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นายปัทชา กระแสร์เสียง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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COMPARISON OF PHYSICAL PERFORMANCE BETWEEN WAI KHRU RAM MUAY THAI AND YOGA TRAINING IN ADULT THAIS

Pattacha Krasaesieng

A Thesis Submitted in Fulfillment of the Requirements for the

Degree of Master of Science in Environmental Biology

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COMPARISON OF PHYSICAL PERFORMANCE BETWEEN WAI KHRU RAM MUAY THAI AND YOGA TRAINING IN ADULT THAIS

Suranaree University of Technology has approved this thesis submitted in partial fulfillment of the requirements for the Master's Degree.

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ปัทชา กระแสร์เสียง : การเปรียบเทียบสมรรถภาพทางกายระหว่างการฝึกการไหว้ครูรำมวยไทยกับโยคะในคนไทยวัยหนุ่มสาว (COMPARISON OF PHYSICAL PERFORMANCE BETWEEN WAI KHRU RAM MUAY THAI AND YOGA TRAINING IN ADULT THAIS) อาจารย์ที่ปรึกษา : ผู้ช่วยศาสตราจารย์ ดร.ณัฐวุฒิ ธานี, 70 หน้า.

วัตถุประสงค์ในการศึกษาครั้งนี้เพื่อเป็นการสืบหาผลของการไหว้ครูรำมวยไทยและโยคะที่มีต่อสมรรถภาพทางกายในคนไทยวัยหนุ่มสาว ในการศึกษาครั้งนี้มีจำนวนกลุ่มตัวอย่าง 26 คน ถูกแบ่งออกเป็นสามกลุ่มได้แก่ กลุ่มไหว้ครูรำมวยไทย 8 คน โยคะ 9 คน และกลุ่มควบคุม 9 คน กลุ่มไหว้ครูรำมวยไทยและกลุ่มโยคะได้รับการฝึกที่ความหนักร้อยละ 60 ของอัตราการเต้นของหัวใจสูงสุดนาน 60 นาทีต่อวัน 3 วันต่อสัปดาห์เป็นเวลา 8 สัปดาห์ น้ำหนักตัว ค่าดัชนีมวลกาย อัตราการใช้ออกซิเจนสูงสุด ความแข็งแรงของขาและหลัง ความยืดหยุ่นและปริมาณการ หายใจถูกวัดทั้งก่อนและหลังการฝึก 8 สัปดาห์ จากการศึกษาครั้งนี้พบว่า น้ำหนักตัวลดลงอย่างมีนัยสำคัญในกลุ่มโยคะ ($p<0.05$) และกลุ่มไหว้ครูรำมวยไทย ($p<0.01$) ในขณะที่กลุ่มควบคุมกลับเพิ่มขึ้นหลังจากการฝึกในสัปดาห์ที่ 8 แต่ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติ ค่ าดัชนีมวลกายได้ลดลงอย่างมีนัยสำคัญในกลุ่มโยคะ ($p<0.05$) และกลุ่มไหว้ครูรำมวยไทย ($p<0.01$) ตามลำดับ แต่ไม่พบการเปลี่ยนแปลงในกลุ่มควบคุม ส่วนอัตราการใช้ออกซิเจนสูงสุดของกลุ่มการฝึกทั้งสองกลุ่มจะเพิ่มขึ้นอย่างมีนัยสำคัญเมื่อเปรียบเทียบกับกลุ่มควบคุม จากผลการศึก ษาแสดงให้เห็นว่ากลุ่มไหว้ครูรำมวยไทยสามารถเพิ่มสมรรถภาพทางกายได้ดีเทียบได้กับกลุ่มโยคะ สรุปได้ว่าการไหว้ครูรำมวยไทยสามารถใช้เป็นรูปแบบหนึ่งในการออกกำลังกายเพื่อทำให้มีสุขภาพที่ดีขึ้น

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PATTACHA KRASAESING : COMPARISON OF PHYSICAL PERFORMACNE BETWEEN WAI KHRU RAM MUAY THAI AND YOGA TRAINING IN ADULT THAIS. THESIS ADVISOR : ASST. PROF. NATHAWUT THANEE, Ph.D. 70 PP.

PHYSICAL PERFORMANCE/ WAI KHRU RAM MUAY THAI/ YOGA/ ADULT THAIS/ BODY WEIGHT/ BODY MASS INDEX/ MAXIMUM OXYGEN CONSUMPTION/ LEG AND BACK STRENGTH/ FLEXIBILITY/ VITAL CAPACITY

The aim of this study is to investigate and compare the effects of Wai Khru Ram Muay Thai (WT) and Yoga (YT) training on physical performance in adult Thais. Twenty six subjects participated in this study were divided into three groups: WT (n=8), YT (n=9) and control group (n=9). Both WT and YT groups performed training with intensity 60% of maximum heart rate, 60 minutes/day and 3 days/week for 8 weeks. Body weight, body mass index (BMI), maximum oxygen consumption (VO_2max), leg and back strength, flexibility and vital capacity (VC) were measured before and after the 8 weeks of trainings. The study found that body weight decreased significantly in the YT ($p<0.05$) and WT ($p<0.01$) groups, while it increased insignificantly after the 8 weeks of training in the control group. The BMI values decreased significantly in the YT ($p<0.05$) and WT ($p<0.01$) groups while that in control group did not change. The VO_2max in both training groups increased significantly ($p<0.05$) compared to that of the control group.

The results showed that WT group can improve physical performance as well as the YT group. In conclusion, WT can be used as one kind of exercise for getting a better health.

School of Biology

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LIST OF ABBREVIATIONS

ACSM	=	American College of Sports Medicine
ATP	=	Adenosine triphosphate
BMI	=	Body mass index
BMR	=	Basal metabolic rate
BSA	=	Body surface area
DoP	=	Double product
FAD	=	Flavin adenine dinucleotide
FEV_1	=	Force expiratory volume in one second
FFA	=	Free fatty acid
FVC	=	Force vital capacity
HR	=	Heart rate
NAD	=	Nicotinamide adenine dinucleotide
$PaCO_2$	=	Partial pressure of carbon dioxide
PaO_2	=	Partial pressure of oxygen
PCr	=	Phosphocreatine
RPE	=	Rating of perceived exertion scales
RPP	=	Rate pressure product
VC	=	Vital capacity
VCO_2	=	Carbon dioxide output
VO_2	=	Oxygen uptake

LIST OF ABBREVIATIONS (Continued)

VO_2max	=	Maximum oxygen consumption
WT	=	Wai Khru Ram Muay Thai training
YT	=	Yoga training

CHAPTER I

INTRODUCTION

Muay Thai or Thai Boxing is one of popular martial art not only in Thailand but also in Europe, America and Southeast Asian countries. Muay Thai uses kicks and punches in a ring with gloves similar to western boxing. One of the most important traditions of Muay Thai is Wai Khru Ram Muay Thai which is not an optional ritual or reserved for special occasions. Before each and every bout, Muay Thai fighters must perform Wai Khru Ram Muay Thai which they respect and pray for their safety in the victory. This ritual has been developed in different ways; in different regions have their own postures, even under different teachers to design. Therefore, it is theoretically impossible for two fighters to perform identical Wai Khru postures. This Wai Khru Ram Muay Thai is grateful and aesthetic ritual, both practical and spiritual. In a practical sense, it functions as a warm up and gives fighters for relaxation both physical and mental (ยศเรืองสา, 2545).

One kind of exercise which is similar to Wai Khru Ram Muay Thai is Yoga, and it is more popular than Wai Khru Ram Muay Thai in Thailand, this popular exercise is originated from Indian science which includes practices of specific posture, regulation of breathing and meditation. Outside India, Yoga is typically associated with Hatha Yoga which has been widely used to describe practice of postures in order to have better physical and mental health.

Yoga is one type of exercise which can improve physical fitness because there are many postures that can be trained from basic to professional steps and it is not intense workout as a high intensity especially in basic step. In addition, there are many studies to prove that Yoga has many benefits to physical fitness. In the past several years, Telles et al. (2000) found that combination of Yoga postures interspersed with relaxation can reduce effectively arousal more than relaxation alone does. Furthermore, the combination of the Yoga postures with supine rest in cyclic meditation lowers oxygen consumption than resting supine alone does (Sarang and Telles, 2006).

Many researches study the effect of Yoga on physiological responses. They found that Yoga could help for the visual discomfort in computer users (Telles et al., 2006), improved pain control of chronic urologic patients (Ripoll and Mahowald, 2002) and stress reduction, which increased sense of well-being. Sherman et al. (2005) studied effect of Yoga on chronic low back pain patients, they found that Yoga exercise reduced the pain effectively and effects persisted for at least several months. Other beneficial effects of Yoga exercise have been studied by Bastille and Gill-Body in 2004, they suggested that Yoga exercise supported to the growing evidence that improvements in impairments and mobility limitations could be achieved with people with chronic poststroke hemiparesis.

Moreover, Yoga interventions are generally effective in reducing bodyweight, blood pressure, glucose and high cholesterol levels (Yang, 2007).

Unlike Yoga exercise, effects of Wai Khru Ram Muay Thai have not been fully investigated. To our knowledge, there is study of effect of Muay Thai aerobic dance on energy expenditure and maximum oxygen uptake in University students (สุดา กาญจนะวณิชย์, 2550).

Due to limited number of measurement parameters, these studies cannot assess completely effects of Wai Khru Ram Muay Thai on physical fitness.

Accordingly, it is necessary to study the effects of this Thai's traditional exercise on physical performance. To access its effectiveness, physiology responses of Wai Khru Ram Muay Thai exercise is compared to Yoga exercise.

1.1 Research objectives

1.1.1 To investigate the physical fitness between Wai Khru Ram Muay Thai and Yoga practitioners after training for 8 weeks.

1.1.2 To compare resultant of physical fitness between Wai Khru Ram Muay Thai and Yoga practices after training for 8 weeks.

1.2 Research hypotheses

1.2.1 Training for 8 weeks will improve physical performance of Wai Khru Ram Muay Thai practitioners.

1.2.2 The physical performance of Wai Khru Ram Muay Thai exercise training can be achieved as that of Yoga training.

1.3 Scope and limitations of the study

This study was performed at Suraniwes 8-10 building and Equipment Center for Science and Technology at Suranaree University of Technology, Nakhon Ratchasima, Thailand. Twenty six subjects participated in this study. The intensity of training is 60% of maximum heart rate, 60 minutes/day and 3 days/week for 8 weeks. Heart rate, maximum oxygen consumption, leg and back strength, flexibility and vital capacity were determined before and after 8 weeks training.

This research was approved by the Ethical Committee of Suranaree University of Technology. All participants' health conditions were checked and screened by a physician at the Maternity hospital, Nakhon Ratchasima and both training groups had trained for 8 weeks in the same condition and were taken care by a physician in an emergency situation.

CHAPTER II

LITERATURE REVIEW

Overviews of physiological responses during exercise

The physiological responses during exercise depends on the intensity, duration and frequency of the exercise as well as the environmental conditions such as hot or cold conditions. During exercise, oxygen and substrate in the skeletal muscle are increased and carbon dioxide and metabolites are removed. The cardiovascular and respiratory systems must work together when the body especially working muscles needed the oxygen.

2.1 Energy sources

Cells generate adenosine triphosphate (ATP) through three different processes as follow:

2.1.1 The ATP-PCr system

ATP is the common chemical that provides energy for all forms of biological work and is essential for muscle contraction.

Phosphocreatine (PCr) is another high energy compound that can be hydrolyzed to provide the energy and resynthesis of ATP. PCr stores in the skeletal muscle and give high energy in the first few seconds during exercise at the short time such as sprinting (Plowman and Smith, 2008).

$$\text{Pcr} + \text{ADP} \xrightarrow[\text{Creatine Kinase}]{} \text{ATP} + \text{PCr}$$

2.1.2 The glycolytic system

Glycolytic system involves glycolysis pathway which glycogen and glucose and converted to two pyruvate molecules. This process does not require oxygen, so we call “anaerobic glycolysis”. In this case, the pyruvic acid is converted to lactic acid. This acidification can induce the muscle fatigue.

2.1.3 The oxidative system

The oxidative system is the final system of cellular production. This process needs oxygen to provide the energy which is called “cellular respiration”. During long term activity, muscles need oxygen for supply. In glycolysis pathway, when oxygen is needed, pyruvate is converted to acetyl coenzyme A to enter Krebs cycle and produces hydrogen to combine with two coenzymes: Nicotinamide adenine dinucleotide (NAD) and Flavin adenine dinucleotide (FAD) to enter electron transport chain. At the end of the chain, hydrogen ion combines with oxygen to form water. Then the oxidative system can generate the 38 molecules of ATP (McArdle et al., 2007).

