5	11.4	14.3	18.2	11.8
Diabetes mellitus	1.6	1.4	1.7	0	0	0	3.6	3.0	3.9
Dyslipidemia	8.4	11.4	6.6	8.4	13.5	5.7	8.3	9.1	7.8
Hypertension+ Diabetes mellitus+ Dyslipidemia	16.2	10.0	19.8	16.8	5.4	22.9	15.5	15.2	15.7
Hypertension + Diabetes mellitus	9.4	7.1	10.7	8.4	5.4	10.0	10.7	9.1	11.8

TABLE 16 (Continued)

variables	60-69 yrs.			60-64 yrs.			65-69 yrs.		
(mean ± SD)	Both group	Male	Female	Both gender	Male	Female	Both group	Male	Female
Chronic disease (%) (Cont.)									
Hypertension +	**20.4**	11.4	**25.6**	**16.8**	**13.5**	18.6	**25.0**	9.1	**35.3**
Dyslipidemia									
Diabetes mellitus+	2.1	1.4	2.5	1.9	0	2.9	2.4	3.0	2.0
Dyslipidemia									
Occupation (%)									
Farmer	**40.2**	**42.3**	**39.7**	**43.9**	**45.9**	**42.9**	**35.9**	**39.4**	35.3
Work of employee (labor)	20.6	28.2	14.9	21.5	27	18.6	16.7	**27.3**	9.8
Housekeeping	28.6	15.5	36.4	22.4	10.8	28.6	36.9	21.2	**47.1**
Merchant	8.0	9.9	7.4	8.4	10.8	7.1	8.3	9.1	7.8
Fishery	0.5	1.4	0	0.9	2.7	0	0.0	0	0
Cook	1.5	1.4	1.7	2.8	2.7	2.9	0.0	0	0
Contractor	0.5	1.4	0	0	0	0	1.2	3.0	0

TABLE 16 (Continued)

variables (mean ± SD)	60-69 yrs.			60-64 yrs.			65-69 yrs.		
	Both group	Male	Female	Both gender	Male	Female	Both group	Male	Female
Income per month (%)									
<5,000 bath	29.3	17.1	36.4	24.3	13.5	30	35.7	21.2	45.1
5,000 – 10,000 bath	**51.8**	**64.3**	**44.6**	**53.3**	**64.9**	**47.1**	**50.0**	**63.6**	**41.2**
>10,000 bath	18.8	18.6	19.0	22.4	21.6	22.9	14.3	15.2	13.7
Status (%)									
Single	5.2	2.9	6.6	4.7	0	7.1	6.0	6.1	5.9
Married	**72.8**	**87.1**	**64.5**	**74.8**	**83.8**	**70**	**70.2**	**90.9**	**56.9**
Widow	18.3	7.1	24.8	16.8	10.8	20	20.2	3.0	31.4
Divorce	3.7	2.9	4.1	3.7	5.4	2.9	3.6	0	5.9

TABLE 17 BODY MASS INDEX, AND VITAL SIGNS OF PARTICIPANTS IN PHASE II STUDY (60-69 YEARS)

Variable	All 60-69 yrs.	age group 60-64 yrs.	age group 65-69 yrs.	p-value (age group)
Gender (n)				
Male	70	37	33	
Female	121	70	51	
Age (yrs.) (mean ± SD)				
Male	64.4±2.7	62.2±1.4	66.9±1.2	0.636
Female	64.0±2.6	62.1±1.4	66.7±1.2	0.136
p-value (gender)	0.600	0.499	0.954	
BMI (kg/m^2) (mean ± SD)				
Male	24.1±3.3	24.2±3.4	23.7±3.4	0.532
Female	25.7±4.5	26.1±4.1	23.1±4.9	0.208
p-value (gender)	0.012	0.106	0.053	
Systolic pressure (mmHg) (mean ± SD)				
Male	136.2±16.1	135.1±17.3	137.5±14.9	0.182
Female	133.1±16.2	132.4±17.0	134.1±15.1	0.209
p-value (gender)	0.909	0.802	0.888	
Diastolic pressure (mmHg) (mean ± SD)				
Male	83.4±10.2	83.5±10.3	83.2±10.2	0.900
Female	80.1±10.0	78.4±10.0	82.5±9.6	0.682
p-value (gender)	0.725	0.725	0.591	
Heart rate (b/m) (mean ± SD)				
Male	77.8±10.8	77.8±11.0	77.8±10.6	0.775
Female	79.1±10.3	78.3±10.6	80.0±10.0	0.481
p-value (gender)	0.423	0.614	0.444	
%O2 sat. (mean ± SD)				
Male	97.7±0.9	97.6±1.0	97.7±0.8	0.495
Female	97.5±1.0	97.5±1.0	97.5±0.9	0.524
p-value (gender)	0.174	0.415	0.291	

TABLE 18 PHYSICAL FITNESS SCORE OF PARTICIPANTS IN PHASE II STUDY (60-69 YEARS)

Variable	All 60-69 yrs. (M=70, F=121)	age group		ANOVA; main effect	
		60-64 yrs. (M=37, F=70)	65-69 yrs. (M=33, F=51)	p-value (age)	p-value (interaction)
Arm curl (reps.)					
Male	15.3 ± 3.5	15.4 ± 3.7	15.2 ± 3.4	0.389	0.333
Female	14.8 ± 3.2	14.9 ± 3.0	14.6 ± 3.4		
p-value (main effect; gender)	0.251				
Chair Stand (no. stands)					
Male	14.8 ± 3.2	15.0 ± 3.2	14.5 ± 3.2	0.854	0.728
Female	12.9 ± 3.1	13.3 ± 3.0	12.4 ± 3.2		
p-value (main effect; gender)	<0.001*				
2-min step (no. steps)					
Male	70.5 ± 14.3	70.3 ± 11.9	70.7 ±16.8	0.651	0.778
Female	62.3 ± 15.3	63.6 ± 15.4	60.4 ± 15.2		
p-value (main effect; gender)	<0.001*				
Back scratch (in.)					
Male	-20.6 ± 15.0	-21.7 ± 15.1	-19.4 ± 15.0	0.047*	0.326
Female	-14.3 ± 12.7	-14.2 ± 13.0	-14.4 ± 12.3		
p-value (main effect; gender)	0.002*				
Chair sit-and-reach (cm.)					
Male	12.0 ± 9.6	12.9 ± 10.1	10.9 ± 9.0	0.053	0.288
Female	16.9 ± 8.9	16.8 ± 9.7	17.0 ± 7.8		
p-value (main effect; gender)	<0.001*				
8-ft up-and-go (s)					
Male	7.0 ± 1.1	6.9 ± 1.2	7.0 ± 1.0	0.497	0.830
Female	7.5 ± 1.6	7.4 ± 1.6	7.8 ± 1.5		
p-value (main effect; gender)	0.014*				

TABLE 18 (Continued)

Variable	All 60-69 yrs. (M=70, F=121)	age group 60-64 yrs. (M=37, F=70)	65-69 yrs. (M=33, F=51)	ANOVA; main effect p-value (age)	p-value (interaction)
BMI (kg/m^2)					
Male	24.0 $\pm$ 3.4	24.2 $\pm$ 3.4	23.7 $\pm$ 3.4	0.586	0.743
Female	25.7 $\pm$ 4.5	26.1 $\pm$ 4.1	25.1 $\pm$ 4.9		
p-value (main effect; gender)	0.015*				
WC (cm.)					
Male	87.7 $\pm$ 9.5	87.6 $\pm$ 9.4	87.8 $\pm$ 9.8	0.343	0.542
Female	87.8 $\pm$ 11.1	88.7 $\pm$ 10.5	86.3 $\pm$ 11.9		
p-value (main effect; gender)	0.978				

TABLE 19 AGE-GROUP (YEARS) PERCENTILES FOR MEN AND WOMEN IN PHASE II STUDY (60-69 YEARS)

percentile	60-64 yrs. group		65-69 yrs. group		All 60-69 yrs.	
	male (n= 37)	female (n= 70)	male (n= 33)	female (n= 51)	male (n= 70)	female (n= 121)
Arm curl (reps.)						
10th	10	11	10.4	10	10.1	11
25th	12.5	13	13.5	12	13	12.5
50th	15	15	15	15	15	15
75th	19	17	16.5	17	17	17
90th	20.2	19	19.2	19.8	20	19

TABLE 19 (Continued)

percentile	60-64 yrs. group		65-69 yrs. group		All 60-69 yrs.	
	male (n= 37)	female (n= 70)	male (n= 33)	female (n= 51)	male (n= 70)	female (n= 121)
Chair Stand (no. stands)						
10th	11	10	11	8	11	9
25th	12.5	11	12	10	12	11
50th	15	13	14	12	14.5	13
75th	17	15	17	14	17	14
90th	19.2	18	19	17	19	17
2-min step (no. steps)						
10th	59	44.1	51	39.2	51.2	42.2
25th	63.5	55	58.5	49	61	52.5
50th	68	64	69	56	68.5	63
75th	77.5	74	86.5	72	81	72.5
90th	85.8	83.9	94	83	93.6	83

TABLE 19 (Continues)

percentile	60-64 yrs. group		65-69 yrs. group		All 60-69 yrs.	
	male (n= 37)	female (n= 70)	male (n= 33)	female (n= 51)	male (n= 70)	female (n= 121)
Back scratch (cm.)						
10th	-41.4	-32.0	-40.8	-29.0	-40.8	-31
25th	-33.0	-25.0	-30.5	-24.0	-32.3	-24.5
50th	-24.0	-13.0	-15.0	-15.0	-22.5	-15
75th	-14.5	-2.0	-9.5	-4.0	-12.5	-2.5
90th	4.4	2.0	1.8	3.0	2.9	2
Chair sit-and-reach (cm.)						
10th	-4.0	4.0	4.0	5.6	1	4
25th	7.5	10.8	5.5	12.0	6.8	11
50th	13.0	17.0	10.0	17.0	11.5	17
75th	18.5	24.0	18.5	22.0	18.3	23
90th	27.2	28.9	23.2	27.8	24	28
8-ft up-and-go (s)						
10th	8.9	9.4	8.3	9.7	5.6	5.9
25th	7.5	8.0	8.0	8.5	6	6.5
50th	7.0	7.0	7.1	7.7	7	7.3
75th	5.9	6.3	6.0	7.0	7.6	8.3
90th	5.2	6.0	5.8	5.6	8.4	9.4

TABLE 19 (Continues)

percentile	60-64 yrs. group		65-69 yrs. group		All 60-69 yrs.	
	male (n= 37)	female (n= 70)	male (n= 33)	female (n= 51)	male (n= 70)	female (n= 121)
BMI (kg/m^2)						
10th	19.9	21.4	19.8	19.0	20	20.2
25th	22.3	23.4	20.9	21.7	21.4	22.7
50th	23.8	26.0	23.0	24.7	23.3	25
75th	26.2	29.3	26.3	29.7	26.2	29.4
90th	28.4	30.9	28.7	31.9	28.3	31
WC (cm.)						
10th	73	75	74	67	73.3	73
25th	81	84	82	79	81.5	80
50th	89	89	87	87	88	88
75th	93	96	95	96	94	96
90th	99	101	104	101	99.9	100.5

Phase III: Effect of 8 weeks individual home-based exercise program in community-dwelling elderly

Effect of 8 weeks individual home-based exercise program

A total of 191 elderly (60-69 years old) were recruited for the study and 106 elderly were randomly selected by inclusion criteria. Only 77 participants received the program the first time, and the overall recruitment rate for this study was 40.3% (77/191). The reasons for dropout (n=16) from the study and lack of follow-up included personal reasons (n=4) and health problems (n=5), from personal reason (n=7). At the end of the program (8 weeks) was

83.8% of participants the exercise group completed the program, while 75% of participants in the control group completed the program. Personal reasons were given as the primary reason for dropouts from both groups (68.75%) and health reasons were given as the secondary reason for both groups (31.25%). Thus 31 participants in the exercise group and 30 participants in the control group completed the study.

