ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและความเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน

นายสิทธา พงษ์พิบูลย์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
สาขาวิชาวิทยาศาสตร์การกีฬา
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ปีการศึกษา 2559

THE EFFECTS OF SPEED AND PATTERNS OF WALKING ON AEROBIC CAPACITY AND CORONARY HEART DISEASE RISK PROFILES IN MIDDLE-AGED OVERWEIGHT AND OBESE INDIVIDUALS

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A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Sports Science
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Thesis Title	THE EFFECTS OF SPEED AND PATTERNS OF WALKING ON AEROBIC CAPACITY AND CORONARY HEART DISEASE RISK PROFILES IN MIDDLE-AGED OVERWEIGHT AND OBESE INDIVIDUALS
By	Mr. Sitha Phongphibool
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สิทธา พงษ์พิบูลย์ : ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและความเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน (THE EFFECTS OF SPEED AND PATTERNS OF WALKING ON AEROBIC CAPACITY AND CORONARY HEART DISEASE RISK PROFILES IN MIDDLE-AGED OVERWEIGHT AND OBESE INDIVIDUALS) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ถนอมวงศ์ กฤษณ์เพ็ชร์, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: อรชุมา หุตะโกวิท, 162 หน้า.

การวิจัยนี้ มีวัตถุประสงค์เพื่อศึกษาผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักตัวเกินและอ้วน กลุ่มตัวอย่างเป็นอาสาสมัครที่มีน้ำหนักตัวเกินและอ้วน จำนวน 69 คน เป็นเพศชาย 16 คน และเป็นเพศหญิง 53 คน อายุ 40 – 60 ปีและมีปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจ อย่างน้อย 2 ข้อ กลุ่มตัวอย่างถูกแบ่งโดยใช้วิธีสุ่มแบบง่ายเพื่อจัดเข้ากลุ่ม 3 กลุ่ม ได้แก่ กลุ่ม A (เดินด้วยความเร็วที่ 70% ของความเร็วสูงสุด) กลุ่ม B (เดินด้วยความเร็วที่ 80% ของความเร็วสูงสุด) และกลุ่มควบคุม (เดินในความเร็วปกติ) กลุ่มอาสาสมัครได้รับการทดสอบสมรรถภาพก่อน และ หลังการฝึกออกกำลังกายโดยวิธี Bruce ramp protocol เพื่อประเมินความสามารถในการใช้ออกซิเจน จุดเปลี่ยนของการหายใจ และการตอบสนองทางสรีรทางกาย กลุ่ม A และกลุ่ม B ได้ทำการทดสอบการเดิน Intermittent Treadmill Walk Test (ITWT) เพื่อกำหนดความสามารถในการเดินเร็วสูงสุดและความเร็วที่ 70% และ 80% ของความเร็วสูงสุด การใช้พลังงานได้ถูกคำนวนเพื่อนำมากำหนดเวลาในการเดินในแต่ละกลุ่ม วิเคราะห์ความแตกต่างภายในกลุ่มก่อนและหลังได้รับการฝึกในด้าน คุณลักษณะทางกาย สรีรทางกาย และ โลหิตวิทยา ด้วย Paired t-test ส่วนการวิเคราะห์ความแตกต่างระหว่างกลุ่ม 3 กลุ่ม (70% และ 80% ของความเร็วสูงสุด และเดินในความเร็วปกติ) ใช้ One-way ANOVA และทดสอบต่อเนื่องด้วย LSD เพื่อหาความแตกระหว่างคู่ และเพื่อเปรียบเทียบกลุ่มการเดิน ที่เป็นรูปแบบกับกลุ่มการเดินที่ไม่เป็นรูปแบบ ทดสอบด้วย Independent t-test ที่ระดับนัยสำคัญที่ 0.05

ผลการวิจัยพบว่า หลังการทดลอง 10 สัปดาห์ พบว่ากลุ่ม A และกลุ่ม B มีการลดลงของน้ำหนักตัวอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 เมื่อเปรียบเทียบกับกลุ่มควบคุม อย่างไรก็ดี กลุ่ม B เท่านั้นที่แสดงให้เห็นถึงการลดลงของดัชนีมวลกาย เส้นรอบเอว เส้นรอบสะโพก อัตราส่วนรอบเอวต่อรอบสะโพก และเปอร์เซ็นต์ไขมันอย่างมีนัยสำคัญทางสถิติ 0.05 กลุ่มทดลองและกลุ่มควบคุม มีการเปลี่ยนแปลงของอัตราการเต้นของหัวใจในขณะพักลดลงหลังการฝึกซ้อมอย่างมีนัยสำคัญทางสถิติ 0.05 กลุ่ม A มีการเปลี่ยนแปลงของความดันโลหิตซีสโตลิคและไดแอสโตลิคในขณะพักอย่างมีนัยสำคัญทางสถิติ 0.05 ในขณะที่กลุ่มควบคุม มีการเปลี่ยนแปลงของความดันโลหิตซีสโตลิคในขณะพักและความดันโลหิตไดแอสโตลิคที่สูงสุดอย่างมีนัยสำคัญทางสถิติ 0.05 ในขณะที่ กลุ่ม B ไม่มีการเปลี่ยนแปลงของความดันโลหิต