2.2 Oxidation of fat

Fat stores inside muscle fibers and fat cells can supply 70,000-75,000 kcal. Triglycerides are major sources of energy and breakdown into glycerol and free fatty acid (FFA) this process is called lipolysis. The fat metabolism follows the same path as carbohydrate metabolism; the products of FFA oxidation are ATP, H_2O and CO_2 as shown in Figure 2.1

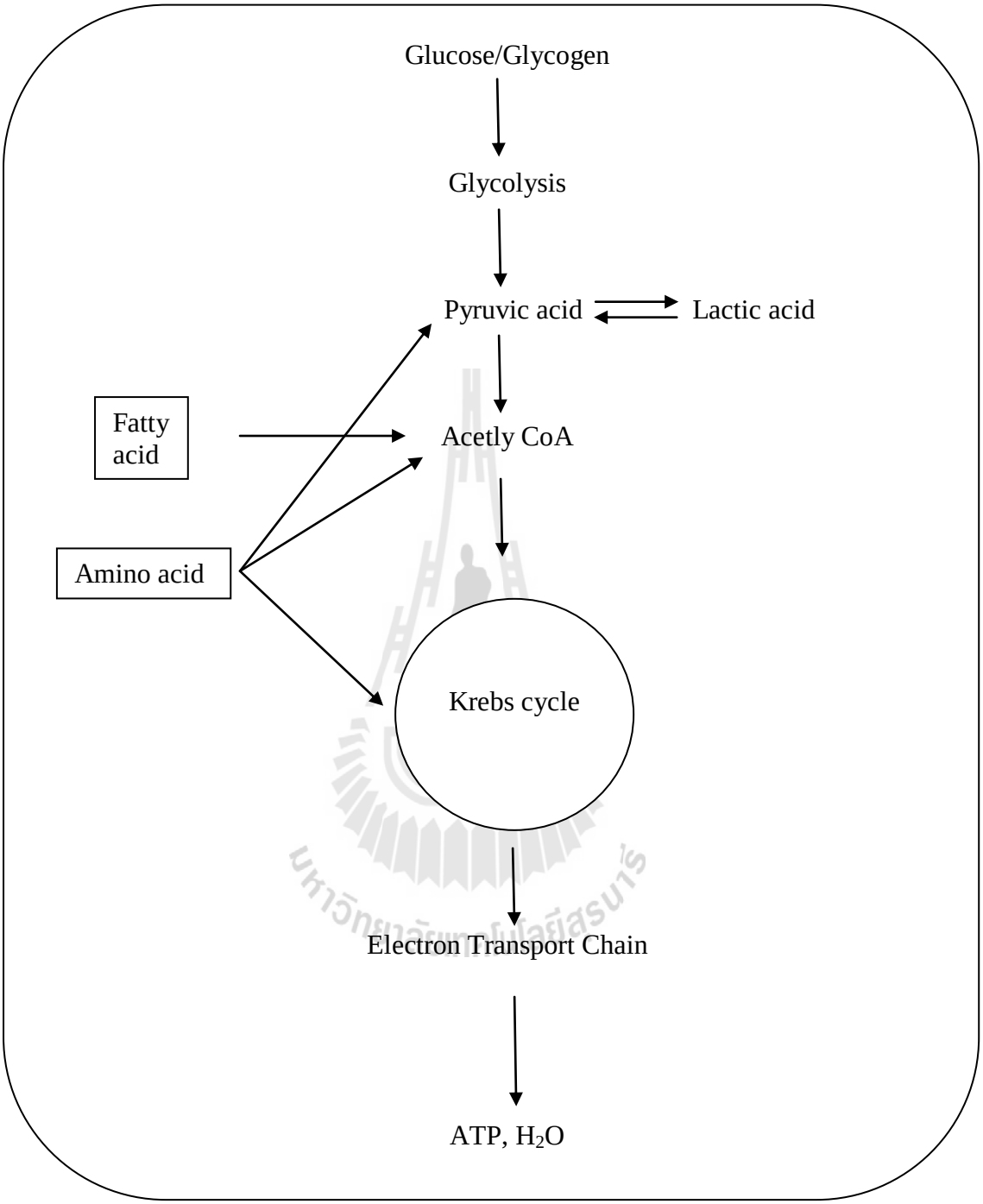


Figure 2.1 An overview of substrate metabolism.

2.3 Oxidative of proteins

Protein's energy is not as easy determination because it contains nitrogen which is used to form new amino acid and remaining nitrogen cannot be oxidized by the body it is converted into urea and excreted in the urine.

During exercise, the protein catabolism uses less than 5% of energy expended, 80% in general the protein catabolism is ignored.

As body starts to exercise, energy needs increase. At rest, the energy expenditure that body uses is about 0.3 L of O_2/min or 18 L/h or 432 L/day which usually burns a mixture of carbohydrate and fat. The standardized which measure of energy expenditure at rest is called the basal metabolic rate (BMR). The factors which affect the BMR are age, body temperature, stress and hormones. The average of BMR for an individual in normal daily activity is from 1,800-3,000 kcal/day. Prasad et al. (2001) found that the energy cost of basic Yoga technique, pranayama reduced respiratory frequency which induced the oxygen consumption lower than that compared with field walking and treadmill walking (Brooks et al., 2000).

2.4 Respiratory system

The function of respiration is delivery of oxygen to the tissues and removes carbon dioxide out of the body. This transportation involves pulmonary ventilation, pulmonary diffusion, transport oxygen and carbon dioxide via the blood and capillary gas exchange. The respiratory center is located at the medulla oblongata which controls the rate and depth of breathing.

Breathing is regulated by a changing chemical environmental. As the exercise begins, before any chemical stimulation occurs, the motor cortex becomes more active and

transmits the impulse to inspiratory center by increasing respiration. As exercise progresses, metabolism in muscles are increased, then the heat, CO_2 and H^+ are generated. This is sensed by the chemoreceptor. Therefore, the rate and depth of respiration are increased. During exercise, ventilation can increase from 5-6 L/min to 100 L/min (Plowman and Smith, 2008).

2.5 Cardiovascular system

During exercise blood flow to the active muscles increase 80-85% of the cardiac output. This shift in the blood flow to the muscles is accomplished primarily by reducing the blood flow to the kidneys, liver, stomach and intestine.

Also, the metabolic rate of muscle tissue increases during exercise therefore, the waste products also accumulate and cause an increase in acidity, carbon dioxide and temperature in the muscle. In addition, decrease pH and increased temperature shift the oxygen dissociation curve for hemoglobin to the right in exercising muscle. The increase in blood flow to the muscles requires an increase in the cardiac output which is in direct proportion to the increase in oxygen consumption.

The cardiac output is equal to heart rate multiply by stroke volume which is about 5 L/min. Cardiac output can increase directly with increasing exercise intensity between 20-40 L/min. Heart rate (HR) and stroke volume increase to about 90% of their maximum values during strenuous exercise and cardiovascular function is the limiting factor for oxygen delivery to the tissues.

For blood pressure, the systolic blood pressure increases in direct proportion to increases the exercise intensity and not more than 250 mmHg in healthy or athletes at maximal levels of aerobic exercise. Furthermore, there is a large increase in venous

return as a consequence of muscular contraction, blood diversion from on the viscera and vasoconstriction (Plowman and Smith, 2008 and McArdle et al., 2007).

2.6 Cardiorespiratory training

Cardiorespiratory endurance or aerobic endurance is the ability of the whole body to sustain prolonged exercise. Long term aerobic training generally increases the heart's mass and volume with greater left-ventricular and diastolic volumes during rest and exercise. This enlargement, characterized by increased size of the left ventricular cavity (concentric hypertrophy) and modest thickening of its wall. These improvements can let activity at higher work rate or faster pace, improving performance (Brooks et al., 2000). Long term exercise also alters the contractile properties of cardiac muscle fibers that increased the activity of Ca^{2+} and changes in force-length relationship and increased power output.

Endurance training decreases the intrinsic friary rate of sinoatrial (SA) nodal pacemaker tissue and increased parasympathetic activity. These adaptation let the endurance athletes or sedentary who trained aerobic exercise heart beat is slower than non-athlete or untrained persons.

Endurance training causes the heart's stroke volume to increases during exercise, this change due to four factors

- Left ventricular volume and mass are increased
- Reduced cardiac and arterial stiffness
- Diastolic filling is increased
- Improved intrinsic cardiac contractile function

Cardiac output at rest or during sub maximal levels of exercise remains unchanged or decreases slightly after training. However, cardiac output increases at maximal exercise from 14-20 L/min in untrained person and 25-35 L/min in trained people (McArdle et al., 2007).

Exercise training increases inspiratory muscle capacity to generate force and sustain a given level of inspiratory pressure. These training adaptations benefit exercise performance in these ways:

- Reduce overall exercise energy demands
- Reduce lactate production by ventilation
- Enhance ventilator muscle metabolize blood lactate

2.7 Other aerobic training adaptations

2.7.1 Body composition

Exercise training can reduce body mass and body fat due to the FFA being used as the energy resource during exercise (Birch et al., 2005).

2.7.2 Body heat transfer

Trained person will have a larger plasma volume and dissipate heart faster and more effectively than sedentary.

2.7.3 Psychological benefits

Exercise training can lead to the reduction of the anxiety, depression, stress and improvement in mood.

2.8 Guidelines and recommendation of physical fitness by the American College of Sports Medicine (ACSM)

2.8.1 Cardiovascular function

Cardiovascular and health benefits derived from three bouts of 10 minutes daily exercise throughout the day or one continuous 30 minutes session. The intensity will start from light to heavy exercise with 40-50% to 85% VO_2max or 55-65% to 90% maximum HR. The duration of exercise is at least 20-60 minutes more than twice per week (Plowman and Smith, 2008).

2.8.2 Joint flexibility

A balance fitness program incorporates static and dynamic range of motion exercise of the body's major muscle/tendon groups (four repetitions per group) performed two to three days a week.

2.9 Muay Thai

Muay Thai is a combat sport from Thailand that uses stand-up striking along with clinching techniques. The word "Muay" derives from the Sanskrit "Mavya" which means "to bind together". In Thailand, Muay Thai evolved from the older Muay Boran or ancient boxing, an unarmed combat method which would have been used by Siamese soldiers after losing their weapons in battle.

Muay Thai progressed greatly during the reign of Rama V as a direct result of the king's personal interest in the art. The country was at peace and Muay Thai functioned as a means of physical exercise, self-defense, recreation and personal advancement. The most famous Muay Boran fighter is Nai Khanomtom who fights

against with the ten Burmese fighters by using Muay Boran during the ancient Siam capital of Ayuthaya in 1767. Before, he fight Muay Boran with Burmeses fighters, he did a traditional Wai Khru or pre-fight dance to pay respects to his teacher and ancestors, as well as spectators, dancing around his opponent, than when the fight began, he changed out, using punches, kicks, elbows and knees to beat until his opponent collapsed (http://en.wikipedia.org/wiki/Muay_thai, 2010).

Wai Khru Ram Muay is one kind of warm up activity in Thai culture which is performed before Muay Thai fighting. The word "Wai" means respect to others by putting the hand together like in praying. "Khru" means a teacher. "Ram" means dance in the old Thai traditional style.

"Muay" means boxing. Usually, Thais prefer to call it short "Ram Muay" or "Wai Khru" (http://en.wikipedia.org/Wai_Khru_Ram_Muay, 2010).

From the past, Muay Thai was usually fought in front of the king, so it shows not only respect to the teacher or trainers but also to apologize to the king for the brutality in fighting. Furthermore, Wai Khru is a graceful and an aesthetic ritual, both practical and spiritual. In a practical sense, it functions as a warm up and relaxation for fighter's body and mind (ยศเรืองสา, 2545).

Wai Khru Ram Muay Thai has many postures to do such as "Prom See Naa", "Hong Hern", "Sue Lak Hang" etc. In the present, people aware their wellness and health by trying to exercise following the western or eastern style exercise, aerobic exercise, bicylcle etc. more than Thai wisdom exercise style (Wai Khru Ram Muay Thai, Mae Mai Muay Thai etc.). Many researchers found that doing the regular aerobic exercise; the cardiovascular such as heart rate will decrease improving circulation and reducing blood pressure. In addition muscular will strengthen and

improved the ability of muscles to use fats during exercise, so the body can burns the body fat and the bodyweight will reduce. Furthermore, exercise can improve mental health, including reducing stress and lowering the incidence of depression. However, there is no research yet about Wai Khru Ram Muay Thai which is the Thai's traditional exercise on physiological responses.

2.10 Yoga

Yoga is a physical, mental and spiritual discipline, originating in India, The Sanskrit word "Yoga" means to join, to unite or to attach. There are several branches of Yoga such as Raja Yoga, Karma Yoga, Jnana Yoga, Bhakti Yoga and Hatha Yoga. Outside India, Yoga is typically associated with Hatha Yoga which has been widely used to describe practice of posture in order to have better physical and mental health.

Yoga came to the attention of an educated western public in the mid 19^{th} century. The Swami Vivekananda is the first Hindu teacher who support and disseminate aspects of Yoga to a western people. Yoga is also bloom for heart health, legitimizing Yoga as a purely physical system of health exercise outside of the culture (http://en.wikipedia.org/wiki/Yoga, 2010).

Yoga is used for treatment of cancer patients to decrease depression, insomnia, pain and fatigue and increases anxiety control. Yoga is also used to improve cognitive functions and reduce stress in schizophrenia patients and their quality of life was better after Yoga for 4 months.

Danucalov et al. (2008) found that the oxygen uptake (VO_2) and the carbon dioxide output (VCO_2) were statistically different during the meditation and the pranayama practices compared with those of the rest. In addition, the heart rate at rest

reduce significant than that of the meditation inconsistent with Chaya et al. (2006). However, Harinath et al. (2004) found that after Yoga practices for three months, the systolic, diastolic and mean arterial blood pressure showed a significant reduction while the force vital capacity (FVC), force expiratory volume in one second (FEV_1) showed a significant increased in the Yoga group.

Sarang et al. (2006) trained the cyclic meditation which was the technique that combined “stimulating” and “calming” involves the practice of Yoga postures for equilibrium of the mental. They found that oxygen uptake, breathing rate and breathe volume increased during the stimulating practice of cyclic meditation and returned back to the baseline during calming practice.

The hormone melatonin which is control the day and night cycle and caused sleep-induced relaxation. Furthermore, some studied found that melatonin also showed to decrease blood pressure.