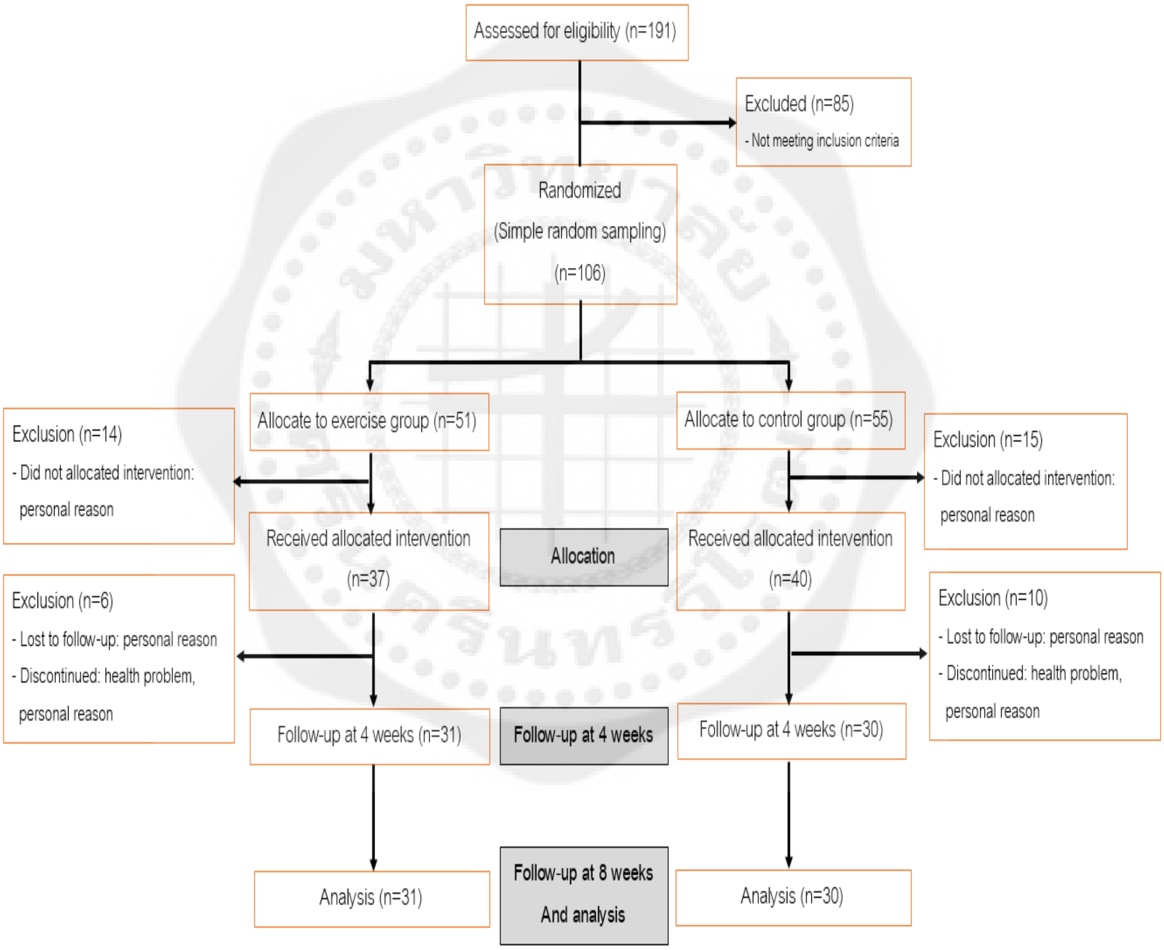


FIGURE 21 FLOW CHART OF PARTICIPANT RECRUITMENT AND TRIAL DESIGN.

All the data were presented as mean ± standard deviation. The baseline characteristics of the elderly are shown in Table 20. There were no significant differences between the exercise and control groups in all baseline characteristics and physical fitness levels. The data of physical fitness testing at 4 weeks of training indicated that the exercise group increased with a significant difference compared to the control group. Data were composed of the arm curl test (E=14.2 ± 2.5 vs. C=14.2 ± 2.5), chair sit and reach test (E=14.5 ± 2.4 vs. C=12.1 ± 2.0), and 2 minute step in place test (E=72.1 ± 11.3 vs. C=54.0 ± 13.5); p< 0.05. After 8 weeks, the exercise group increased with significant difference compared to the control group in arm curl test (E=18.1± 2.3 vs. C=14.7 ± 2.2), chair stand test (E=15.5 ± 2.3 vs. C=12.5 ± 2.3), 2MST (E=75.8 ± 10.8 vs. C=52.2 ± 13.0), and chair sit and reach test (E=19.4 ± 6.3 vs. C=13.3 ± 8.4) (*p*< 0.05). However, physical fitness levels in 4 tests; back scratch test, 8-foot up and go test, body mass index (BMI) and waist circumference did not show a significant difference between the exercise and control groups (*p*>0.05).

TABLE 20 BASELINE (WEEK 0) CHARACTERISTIC OF EXERCISE AND CONTROL GROUPS, MEANS ± SD (RANGE)

variable	exercise group (n=31)	control group (n=30)	p-value
Age, year	64.0 ± 2.3	64.5 ± 2.6	>0.05
	(60 – 69)	*(60 – 68)*	
Gender (n)	Male 15, Female 16	Male 14, Female 16	
Body Mass Index	24.8 ± 4.5	25.1 ± 4.1	>0.05
(kg/m^2)	*(17.4 – 41.3)*	*(19.3 – 34.0)*	
Waist circumference (cm.)	86.2 ± 9.8	89.8 ± 9.6	

TABLE 20 (Continued)

variable	exercise group (n=31)	control group (n=30)	p-value
Chronic conditions (%)			
(Hypertension, Diabetes mellitus and Dyslipidemia)	90	80	
Vital Sign			
Systolic pressure (mmHg)	132.5 ± 18.1	133.0 ± 16.9	>0.05
	(97 – 160)	*(102 – 160)*	
Diastolic pressure (mmHg)	81.2 ± 12.1	81.2 ± 9.8	>0.05
	(60 – 107)	*(66 – 97)*	
Heart rate (bpm)	77.8 ± 8.7	80.7 ± 12.9	>0.05
	(60 – 95)	*(60 – 100)*	
% Oxygen saturation	97.3 ± 1.0	97.6 ± 0.9	>0.05
	(95 – 98)	*(95 – 99)*	

Note: represents as mean ± SD (range)

The data in this study were compared to the time course exercise programs at 0, 4 and 8 weeks for each group. The exercise group showed increased significant difference between 0 to 4 weeks, and 0 to 8 weeks in arm curl test (week 0 =13.5 ± 2.6, week 4th =16.9 ±2.2, week 8th = 18.1 ± 2.3), chair stand test (week 0 = 12.1 ± 1.8, week 4th = 14.5 ± 2.4, week 8th = 15.5 ± 2.3), 2MST (week 0 = 60.3 ±8.6, week 4th = 72.1 ± 11.3 , week 8th =75.8 ± 10.8), 8-foot up and go test (week 0 = 7.5 ± 1.1, week 4th = 6.4 ± 1.1, week 8th = 6.3 ± 0.9), chair sit and reach test (week 0 = 12.3 ± 9.8, week 4th = 19.8 ± 6.7, week 8th = 19.4 ± 6.3), ($p< 0.05$). In addition, the data of the exercise group compared with 4 and 8 weeks showed increased significant difference in arm curl test (week 4th = 16.9 ±2.2, week 8th =18.1 ± 2.3), and chair stand test (week 4th = 14.5 ± 2.4, week 8th = 15.5 ± 2.3), ($p< 0.05$). However, the BMI and waist circumference showed no significant difference ($p>0.05$). Data is reported in table 21 and figure 22. On the other hand, the control group did not show any significant difference for all physical fitness tests when comparing data between 0, 4 and 8 weeks ($p>0.05$).