หลังการทดลอง 10 สัปดาห์ กลุ่ม A และกลุ่ม B มีการเพิ่มของความสามารถในการใช้ออกซิเจนสูงสุดหลังการฝึกซ้อมอย่างมีนัยสำคัญทางสถิติ 0.05 เมื่อเปรียบเทียบกับกลุ่มควบคุม กลุ่มทดลองและกลุ่มควบคุมมีการเพิ่มของจุดเปลี่ยนของการหายใจ ความเร็วของการเดินสายพานในการทดสอบ และเวลาในการเดินทดสอบอย่างมีนัยสำคัญทางสถิติ 0.05 ในกรณีของปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจ กลุ่ม B มีการลดลงของคอเลสเตอรอลทั้งหมด ไตรกลีเซอไรด์ แอลดีแอล-คอเลสเตอรอล และอัตราส่วนของคอเลสเตอรอลทั้งหมดต่อเอชดีแอลอย่างมีนัยสำคัญทางสถิติ 0.05 กลุ่ม A และกลุ่มควบคุม

เมื่อเปรียบเทียบระหว่างกลุ่ม พบว่า กลุ่ม A และกลุ่ม B มีการเพิ่มของความสามารถในการใช้ออกซิเจนสูงสุด จุดเปลี่ยนของการหายใจ และมีการลดของคอเลสเตอรอลทั้งหมดและไตรกลีเซอไรด์อย่างมีนัยสำคัญทางสถิติ 0.05 เมื่อเปรียบเทียบกับกลุ่มควบคุม และเมื่อเปรียบเทียบระหว่างกลุ่มการเดินที่เป็นรูปแบบสามารถเพิ่มความสามารถในการใช้ออกซิเจนสูงสุดและเพิ่มจุดเปลี่ยนของการหายใจ และสามารถลดอัตราส่วนรอบเอวต่อรอบสะโพกและลดคอเลสเตอรอลทั้งหมดได้อย่างมีนัยสำคัญทางสถิติ 0.05 เมื่อเปรียบเทียบกับกลุ่มการเดินที่ไม่เป็นรูปแบบ

สรุปได้ว่า การฝึกเดินด้วยความเร็ว 70% และ 80% ของความเร็วสูงสุดและเป็นรูปแบบจะช่วยเพิ่มความสามารถในการใช้ออกซิเจนสูงสุด เพิ่มจุดเปลี่ยนของการหายใจ และปรับเปลี่ยนปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจโดยช่วยลดอัตราส่วนรอบเอวต่อรอบสะโพก ปรับเปลี่ยนคอเลสเตอรอลทั้งหมด ไตรกลีเซอไรด์ แอลดีแอล-คอเลสเตอรอล และอัตราส่วนของคอเลสเตอรอลทั้งหมดต่อเอชดีแอลให้ลดลง การเดินในความเร็วที่เหมาะสมและเป็นรูปแบบส่งผลให้มีการเปลี่ยนแปลงทางสรีรวิทยาได้

สาขาวิชา วิทยาศาสตร์การกีฬา	ลายมือชื่อนิสิต ....
ปีการศึกษา 2559	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....
	ลายมือชื่อ อ.ที่ปรึกษาร่วม ....

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KEYWORDS: AEROBIC CAPACITY / VO2 PEAK / OVERWEIGHT / WALKING / CHD RISKS

SITHA PHONGPHIBOOL: THE EFFECTS OF SPEED AND PATTERNS OF WALKING ON AEROBIC CAPACITY AND CORONARY HEART DISEASE RISK PROFILES IN MIDDLE-AGED OVERWEIGHT AND OBESE INDIVIDUALS. ADVISOR: PROF. THANOMWONG KRITPET, Ph.D., CO-ADVISOR: ORNCHUMA HUTAGOVIT, MD, 162 pp.

The aim of this study was to investigate the effects of speed and the patterns of walking on aerobic capacity and Coronary Heart Disease (CHD) risk profiles in middle-aged overweight and obese individuals. Sixty-nine overweight and obese volunteers, 16 males and 53 females, aged 40-60 years old with at least 2 risk factors for CHD were recruited for this study. A simple randomization technique was employed to allocate the subjects into one of the three specific groups, Group A: a speed of 70% walking speed; Group B: a speed of 80% of walking speed; Group C: Self-paced walking. All groups performed Bruce ramp protocol at pre- and port-training to assess aerobic capacity, ventilator threshold, and physiological responses. Group A and Group B underwent Intermittent Treadmill Walk Test (ITWT) to determine maximal walking speed and 70% and 80% speed of maximal walking speed. Energy expenditure was calculated and specific walk time for each group was determined. Baseline characteristics were expressed in mean and standard deviation (SD). Intra-group differences at pre- and post-training in morphological, physiological, and hematological variables were analyzed by paired t-test. The One-way ANOVA was employed to determine the variability of the data among the three groups (70%, 80%, and self-regulated) with LSD post hoc test to detect any significant differences. Furthermore, to determine the effect of patterns of walking, the structured groups were combined and compared with the unstructured group. The independent t-test was utilized to determine the differences between the two patterns of walking with significant difference was set at $p < 0.05$.

Results: After 10 weeks of study, the findings of the speed of walking showed that Group A and Group B significantly decrease in body weight ($p < 0.05$) at post-training when compared to the Control. However, only Group B showed significant reduction in body mass index (BMI), waist and hip circumference, waist to hip ratio (WHR), and percent body fat ($p < 0.05$) at post-training. All study groups exhibited a significant reduction in resting heart rate at post-training ($p < 0.05$). Group A showed significant decreased in resting systolic and diastolic blood pressure ($p < 0.05$) while Control exhibited significant reduction in resting systolic blood pressure and peak diastolic blood pressure ($p < 0.05$) at post-training. No change in blood pressure was observed in Group B.