CHAPTER III

MATERIALS AND METHODS

3.1 Ethical approval

Before participation in the experiment, all subjects were informed about the experimental protocol and possible risks involved and wrote the informed consent. This research was approved by the Ethical Committee of Suranaree University of Technology.

3.2 Subjects

Twenty six healthy subjects (4 males, 22 females) were participated in this experiment. Their health conditions were checked and screened by a physician at the Maternity hospital, Nakhon Ratchasima. Their ages were 20 years old. They did not do daily exercise or exercise less than 3 days/week.

Exclusion criteria were:

- Athlete
- Alcohol consumer
- Heart disease
- Hypertension
- Asthma
- Diabetes

- Allergy
- Subjects who receive the surgery on legs and back
- Neuromuscular and skeletal disorder, hypertension, asthma patients
- Drug user
- Currently smoking or heavy smoking
- Caffeine or alcohol taking within 24 hours prior to the study

They were randomLy divided into two groups as follows:

1. Group I was a control group consisting of 9 subjects who had frees life style activities and exercise less than 3 days/week.

2. Group II was a training group which was divided into 2 groups:

2.1 Wai Khru Ram Muay Thai (WT) training group of 8 students

2.2 Yoga training (YT) group of 9 students

Both training groups had trained for 8 weeks in the same condition and were taken care by a physician in an emergency situation.

In this study, there were 30 subjects that divided to 10 subjects for each groups at the first time but during training period they were dropped out 2 of WT, 1 of Yoga and 1 of control groups, respectively.

3.3 Materials and methods

The main parameters of physiological responses were collected before and after the 8^{th} week of the training.

3.3.1 Anthropometry

Anthropometry and body weight were measured in centimeters and kilograms, respectively while body mass index (BMI) were calculated by using the ratio of body mass (kg) and height^2 (m^2).

3.3.2 Hematocrit

Blood was taken from the finger and centrifuged by microcentrifuge (HermLe Z233 M-2) at 12,000 rpm for 5 minutes.

3.3.3 Percentage of body fat

Fat mass was measured indirectly by a Skinfold caliper (Baseline® Skinfold Calipers) at 4 sites: triceps, biceps, subscapular and suprailiac. Body density was calculated by the Durning and Womersly's equation (1974) as follow:

Body density for 20-29 years old subjects:

- For men = 1.1631 – [0.0632 x log Σ (skinfold)]
- For women = 1.1599 – [0.0717 x log Σ (skinfold)]

Then the body density was used to calculate the percentage of body fat according to the Siri's equation (1961).

- %Body Fat = [(4.95 / Body density) – 4.5] x 100

3.3.4 Respiratory parameter

Vital capacity was determined by a spiropet spirometer (Graham Spiropet Spirometer). In this experiment, subjects were asked to take deep breath and blow out all of the air. The measurements were repeated twice and recorded the maximum value of the capacity in milliliters and determined by body surface area (BSA) that calculated by The Mosteller formula (1987).

- BSA (m^2) = √([Height(cm) x Weight(kg)]/ 3600)

3.3.5 Flexibility

Subject's flexibility was tested by using a sit and reach test technique. Flexibilities were tested twice by sitting and stretching their hand as far as they could. The maximum value of the stretching was recorded in centimeters.

3.3.6 Leg and back strength

Subject's leg and back strengths were determined by a leg-back dynamometer (Takei A5102). Subjects were tested twice by bending the knees and keeping their back in a vertical position, and then extending knees up as much as they could without arms pull. As for the back strength the measurements were performed twice by bending the back and keeping legs in a vertical position and rising the back upward as much as they could without arms pull. The maximum value of two strengths was recorded in kilograms.

3.3.7 Cardiovascular parameters

Heart rate (HR) was measured by using a telemetry HR monitor (Polar FS1 Heart Rate Monitor) while maximum oxygen consumption (VO_2max) was determined by a modified Astrand's protocol on cycle ergometer (Ergomedic 828E, Monarch, Sweden) and gas analyzer (Cortex Metamax 3B) was used to detect oxygen and carbon dioxide.

After sitting on the cycle ergometer for 5 minutes, the subjects started the test by warming up with pedaling at 0 watt with a constant speed of 50 rounds per minute (rpm). Work load was increased by 25 watts every 3 minutes until exhaustion or subject cannot maintain speed at 50 rpm. For recovery, subjects pedaled without load for 5 minutes. Rating perceived exertion (RPE) was recorded during the test.

3.4 Training

The subjects in training group were divided into 2 groups.

3.4.1 Wai Khru Ram Muay Thai training

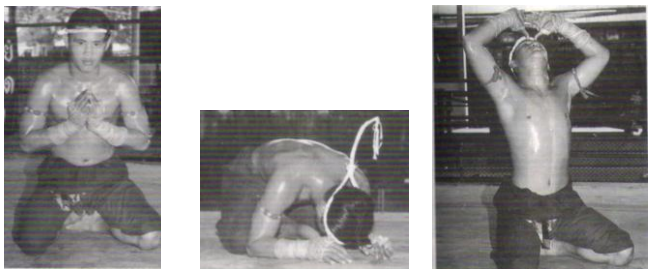
Subjects were trained by a WT trainer for 60 minutes per day, 3 days per week for 8 weeks.They trained 4 postures of WT that were “Dhep Panom”, “Patom”, “Prom” and “Sue Lak Hang” as follows:

3.4.1.1 Sit position Dhep Panom posture

Step 1: Kneel down with a straight back and right foot lie on left foot. Sit on both heels and put the hands together in salute at chest level. Pray to Holy things to protect them and pay obeisance 3 times as shown in Figure 3.1.

Step 2: Bend the body and stretch both arms forward until fingers touch the floor. Use the thumb for binding both hands.

Step 3: Raise the hands together for saluting above forehead. Bend the elbows and turn up and bring both thumbs to touch between the eyebrows. Bend the body backward appropriately and then down the hands to a chest level. Repeat step 2-step 3 for 3 times as shown in Figure 3.1.



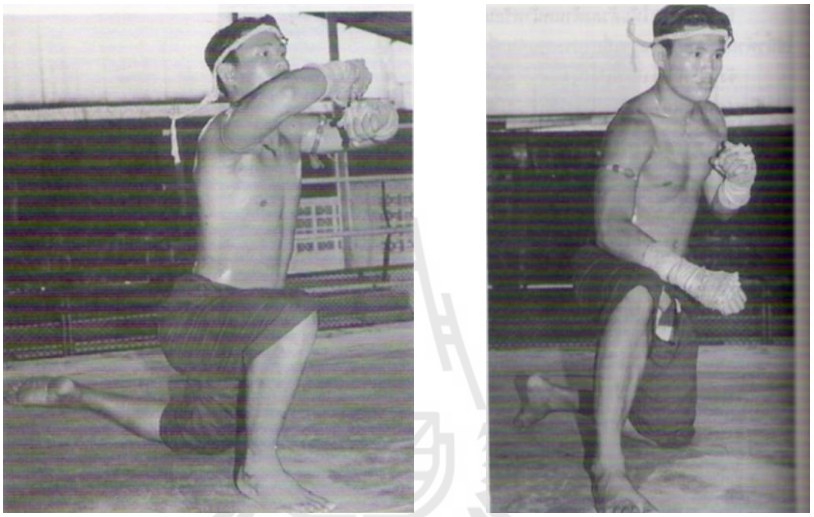
(A) (B) (C)

Figure 3.1 Dhep Panom posture: (A) 1st step, (B) 2nd step and (C) 3rd step.

Source: Office of the National Culture Commission, Ministry of Education (1997) Art of Muay Thai.

3.4.1.2 Patom posture

In the first step, Kneed on the left knee and put both arms in the horizontal position in front of the chin. Bent right knee perpendicularly and put it in the front. Bend body forward the right hand on the right leg while the left hand on the chest level, Clenches the both fists as shown in Figure 3.2.



(A) (B)

Figure 3.2 Patom posture: (A) 1st step and (B) 2nd step.

Source: Office of the National Culture Commission, Ministry of Education (1997) Art of Muay Thai.

3.4.1.3 Prom posture

From the Patom posture, the subjects slightly bend the body forward on the left heel. Let the right foot then straight and flexion the right foot. Turn the arm 3 times as shown in Figure 3.3.

Figure 3.3 Prom posture.

Source: Office of the National Culture Commission, Ministry of Education (1997) Art of Muay Thai.

3.4.1.4 Sue Lak Hang posture

Step 1: Kneel on the right knee. Lift hands, stretch and wave both arms up and down. Lift the head up and down. Put the weight on the left foot and make the balance of the body by ad justly the right foot then move the body as shown in Figure 3.4A.

Step 2: Bend the body backward to release the weight on the left foot and stretch the left foot forward. Move both hands up and down and then left and right sides as shown in Figures 3.4B and 3.4C.

Step3: Stand by the right leg and lift the left leg backward and bend the body forward. Move both hands perpendicularly up and down as shown in Figure 3.4D.

(A) (B)

(C) (D)

Figure 3.4 Sue Lak Hang posture: (A) 1st step, (B), (C) 2nd step and (D) 3rd step.

Source: Office of the National Culture Commission, Ministry of Education (1997) Art of Muay Thai.

3.4.2 Yoga training

The subjects were trained the Yoga for 60 minutes per day, 3 days per week for 8 weeks. Subjects in Yoga groups were trained 6 positions in sequence of Surya Namaskar, Swastikasana, Parvatasana, Trikonasana, Veerasana and Vrikshasana.

3.4.2.1 Surya Namaskar

Step 1: Inhale and maintain the position in standing position with hands joined together near chest, feet together and toes touching each other.

Step 2: Exhale and bend forward in the waist till palms touch the ground in line with the toes. While exhaling bent forward in the waist. Palms touching the ground Legs straight and try to touch the forehead to the knees.

Step 3: Inhale and take the left leg back with left toes on the floor, press the waist downwards and raise the neck, stretch the chest, forward and push shoulders backwards. Keep the right leg and both the hands in the same position. Keep the right leg folded. Take the left leg backwards and touch the knee to the floor, keeping the toes erect. The knee of the right leg will be bent. The knee of the left leg should touch the ground and drop the waist and hips towards the floor.

Step 4: Hold the breath and raise the knee of left leg. Take the right leg backwards and keep it close to the left leg. Straighten both the legs and both hands. Keep the neck straight and site fixed. Keep both the toes erect. Take the right leg back and place it beside the left leg, keeping the toes erect. Keep the body in one straight line plank position. Keep the arms straight.

Step 5: Exhaling bend both the hands in elbows and touch forehead on the ground and touch the knees on the ground and keep both the elbows close to chest. The forehead, chest, both the palms, both the toes, knees should touch

the ground and rest of the body not touching the floor. Bring the body towards the floor placing the 8 parts on the floor: toes, knees, chest, palms, and forehead. Keep the hands close to the body, next to the shoulders.

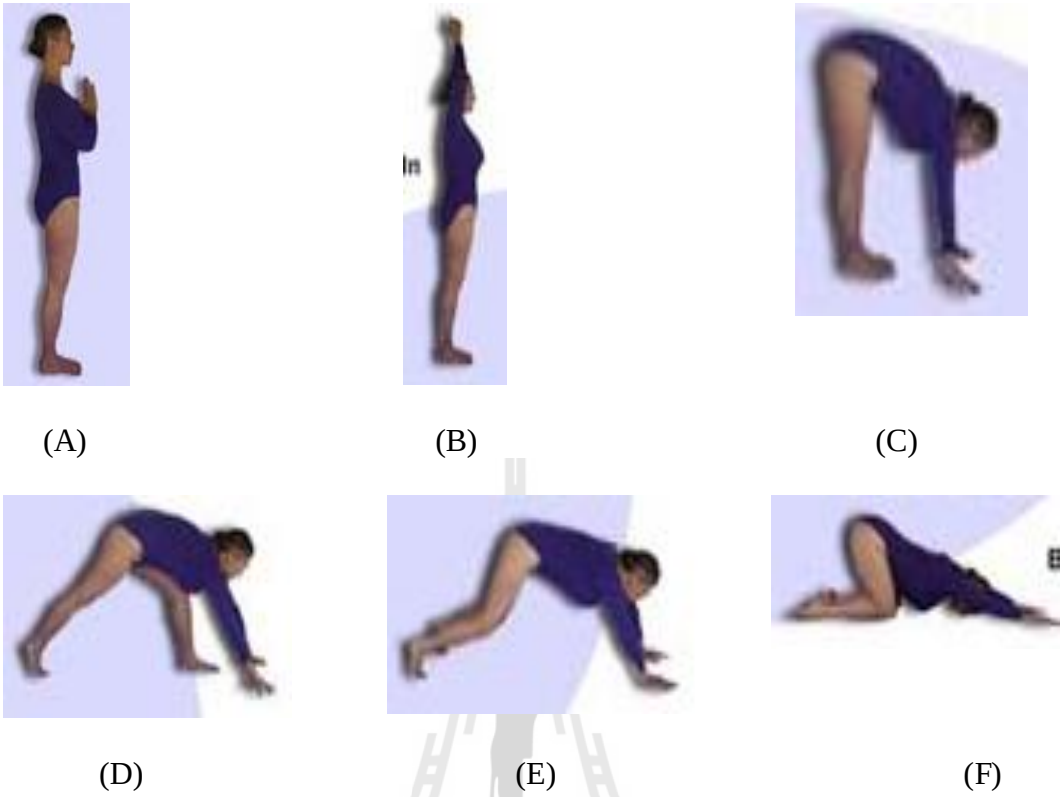
Step 6: Inhale and straighten the elbows, stretch the shoulders upwards, press the waist downwards but don't bend the arms. Keep the knees and toes on the floor. Push the neck backwards and site upwards. Push the upper body upwards so that the arms are straight. Open the chest, pull the shoulders downwards and drop the head and neck backwards and gaze upwards towards the sky. Keep the heels, legs and knees together.