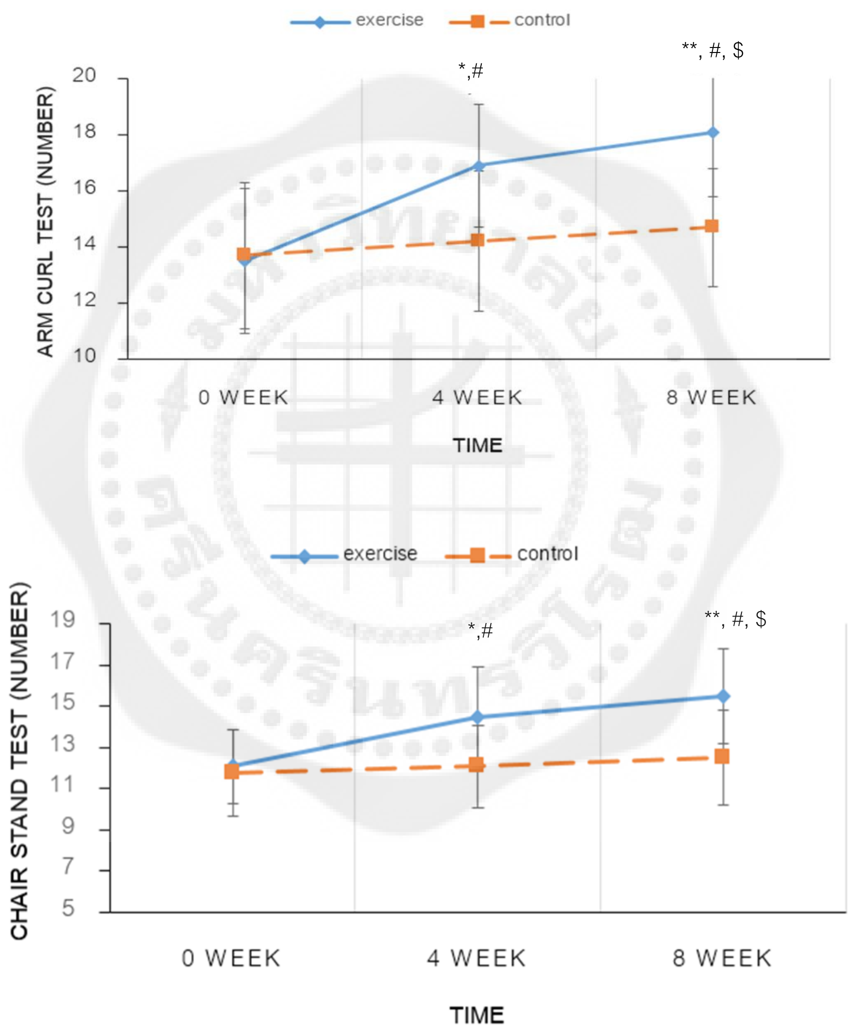
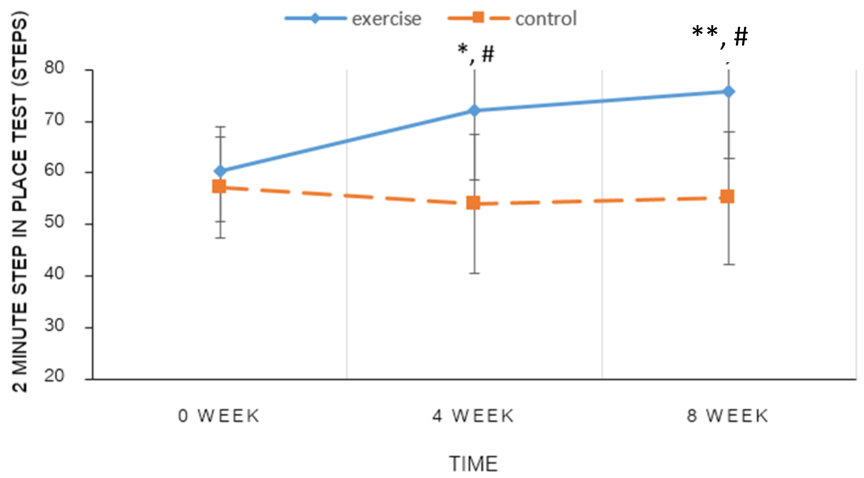
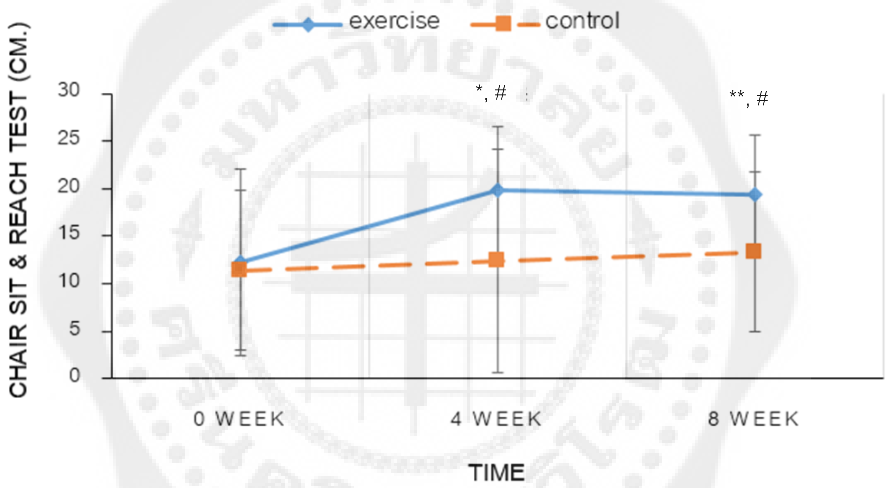


FIGURE 22 CHANGES IN PHYSICAL FITNESS SCORE FROM WEEK 0 (BASELINE) TO END OF THE STUDY





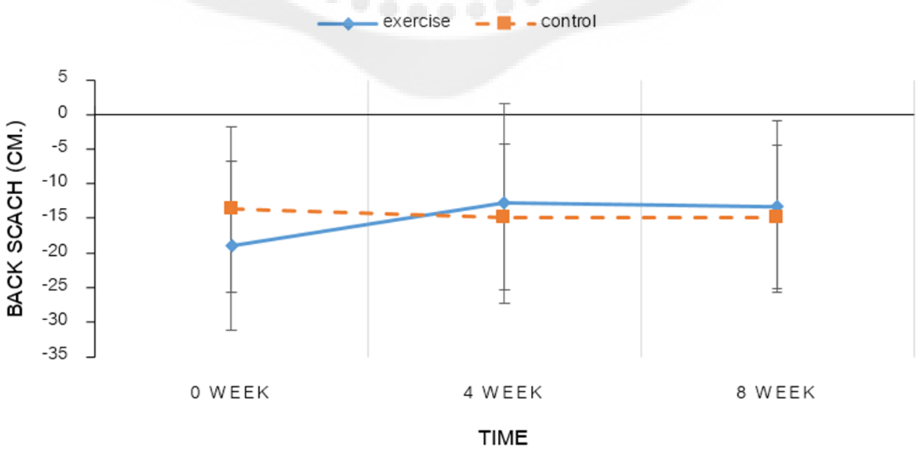
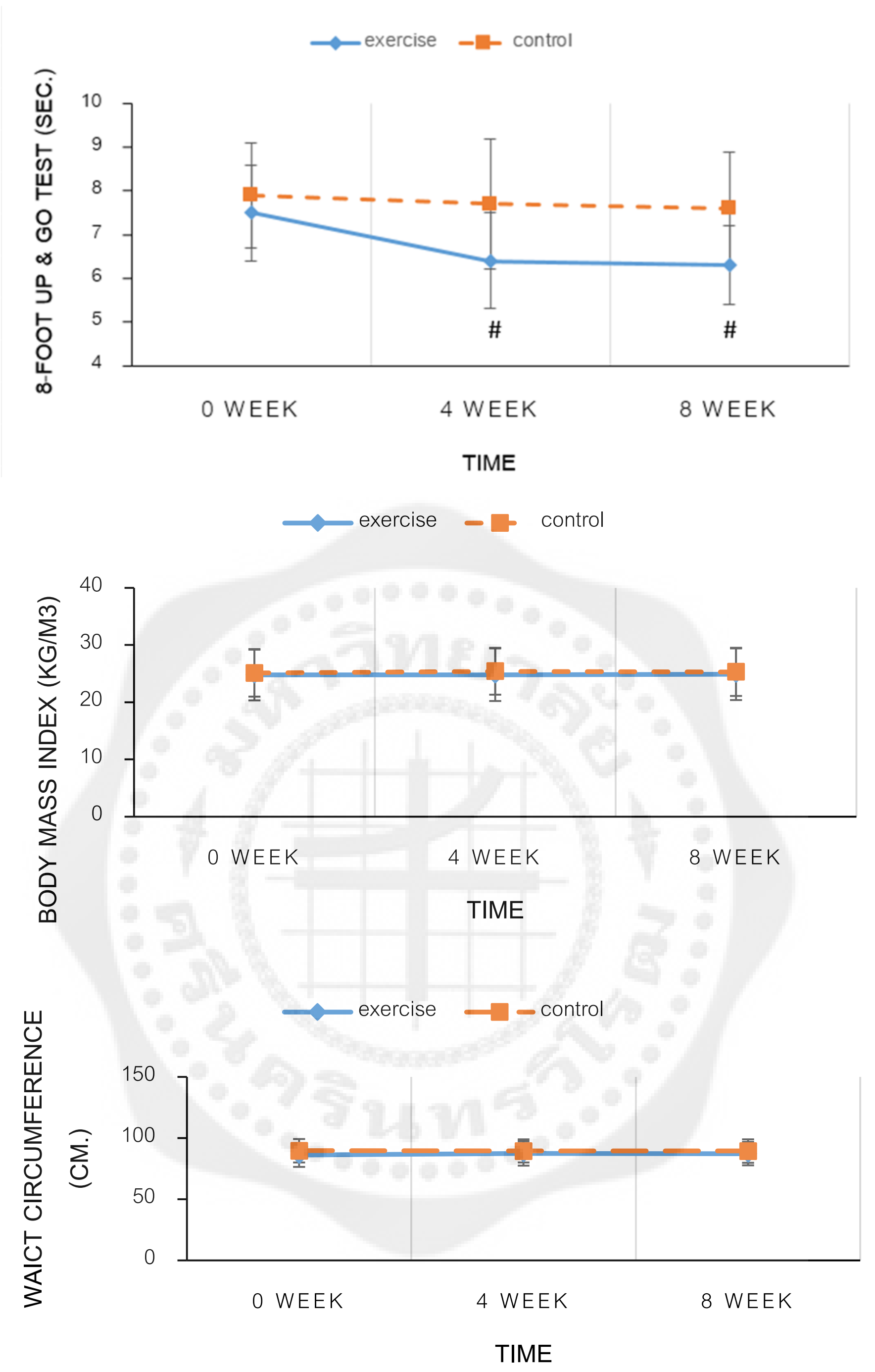


FIGURE 22 (Continued)



Note: * p < .05 exercise group versus control group at 4 weeks, ** p < .05 exercise group versus control group at 8 weeks, # p < .05 exercise group at 4 & 8 weeks versus exercise group at baseline, $ p < .05 exercise group 8 weeks versus exercise group at 4 week

FIGURE 22 (Continued)

TABLE 21 CHANGES IN PHYSICAL FITNESS SCORE FROM BASELINE (WEEK 0) TO END OF THE STUDY, MEAN $\pm$ SD

Tests	Group	Pre-test (0 wk.)	Post-test (4 wk.)	Post-test (8 wk.)
Arm curl (no. reps.)	exercise	13.5 $\pm$ 2.6	16.9 $\pm$ 2.2	18.1 $\pm$ 2.3
	control	13.7 $\pm$ 2.6	14.2 $\pm$ 2.5	14.7 $\pm$ 2.1
Chair Stand (no. stands)	exercise	12.1 $\pm$ 1.8	14.5 $\pm$ 2.4	15.5 $\pm$ 2.3
	control	11.8 $\pm$ 2.1	12.1 $\pm$ 2.0	12.5 $\pm$ 2.3
2-min step (no. steps)	exercise	60.3 $\pm$ 8.6	72.1 $\pm$ 11.3	75.9 $\pm$ 10.8
	control	57.3 $\pm$ 9.8	54.0 $\pm$ 13.5	55.2 $\pm$ 12.9
Back scratch (cm.)	exercise	-18.9 $\pm$ 12.2	-12.8 $\pm$ 14.4	-13.3 $\pm$ 12.4
	control	-13.7 $\pm$ 12.0	-14.8 $\pm$ 10.6	-14.8 $\pm$ 10.3
Chair sit-and-reach (cm.)	exercise	12.3 $\pm$ 9.8	19.8 $\pm$ 6.7	19.4 $\pm$ 6.2
	control	11.4 $\pm$ 8.4	12.4 $\pm$ 11.8	13.3 $\pm$ 8.4
8-ft up-and-go (sec.)	exercise	7.5 $\pm$ 1.1	6.4 $\pm$ 1.1	6.3 $\pm$ 0.9
	control	7.9 $\pm$ 1.2	7.7 $\pm$ 1.5	7.6 $\pm$ 1.3
Body mass index (kg/m^2)	exercise	24.8 $\pm$ 4.5	24.8 $\pm$ 4.6	24.9 $\pm$ 4.5
	control	25.1 $\pm$ 4.1	25.4 $\pm$ 4.1	25.3 $\pm$ 4.2
waist circumference (cm.)	exercise	86.2 $\pm$ 9.8	87.5 $\pm$ 9.9	87.3 $\pm$ 9.7
	control	89.8 $\pm$ 9.6	89.5 $\pm$ 9.4	89.5 $\pm$ 9.5

CHAPTER 5
DISCUSSION AND CONCLUSION

Phase I: The percent heart rate reserve and dyspnea level responses to 2MST compare to 6MWT-10m and 6MWT-30m in community-dwelling elderly

The test-retest reliability of the modified senior fitness test Thai-version found high test retest-reliability. The reliability and validity of 2MST and 6MWT-10 m was compared to the standard test, the 6MWT-30m. The results showed high test retest-reliability. The validity of the 2MST and 6MWT-10 m, when compared to 6MWT-30 m using %HRR was found to have significant correlation. In addition, the RPE of 2MST and 6MWT-10m when compared to the 6MWT-30m after testing showed a low level of correlation.