After 10 weeks of training, Group A and Group B exhibited significant increase in VO_2 peak at post-training when compared to Control ($p < 0.05$). All groups showed significant improvement in ventilator threshold, maximal treadmill speed and treadmill time ($p < 0.05$) at post-training. In terms of CHD risk profiles, Group B showed a significant reduction in total cholesterol, triglycerides, LDL-Cholesterol, and CHOL/HDL ratio ($p < 0.05$) at post-training. No improvement in these parameters were observed in Group A and Control.

When the change of these parameters were compared between groups, Group A and Group B exhibited significant increase VO_2 peak and ventilator threshold and significant decrease in total cholesterol and triglycerides ($p < 0.05$) when compared to Control. The improvement in these parameters were more pronounced in Group B.

After 10 weeks of study, the findings of the patterns of walking showed that the structured pattern of walking significantly increase in VO_2 peak and ventilator threshold and significantly decrease in waist to hip ratio (WHR) and total cholesterol ($p < 0.05$) when compared to unstructured pattern of walking.

Conclusion: The speed of walking at 70% and 80% of maximal walking speed and the structured pattern of walking improves aerobic capacity, ventilator threshold, and modifies CHD risk profiles in terms of waist to hip ratio, total cholesterol, triglycerides, LDL-Cholesterol, and CHOL/HDL ratio. Walking at optimal speed and in a structured setting results in physiological improvement.

Field of Study: Sports Science

Academic Year: 2016

Student's Signature ______________

Advisor's Signature ______________

Co-Advisor's Signature ______________

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CHAPTER I

INTRODUCTION

Physical inactivity is considered a risk factor for a number of illnesses and for all causes of mortality. Individuals in the society do not engage in sufficient physical activity to realize its benefits. According to the United States Surgeon General's Report (1996), sedentary behavior is linked to coronary heart disease (CHD), type 2 diabetes, hypertension, obesity, osteoporosis, and depression. The data revealed that more than 60% of adults do not participate in regular physical activity on the regular basis and 31% of these sedentary adults are not exercising at all. Furthermore, the prevalence of inactivity is highest among adults aged greater than 65 and evidence further suggested that 50% of those inactive individuals do not plan to start an exercise program in the near future. The Thai National Statistic Office (2011) showed that the majority of Thai people are not currently active enough. The data demonstrated that only 26.1% of individuals that were older than 11 years old—including middle-aged adults—engaged in regular exercise training. Likewise, out of those that engaged in exercise training, only 7.3% exercised on the regular basis and the main purpose for regular exercise participation was to improve one's health. Survey conducted by the Department of Disease Control, Ministry of Public Health, Thailand (2015) revealed that 19.7% of Thai males were overweight and only 5.0% were obese whereas 26.1% of Thai females were overweight and 9.8% were obese. The report showed that Thai females are more prone to being overweight and obese than their gender counterpart.

Participation in regular physical activity is an important health behavior in preventing overweight and obesity and in reducing the severity of many non-communicable diseases. Major organizations in health promotion and disease prevention such as the American College of Sports Medicine (ACSM), American Heart Association (AHA), American Diabetes Association (ADA), World Health Organization (WHO), Center and Disease Control and Prevention (CDC), and Institute of Medicine (IOM) all have encouraged that individuals to be physically active.

Evidence has demonstrated the proven effect of physical activity and exercise in terms of disease prevention. Knowler et al. (2002) compared the effectiveness of metformin or lifestyle intervention (i.e. exercise) in the prevention of type II diabetes. In this study, 3234 non-diabetic subjects who were overweight or obese and manifested an elevated fasting and post-loaded plasma glucose were randomly assigned to metformin or lifestyle group. In the lifestyle group, subjects were instructed to engage in brisk walking as a form of exercise for 150 minutes per week and they were followed for 2.8 years. At the conclusion of the study, the result revealed that the lifestyle intervention group reduced the incidence of diabetes by 58% when compared to the metformin group (31%). The investigators concluded that lifestyle intervention (i.e. exercise) was more effective in the prevention of diabetes than the use of metformin.

Physically active of sufficient volume can likewise result in morphological change. McInnis (2000) stated that physical activity--particularly endurance exercise--of sufficient intensity, duration, and frequency has favorable effect on weight loss and total fat distribution. Similarly, Jakicic and Gallagher

(2003) examined the effect of exercise duration and intensity on weight loss in overweight, sedentary women and found that women with greater levels of exercise had greater magnitude of weight loss following the 12 months exercise intervention. The investigators concluded that much of the weight loss was due to the highest amount of energy expended during exercise training.

Expending significant amount of energy not only beneficial to weight loss, but it also exerts significant physiological change to the coronary artery when coupled with proper diet. Hambrech et al. (1993) investigated the intensity of leisure time physical activity in patients with Coronary Artery Disease (CAD). The result revealed that patients on anti-atherogenic diet who expended approximately 1,600 calories per week through exercise may arrested the progression of atherosclerotic lesions, whereas overall regression of atherosclerotic plaque was observed only in those who expended 2,200 calories per week. The investigators concluded that adequate caloric expenditure along with proper kind of diet can produce significant change to the progression of Coronary Artery Disease (CAD).

Being active on a regular basis at optimal intensity, frequency, and duration will also result in the improvement of cardiovascular fitness, which is an important component for survival in both healthy and clinical populations. Squires (1998) stated that heart failure individuals who have maximal aerobic capacity of less than 10 ml/kg/min have up to 49% chance of early mortality in the next year. Conversely, heart failure individuals who have maximal aerobic capacity of greater than 18 ml/kg/min is associated with excellent chance of survival and better prognostic outlook compare to those with lower value. Evidence also showed an inverse association between high level of cardiovascular fitness and mortality (i.e.

highest fitness lower mortality) (ACSM, 2014). Dorn et. al. (1999) revealed that for every MET (i.e. 1 MET = 3.5 ml/kg/min) improvement in aerobic capacity translates to 12% improvement in survival in all groups.