Step 7: Hold the breath, bend the neck downwards and press the chin in the throat, push the body backwards and touch the heels on the ground, raise the waist upwards. Push the body upward so the buttocks and waist are raised into the air as in step 4

Step 8: Hold the breath as in step 7, bring the right leg in the front and place it in between the hands like in step 3 but instead of left leg in the front here take right leg and place left leg in the back with left knee and toes on the ground.

Step 9: Exhale and bring the left leg forwards as in the step 2 and place it in between both the arms. Take the left leg forward and place it beside the right.

Step 10: Inhaling start getting up and attain the position as in step 1.



(A) (B) (C)

(D) (E) (F)

Figure 3.5 Surya Namaskar: (A) 1st step, (B) 2nd step, (C) 3rd step, (D) 4thstep, (E) 5th step and (F) 6th step.

Source: http://audioyoga.com/AY4/index.

3.4.2.2 Swastikasana

Step 1: Spread both the legs and keep them at a distance of 1 to 1.5 feet.

Step 2: Bend left leg in knee and place its soul touching inner side of the right thigh.

Step 3: Bend right leg in knee and place its foot in between the thigh and the calf of the leg. Keep the wrists of both the hands on the respective knees and continue normal breathing.

(A) (B) (C)

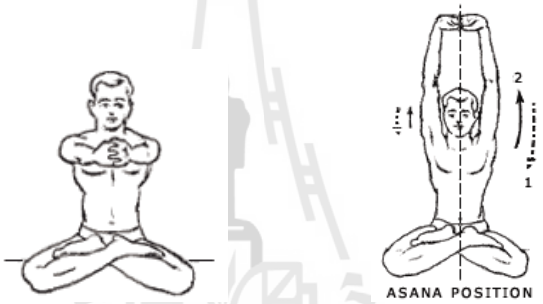
Figure 3.6 Swastikasana position: (A) 1st step, (B) 2nd step and (C) 3rd step.

Source: http://www.yogapoint.com/info/swastikasana.htm.

3.4.2.3 Parvatasana

Step 1: From Swastikasana take both the hands forward and lock the fingers of both the hands together.

Step 2: Take the hands over the head and turn the palms downside up facing the upside. Stretch the body upwards with the arms stretched towards the sky, stabilize the position and continue normal breathing, relax the body and bring the hands and take the sitting posture.



(A) (B)

Figure 3.7 Parvatasana: (A) 1st step, (B) 2nd step.

Source: http://www.yogapoint.com/info/parvatasana.htm.

3.4.2.4 Trikonasana

Step1: From Stand position, lift the left leg and place it at a maximum distance towards the left, turn the toe of the left foot towards the left and inhale.

Step2: Exhale and bend the left leg in the knee and place the left hand palm near the left foot toe.

Step 3: Take the right hand forward straight above the right ear and continue smooth breathing. Bring the right hand to its original place, straighten the left knee and bring the left hand to its original place, turn the left leg toe to front and bring the left leg near the right one and take up the standing position.

(A) (B) (C)

Figure 3.8 Trikonasana: (A) 1st step, (B) 2nd step and (C) 3rd step.

Source: http://www.yogapoint.com/info/trikonasana.htm.

3.4.2.5 Veerasana

Step1: From stand position, take the left foot forward and place the left foot on the floor at the maximum distance from the initial position.

Step2: Bring both the hands together, join the palms and place them on the knees of the left leg. Bend the left leg in the knee in such a way that the thigh and the calf come in 90 degrees and keep the right leg straight.

Step3: Raise the joined hands up and take them back above the head and then without bending the hands in the elbows. Bend the head backward and keep the sight backward down. Then bring the body forward and place the hands on the knee, keep sight to the front, straighten the knee and restore the hands to their original place and restore the left leg to its place and take up standing position.

(A) (B) (C)

Figure 3.9 Veerasana: (A) 1st step, (B) 2nd step and (C) 3rd step.

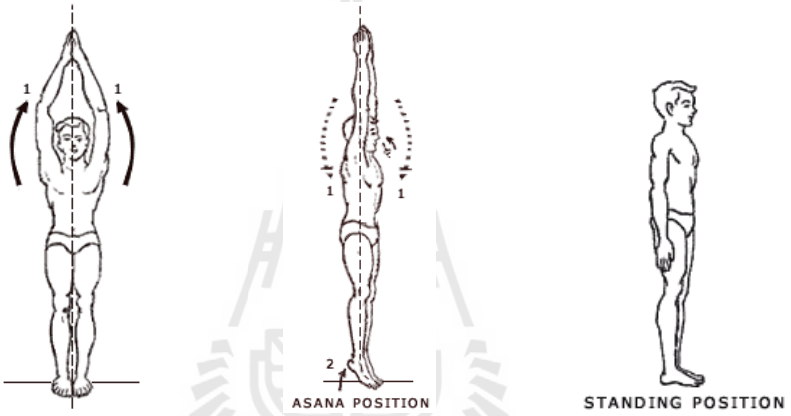
Source: http://www.yogapoint.com/info/veerasana.htm.

3.4.2.6 Vrikshasana

Step1: From stand position, exhale and inhale take both the arms up above the head from the sides and join the palms at the top.

Step2: Lift the heels and stand on the toes and pull the whole body upward and continue smooth breathing.

Step3: Inhale and exhale bring both the hands down from the sides and bring the heels on the floor and take up standing position.



(A) (B) (C)

Figure 3.10 Vrikshasana: (A) 1st step, (B) 2nd step and (C) 3rd step.

Source: http://www.yogapoint.com/info/vrikshasana.htm.

3.5 Experimental protocol

Each subject performed five experiments which consisting of vital sign record, lung performance, flexibility test, muscle strength and maximum oxygen consumption before and after the 8^{th} week of training. Two hours before testing in each experiment, subjects were not allowed to have both meal and severe exercise.

On the experiment day, subjects were asked to wear short pant throughout the experiment and subjects was asked to take a rest for 10 minutes at arrival. Their hematocrit was tested to confirm they were not anemia for safety testing. Their bodyweight and vital signs were recorded, while their vital capacity was measured by the spiropet spirometer. Next, subjects were asked to rest for 15 minutes and their flexibility was determined by the sit and reach test, while the muscle strength was measured by the leg-back dynamometer, respectively. After these measurements, the cardiovascular parameters were measured.

Experimental protocol

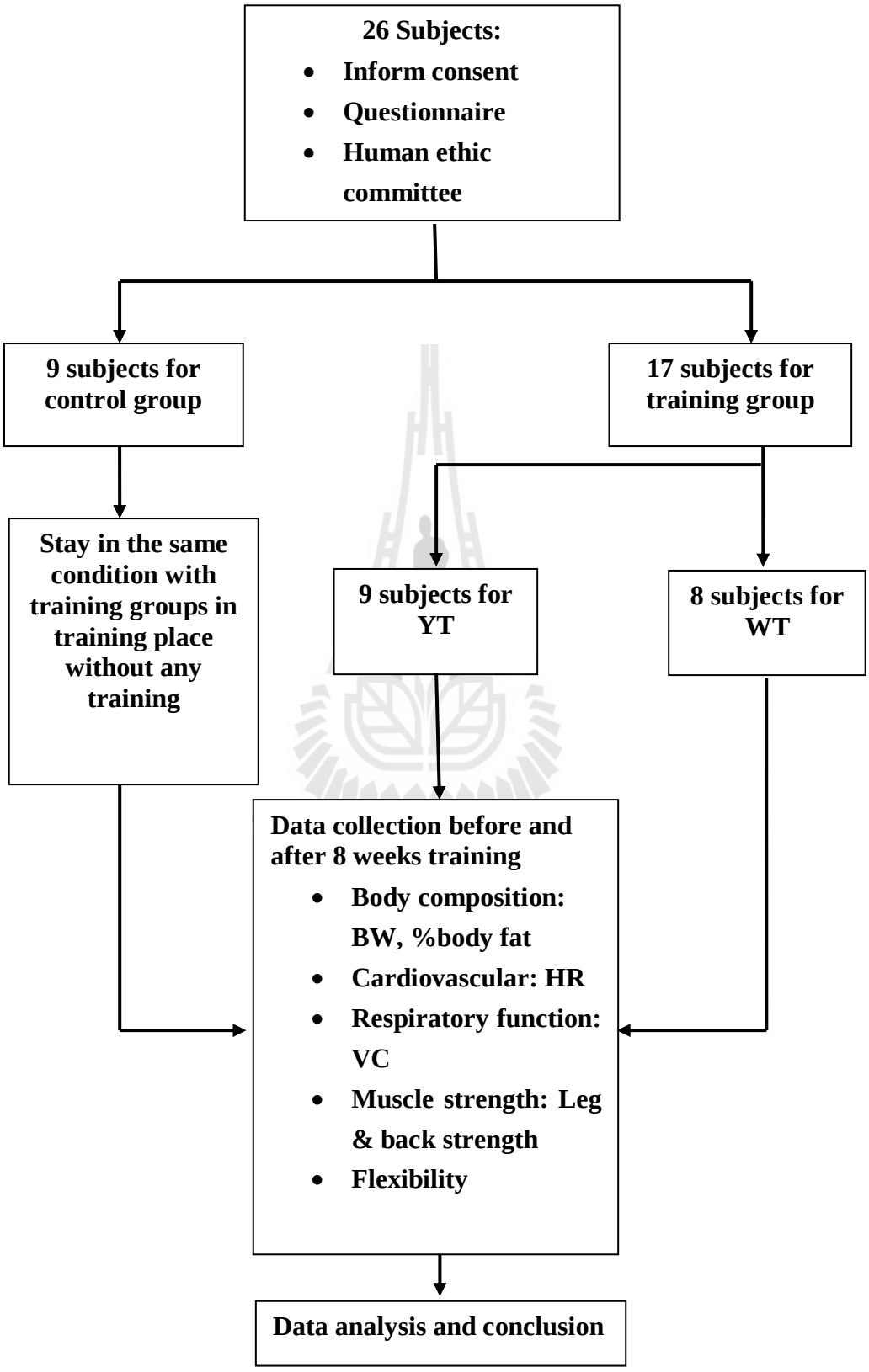


Figure 3.11 Experimental protocol.

3.6 Statistical analyses

The data was expressed as mean±standard deviation. In order to analyze the difference among groups, paired student's test and one way ANOVA were used. P value of less than 0.05 was considered statistically significant by using SPSS version 16 (IBM, 2008).

CHAPTER IV

RESULTS

4.1 Body weight

Figure 4.1 shows the body weights of the WT, the YT and the control groups before and after 8 weeks training. Before training, the body weight of the WT, the YT and the control groups were 57.37±13.24 kg, 55.26±10.15 kg and 47.72±7.29 kg, respectively. After 8 weeks of training their body weight were reduced to 56.29±12.93 kg and 53.87±9.39 kg in WT and YT groups, respectively, while that of control group was slightly increased (48.00±7.58 kg). These results showed that percent change of body weight of WT and YT groups were different when compared with control groups. Body weight of WT and YT groups were decreased high significantly ($p<0.01$) by 1.85% and 2.33%, respectively, while that in control group was slightly increased (0.54%).

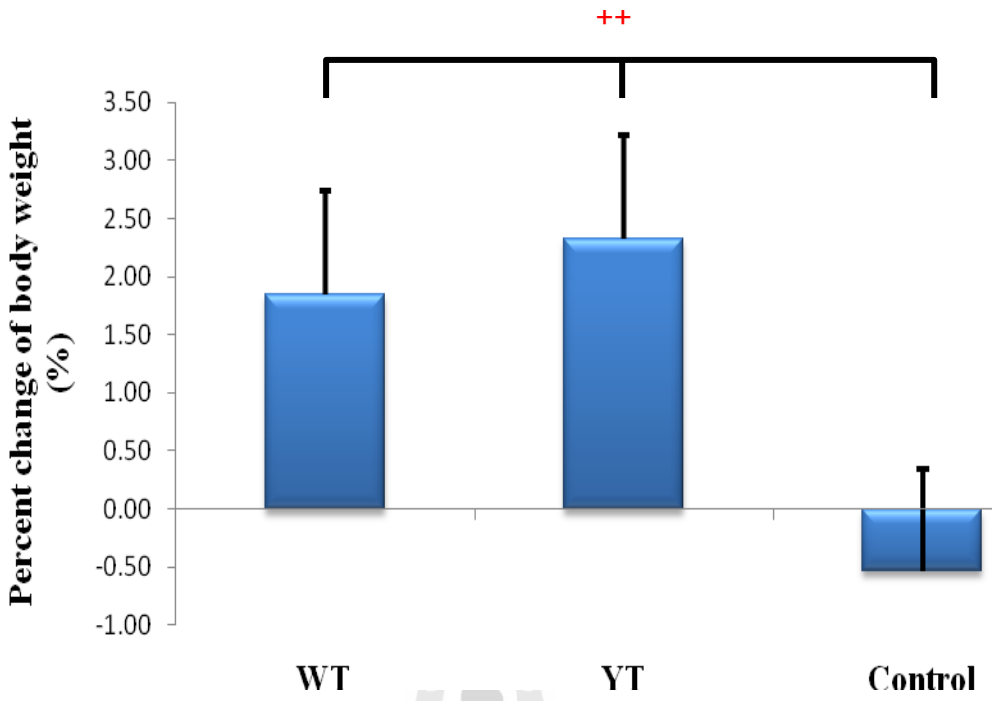


Figure 4.1 Percent change of body weights of WT, YT and control groups between before and after 8 weeks training. The data were mean ± SD. ++ = $p<0.01$ compared between groups (Tamhane's T2 ANOVA).