1. Test retest-reliability of the modified senior fitness test Thai-version

The results showed that modified senior fitness test Thai-version has high test-retest reliability (ICC > 0.89) similarly to previous studies (ICC = 0.84-0.98) [3, 14, 18, 25, 41, 47, 113, 114]. Our method and subject was similar to these studies that subjects were elderly (over 60 year old) and also the second and third times for test-retest reliability were performed on two different occasions 2 to 5 days apart.

2. Reliability and validity of 2MST and 6MWT

In order to determine the proper cardiopulmonary endurance test for the elderly that can be applied in limit space. Therefore, the present study tested the reliability and validity of two tests (2MST and 6MWT-10m.) when comparing with 6MWT-30m. as reference test. Three tests showed similar exercise intensity when using two variables, including %HRR and RPE. %HRR is expansive considered to be equivalent to $\%VO_2max$ which related to oxygen consumption reserve for exercise prescription purposes.

Positive correlation (r>0.7) of %HRR level used in present study to determine the validity of the 2MST and 6MWT-10m, when compared to 6MWT-30m suggested that these three tests were comparable. This result was similar to the study of Rikli and Jones (1998), which carried out a comparison test for SFT and criterion measurement. In their study, positive correlation between 6MWT and time on treadmill to 85% predicted maximum heart rate (r= 0.78) were found. The results found in present study was accepted and indicated moderate correlation [(14, 115)]. Percent heart rate reserve is used to demonstrate exercise intensity because it showed high correlation with VO_2 max [(116)]. The advantage of using %HRR in present study was its suitability for field testing in the community. As a consequence, 2MST, 6MWT-10m, and 6MWT-30m were comparable in exercise intensity when using %HRR.

Present study showed that the correlation between 2MST and 6MWT-10m with 6MWT-30m was 0.71 to 0.74 for during and post-test except for the correlation between 6MWT-10m and 6MWT-30m, which was found to be 0.84 for post-test. This could be due to 6MWT-10m and 6MWT-30m having the same walkway patterns and using the same total test. The present study showed that the %HRR intensity of 2MST was higher than 6MWT (29.8-36.7 and 18.5-24.1 respectively). However, the exercise intensity of each tests (2MST, 6MWT) resulted in Very light to Light intensity (Very light intensity = <20%HRR, Light intensity = 20<40%HRR) [(116)].

RPE was used in the present study to determine exercise intensity, which can be subjective. RPE is usually used for monitoring exercise tolerance and impending fatigue during exercise [(102)]. However, the present study found low correlation (r=0.4-0.58) of RPE between 2MST and 6MWT-10m with 6MWT-30m. RPE has limitations in low exercise intensity and led to floor effect for RPE scale response. The elderly group in the present study, when tested with 2MST and 6MWT, represented the low RPE scale (mean $\pm$ SD = 0.6 $\pm$ 0.2/10 scale of CR-10 point). RPE may be insufficient for monitoring light intensity exercise response in elderly people. Other evaluation methods for dyspnea on exertion that could be applied for such low intensity exercise may include talk test or a respiratory rate monitoring.

The present study found that the modified senior fitness test Thai-version was reliable. Both 6MWT-10m and 2MST showed reliability and validity when compared with a standard 6MWT-30m, suggesting that 2MST and 6MWT-10m could be used as an alternative to 6MWT-30m. Therefore, the modified senior fitness test Thai-version can be applied in the Thai elderly.

The 2MST uses a repetitive pattern, is easy, requires less area and time, which is suitable for an elderly community because elderly people with declining nervous system function may struggle with recognition and anticipatory postural adjustment (117). However, 2MST is not appropriate for elderly people who have knee pain or have hip pain while high stepping. In addition, 6MWT-10m is not suitable for elderly people who experience dizziness during walking and turning because 6MWT-10m uses more walking turns (8). Therefore, 2MST was used in phase II for cardiopulmonary endurance assessment for the elderly.

Phase II: physical fitness level of the community-dwelling elderly in Ongkharak district

Physical fitness level of participants

In phase II, the present study determined the age – specific normative physical fitness scores of a population of Thai community-dwelling elderly in Ongkharak district. All participants were able to complete the full battery of fitness tests and these tests can be considered appropriate for this population. However, in some studies, not all (22, 72) participants were able to complete all the fitness tests (more than 80% of the participants were able to complete the full battery of fitness). These studies were for 60 - 84 or 60 - 94 year olds. In our assessment, the 60-69 age group samples were active participants. The general characteristics of BMI, the males are mostly in the normal range and females are predominantly in pre-obese range.

The chair sit and reach scores, which measures lower body flexibility were higher than in the previous study (22, 72, 74). In addition, the present study produced average physical fitness level which considerably US elderly [22]. This may reflect factors such as the way of life in Thai culture like sitting on the floor and occupational (such as planting shrubs) of Thai elderly.

Conversely, the chair stand scores assess lower body strength from both genders and both age groups scored higher than that reported in Macfarlane 2006 (mean $\pm$ SD; 12.3 $\pm$ 4.2)[71]. Results found in the present study was a little lower than that in some studies including Chen 2009 [74], Rikli 1999 [22], and Marques 2013 [73]. However, the Minimal Detectable Change (MDC) [118] scores of the chair stand scores is 2 repetition score. Using MDC, it may indicates the lower body strength of the elderly subjects in this research is similar to the results of other research.

The arm curl used to assess upper body strength, both genders and both age groups scored lower results than in Rikli 1999 [22] and Marques 2013 [73] but the difference was within the MDC value of arm curl scores (2.3 repetitions score). This may indicate that the male subjects selected in present study had less upper body strength than males selected in other studies.

The 2MST assess cardiopulmonary endurance, it was found that both genders and both age groups scored lower than that reported in Rikli 1999 [22] and Chen 2009[74] by approximately 30 step. This may indicate that the cardiopulmonary endurance of the elderly subjects in the present study was lower than those subjects selected in Rikli 1999 [22] and Chen 2009 [74].

In addition, for the 8-foot up and go, which investigate agility and dynamic balance the results in present study were lower than the previous study [22, 73, 74] implying that the physical fitness level were considerably lower (lower than the 50^{th} percentile) compared to the elderly subjects tested from the US [22].

The back scratch assess upper body flexibility, in present study, it was found that both genders and both age groups scored lower than that reported in Rikli 1999 [22]. In addition, the back scratch score in present study (men = -20.6$\pm$15, female = -14.3 $\pm$12.7) were lower than the results of The Sports Authority of Thailand (men = -5.3$\pm$12.1, female = -2.8 ±9.3)[98], which studied elderly Thai subjects at the same age for both genders. The back scratch scores were lower than the MDC scores (4.6 centimeter). The back scratch test is the test for flexibility of the shoulder joint which declines with advancing age [22]. People who use their shoulders flexibility such as gymnastics, athletes or occupations that use the shoulder joint regularly have good shoulder flexibility.

The physical fitness levels of the participants in present study were different from other reports [22, 72-74]. This may reflect different levels of physical activity and exercise. For example, more than 65% and 77% of volunteers in other studies [22, 74, 98] reported to have exercise at least 3 days/week. But in the present study, the participants lived in community and more than 60% of the participants did not report doing any other physical activity apart from daily-living tasks. Up to 40% of the participants were farmers, but they did not work every day and followed a sedentary life style.

Moreover, our data showed that men (60 - 69 age group) were overweight (mean ± SD; 24.0±3.4) while women (60 - 69 age group) were pre-obese (mean ± SD; 25.7±4.5). The BMI found in phase II of the present study was similar to that of Rikli 1999 [22]. Compared to WHO category BMI classification, it was found that the average BMI of males was overweight, while the average of females was in the range of pre-obese. When looking at the percentile the both gender are in the normal to pre-obese of BMI. It is interesting that the BMI should be reported as the average or the percentile.

The waist circumference [58] of females (both age groups) in our data was more than 80 cm and associated with morbidity (diabetes mellitus, cardiovascular disease), and mortality [67, 70]. On the other hand, the score of males (both age groups) was lower than 90 cm with less risk factor for heart disease [59].

Effect of gender and age groups

When looking at age groups, there was only a difference in results in back scratch test. This is the same effect as shown in previous research [22, 73], which may be due to the fact that older age results in reduced flexibility. Therefore, we should pay close attention to the reduction of the flexibility of shoulder joints in the elderly.

Looking at difference between genders, it was found that physical fitness levels in terms of lower body strength, cardiopulmonary endurance, and balance in males were all higher than females. This result is consistent with recent studies [22] that usually indicate that males are physically stronger than females. In addition, males had more BMI scores than females. The results are the same as the previous studies [22, 73]. This may be due to the fact that males have less fat composition than females, which may result in a lower body mass index scores. In present study, it was found that physical fitness levels in terms of upper body flexibility and lower body flexibility in females were higher than that of males, this result is consistent with recent studies [22, 73]. This may be females have more flexibility in their activity than men such as wearing the underwear.

Present study established the physical fitness level for elderly in community-dwelling in Thailand (age 60-69). The physical fitness level of both age groups of cardiopulmonary endurance and lower body strength were no difference in male compared to female. The physical fitness level may be helpful for the age-assessment of fitness performance and the design of individual programs that promote functional ability in older adults. For the purpose of increasing physical fitness, the participants who achieved higher than average of cardiopulmonary endurance and lower body strength were exclude from phase III.

Phase III: Effect of 8 weeks individual home-based exercise program in community-dwelling elderly

The aim of study in phase III was to investigate the effect of a simple individual home-based progressive exercise program on physical fitness levels in community-dwelling elderly. Several studies have examined the relationship between exercise and physical activity [87, 109, 119-122) but these utilised multicomponent exercise modalities or general exercise in their designs.

The present study investigated the potential of 4, and 8-week individual home-based exercise programs which significantly improved physical fitness levels in many components (strengthening of upper and lower body, cardiopulmonary endurance, and lower flexibility) in the elderly when compared to the control group. Individual home-based progressive exercise was examined for each participant in the appropriate exercise program to gain the potential of physical fitness in the elderly. The dropout rate of present study were 16.2% and 25% in the exercise group and control group, respectively. The exercise group had a higher adherence rate than the control group which was a result of the participants paying more attention to the follow-up. Telephone calls were made every week and visits every two weeks for prescribing the progressive exercise program for the exercise group.