Walking is the best form of physical activity and exercise. It is easily accessible, does not require special equipment, can be perform anywhere, requires no special training, and elicits numerous health benefits. Jakicic et al. (2003) conducted a 12 months walking study to assess the relationship in weight loss and the amount of walking in overweight sedentary women. In this study, 201 sedentary obese women with the mean age of 37 years old and the mean BMI of 32.6 kg/m^2 were recruited to participate in the study and were randomized into 4 exercise groups at different intensity and duration (i.e. vigorous intensity/high duration; moderate intensity/high duration; vigorous intensity/moderate duration; moderate intensity/moderate duration). Walking was utilized as a form of exercise and the subjects were instructed to walk 5 days per week and to maintain the walking intensity by monitoring their prescribed target heart rate and the rating of perceived exertion (RPE). At the conclusion of the study, weight loss was statistically significant after the intervention and occurred in all exercise groups. The group that performed vigorous intensity/high duration appeared to lose more weight than the other groups; however, the amount of weight reduction was not statistically significant between exercise groups. The investigators concluded that the amount of weight loss was related to the amount of exercise (walking) performed.

Other investigators also looked at the relationship between walking and the risk of cardiovascular events. The Women's Health Initiative Study showed that there was a 30% reduction in cardiovascular events among women who engaged in brisk walking for just 2.5 hours per week (Mason, 2002). In addition, the Nurses' Health Study, which followed 72,488 healthy middle-aged female nurses for eight years, showed a 30-40% lower rate of myocardial infarction in the female nurses who walked briskly for 3 to 4 hours per week or exercised vigorously for 1.5 hours per week compared to their sedentary counterparts (Mason, 1999). The investigators concluded from the findings that the more an individual walked, the lower the risk of developing a future cardiovascular event.

Despite the fact that past research had looked at the amount of walking on physiological and morphological changes and the risk of developing cardiovascular emergency, none had assessed the impact and the importance of the pattern and the velocity of walking in terms of improving aerobic capacity and modifying risk factors for coronary heart disease (CHD). Therefore, further research is warranted to investigate the efficacy of speed and patterns of walking on aerobic capacity and CHD risk profile.

Rationale

Walking is the most fundamental form of physical activity and exercise. It is easy, economical, and can be performed anywhere at any time. Moreover, it is less stressful on the joints when compared to running and requires no special equipment or training other than a good pair of walking or running shoes. If performed frequently enough, walking can be as effective as other forms of exercise for health enhancement and improving physical fitness. Current health recommendation suggests that most individuals should engage in 30 minutes of daily physical activity or should accumulate up to 150 minutes or more of physical activity at moderate intensity per week in order to gain health benefits and prevent the occurrence of diseases (ACSM, 2014; AHA, 2013). This amount of physical activity can be obtained easily by engaging in a daily brisk walking. The walking session can be continuous or intermittent throughout the day depending on individuals' preferences or circumstances.

Previous studies (Laukkanen et al., 2001; Mason et al., 2002; Kelley et al., 2004; Murtagh et al., 2004; Schwarz et al., 2005; Houel et al., 2013) revealed the beneficial effects of walking on physical fitness, physiological adaptation, morphological changes, and improvement in survivability. However, most of these studies did not control for the energy expenditure of walking or the walking pace utilized by the subjects. These studies recommended that their subjects walked briskly or walked regularly as much as possible throughout the study and the volume of walking was controlled by time, by energy expenditure, or the number of steps taken during the session. In addition, the effects of patterns on walking (i.e. structured or unstructured) outcome were not compared. While these methods may sound promising, the problem posed was that brisk walking might be perceived as easy by one person but quiet difficult for another. The perception of easy or hard while walking may have influenced the outcome. Furthermore, individuals may not expended the same amount of energy even though they walked at the same amount of time or had taken the same number of steps. This is because the individuals may have walked at a different pace that will result in the different amount of energy being utilized. Energy expenditure during walking is dependent of walking pace, body weight, and environment (i.e. more energy is expended if one were to walk faster, having higher body weight, or walking on an uneven ground) (Morris, 1997).

Previous research conducted by Asikainen et al. (2002) showed that walking can be as effective as other forms of exercise for stimulating physiological change. When sufficient was energy expended during walking (i.e. 1,000 calorie per week), positive improvement in aerobic fitness occurred. To achieve sufficient energy expenditure, ones must engage in more frequent or longer duration of physical activity. Knowler et al. (2002) also discovered similar finding on physical activity and health. Their research revealed that 150 minutes of physical activity per week—obtained in an accumulated manner—was sufficient to prevent the onset of diabetes. However, this amount of physical activity (i.e. 150 minutes per week) may not be enough to prevent weight gain, induce further weight reduction, or modify certain risk factors (Jakicic, 2001 & 2003). Consequently, greater amount of time may be required if further health benefits were to improve. Schwarz et al. (2005) revealed that walking velocity affected the physiological responses in healthy recreational athletes. Their studies demonstrated that walking velocity of 70%, 80%, and 90% of maximal walking velocity increased in oxygen consumption, heart rate, lactate concentration, and energy expenditure. The investigator also discovered that the walking velocity of 70% of maximal velocity was the minimum threshold (55%VO_2max) for the improvement in cardiorespiratory endurance (ACSM, 2014). On the other hand, the velocity of 90% of maximal walking velocity was too exhausting and placed too much strain on the body; thus, faster velocity was not recommended in those with medical condition. To achieve health benefits from walking, the investigators advised that the lower end of the velocity continuum (70% max walking velocity) should be sought after. Despite, the changes that were observed during the study, this changes were acute responses. Chronic adaptation as a result of walking at various velocities was not study at the time.