4.2 Body mass index (BMI)

The BMI of these groups is shown in Figure 4.2. The BMI of the of the WT, the YT and the control groups before training were 23.02±4.41 kg/m^2, 21.88±4.18 kg/m^2 and 18.77±1.68 kg/m^2 respectively, while those after training were 22.59±4.30 kg/m^2, 21.34±3.94 kg/m^2 and 18.87±1.73 kg/m^2, respectively. These results showed that the percent change of two training groups were different when compared with control groups. BMI of WT and YT groups were decreased high significantly ($p<0.01$) by 1.85% and 2.33%, respectively, while that in control group was slightly increased (0.54%).

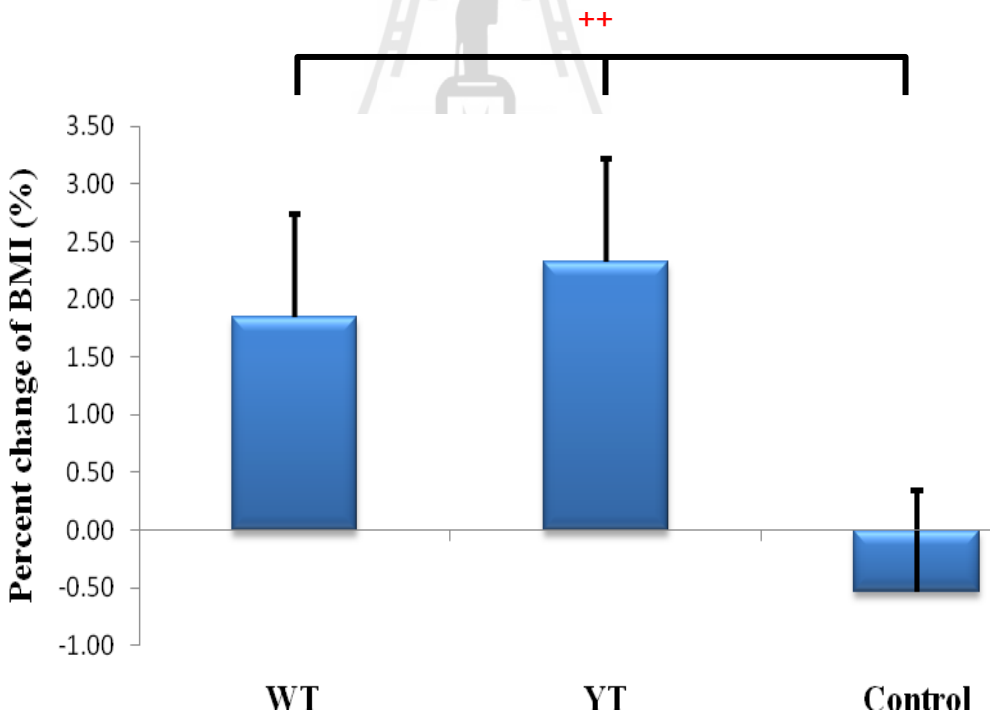


Figure 4.2 Percent change of BMI of WT, YT and control groups between before and after 8 weeks training. The data were mean ± SD. ++ = $p<0.01$ compared between groups (Tamhane's T2 ANOVA).

4.3 Percent of body fat (%)

The percent of body fat before and after training shown in Figure 4.3 were determined according to Siri's equation. It can be seen from this figure that the percentage of body fat of the WT group decreased significantly ($p<0.05$) by about 7.88% from 28.33±4.52% to 26.12±4.76%. In the YT group, the decrease also significant ($p<0.05$) was about 22.18% from 27.61±4.99% to 21.31±6.27%. As for the control group, there was no significant change that can be observed, but there were not significant different when compared between groups.

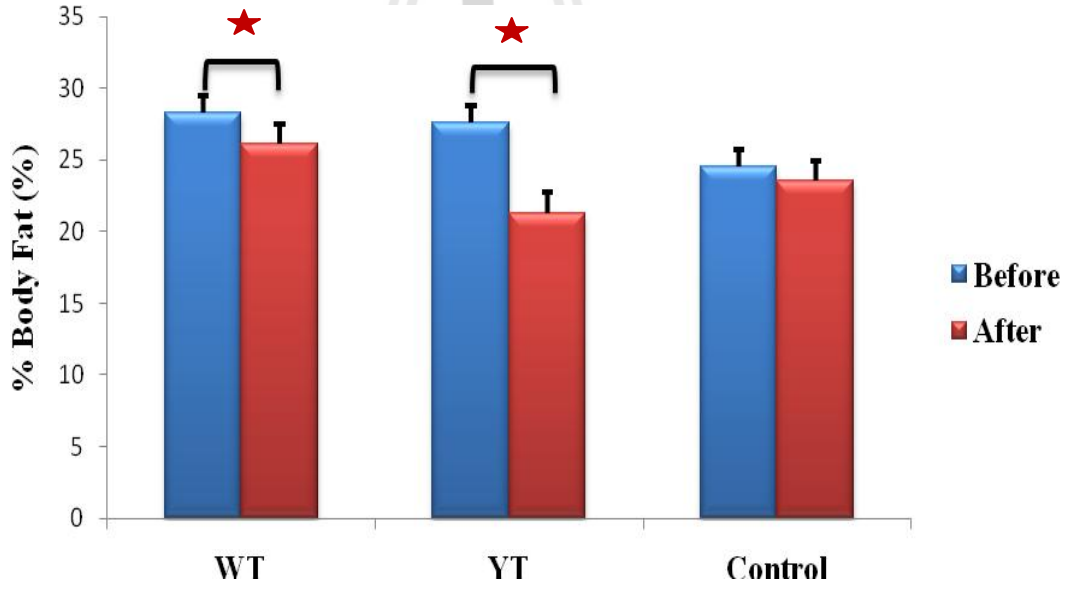


Figure 4.3 Percent of body fat of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

4.4 Vital capacity (VC)

Figure 4.4 shows the variations of the VC before and after training. The VC/BSA of the WT, the YT and the control group before training were 1,252±361 mL/m^2, 1,350±282 mL/m^2 and 1,232±161 mL/m^2, respectively. After 8 weeks of training, their VC became 1,415±297 mL/m^2, 1,391±284 mL/m^2 and 1,259±171 mL/m^2 in the WT, the YT and the control group respectively. The results showed that only the VC of the WT group increased significantly after the training, while those of the YT and control groups did not significant change and there were not significant different when compared between groups..

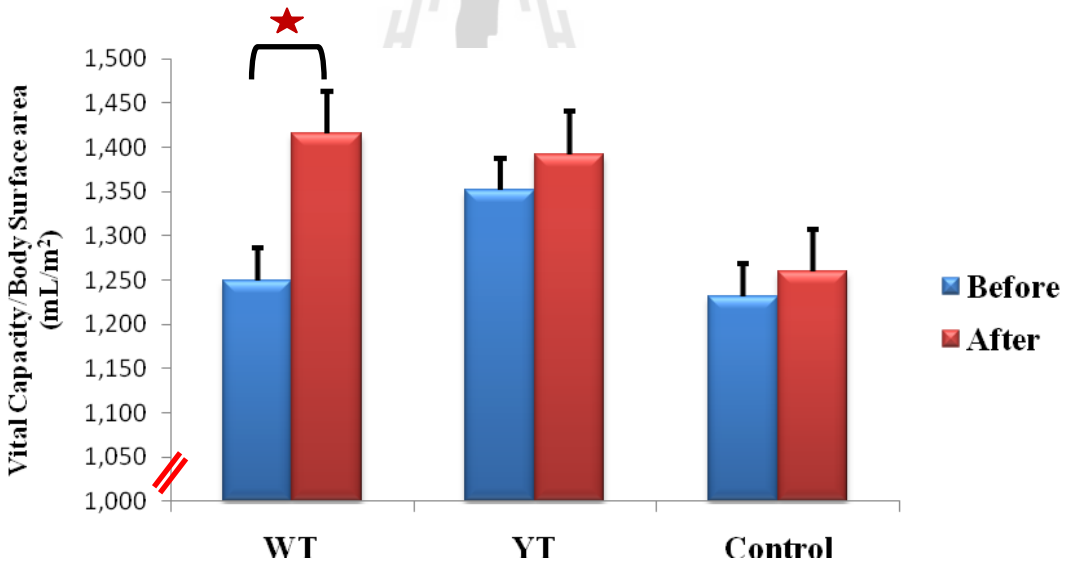


Figure 4.4 Vital capacity/Body surface area of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

4.5 Muscle strength

The changing of the muscle strength is shown in Figure 4.5. The leg strength increased significantly ($p<0.05$) by about 19.82% in the WT group and 18.71% in YT group, while that in control group was not significant change as shown in Figure 4.5a. The back strength also increased significantly ($p<0.05$) by about 20.95% in the WT group and 9.65% in the YT group. However, the back strength of the control group did not increase and there were not significant different when compared between groups as shown in Figure 4.5b.

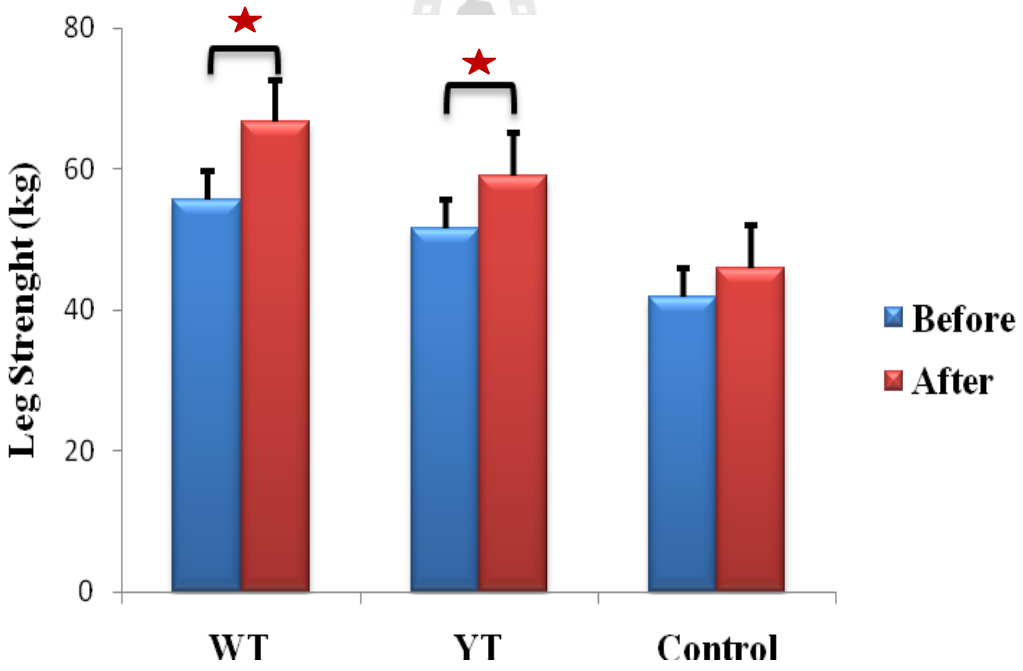


Figure 4.5a Leg strength of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

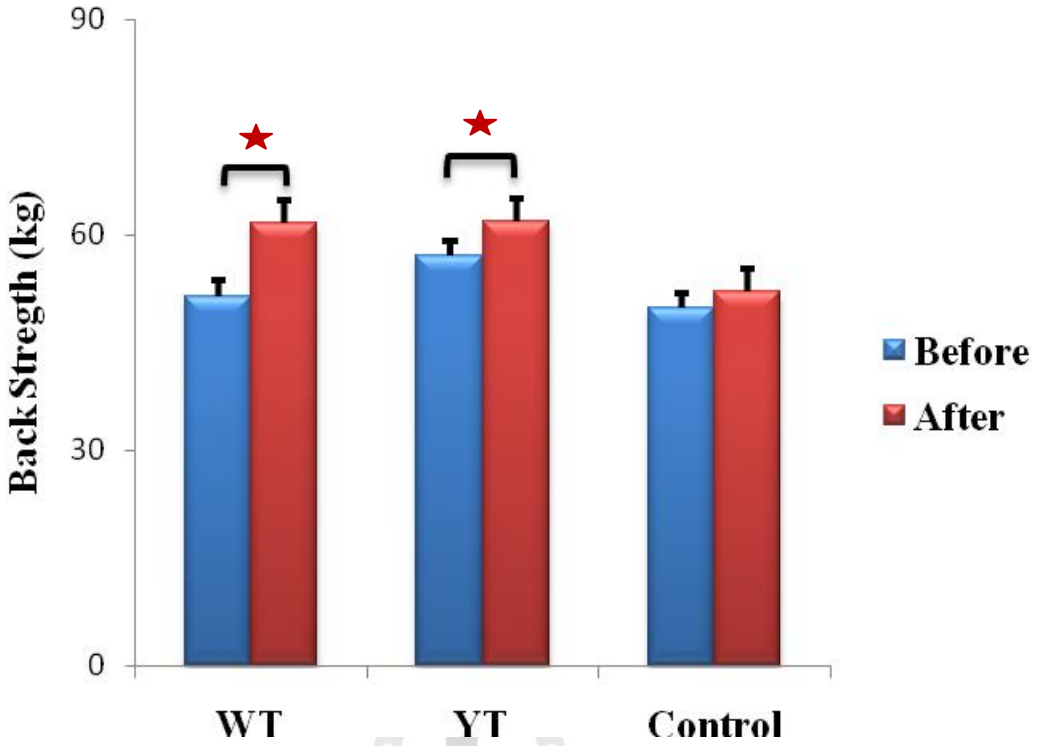


Figure 4.5b Back strength of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

4.6 Flexibility

Figure 4.6 shows the flexibilities of the three groups before and after trainings. The flexibilities of the WT and the YT groups became highly significantly higher ($p<0.01$) by about 19.52% and 21.73%, respectively, while that in the control group was not significant and there were not significant different when compared between groups.