Effect of individual home-based exercise program on muscle strength

In the present study, the elderly exercised at home following the individual exercise prescription which has 8 weeks progression of intensity. The physical fitness test data, arm curl test (upper extremity strengthening) and the chair stand test (lower body strength) significantly improved at 4 and 8 weeks respectively, when compared with the control group.

This result of the upper muscle strength is consistent with recent studies [87, 123-128]. The upper muscle strength as the wall push up exercise improved the upper body strength of the elderly in 8 weeks. The wall push up exercise was the body weight exercise in the elderly. In addition, the wall push up exercise progressed in intensity through the period of study.

In the present study, improved lower muscle strength were consistent with findings from a recent study [87, 123] [124-130] which probably used a multicomponent exercise program for lower muscle strength training such as, step cardiopulmonary training [123, 124], walking program [123, 129, 130], squats, stair climbing [127], and resisted exercise program [87, 123, 125-129]. Interestingly, the sit to stand exercise and marching exercise showed potential for improving the lower muscle strength of the elderly in present study. The sit to stand exercise and marching exercise were simple exercises for the elderly. These exercises were performed in the same pattern in the same place, which was easier for the elderly to exercise.

Many studies found that progressive upper and lower strength training for 6-8 weeks showed improved muscle strengthening in the elderly [87, 131]. The resistance training induced neuromuscular adaptation and muscle hypertrophy (increasing of cross section area of muscle) in the elderly [132-136]. Some studies have investigated changes in neuromuscular adaptation such as increased motor unit firing rate following 6- week exercise training [33, 137]. Several studies reported that over 8 weeks of strength training in the elderly resulted in increased muscle area and type I, II muscle area [138-142].

In the present study, low intensity exercise program increased lower body strength in the elderly, consistent with many recent studies. Low intensity strengthening training increased muscle strength up to 20-70% when performed one to three sessions per week for 6 to 24 weeks [143-145]. Recent research showed that exercises increased cardiopulmonary capacity. Locks et al [146] showed improved performance in the 6MWT and five-time chair stand test in the elderly after a 6 weeks resistance exercise program performed twice a week. Present study showed similar results from an individual progressive 8 weeks program of exercise at three times a week. However, Hong et al [147] presented controversial data which showed no significant difference in interaction between time and group of muscle strength after exercise ($p>0.05$), except for the chair stand exercise which showed a significantly different main effect of group and time ($p = 0.017$). Present data indicated that the sit to stand exercise and marching exercise were sufficient to improve the lower muscle strengthening.

Effect of individual home-based exercise program on cardiopulmonary endurance

The cardiopulmonary endurance capacity was evaluated by 2MST. This test was a simple endurance capacity test for the elderly. In the present study, the 2MST significantly increased in the exercise groups at 4 and 8 weeks compared with the control group. The participants were exercised by marching for 20 minutes for 2 weeks, which progressed by 5-minute exercise duration every 2 weeks. Marching was a simple exercise for participants and easy for motor movement of the elderly. In addition, the intensity of the marching exercise (%HRR) was moderate aerobic exercise: 50.2 ± 4.6, 49.4 ± 5.0, and 49.0 ± 4.5 at 0, 4, and 8 weeks, respectively. Recent studies showed consistent data when the aerobic exercises were increased in endurance capacity as represented by the increasing 2MST score [123, 126, 128]. In addition, a recent study assessed cardiopulmonary endurance capacity by the 6MWT [124, 125, 127] and showed that mean maximal oxygen uptake (11%) [148] increased after aerobic training for 8 weeks.

Increasing endurance capacity after exercise, may be due to the result of cardiovascular, muscular and metabolic adaptations [149]. These adaptations consist of increased oxidative muscle capacity, total amount of hemoglobin, mitochondria number and size, and muscle mass and performance [149]. In addition, endurance training increased the muscle cross-sectional area of muscle fibers (Type I fibers and type IIa fibers) [150, 151], capillary density and lactate dehydrogenase. Moderate intensity aerobic exercise should produce a noticeable increase in heart rate and respiratory rate which is suitable for cardiopulmonary responses and adaptation for elderly. The cardiovascular response for the elderly is composed of two mechanisms, namely central and peripheral responses. The central response of cardiovascular to aerobic training involves heart function improvement, such as stroke volume and a cardiac output increase, subsequently resulting in higher blood flow to the other parts of the body, for example exercising skeletal muscles and brain function[152]. In addition, for the peripheral response, aerobic exercise may improve perfusion to exercising muscles due to an increase in endothelial vasodilator such as nitric oxide[153].

The elderly in the present study had increased exercise capacity in the fourth weeks from baseline than eight weeks from fourth weeks. This may reflect that the elderly have low physical fitness levels before receiving exercise program.

On the other hand, Hong et al. [147] reported no significant improvement of cardiopulmonary endurance capacity when performed tele-exercise program in elderly. The tele-exercise program was focus in resistance exercise more than aerobic exercise in elderly that was insufficiency for improvement cardiopulmonary endurance capacity.

Effect of individual home-based exercise program on flexibility

In the present study, lower body flexibility was assessed by chair sit and reach test and increased significantly when compared with the control group at 4 and 8 weeks after training. The participants stretched the lower body and flexibility training was performed 5 times per day, 3 days per week. Results were consistent with recent studies [123-125]. The flexibility exercise increased the score of the chair sit and reach test in the elderly after for 8 weeks. On the other hand, recent studies also showed controversial data. Brovold et al. [127], and Justin et al. [126] reported no significant improvement in lower body flexibility for flexibility training in the elderly. These studies focused on upper body flexibility training before and after the exercise period to prevent injury, which was not the focus of the lower flexibility exercise.

In present study, the back scratch test evaluated upper body flexibility, particularly of the shoulders. The active daily living of the elderly is composed of components such as strength, flexibility of muscles, especially upper flexibility for reaching, push, hand behind back etc. All participants had normal range of motion of the shoulders with no previous injury of the shoulder joint. Data in present study showed no significant difference in the back scratch score between the exercise and control groups after flexibility training for 8 weeks. This result was consistent with recent studies that showed no significant difference in the back scratch score. Justin et al. (2012) [126] and Hong et al. (2013) [147] found that back scratch scores were not significantly different between the exercise group and control group after 8 weeks of flexibility training. In present study, the participants still worked as farmers and used their arms many times per day. Therefore, the participants had full range of upper motion and flexibility performance of the shoulder joints. Present study, our recommendation was that all participants should take flexibility exercise at least 3 days per week to maintain the range of motion of the shoulder joints to function well and achieve active daily living and good quality of life.

Effect of individual home-based exercise program on balance and agility

Balance is a functional ability composed of many components such as the strengthening of muscle, the proprioceptive sensation of joints, and the neuromuscular adaptation [108]. Dynamic balance and agility performance in the elderly was assessed by the

8-foot up and go test. In the present study, we trained participants for balance training using one leg stand exercise performed 30 seconds per time, 8 times per day, 3 days a week for 8 weeks. The exercise was progressively increased 2 times every 2 weeks (8x for 1st-2nd weeks, 10x for 3rd-4th weeks) and kept at 12x the 5th-8th weeks. Results showed that the 8 foot up and go score improved significantly in the exercise group at 4 and 8 weeks of training but there was no difference when compared with the control group. Our data were consistent with recent studies of exercise for balance training for 6–12 weeks in the elderly which shown improvement of the 8 foot up and go score (87, 124, 126, 128). On the other hand, Brovold et al. (2013) (127), Todde et al. (2016) (123), and Hong et al. (2017) (147) found that balance training did not improve the dynamic balance ability of the elderly when assessed by the 8-foot up and go test after training. However, Cavalho et al. (125) found that an exercise program for 8 months consisting of walking, jogging, dancing, aerobic and step exercise improved balance and agility in the elderly. Similarly, Ladda et al. (154) reported that 12 weeks simple home-based balance training program (hip abductors and extensors strengthening exercise, marching, stepping over a bench, quadriceps exercise, standing up on the chair, and tandem walk) significantly improved form the baseline and the exercise group performed significantly better than the control group in the functional reach test and timed up-and–go test after 3 months. Moreover, the ACSM recommends balance exercises for the elderly composed of 1) progressively difficult postures that gradually reduce the base of support 2) dynamic movement that perturbs the center of gravity 3) stressing postural muscle group, and 4) reducing sensory input (32). Exercise for balance in the present study was the one leg stand as the first component.

In the present study, participants trained for 8 weeks showed improvement in the 8-foot up and go score in the exercise group but there was no difference in the control group. The mode of exercise, duration and intensity of balance training were inadequate to improve the balance ability in the elderly.

The one leg stand exercise in our program is a static balance exercise and involves horizontal movement of the body. Although in our program the marching exercise reduced the base of support, the movement of the marching exercise still induced vertical and horizontal movement of the body. However, the 8-foot up and go test was designed to assess agility and dynamic balance. The mobility component of this balance test refers to the horizontal and A-P plane movement of the body. The one leg stand and marching exercise are both suitable for individual home-based exercise as they are safe and simple to perform. However, these exercises are not sufficient to improve the balance and agility of elderly people. Therefore, further studies should increase the mode of exercise, intensity and duration of balance training in the elderly, especially in deconditioning elderly who risk of falling down.

Effect of individual home-based exercise program on body composition

The assessment of body composition is composed of BMI and waist circumference which represent the body's subcutaneous fat. Our data showed no significant difference between the exercise and control groups. The BMI data was consistent with recent studies which found that exercise did not improve BMI in the elderly, [(124, 147)] however, they reported statistically significant improvement in waist circumference [(124)]. The intensity of exercise was 50-70% HRR and for 12 weeks in active women in public places.

The body composition is composed of three components which are body fat, muscle, and bone mass. The main energy source used during aerobic exercise is oxidative phosphorylation, which is obtained via the beta-oxidation of fat. Low to moderate intensity aerobic exercise stimulates the production of oxidative phosphorylation. A recent study showed the efficiency programs of exercise for reducing weight and visceral fat should include aerobic exercise performed for a duration of about 50 – 60 minutes, with moderate to high intensity (50-70% VO_2max), and completed at least 5 days per week. In addition, the program should be continued for at least 3 months [(155)]. However, there are other factors that influence the reduction of body fat, prevent loss of muscle and bone mass in elderly people which include good nutrition, changing physical activity (to become more active), and medication. Present study, the main energy source used by the subjects was glycogen because the exercise duration was not long enough to activate the use of oxidative phosphorylation.

The efficiency program exercise for reduce weight and visceral fat should be aerobic exercise which is the long duration, 50–60 minutes, moderate to high intensity (50-70% VO_2max), and 5 day per week. In addition, the program should be long time of training up to

3 months. Thus, the intensity or duration of our exercise program was adequate to improve BMI and waist circumference in the elderly. Further studies should design exercise programs that show improvement of BMI and WC and lose weight.