For this reason, the present investigation will attempt to explore the physiological and morphological changes that result from walking at different speed such as 70%, 80%, and self-regulated when the energy expenditure of walking was controlled to 1,000 calories per week in overweight and obese middle-aged individuals. All groups will engage in a different amount on walking (i.e. frequency and duration). It is estimated that walking frequency is 3-5 days per week or approximate duration of walking is approximately 300 minutes.

Statement of problem

In overweight and obese individuals who are at risk for developing coronary heart disease (CHD), walking is perhaps the most appropriate form of exercise since it is less stressful on the body (i.e. low impact, less metabolic demand, and less taxing on the heart) and has many physiological and psychological benefits. It improves circulation, enhances physical function, and heightens sense of well-being. Although, the benefits of regular walking are well documented in the past and many studies have utilized healthy populations. Less is known about physiological responses to the speed and patterns of walking in overweight and obese individuals who are at risk for developing CHD. Furthermore, the speed selection and the patterns of walking may also differ between healthy and overweight and obese populations.

Research objectives

1. To investigate and compare the effects of the speed of walking on aerobic capacity and coronary heart disease (CHD) risk profiles in overweight and obese individuals.

2. To investigate and compare the effects of patterns of walking (i.e. structured vs unstructured) on aerobic capacity and coronary heart disease (CHD) risk profiles in overweight and obese individuals.

3. To compare the baseline characteristics such as morphology and physiology variables between the overweight and obese males and females.

Hypothesis

1. The speed of walking will affect the outcome on the aerobic capacity and CHD risk profiles.

2. The patterns of walking (i.e. structured vs unstructured) will affect the outcome on the aerobic capacity and CHD risk profiles.

3. Males and females will differ in the baseline morphological and physiological variables.

Research scope

Subjects

This study assessed the effect of speed and patterns of walking on aerobic capacity and CHD risk profiles in overweight and obese middle-aged individuals. For this study, sixty-nine volunteered health department personnel and hospital staff, aged 40 - 60 years old who were overweight and obese men and women with 2 or more CHD risk factors were recruited and randomly allocated into 3 groups as follow:

1. Groups A: This group underwent a 10 weeks of walking program at 70% of maximal walking speed. The subjects engaged in a walking program of 3-5 times per week in an attempt to expend 1,000 calories per week. The time utilized during the walking session vary depending on individual's rate of energy expenditure. Basic instruction on physical activity and diet were provided.

2. Group B: This group underwent a 10 weeks of walking program at 80% of maximal walking speed. The subjects engaged in a walking program of 3-5 times per week in an attempt to expend 1,000 calories per week. The time utilized during the walking session vary depending on individual's rate of energy expenditure. Basic instruction on physical activity and diet were provided.

3. Group C: This group did not receive any exercise intervention. However, they were engaged to carry out a normal physical activity and were also encouraged to accumulate the total time of 300 minutes of leisurely walking per week in order to expend 1,000 calories per week. Basic instruction on physical activity and diet were provided. The subjects were provided with a pedometer (OMRON HJ-323u-triaxis, Japan) to track the amount of steps taken per day. The investigator contacted the subjects every 2 weeks to obtain the amount of steps that the subject

walked per day by downloading the pedometer data on to the computer. The pedometer was capable of storing the data such as step count, distance, and calories expended up to 22 days.

The exercise testing and exercise sessions were be carried out at the Faculty of Sports Science, Chulalongkorn University and/or at the subjects' hospital fitness facilities. For this study, the investigator was not able to control the dietary habits and the amount of daily physical activity (occupation, household, and leisure) performed.

Operational definition

Aerobic Capacity: Is the maximal amount of oxygen that the body can utilize during extreme physical exertion. The term "aerobic capacity" is often used synonymously with "maximal oxygen consumption or VO_2 max or VO_2 peak." Aerobic capacity is an important determinant of physical fitness and physical endurance and is typically expressed as Liter per minute (L/min) or milliliter per kilogram of body weight per minutes (ml/kg/min)

Coronary Heart Disease (CHD): Is an atherosclerotic disease that affects the coronary circulation as a result of plaque accumulation that interfere with blood flow

Coronary Heart Disease Risk Profiles: Are the overall risk factors that contribute to the development of Coronary Heart Disease (CHD) such as elevate blood pressure, impaired fasting glucose or diabetes, elevate total cholesterol, elevate triglycerides, elevate LDL-cholesterol, low HDL-cholesterol, high waist circumference, elevate high sensitivity C-Reactive Protein (hs-CRP), and being overweight or obese

Metabolic Equivalent (MET): Is a physical measure that expresses the energy cost and oxygen consumption of physical activity.

Middle-Age Adults: Is the period beyond young adulthood and before the onset of old age. For this research individuals aged ≥40 and ≤60 years old will be recruited.

Overweight: Having body mass index ≥23kg/m2 but <25 kg/m2 (WHO, 2000 & Tang, 2012)

Obesity: Having BMI ≥25 kg/m^2 (WHO, 2000 & Tang, 2012)

Underweight	≤18.5 kg/m^2
Normal range	18.5 – 22.9 kg/m^2
Overweight	23.0 – 24.9 kg/m^2
Obese I	25.0 – 29.9 kg/m^2
Obese II	≥30 kg/m^2

Overweight and obesity classification for Asian-Pacific guidelines (WHO, 2000 & Tang, 2012)

Structured Walking: A type of walking that is carried out at specific intensity and duration in an exercise facility at a specific time in order to expend specific amount of calories.