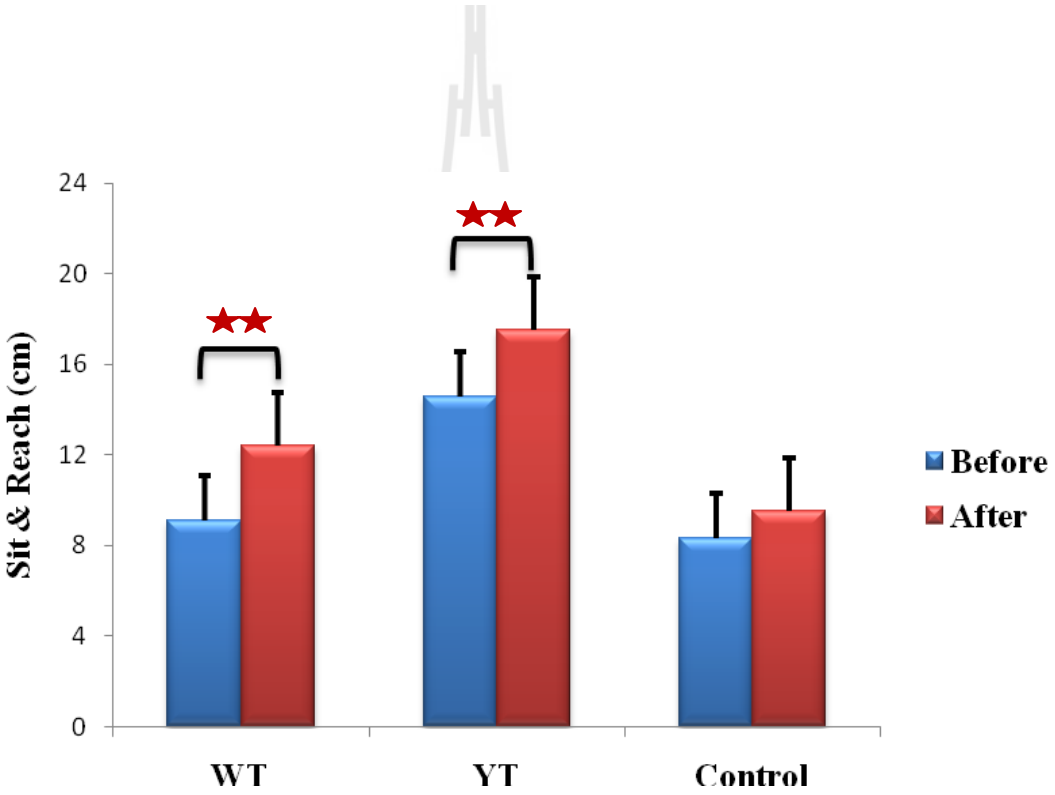


Figure 4.6 Flexibility of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$, ** = $p<0.01$ compared between before and after training in each group.

4.7 Cardiovascular system

The heart rate (HR) was shown in Figure 4.7. The HR at rest of the WT, the YT and the control groups were 83.25±6.56 bpm, 78.22±8.30 bpm and 83.22±9.19 bpm, respectively. After the 8 weeks of training, the HR of those three groups at rest became 78±11.83 bpm, 77.78±4.89 bpm and 78.56±12.09 bpm, respectively in WT, the YT and the control groups.

The systolic blood pressure at rest of the WT, the YT and the control groups changed from 111±8.23 mmHg, 104±6.79 mmHg and 106±7.49 mmHg to 115±13.39 mmHg, 103±8.01 mmHg and 110±8.75 mmHg, respectively.

The diastolic blood pressure at rest of the WT, the YT and the control groups after training did not change.

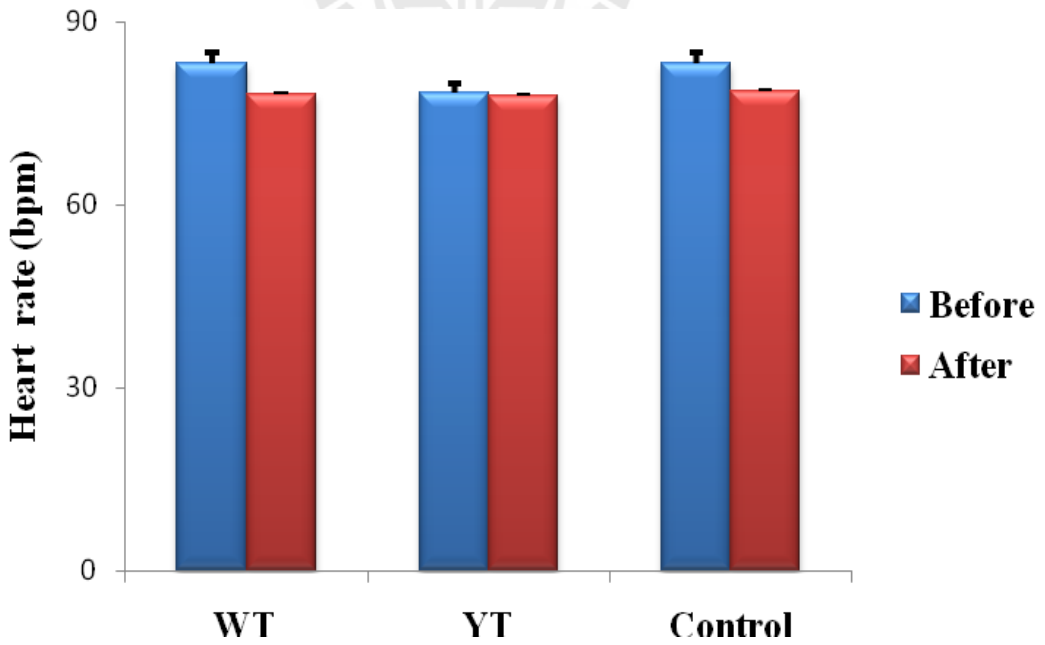


Figure 4.7 Heart rate of WT, YT and control groups before and after 8 weeks training.

Rate pressure products (RPP) at rest were 151.75±20.96, 151.65±12.93 and 159.95±13.92, respectively in the WT, the YT and the control groups before training. After 8 weeks training, RPP at rest were 134.05±10.60, 138.95±9.36 and 157.88±19.76, respectively in the WT, the YT and the control groups. The results showed that RPP in the WT and the YT groups were significantly decreased ($p<0.05$) after 8 weeks of training while that in the control group did not change and there were not significant different when compared between groups as shown in Figure 4.8.

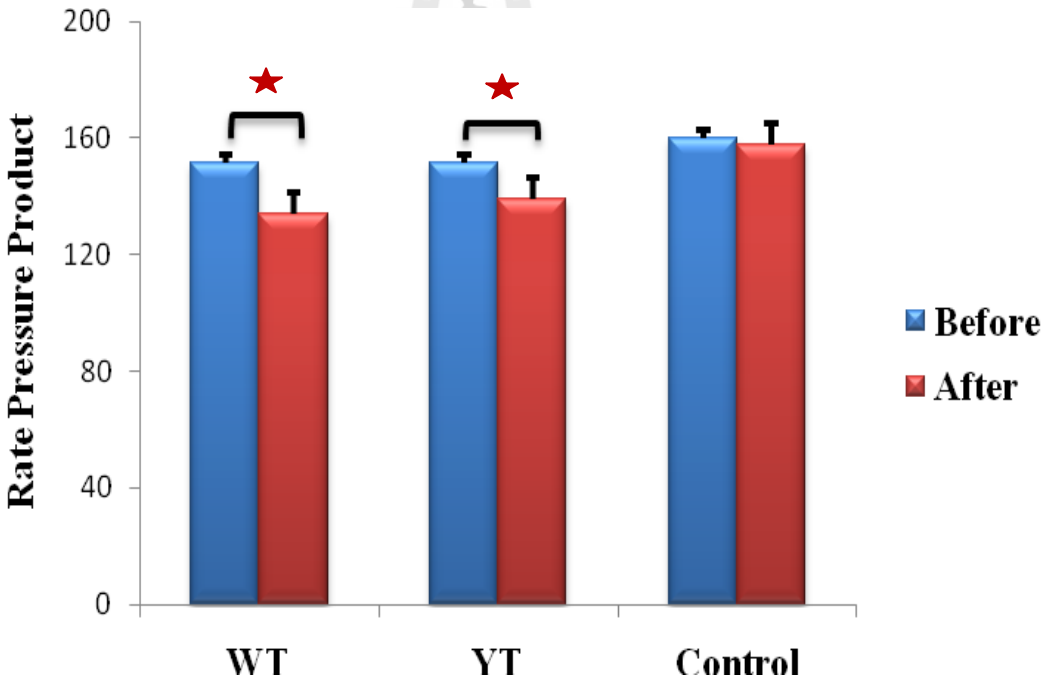


Figure 4.8 RPP of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

Double products (DoP) were 12098.50±1019.71, 11972.65±912.33 and 12162.03±1323.03, respectively in the WT, the YT and the control groups before training. After 8 weeks training, DoP became 10684.04±942.78, 10960.21±686.92 and 11988.76±1494.78, respectively in the WT, the YT and the control groups. The results showed that DoP in the WT and the YT groups also were significantly decreased ($p<0.05$) after 8 weeks of training while that in the control group did not significantly change and there were not significant different when compared between groups as shown in Figure 4.9.

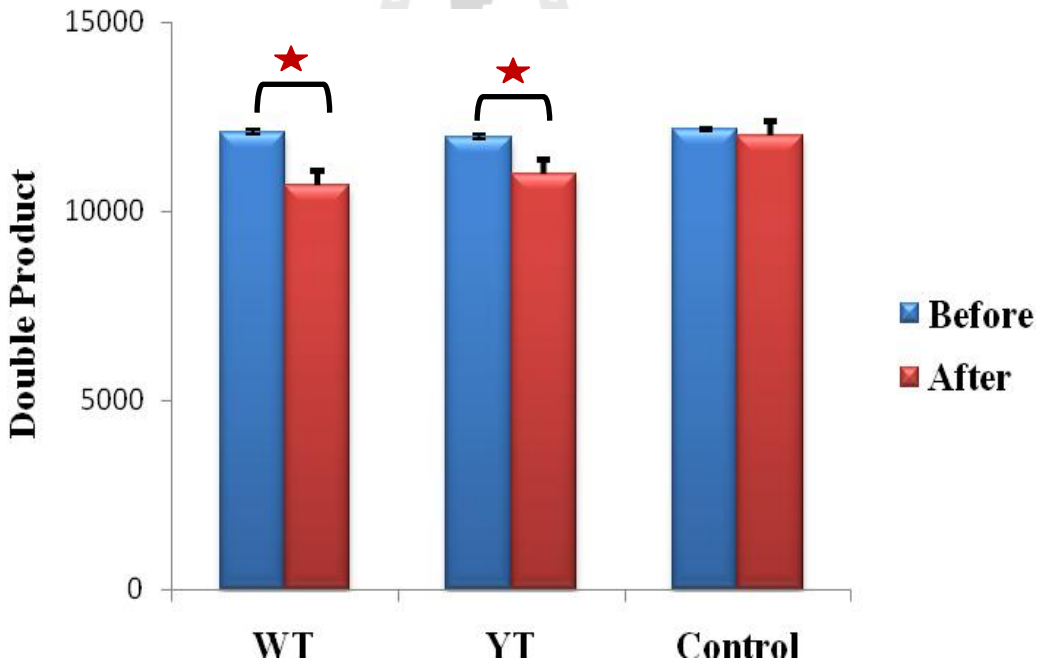


Figure 4.9 DoP of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. * = $p<0.05$ compared between before and after training in each group.

The variations of the maximum of oxygen consumption (VO_2max) of WT, the YT and the control groups are shown in Figure 4.10. The values before training were 38.50±7.21 mL/min/kg, 35.78±6.04 mL/min/kg and 38.56±3.64 mL/min/kg, respectively. After 8 weeks training the VO_2max of WT, the YT and the control groups changed to 41.87±7.92 mL/min/kg, 40.00±5.10 mL/min/kg and 39.56±7.27 mL/min/kg, respectively. The changing of the VO_2max of WT and the YT groups were highly significant increased ($p<0.01$) while that of the control group did not significantly change. VO_2max in WT, YT and control groups were different when compared between groups, especially VO_2max in WT and YT groups were increased high significantly ($p<0.01$) than that in control group.