Limitation and further study

In phase II, the present study included participants 60 - 69 years old, therefore, our results cannot be generalized to other age groups. Moreover, the sample size of the elderly in present study (n=191) may not be sufficient to represent Thai elderly as it is only represent elderly in Ongkharak district. Other studies in the U.S. [22], Taiwan [74], Spain [72], and Portugal [73] reported sample sizes of approximately 379 to 3,314. In addition, participants were only community-dwelling. Thus, it may not be possible to generalize our data to people living in cities. Further studies on city populations with difference lifestyles may show different physical fitness levels. In addition, studies in the elderly should be conducted in other age groups (>69 year old).

In phase III study, the dropout rate of the control group was higher than that of the exercise group because the exercise group had more frequent visit days compared to the visit days of the control group. Further studies on city populations or studies in the elderly should be conducted in other age groups (>69 year old) and equal frequent visit days for all group. Furthermore, the effect of individual home-based progressive exercise program on the cognitive impairment in community-dwelling elderly should also be investigated.

Implication

The 2MST could be utilized to evaluate cardiopulmonary endurance in the elderly similarly to 6MWT. The individual home-based progressive exercise program used in the present study is safe and easy to perform. In addition, a suitable progressive exercise prescription for community-dwelling elderly was recommended to evaluate their individual physical fitness levels before application of an exercise program. Continuous follow-up such as telephone call used in this study will help to achieve adherence.

Conclusions

This study established the physical fitness levels for elderly in community-dwelling in Ongkarak, Thailand (age 60-69). The physical fitness levels differentiated male from female. The physical fitness levels score may be helpful for the age-assessment of fitness performance and the design of individual progressive exercise programs that promote functional ability in older adults, in particular for those who achieved lower than average.

Our results showed that individual home-based progressive exercise training for 8 weeks improved physical fitness including the arm curl test, chair stand test, 2-minute step in place test, and chair sit and reach test in community-dwelling older adults. However, this program did not improve back scratch test, 8-foot-up and go test, and body composition.

Therefore, the 8-week individual home-based progressive exercise as health promotion exercise prescription based on physical fitness level was shown to be effective in improving strength, endurance, and lower body flexibility in community-dwelling elderly.

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APPENDICES

APPENDIX A

APPENDIX A

แบบคัดกรองผู้เข้ารับการทดสอบสมรรถภาพร่างกาย (Screening form for participants)

วันที่ ....ชื่อโรงพยาบาลส่งเสริมสุขภาพตำบล...

ส่วนที่ 1 ข้อมูลทั่วไป

1.ชื่อ.....................................นามสกุล..อายุ..................ปี

2. เพศ ☐ ชาย ☐ หญิง 3.อาชีพ..

4.ที่อยู่..

5. รายได้รวมของครอบครัวต่อเดือน

☐ ต่ำกว่า 5,000 บาท ☐ 5,000 – 10,000 บาท ☐ มากกว่า 10,000 บาท

6. สถานภาพสมรส

☐ โสด ☐ คู่ ☐ หม้าย ☐ หย่า/แยกกันอยู่

7. <u>คุณสมบัติอาสาสมัคร *(Inclusion criteria ต้องตอบ "**ไม่ใช่**" ทุกข้อ)*</u>

ใช่	ไม่ใช่	
☐	☐	1) มีอายุน้อยกว่า 60 ปี หรือไม่?
☐	☐	2) มีประวัติการเป็น lung diseases, heart failure, unstable angina, recent myocardial infarctions, aortic aneurysmหรือไม่?
☐	☐	3) มีภาวะความดันโลหิตสูงที่ไม่สามารถควบคุมได้ ($\geq$160/110 mmHg) หรือไม่?
☐	☐	4) มีประวัติของ joint pain, เจ็บหรือแน่นหน้าอกเวียนศีรษะ หรือเคยเป็นลมหมดสติในระหว่างการเดิน หรือออกกำลังกายหรือไม่?
☐	☐	5) ใช้อุปกรณ์ช่วยเดินระหว่างเดินหรือไม่

8. โรคประจำตัว ☐ ความดันโลหิตสูง ☐ เบาหวาน

☐ ไขมันในโลหิตสูง ☐ อื่นๆระบุ......................................

ส่วนที่ 2 การตรวจสุขภาพเบื้องต้น

Blood pressure...........................mmHg SpO2….….……% Heart rate…………..….bpm.

APPENDIX B

APPENDIX B (Phase I)

แบบบันทึกข้อมูลการทดสอบสมรรถภาพร่างกายในผู้สูงอายุ

(Scorecard: Physical fitness test)

1. **การทดสอบ** ย่ำเท้ายกเข่าสูง 2 นาที (จำนวนครั้งใน 2 นาที)

Before V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

After V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

V/S	เวลา (ขณะทดสอบ)						Recovery	
	20 วินาที	40 วินาที	1 นาที	1.20 นาที	1.40 นาที	2 นาที	5 นาที	7 นาที
HR								
RPE	-	-		-	-			

จำนวนครั้งที่ได้ใน 2 นาที………………ครั้ง

ขณะสิ้นสุดการเดินย่ำเท้าที่ 2 นาทีมีอาการ เมื่อยขา ล้าขา เหนื่อยหอบ เวียนศีรษะ อื่นๆ.....................

2. **การทดสอบ** 6MWT ระยะทาง 10 เมตร (ระยะทางที่เดินได้ใน 6 นาที)

Before V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

After V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

V/S	เวลา (ขณะทดสอบ)						Recovery	
	1 นาที	2 นาที	3 นาที	4 นาที	5 นาที	6 นาที	9 นาที	11 นาที
HR								
RPE	-	-		-				

ระทางที่ได้ใน 6 นาที………………เมตร (…………………รอบ…………………เมตร)

ขณะสิ้นสุดการเดินที่ 6 นาทีมีอาการ เมื่อยขา ล้าขา เหนื่อยหอบ เวียนศีรษะ อื่นๆ.......................

3. **การทดสอบ** 6MWT ระยะทาง 30 เมตร (ระยะทางที่เดินได้ใน 6 นาที)

Before V/S: BP…………….mmHg HR…………bpm SpO2……….% RPE…………….

After V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

V/S	เวลา (ขณะทดสอบ)						Recovery	
	1 นาที	2 นาที	3 นาที	4 นาที	5 นาที	6 นาที	9 นาที	11 นาที
HR								
RPE	-	-		-				

ระทางที่ได้ใน 6 นาที………………เมตร (…………………รอบ…………………เมตร)

ขณะสิ้นสุดการเดินที่ 6 นาทีมีอาการ เมื่อยขา ล้าขา เหนื่อยหอบ เวียนศีรษะ อื่นๆ.......................

APPENDIX C

APPENDIX C (Phase II, III)

แบบบันทึกข้อมูลการทดสอบสมรรถภาพร่างกายในผู้สูงอายุ

(Scorecard: Physical fitness test)

การทดสอบ	ครั้งที่ 1	ครั้งที่ 2*	ข้อคิดเห็น
1. ยกน้ำหนักขึ้นลง (จำนวนครั้งใน 30 วินาที)	....	ไม่ต้องทดสอบ	ขวา หรือ ซ้าย (ที่ใช้ยกน้ำหนัก) ....
2. ลุก – ยืน – นั่ง (จำนวนครั้งใน 30 วินาที)	....	ไม่ต้องทดสอบ	....
3. ย่ำเท้ายกเข่าสูง 2 นาที (จำนวนครั้งใน 2 นาที)	....	ไม่ต้องทดสอบ	....
4. มือไขว้หลังแตะกัน (จำนวนเต็ม ซม.:+/-)	....	....	ขวา หรือ ซ้าย (แขนที่อยู่เหนือไหล่) ....
5. นั่งเก้าอี้แตะปลายเท้า (จำนวนเต็ม ซม.:+/-)	....	....	ขวา หรือ ซ้าย (ขาที่เหยียด) ....
6. ลุก–เดิน–นั่ง ไปกลับ 8 ฟุต (ความละเอียดที่ 1/10 วินาที)	....	....	....
7. องค์ประกอบของร่างกาย ดัชนีมวลกาย (BMI: Kg/m^2)	น้ำหนัก ....Kg.	ส่วนสูง ....cm.	BMI=……………………………
รอบเอว	………………..cm		

* ทดสอบ 2 ครั้งและใช้ค่าที่ดีกว่า

6MWT

Before V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

After V/S: BP…………….mmHg HR………………bpm SpO2…………….% RPE…………….

ระทางที่ได้ใน 6 นาที………………เมตร (…………………รอบ…………………เมตร)

ขณะสิ้นสุดการเดินที่ 6 นาทีมีอาการ เมื่อยขา ล้าขา เหนื่อยหอบ เวียนศีรษะ อื่นๆ.......................

APPENDIX D

APPENDIX D

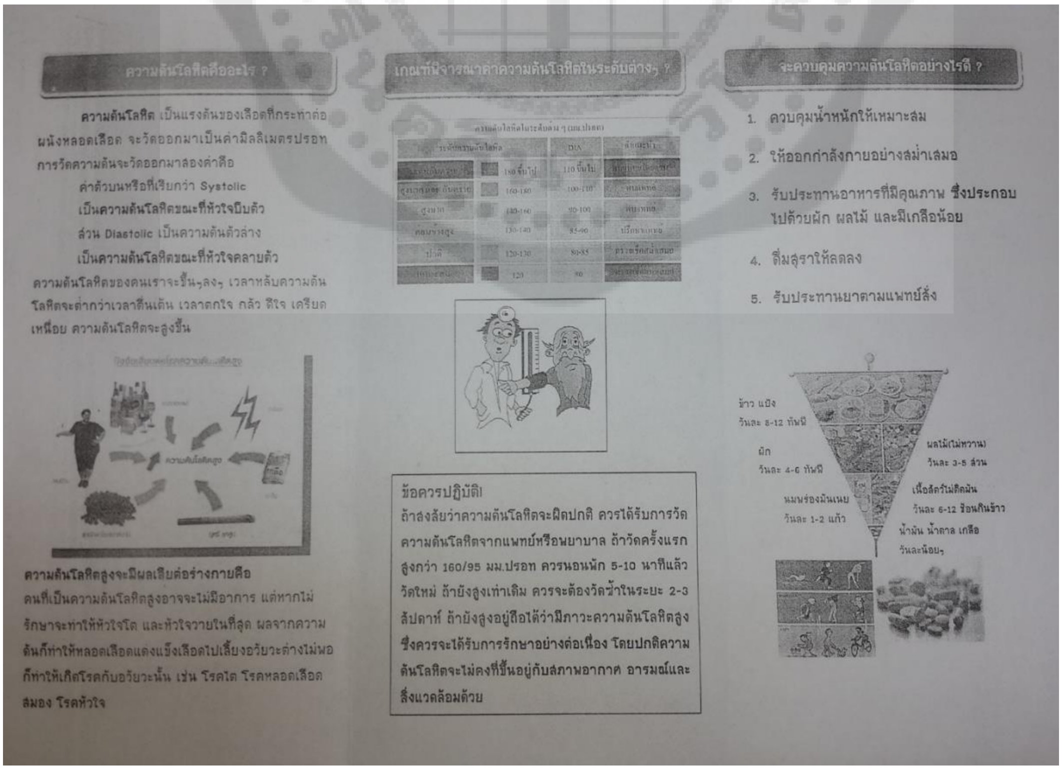
Perceived Exertion (10 point Rate of perceived exertion)