Unstructured Walking: A the type of walking that is carried out on the daily basis in different settings without the use of an exercise facility.

Benefits expected from the study

Benefit in terms of sports science

1. To be able to explain how aerobic capacity and CHD risk profiles are influenced by the speed and patterns of walking (i.e. structured vs unstructured).

2. To learn how specific type of walking patterns (i.e. structured vs unstructured) will better enhance physiological and morphological changes in overweight and obese individuals who are at risk for CHD.

3. Identify specific walking speed that can be prescribed to those at risk for developing CHD or to those with existing conditions.

Benefits in terms of new knowledge

1. The specific walking speed and pattern can be utilized for fitness improvement and health enhancement.

2. The specific walking speed can be customized to fit individual's exercise program—for those that are healthy and those with medical conditions.

3. The appropriate patterns of walking can be selected for the modification of cardiorespiratory fitness and CHD risk profiles in those who are overweight and obese.

CHAPTER II

LITERATURE REVIEW

The aim of this study was to investigate the effects the speed of walking and the pattern (i.e. structured vs unstructured) of walking on aerobic capacity and the CHD risk profiles in middle-aged overweight and obese individuals. This chapter explored and discussed the following topics:

1. Aerobic capacity
2. Coronary Heart Disease (CHD)
3. Walking
4. Walking as a form of exercise
5. Walking, aerobic capacity, and mortality
6. Walking and CHD risks

Aerobic capacity

Aerobic capacity, functional capacity, and maximal or peak oxygen consumption (VO_2max or VO_2peak) are used synonymously and are generally referred to “the maximal amount of oxygen that the body can consume and utilize during extreme physical exertion” (ACSM, 2014). It is an important measurement because it defines the limits of the cardiopulmonary system and physical fitness (Balady et al., 2010). For the purpose of this literature review, the term “aerobic capacity” will be used in reference of “the maximal amount of oxygen consumption”.

Possessing high aerobic capacity is beneficial to ones’ health and it is generally an indication of good cardiorespiratory fitness. It improves heart and lungs conditions, reduces the risk of early mortality from all causes (AACVPR, 2006; Balady et al., 2010; ACSM, 2014), and prevents the chance of developing diseases such as heart disease, diabetes, hypertension, stroke, or colon cancer (Fletcher et al., 2013; ACSM, 2014). Research has shown clinical importance of aerobic capacity in predicting survivability. The data revealed that in the clinical population such as people with chronic heart failure who has maximal aerobic capacity less than 10 ml/kg/min have a 1-year survivability of 47%. Conversely, heart failure individual who has maximal aerobic capacity greater than 14 ml/kg/min is associated with excellent chance of survival (1-year survivability of 94%) and better prognostic outlook than those who are lower (Balady et al., 2010). Data also indicated that for every 1 MET (3.5 ml/kg/min) increase in aerobic capacity translates to 12% improvement in survival (Balady et al., 2010; Fletcher et al., 2013; ACSM, 2014).

Blair et al. (1989) evaluated middle-aged men (n=10,224) and women (n=3,120) patients with maximal treadmill exercise test for their fitness levels. The subjects were categorized into different fitness levels (i.e. low, moderate, and high) and were followed for an average of 8 years. What the investigators discovered was that the death rate from coronary incidence was lower in those who possessed high fitness level (3.1 for males; 0.8 for females) when compared to those with low fitness level (24.6 for males; 7.4 for females). Blair et al. (1995) also further assessed in the change is aerobic capacity and the risk of mortality. A large number of men (n=9,777) ages range of 20-82 years old underwent two maximal treadmill exercise test at a mean interval of 4.9 years and these subjects were followed for 5.1 years to assess the change in physical fitness on the risk of coronary death. The investigators found that more deaths from coronary events occurred in those that were unfit.

Conversely, those that improved in their physical fitness (increased aerobic capacity) experienced an age-adjusted relative risk of 0.48 (52% reduction in risk; 95% confidence interval 0.31-0.74). From the data provided, it is clear that aerobic capacity contribute to the survivability; thus, improvement in aerobic capacity will contribute to longer life span and improve quality of life.

Coronary Heart Disease (CHD)

Coronary Heart Disease (CHD) or sometimes referred to it as "Coronary Artery Disease" (CAD) is an atherosclerotic disease affecting the arteries of the coronary circulation. CHD is typically presents as either angina pectoris or myocardial infarction that is due to the blockage in the coronary arteries as a result of plaque accumulation that interfere with blood flow (AACVPR, 2006; ACSM, 2014). CHD is the most common causes of heart disease and affected many individuals. Data showed that individuals with CHD have 5 to 7 times the risk of having a heart attack higher than general population (Lloyd-Jones et al., 2010). The US healthcare services had estimated that the direct cost of CHD had exceeded 150 billion dollars annually and this expense is likely to escalate in the future (CDC, 2013). Furthermore, CHD is not only affecting the industrialized nations, developing country such as Thailand is also affected as well. Currently, vast numbers of populations—especially middle-aged and elderly are affected by this condition. The economic cost (i.e. direct and indirect) of CHD in Thailand is believed to be high but the exact figure is yet to be precisely determined due to the lack of reliable database.