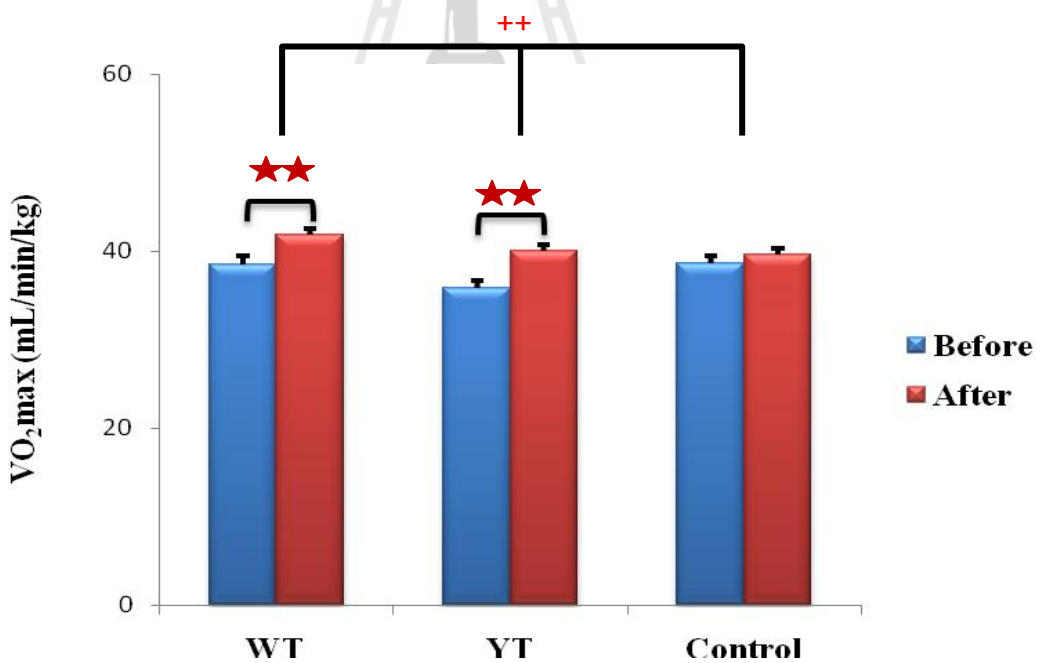


Figure 4.10 VO_2max of WT, YT and control groups before and after 8 weeks training. The data were mean ± SD. ** = $p<0.01$ compared between before and after training in each group. ++ = $p<0.01$ compared between groups (Tamhane's T2 ANOVA).

CHAPTER V

DISCUSSION

The results showed that after training Wai Khru Ram Muay Thai and Yoga for 60 minutes per time, 3 days per week for 8 weeks, the bodyweight of the WT and the YT groups reduced by 1.85% and 2.33%, respectively. As a consequence, the BMI and percentage of body fat in WT, YT and control groups were different when compared between groups, especially both WT and YT groups were decreased significantly when compared with control group. This is because the FFA which is in an intracellular and an extracellular of the cells together with a triacyl-glycerol which is in an intercellular of the muscle are used to produce 30-80% of the energy during the exercise training.

Other factors which affect the bodyweight are food intake, physical performance, the duration and the intensity of the exercise. Note that when the intensity is greater than 40% of the maximum heart rate, it affects on the bodyweight reduction increases. According to Miller et al. (1997), an exercise for 15 weeks can reduce the bodyweight of the subjects by about 7 pounds, whereas, by combining the exercise with a diet control, the reduction of the bodyweight can be increased to 20 pounds. Furthermore, several researches reported that after children exercised for 40 minutes per time, 5 days per week for 4 months, without a diet control, the reductions of a fat tissue in a visceral and an abdominal tissue in an exercise group were more

than those in a control group. It was also found that the fat free mass in the exercise group became higher than the control group.

In addition, in adolescents who did heavy exercises, the fat around abdominal area reduced more than the control group. Therefore, it can be concluded that a regular aerobic exercise can reduce the fat deposit in the abdominal and the visceral areas more than in other areas.

Our results agree well with the criteria of the ACSM for developing cardiorespiratory which states that the average of the bodyweight can be reduced by about 1.5 kg and the percentage of the fat by about 2.2% after exercise training.

This study also found that the flexibility of the WT and the YT groups increased significantly ($p<0.05$ and $p<0.01$, respectively). This is because the Wai Khru Ram Muay Thai and the Yoga practice are the type of exercises which consist of warm up, exercise and cool down. Before practicing these exercises, we need to warm up for stretching the muscle, tendon, joints and increasing range of motion in order to prevent from injuries. This is in agreement with the study of Hemhachart et al. (2010) that after training basic Muay Thai Chaiya for 8 weeks, flexibility can be increased. Furthermore, Mark et al. (2001) found that plantar flexion, upright shoulder, stretching and bend the body were increased after exercise training.

During exercise, the ventilation of the respiratory system can increase from 5-6 L/min to 100 L/min. This is directly related to the work done at a submaximal exercise. The minute's ventilation can be calculated from the product of the normal breathing in or out in one time and the respiratory rate per minute. In our study, we measured the minute ventilation by the gas analyzer (breath by breath). The measured minute ventilation in the WT, the YT and control groups before training was

22.35±2.29 L/min, 24.27±5.47 L/min and 20.44±4.26 L/min, respectively. After the training, their measurement became 26.20±3.31 L/min, 27.32±5.41 L/min and 21.51±4.90 L/min, respectively. Therefore, the minute ventilation in the WT and the YT groups increased significantly ($p<0.05$), whereas that of the control group did not change. The increase of minute ventilation during the exercise is caused by the activity of the motor center from a proprioceptor of the lower extremity, joints and muscles. Furthermore, the changing of a peripheral chemoreceptor from a partial pressure of oxygen (PaO_2) in arteries and a partial pressure of carbon dioxide ($PaCO_2$) caused a hyperventilation. Moreover, the central chemoreceptor was also activated the respiratory rate in order to remove the carbon dioxide out of body.

The VO_2max increased after the regular aerobic exercise training. Consequently, the difference of the oxygen consumption inside the blood and the arteriovenous increased. As a result, the heart pumps more bloods to the muscle.

After the training, the sympathetic activity decreased. Although, it is followed by the decreased of the heart rate, stroke volume increases. Note that the stroke volume is affected by the contraction, the stiffness of the arteries, the filling time for contraction and relaxation of the heart (McArdle et al., 2007). In our study, the VO_2max before training in the WT, the YT and control groups were 38.50±7.21 mL/min/kg, 35.78±6.04 mL/min/kg and 38.56±3.64 mL/min/kg, respectively, while after training in these three groups were 41.87±7.92 mL/min/kg, 40.00±5.10 mL/min/kg and 39.56±7.27 mL/min/kg, respectively. The VO_2max in the WT and the YT groups increased significantly ($p<0.05$), whereas that of the control group did not change within the group. The increase of the VO_2max of the WT and the YT groups were significantly higher ($p<0.01$) than that of the control group. This result also

agrees with many reports (Balasubramanian and Pansare, 1991; Bera and Rajapurkar, 1993; Madanmohan et al., 2004 and Kim et al., 2008) found that the Yoga training can increase cardiovascular, endurance, energy for anaerobic and can develop physical performance for health promotion.

CHAPTER VI

CONCLUSION

This study found that although the Wai Khru Ram Muay Thai is only a warm up exercise, the training for 60 minutes per day, 3 days per week for 8 weeks can improve the cardiovascular, endurance, the respiratory system, the muscle strength and the flexibility. The bodyweight and the percentage of body fat reduced after training about 2% while control groups were increased. Furthermore, Wai Khru Ram Muay Thai can improve the physical performance same as the Yoga training does. The measurement of parameters of the WT and the YT groups did not show significant difference. Finally, it is concluded that since the Wai Khru Ram Muay Thai can improve physical performance, it can become one type of exercises for health promotion based on Thai culture.

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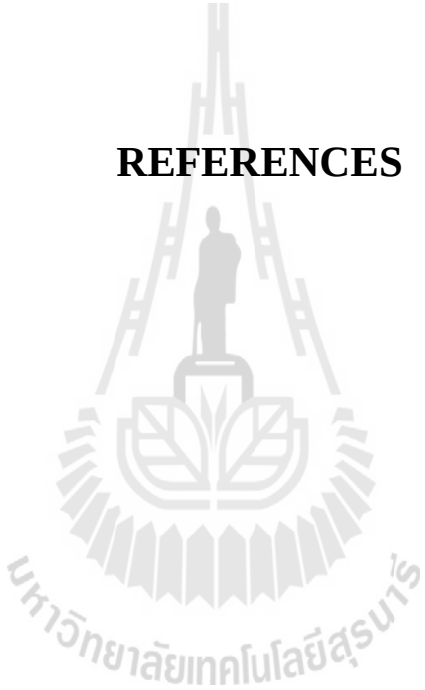

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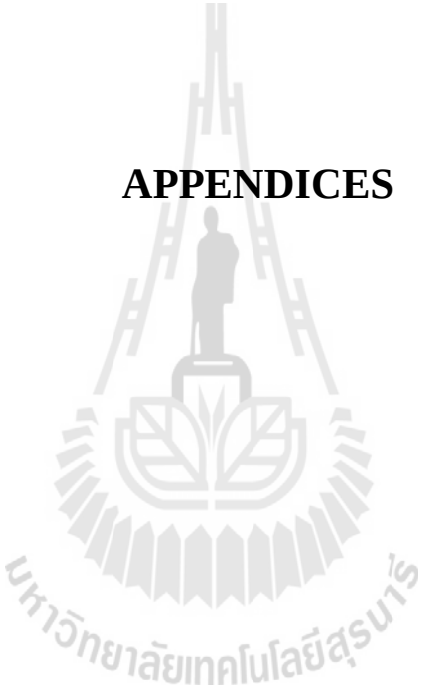
APPENDICES



APPENDIX A

RATING OF PERCEIVED EXERTION SCALES (RPE):

10 POINTS SCALE TYPE

10 Point Scale type

- 0 Nothing at all
- 1 Very light
- 2 Fairly light
- 3 Moderate
- 4 Some what hard
- 5 Hard
- 6
- 7 Very hard
- 8
- 9
- 10 Very, very hard

APPENDIX B

SUMMARY OF HEART RATE OF TRAINING GROUPS

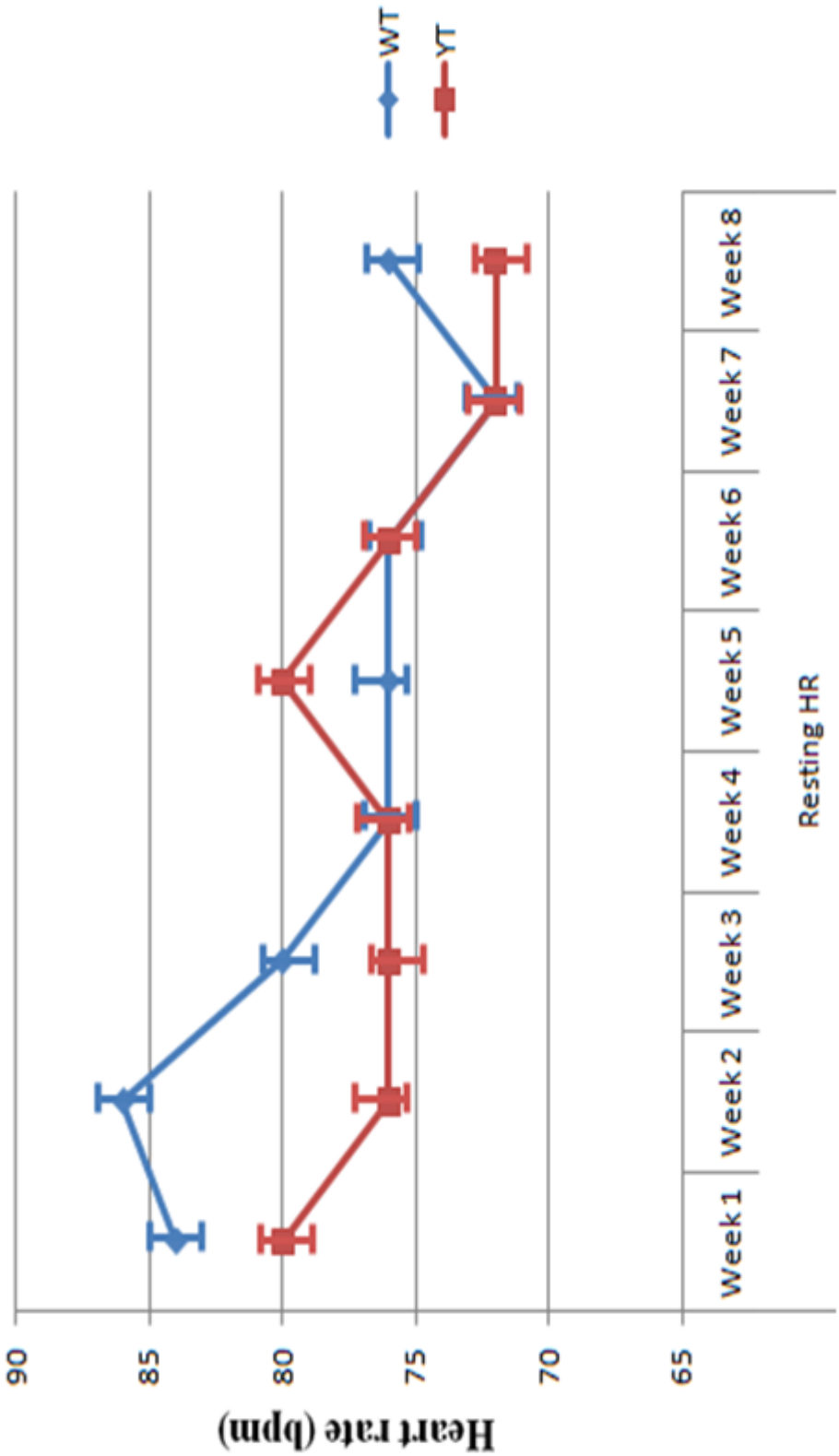


Figure 1B Summary of heart rate at rest for 8 weeks training.