Perceived Exertion (ระดับความเหนื่อย)		
0	ไม่เหนื่อยเลย	Nothing at all
0.5	แทบไม่เหนื่อย	Very, very weak (just noticeable
1	เหนื่อยน้อยมาก	Very weak
2	เหนื่อยเล็กน้อย	Weak (light)
3	เหนื่อยปานกลาง	Moderate
4	เหนื่อยค่อนข้างมาก	Somewhat strong
5	เหนื่อยมาก	Strong (heavy)
6		
7	เหนื่อยมากๆ	Very strong
8		
9	เหนื่อยมากเกือบที่สุด	
10	เหนื่อยมากที่สุดจนทนไม่ไหว	Very, very strong (almost max)

APPENDIX E

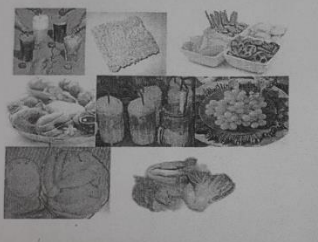
APPENDIX E

Information heath knowledge



อาหารที่ควรหลีกเลี่ยง

น้ำอัดลม, บะหมี่กึ่งสำเร็จรูป, ขนมกรุบกรอบ, เบเกอรี่, กาแฟ, เครื่องดื่มผงรสช็อกโกแลต, ชาเขียว, ขนมหวาน, ผักผลไม้ดอง

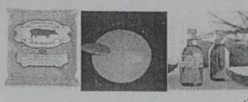


เนื้อสัตว์ที่ควรหลีกเลี่ยง

หลีกเลี่ยงอาหารรสเค็มจัดหรือมีปริมาณโซเดียมที่สูง เช่น อาหารแปรรูปต่างๆ ไส้กรอก, กุนเชียง, แฮม, หมูยอ, หมูแผ่น, หมูหยอง เป็นต้น เนื่องจากเป็นอาหารที่เสี่ยงต่อการเกิดภาวะความดันโลหิตสูง

ไขมันที่ควรหลีกเลี่ยง

ไขมันที่มีกรดไขมันอิ่มตัวสูง มีผลในการเพิ่มระดับโคเลสเตอรอลในเลือด ได้แก่ ไขมันสัตว์ กะทิ น้ำมันมะพร้าว



ข้อควรแก้ไข !

ผู้ป่วยเบาหวานที่มีน้ำหนักเกินมาตรฐาน จำเป็นอย่างยิ่งที่จะต้องลดน้ำหนักลงมาให้ได้ เพราะไขมันที่สะสมในช่องท้องจะทำให้ร่างกายนำน้ำตาลไปใช้เป็นพลังงานยากขึ้น การควบคุมเบาหวานจะทำได้ยาก

<u>อย่าลืม</u> ทำชีวิตให้มีความสุข มองโลกในแง่ดี งดเหล้า งดบุหรี่ด้วยนะคะ เพียงเท่านี้สุขภาพของท่านจะดีขึ้นมาก

สนับสนุนการมีสุขภาพดีโดย สาขาวิชาการส่งเสริมสุขภาพ
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สุขภาพดี ห่างไกลเบาหวาน

เบาหวานคืออะไร ?

โรคเบาหวาน เป็นโรคที่เกิดจากความผิดปกติของต่อมไร้ท่อในตับอ่อนซึ่งผลิตฮอร์โมนอินซูลิน ซึ่งมีหน้าที่ช่วยให้น้ำตาลเข้าสู่เซลล์เพื่อใช้เป็นพลังงานได้ ความผิดปกตินี้อาจเกิดจากเซลล์ในต่อมไร้ท่อไม่สามารถผลิตอินซูลินได้หรืออาจผลิตได้แต่ไม่เพียงพอ จึงทำให้ผู้ที่เป็นเบาหวานมีระดับน้ำตาลในเลือดสูง

สาเหตุสำคัญที่ทำให้เป็นเบาหวาน

1. กรรมพันธุ์
2. รับประทานข้าว แป้ง น้ำตาล และไขมันมากเกินไป
3. ออกกำลังกาย หรือการเคลื่อนไหวร่างกายน้อยลง

อันตรายสำหรับผู้ป่วยเบาหวานที่ควบคุมเบาหวานได้ไม่ดี

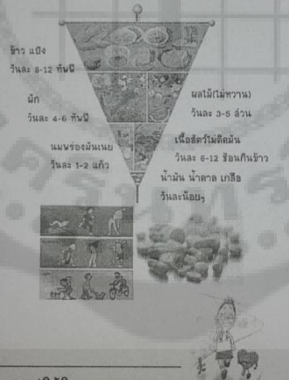
มักเกิดกับผู้ป่วยเบาหวานที่เป็นมานาน อย่างน้อย 5 ปี โดยไม่ทำการรักษาอย่างจริงจังหรือปล่อยปละละเลย *ภาวะแทรกซ้อนที่อาจพบได้* เช่น

1. ไขมันในเลือดสูง
2. โรคหัวใจ และหลอดเลือด
3. โรคไต
4. โรคต้อหิน, ต้อกระจก
5. มีอาการชาเนื่องจากเส้นเลือดที่แขนและขาเสื่อมลง ไม่สามารถรับความรู้สึกใดๆ
6. เป็นแผลติดเชื้อได้ง่าย แต่หายยาก

จะควบคุมเบาหวานกันอย่างไรดี ?

สิ่งสำคัญ 3 ประการ ที่ <u>จำเป็น</u> ต้องทำควบคู่กัน คือ

1. ต้องทานยาทุกวัน
2. กินอาหารอย่างถูกต้อง
3. ออกกำลังกายให้สนุก

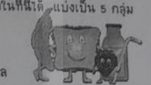


ข้อควรปฏิบัติ!

ผู้ป่วยเบาหวาน<u>ควรแบ่งสัดส่วนของอาหารในแต่ละมื้อให้ใกล้เคียงกัน ควรกินยาและอาหารให้ตรงเวลาและสม่ำเสมอ</u> เพื่อไม่ให้เกิดภาวะน้ำตาลในเลือดสูงหรือต่ำจนเกิดอันตราย เช่น เกิดภาวะวิงเวียนทำให้หมดสติได้

จะกินอย่างไรให้ถูกปากและถูกวิธีด้วย ?

ต้องทำความรู้จักกับอาหารซึ่งในที่นี้ได้ แบ่งเป็น 5 กลุ่ม ให้จำง่ายขึ้น ได้แก่



- กลุ่มข้าว แป้ง น้ำตาล

  อาหารกลุ่มนี้ ถ้ากินมากเกินไปทำให้น้ำตาลในเลือดขึ้นสูงโดยตรงและบางส่วนจะเปลี่ยนเป็นไขมันสะสมอยู่บริเวณพุงได้

- กลุ่มผัก ผลไม้

  ผักมีใยอาหารช่วยชะลอการดูดซึมน้ำตาลและไขมันที่ลำไส้ ผักส่วนมากให้พลังงานต่ำจึงกินได้ไม่จำกัด โดยเฉพาะผักใบเขียว

  แต่ผลไม้มีน้ำตาลจะให้พลังงานมากกว่า และทำให้น้ำตาลในเลือดสูงได้ จึงไม่ควรกินมากเกินไป

- กลุ่มเนื้อสัตว์

  อาหารในกลุ่มนี้รวมถึงเต้าหู้และไข่ด้วย ช่วยซ่อมแซมส่วนที่สึกหรอ สร้างภูมิต้านทานให้ร่างกายและเป็นองค์ประกอบสำคัญของเนื้อเยื่อทั่วร่างกาย

- กลุ่มนม

  นม เป็นแหล่งของแคลเซียมที่ร่างกายดูดซึมไปใช้ได้ดีในการเสริมสร้างกระดูก ป้องกันกระดูกพรุน และยังเป็นแหล่งของโปรตีนด้วย

- กลุ่มไขมันกับเกลือ

  ไขมันมักแอบซ่อนอยู่ในอาหารทั่วไป จึงมีแนวโน้มที่จะกินเกินได้ง่ายเช่นเดียวกับเกลือ ซึ่งถ้ากินเกลือมากเกินไปจะทำให้ตัวบวมน้ำและเพิ่มความดันโลหิตได้

ทำอย่างไรไม่ให้ภาวะไขมันในเลือดสูง ???

1. ลดมัน :
- ✓ หลีกเลี่ยงอาหารที่มีโคเรสเตอรอลสูง ได้แก่ ไข่แดง ไข่นกกระทา เนื้อสัตว์ส่วนที่ติดมัน เครื่องใน สมองสัตว์ อาหารทะเล เนย ไอศกรีม
- ✓ ควรหลีกเลี่ยงอาหารที่ปรุงด้วยน้ำมัน ถ้าจำเป็นต้องใช้ ควรใช้น้ำมันพืชที่มีไขมันไม่อิ่มตัวปรุงอาหาร เช่น น้ำมันรำข้าว น้ำมันดอกทานตะวัน
- ✓ เปลี่ยนวิธีการปรุงอาหาร เป็นการนึ่ง ต้ม ย่างอบ แทนการทอดหรือผัด

2. เพิ่มรับประทานอาหารที่มีเส้นใย เช่น ผัก ผลไม้ เพราะจะขัดขวางการย่อยและการดูดซึมของไขมัน

3. หลีกเลี่ยง :
- ✓ เครื่องดื่มที่มีแอลกอฮอล์และรสหวาน
- ✓ อาหารประเภทแป้ง ขนมหวาน เพราะอาหารประเภทนี้จะเปลี่ยนเป็นไขมันไตรกลีเซอไรด์

4. ออกกำลังกายสม่ำเสมอ เพื่อช่วยเผาผลาญไขมันส่วนเกิน และร่างกายนำไขมันจากเลือดไปใช้ได้ดี นอกจากนี้ยังช่วยเพิ่มระดับไขมันชนิดดีหรือเอชดีแอลด้วย

5. ควบคุมน้ำหนักตัวให้เหมาะสม
สามารถคำนวณโดยใช้สูตร ดังนี้
ผู้ชาย น้ำหนักมาตรฐานเท่ากับ
[0.9 x (ส่วนสูง – 152)] + 48.1
ผู้หญิง น้ำหนักมาตรฐานเท่ากับ
[1.1 x (ส่วนสูง – 152)] + 45.5
และควบคุมรอบเอวไม่ให้เกิน
- ➢ รอบเอวชาย น้อยกว่า 90 ซม.
- ➢ รอบเอวหญิง น้อยกว่า 80 ซม.