The specific cause of CHD cannot be pinpointed, however, there are many risk factors that may contribute to the occurrence of this disease some of which is modifiable and non-modifiable such as elevated blood pressure, elevated total cholesterol, elevated LDL-cholesterol, low HDL-cholesterol, diabetes mellitus, obesity, high waist circumference, physical inactivity, elevated triglycerides, inflammatory markers (e.g. C-reactive protein), ethnicity, and advancing age. All these risk factors can be categorized into three classes: independent risk factors, predisposing risk factors, and conditional risk factors (Grundy et al., 1999).

To reduce the incidence of CHD is to modify all the risk factors that will likely cause the condition. For instance, lipid management is strongly encouraged in those with established CHD. The National Cholesterol Education Program (NCEP): Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adults Treatment Panel III) (Grundy et al., 2001) recommends that lipid management should be aggressively targeted to lower total cholesterol, LDL-cholesterol, triglycerides, non-HDL-cholesterol, and to increase HDL-cholesterol as these lipoproteins have been shown to be independently related to the development of CHD. The NCEP ATP III encouraged those with CHD and CHD equivalent to alter the risk factors by means of diet, exercise, and engage in a healthy lifestyle.

Walking

Walking is a form of physical activity. Every individual has to walk on the daily basis. It allows us to carry out the activity of daily living, improves our physical function, and fundamentally important to our lives. Waking can be done practically anywhere, requires no special equipment or facility, and no special training is needed. If done on a regular basis at appropriate intensity, duration, and frequency, walking can produce similar benefits to other types of exercise. Dunn et al. (1998)

showed that when sedentary individuals were asked to increase physical activity, they did so by increased their walking activity by 20 minutes per day. Thus, walking appeared to be the preferred choice of activity for most sedentary individuals who intended to increase their physical activity.

Walking can be performed at any speed and can be done alone or in a group; furthermore, it can also be classified as exercise in an instance when an individual is performing for the purpose of health enhancement. It has been proven that walking is an important part of weight management (Brown, 2005). It induces energy expenditure that will aid in weight reduction. The more the individual walks, the more calories he/she will expend. The caloric deficit of walking is dependent on speed and distance achieved. Typically, the rate of energy expenditure increases in a curvilinear manner with walking speed. Faster walking speed and longer distance covered will result in higher energy expenditure.

Many experts in the field of health promotion and rehabilitation believe that walking is "the nearest to perfect exercise" (Murphy et al., 2007). According to Browning et al. (2005), walking is relatively a safe form of exercise. It is less stressful on the body in terms of metabolic demand, the workload on the heart, and easy on the joints. The rate of injury is extremely lower when compared to running (Barough, 2003; Hootman, 2003). Walking is generally encouraged and recommended for those that are sedentary, overweight, and elderly in order to improve physical fitness and improve quality of life. There are several known types of walking and are defined as followed: (Barough, 2003; ACSM, 2014)

1. Leisurely walking or stroll is a type of walking that is done in an unhurried manner. It is typically done on the daily basis at a slower pace, as an

individual is engaging in physical activity of daily living such as walking to the bathroom, in the living room, etc.

2. Average walking is the type of walking that the pace is comfortable to an individual. Everyone has his/her own preferred walking pace. This type of walking is neither fast nor slow and is considered to be self-regulated.

3. Brisk walking is a type of walking that is done quickly and in a hurried manner. This type of walking is done for health benefits or as a form of exercise. Brisk walking has been shown to improve health and physical fitness (Fletcher et al., 2013; ACSM, 2014).

4. Race walking is the type of walking that is done in the competition. This type of walking is not generally performed in our daily lives. Race walking is reserved for competitive events and not suitable for certain group of individuals such as elderly or those with medical conditions.

Walking as a form of exercise

Walking is an easy option for exercise. It is the most natural and fundamental form of human movement (Barough, 2003). Regular walking whether leisurely or briskly contributes to the substantial portion of energy expenditure associated with physical activity of free-living and it has been reported to be the preferred form of exercise in sedentary and overweight individuals (Dunn et al., 1998; ACSM, 2014). People who walk for exercise do so at a varying pace. Some walk leisurely at low intensity while others zip along at vigorous pace that results in a sweatier workout. Walking at faster or slower speed will eventually result in health benefits; nevertheless, when it comes to improve cardiorespiratory fitness and reduce the risks of morbidity and mortality, not all walking speeds are created equal. Faster walking speed is superior to the slower one in terms of risks alteration. Williams et al. (2013) found that greater walking intensity is associated with a lower prevalence of type 2 diabetes, hypertension, and hypercholesterolemia when adjusted for distance. Study also showed that the risk of coronary events was 25% lower for walking 2 to 2.9 mph, and 36% lower for walking ≥3 mph relative to those who walked <2 mph, even when adjusted MET/hours/day walked.

Current exercise guidelines recommend that for health purposes, an individual should engage in 30 minutes of moderate intensity physical activity on most days of the week. This moderate intensity translates into approximately 3.5 mph (5.6 kmph) to 4.0 mph (6.4 kmph) of walking speed. Williams et al. (2013) suggested that there are greater health benefits that can be obtained from pursuing faster walking speed. Brisk walking cause favorable physiological changes that slower speed cannot replicate such as improved cardiorespiratory fitness, increased lean body mass, enhanced physical endurance, and higher body fat reduction. Therefore, to improve general health benefits, walking at all speeds is considered crucial. However, if improve physical fitness is the main concern, then walking at a faster speed (briskly) is required to increase further physiological enhancement.