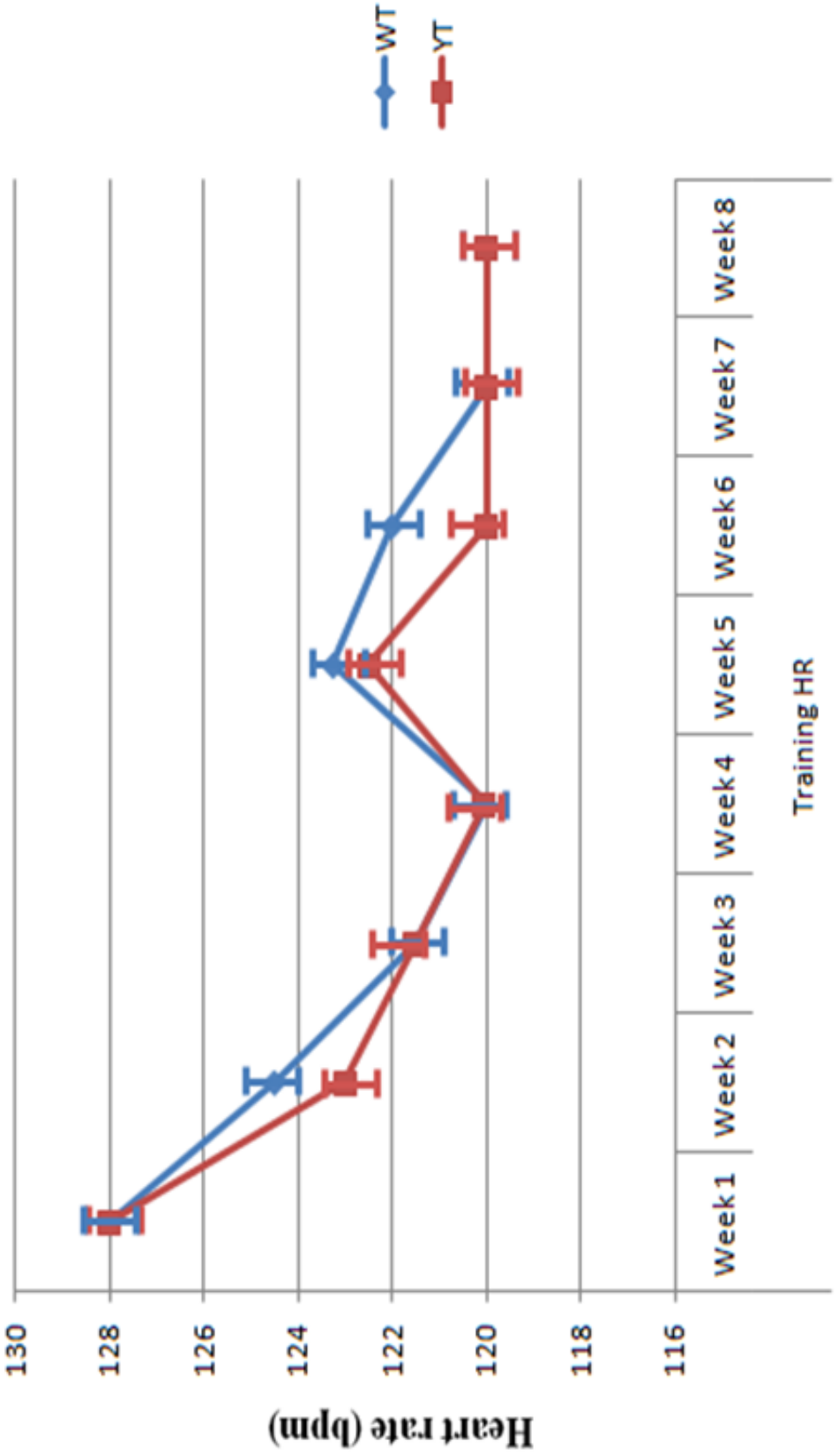


Figure 2B Summary of heart rate during training for 8 weeks training.

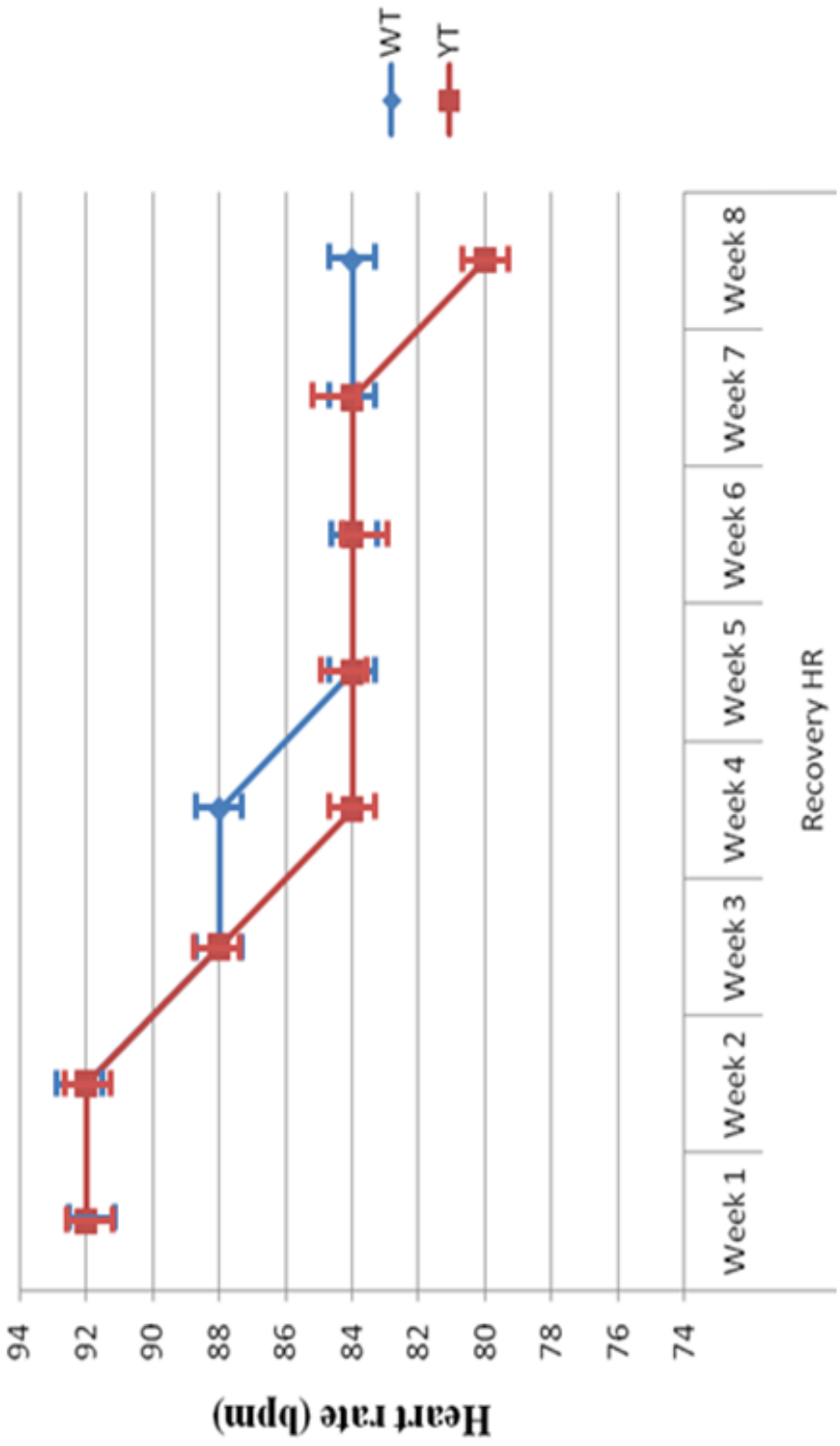


Figure 3B Summary of heart rate at recovery for 8 weeks training.

APPENDIX C

ETHICS COMMITTEE FOR RESEACHES INVOLVING HUMAN SUBJECTS APPROVAL

Ethics Committee

For

Researches Involving Human Subjects, Suranaree University of Technology

.....

Title of Project : Comparison of Physical Fitness Between Wai Khru Ram MuayThai and Yoga Training in Young Thai University Students

Pharmaceutical Protocol Number : --

Principal Investigator : Mr. Pattacha Krasaesieng

Department : School of Biology, Institute of Science

The aforementioned project has been reviewed and approved by Ethics Committee for Researches Involving Human Subjects, based on the Declaration of Helsinki.

Payom Buranasin

..... **Chairman**

(Ms. Payom Buranasin, M.D.)

Ethics Committee for Researches Involving Human Subjects,

Suranaree University of Technology

Date of Approval April, 2010 (Valid for 1 year)

Ethics Committee for Researches Involving Human Subjects, Suranaree University of Technology

Office : Institute of Research and Development, Suranaree University of Technology

Tel./Fax. : 0-4422-4750

APPENDIX D

SUBJECT'S HEALTH CONDITION QUESTIONNAIRE

แบบสอบถาม ประวัติการเจ็บป่วย

วันที่ตอบแบบสอบถาม .....

รหัสอาสาสมัคร: .....

เพศ ( ) ชาย ( ) หญิง

เกิดวัน เดือน ปี ...../...../..... อายุ ..... ปี

โทรศัพท์มือถือ .....

1. ประวัติทั่วไป

1.1 ท่านออกกำลังกาย หรือ ทำงานจนได้เหงื่ออย่างสม่ำเสมอ หรือไม่

( ) ใช่ ( ) ไม่ใช่

ถ้าใช่ ท่านออกกำลังกายเฉลี่ยสัปดาห์ละ ..... ครั้ง ครั้งละ

( ) น้อยกว่า 10 นาที ( ) 10-20 นาที ( ) มากกว่า 20-30 นาที ( ) มากกว่า 30 นาที

1.2 ปัจจุบันท่านสูบบุหรี่ หรือ ยาสูบอื่นๆ หรือไม่

( ) สูบ ..... (โปรดระบุจำนวนมวนที่สูบต่อวัน) ( ) ไม่สูบ

ถ้าสูบ ปัจจุบันท่านสูบบุหรี่มากน้อยเพียงใด

( ) สูบประจำ มานาน ... ปี ประมาณวันละ ..... มวน

( ) เคยสูบ แต่หยุดมานาน ..... ปี สูบมานาน ..... ปี จำนวนที่สูบ .....มวนต่อวัน

( ) สูบนานๆครั้ง

1.3 ปัจจุบันท่านดื่มเหล้าหรือเครื่องดื่มแอลกอฮอล์หรือไม่

( ) ดื่ม ( ) ไม่ดื่ม

ถ้าดื่ม ปัจจุบันท่านดื่มบ่อยมากน้อยเท่าใด

( ) ดื่มทุกวัน ( ) ดื่ม ..... ครั้ง / สัปดาห์

ปริมาณที่ดื่ม ..... แก้วต่อครั้ง

2. ประวัติการเจ็บป่วย

2.1 ท่านมีโรคประจำตัวหรือไม่ ( ) มี ( ) ไม่มี

ถ้ามี ท่านมีโรคประจำตัวอะไร

( ) โรคหัวใจ ( ) ความดันโลหิตสูง ( ) หอบหืด ( ) เบาหวาน

( ) ภูมิแพ้ ( ) โรคข้อและกระดูก ( ) อื่นๆ โปรดระบุ: _____

2.2 ท่านเคยได้รับการรักษาโดยการผ่าตัดหรือไม่ ( ) เคย ( ) ไม่เคย

ถ้าเคย ท่านได้รับการผ่าตัดที่ส่วนใดของร่างกาย

( ) สมอง( ) ดวงตา ( ) ไส้ติ่ง ( ) อื่นๆ โปรดระบุ: _____

2.3 ท่านเคยประสบอุบัติเหตุร้ายแรงจนต้องรับการผ่าตัดหรือไม่ ( ) เคย ( ) ไม่เคย

ถ้าเคย ท่านได้รับการผ่าตัดที่ส่วนใดของร่างกาย

( ) คอ ( ) แขน ขา ( ) หลัง ( ) อื่นๆ โปรดระบุ:_____

2.4 หากท่านเป็นผู้หญิงกรุณาตอบคำถามต่อไปนี้

2.4.1 ตามปกติ ประจำเดือนของท่านมาสม่ำเสมอหรือไม่

( ) สม่ำเสมอ จำนวนวันที่มี _____ วัน

โปรดระบุวันที่มาวันแรกของเดือนที่ตอบแบบสอบถาม _____

( ) ไม่สม่ำเสมอ

2.4.2 ถ้าประจำเดือนของท่านมาไม่สม่ำเสมอ จะมาประมาณ

( ) 2-3 เดือน / ครั้ง ( ) 4-6 เดือน / ครั้ง ( ) อื่นๆ โปรดระบุ:_____

CURRICULUM VITAE

Name: Mr. Pattacha Krasaesieng

Date of Birth: 12 March 1985

Place of Birth: Bangkok, Thailand

Education: He finished high school from Sarasit Pitayalai School, Ratchaburi in 2002, and got Bachelor degree (Occupational Health and Safety) from Suranaree University of Technology, Nakhon Ratchasima in 2007

Presentation:

Krasaesieng, P., Widjaja, W., Kupittayanant, S., and Thanee, N. Physical Fitness of Wai Khru Ram Muay Thai and Yoga Trainings in Young Thai University Students. **International Conference on Sports and Exercise Science (Pre-ASEAN University Games Conference 2010): Exercise & Sports as Medicine**. 11-14 December 2010, Chiang Mai, Thailand (Oral Presentation).

Publication:

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