6. ไปพบแพทย์เพื่อติดตามอาการอย่างต่อเนื่องและสม่ำเสมอ

*** สำหรับผู้ที่ควบคุมอาหารและปฏิบัติตามข้างต้นแล้ว ระดับไขมันยังไม่ลดลงภายในเวลา 3-6 เดือน มีความจำเป็นต้องได้รับยาลดไขมัน และเพื่อความปลอดภัย การได้รับยาลดไขมันต้องอยู่ในความดูแลของแพทย์

โรคไขมันในเลือดสูง

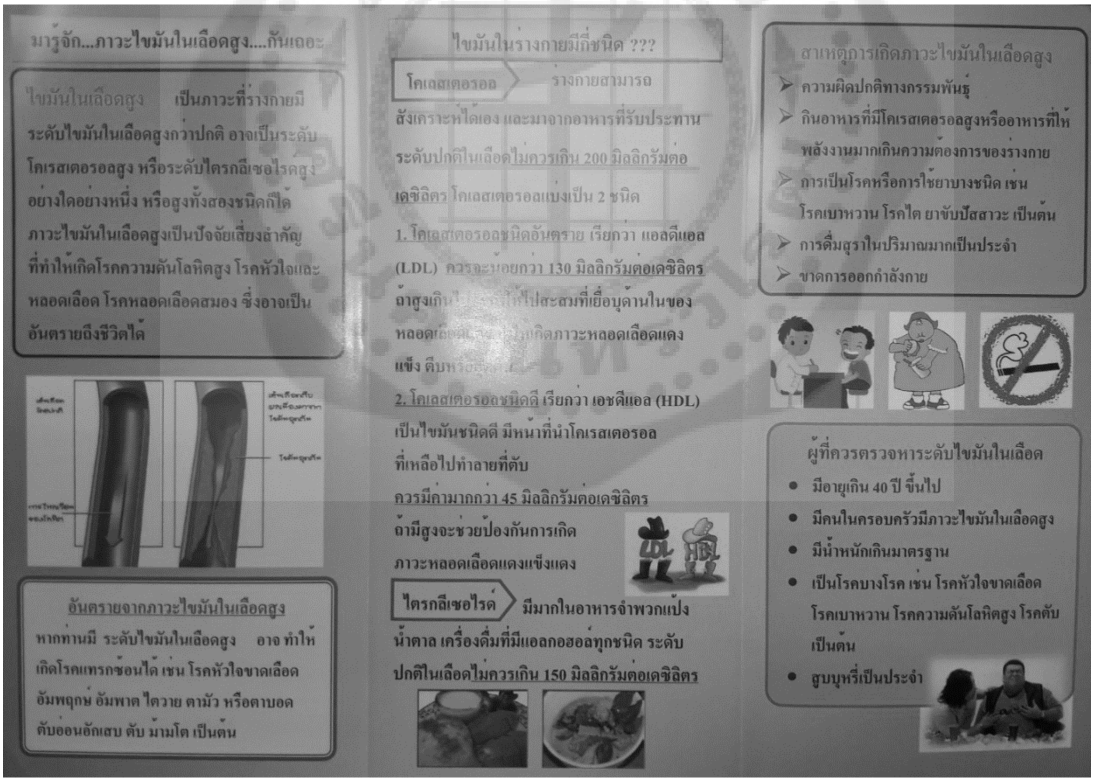
ไขมันในเลือดสูงควบคุมได้

สุขภาพจิตดี

มีการควบคุมอาหาร

เผาผลาญไขมัน หมั่นออกกำลังกาย

จัดทำโดย สาขาวิชาการส่งเสริมสุขภาพ
คณะสหเวชศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ



มารู้จัก...ภาวะไขมันในเลือดสูง....กันเถอะ

ไขมันในเลือดสูง เป็นภาวะที่ร่างกายมีระดับไขมันในเลือดสูงกว่าปกติ อาจเป็นระดับโคเรสเตอรอลสูง หรือระดับไตรกลีเซอไรด์สูง อย่างใดอย่างหนึ่ง หรือสูงทั้งสองชนิดก็ได้ ภาวะไขมันในเลือดสูงเป็นปัจจัยเสี่ยงสำคัญที่ทำให้เกิดโรคความดันโลหิตสูง โรคหัวใจและหลอดเลือด โรคหลอดเลือดสมอง ซึ่งอาจเป็นอันตรายถึงชีวิตได้

อันตรายจากภาวะไขมันในเลือดสูง

หากท่านมี ระดับไขมันในเลือดสูง อาจ ทำให้เกิดโรคแทรกซ้อนได้ เช่น โรคหัวใจขาดเลือด อัมพฤกษ์ อัมพาต ไตวาย ตามัว หรือตาบอด ตับอ่อนอักเสบ ตับ ม้ามโต เป็นต้น

ไขมันในร่างกายมีกี่ชนิด ???

โคเลสเตอรอล ร่างกายสามารถสังเคราะห์ได้เอง และมาจากอาหารที่รับประทาน ระดับปกติในเลือดไม่ควรเกิน 200 มิลลิกรัมต่อเดซิลิตร โคเลสเตอรอลแบ่งเป็น 2 ชนิด

1. โคเลสเตอรอลชนิดอันตราย เรียกว่า แอลดีแอล (LDL) ควรจะน้อยกว่า 130 มิลลิกรัมต่อเดซิลิตร ถ้าสูงเกิน[illegible]ไปสะสมที่เยื่อบุด้านในของหลอดเลือด[illegible]เกิดภาวะหลอดเลือดแดงแข็ง ตีบหรือ[illegible]

2. โคเลสเตอรอลชนิดดี เรียกว่า เอชดีแอล (HDL) เป็นไขมันชนิดดี มีหน้าที่นำโคเรสเตอรอลที่เหลือไปทำลายที่ตับ ควรมีค่ามากกว่า 45 มิลลิกรัมต่อเดซิลิตร ถ้ามีสูงจะช่วยป้องกันการเกิดภาวะหลอดเลือดแดงแข็งแดง

ไตรกลีเซอไรด์ มีมากในอาหารจำพวกแป้ง น้ำตาล เครื่องดื่มที่มีแอลกอฮอล์ทุกชนิด ระดับปกติในเลือดไม่ควรเกิน 150 มิลลิกรัมต่อเดซิลิตร

สาเหตุการเกิดภาวะไขมันในเลือดสูง
- ➢ ความผิดปกติทางกรรมพันธุ์
- ➢ กินอาหารที่มีโคเรสเตอรอลสูงหรืออาหารที่ให้พลังงานมากเกินความต้องการของร่างกาย
- ➢ การเป็นโรคหรือการใช้ยาบางชนิด เช่น โรคเบาหวาน โรคไต ยาขับปัสสาวะ เป็นต้น
- ➢ การดื่มสุราในปริมาณมากเป็นประจำ
- ➢ ขาดการออกกำลังกาย

ผู้ที่ควรตรวจหาระดับไขมันในเลือด
- มีอายุเกิน 40 ปี ขึ้นไป
- มีคนในครอบครัวมีภาวะไขมันในเลือดสูง
- มีน้ำหนักเกินมาตรฐาน
- เป็นโรคบางโรค เช่น โรคหัวใจขาดเลือด โรคเบาหวาน โรคความดันโลหิตสูง โรคตับ เป็นต้น
- สูบบุหรี่เป็นประจำ

APPENDIX F

APPENDIX F

Result of %HRR (phase I)

		2MST		
No.	HR at 1 min. (bpm)	%HRR at 1 min.	HR at 2 min. (bpm)	%HRR at 2 min.
1	94	21.0	99	27.2
2	104	25.4	109	32.8
3	106	26.7	111	35.0
4	91	21.4	98	29.8
5	86	16.7	90	21.4
6	106	38.3	113	46.9
7	94	20.5	99	27.4
8	96	22.5	98	25.0
9	94	24.0	98	29.3
10	94	31.6	101	38.9
11	94	22.9	102	32.5
12	93	29.8	101	38.3
13	88	25.3	92	29.9
14	115	51.2	122	59.3
15	114	48.2	123	58.8
16	108	27.1	110	30.0
17	95	29.1	100	35.4
18	104	37.7	110	45.5
19	111	25.4	114	30.5
20	102	30.1	108	38.4
21	112	42.3	117	48.7
22	115	51.1	118	54.5
23	95	32.2	108	46.7
24	117	48.7	120	52.6
25	92	24.4	103	37.2
26	104	29.2	114	43.1
27	80	15.7	86	22.5
28	100	25.9	117	46.9
29	98	26.2	105	34.5
30	99	24.4	103	29.5
Mean	100.0	**29.8**	106.3	**37.6**
SD	9.4	9.8	9.5	10.5
Min	80	15.7	86	21.4
Max	117	51.2	123	59.3

Result of %HRR (phase I) (Continues)

6MWT-10m				
No.	HR at 3 min. (bpm)	%HRR at 3 min.	HR at 6 min. (bpm)	%HRR at 6 min.
1	89	15.9	85	11.0
2	102	18.8	101	17.2
3	94	20.0	96	22.9
4	76	10.0	86	21.1
5	80	10.6	83	14.1
6	100	29.1	98	26.6
7	92	14.3	93	15.7
8	90	17.1	93	20.7
9	81	12.5	80	11.3
10	85	21.3	88	24.5
11	87	13.4	95	23.2
12	85	18.7	85	18.7
13	77	12.6	78	13.8
14	100	32.1	99	31.0
15	89	17.9	96	26.2
16	98	12.9	104	21.4
17	90	21.8	94	26.9
18	99	30.3	98	28.9
19	101	18.2	101	18.2
20	92	23.8	89	20.0
21	99	20.5	100	21.9
22	91	23.9	95	28.4
23	79	18.1	78	17.0
24	100	27.8	100	27.8
25	81	12.6	85	17.2
26	90	17.7	90	17.7
27	80	13.8	78	11.5
28	91	18.8	106	36.5
29	87	17.0	93	23.9
30	89	14.8	93	19.8
Mean	89.8	18.5	92.0	21.2
SD	7.7	5.8	8.0	6.2
Min	76	10	78	11
Max	102	32.1	106	36.5

Result of %HRR (phase I) (Continues)

6MWT with 30 meter walkway				
No.	HR at 3 min. (bpm)	%HRR at 3 min.	HR at 6 min. (bpm)	%HRR at 6 min.
1	90	13.9	90	13.9
2	95	11.9	102	22.4
3	95	22.5	101	31.0
4	83	11.9	94	25.0
5	85	15.5	85	15.5
6	100	26.3	99	25.0
7	95	19.7	96	21.1
8	95	21.3	94	20.0
9	87	15.8	85	13.2
10	90	27.4	93	30.5
11	87	16.5	88	17.6
12	80	13.2	88	22.0
13	80	12.0	83	15.7
14	107	39.0	103	34.1
15	91	21.2	104	36.5
16	106	27.4	106	27.4
17	98	32.1	100	34.6
18	105	34.7	102	30.6
19	99	11.1	104	19.0
20	87	17.5	88	18.8
21	99	24.7	100	26.0
22	97	29.9	98	31.0
23	86	23.1	81	17.6
24	108	35.5	108	35.5
25	86	22.0	89	25.3
26	96	16.9	102	25.4
27	78	9.4	82	14.1
28	100	28.6	108	38.1
29	92	20.9	93	22.1
30	92	13.2	93	14.5
Mean	93.0	21.2	95.3	24.1
SD	8.2	8.0	8.0	7.5
Min	78	9.4	81	13.2
Max	108	39	108	38.1

VITAE

VITAE

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Education Background:

1995	Secondary Certificate Singburi School
1999	Bachelor of Science (B. Sc.) Srinakharinwirot university
2003	Master of Science (M.Sc.) Chulalongkorn University
2017	Doctor of Philosophy (Physical Therapy) Srinakharinwirot University