Walking and health related-physical fitness

Domestically, research on walking had been conducted to assess its effectiveness on physiological responses; however, the amount of research on this topic is very limited. Siwanuwatn et al., (2007) conducted a study to compare the effectiveness of accumulated walking bouts vs. continuous walking bout on health-related physical fitness in working women. For this study, forty volunteered females (ages 45-59) were recruited to participate in the study. The subjects were randomly assigned to 3 groups (i.e. accumulate walking; continuous walking; and normal physical activity). The 2 walking groups were instructed to walk in two different manners and to achieve 30 minutes of walking per day; 3 days per week. In the accumulated walking group, the subjects had to walk for 10 minutes 3 sessions per day to accumulate up to 30 minutes of walking per day. The continuous walking group, the subjects had to walk 30 minutes continuously in one session; 3 times per week. The control group was advised to engage in regular physical activity of daily-living. At the conclusion of the study, the data showed that VO_2max of the 2 walking groups improved (accumulated group: increased to 24.18±1.60 ml/kg/min; and continuous group: increased to 26.21±4.50 ml/kg/min) when compared to the control group. The continuous walking group also showed a slightly higher VO_2max than the accumulated walking group, while the control group exhibited no change VO_2max. The two walking groups also revealed reductions in percent body fat when compared to the control group. The investigators concluded that the accumulated walking produced physiological changes that were almost just as effective as the continuous walking. The study showed that when walking on regular basis, whether it's continuous or accumulate, both types of walking produce similar effects.

Sirikarnjanakovit & Kritpet (2008) compared the effects of interval walking and continuous walking on health-related physical fitness in elderly women. Thirty volunteered females (ages 55-60) were recruited and were randomly assigned evenly to the interval walking group and the continuous walking group. Both group exercised for 30 minutes per day; 3 days per week for 10 weeks. The subjects in the interval walking group alternated between high walking intensity (80-90% heart rate reserve) and low walking intensity (30-40% heart rate reserve). On the other hand, the continuous walking group walked at the intensity of 60-70% heart rate reserve. The physical fitness assessment was assessed at pre and post walking intervention. The result revealed that the interval walking group exhibited significantly higher peak oxygen uptake when compared to the continuous walking group ($p < 0.05$). Despite the improvement seen in peak oxygen uptake, other physiological variables such as percent body fat, resting heart rate, resting blood pressure, muscular strength, and flexibility were not statistically different between groups. The result of this study demonstrated that the intensity of walking played an important role in the improvement in fitness as showed by the increased in peak oxygen consumption in the interval walking group.

Pasit & Kritpet (2009) compared the effects of conventional walking vs simulated walking on health-related physical fitness in working women. Thirty-nine volunteered women aged 30-45 were recruited and divided evenly into the conventional walking group and the simulated walking group. The subjects in the conventional walking group performed regular walking on the daily basis and were instructed to walk at a pace of 126 steps per minute. The simulated walking group performed standing marches at a pace of 126 steps per minute that were designed to simulate walking movement. The result of the study showed that the 2 walking groups exhibited change in VO_2max (28.29 ml/kg/min for conventional walking; 33.68 ml/kg/min for simulated walking). In addition, the change in percentage body was observed in both groups. More changes occurred in the simulated walking in both VO_2max and percentage body fat when compared to the conventional walking counterparts.

Despite the physiological improvement observed in the previous studies, most research have not ascertained the appropriate walking speed that will improve individual's fitness level and the amount of walking on CHD risks reduction. Thus, an investigation to assess the walking pattern and velocity on aerobic capacity and CHD risks profile should be conducted to ascertain its effectiveness.

Walking, aerobic capacity, and mortality

Walking is the exercise of choice for people with heart disease and other illnesses. It produces less physiological strain on the body and it is easy to perform. Currently, the recommendation advocates 10,000 steps per day for better health and in prevention of chronic diseases (Choi et al., 2007); yet, there is no exact number of steps being suggested to reduce the risk of CVD. Some experts believe that high number of steps such as 10,000 steps per day maybe too exhausting for individuals with heart disease. It may also be inappropriately unrealistic for many sedentary adults who are looking to improve one's health (Tudor-Locke et al., 2004). Thus, a realistic goal is needed to establish a minimum walking steps per day. The more an individual walks, the greater the physical movement which will result in larger energy expenditure and reduces the risk of morbidity and mortality. The following section will explore the relationship of walking on aerobic capacity and mortality.

Laukkanen et al. (2001) assessed the relation of maximal oxygen uptake and exercise testing duration with the overall of CVD and non-CVD mortalities in 1,294 men with no CVD, pulmonary disease, and cancer at baseline in the communities of eastern Finland over the average of 10.7 years. Assessment of maximal oxygen uptake was performed using cycle ergometer. The study result revealed that there were 42 CVD deaths and 82 non-CVD related deaths at follow up. The investigators discovered that the risk of death was higher in the unfit population when compared to the fit counterparts. The relative risk of overall death was 2.76 (95% confidence interval, 1.43-5.33) ($p = 0.002$) and the relative risk of CVD death was 3.09 (95% confidence interval, 1.10-9.56) ($p = 0.05$) in unfit men with maximal oxygen consumption of <27.6 ml/kg/min and exercise duration of <10.2 minutes. They concluded that the cardiorespiratory fitness was an important predictor for premature death. Poor cardiorespiratory fitness was considered to be a risk factor for mortality comparable with elevated blood pressure, diabetes, smoking, and obesity. This study revealed the importance of cardiorespiratory fitness and longevity. Improving cardiorespiratory fitness will require an individual to engage in exercise training and make an adjustment to the current lifestyle. One of the easiest ways is to engage in regular walking.

Mason et al. (2002) examined the physical activity score (MET/hours/week) of walking, vigorous exercise, and hours spent sitting on the incidence of coronary events and total cardiovascular events in 73,743 postmenopausal women ages 50-79 years old. From the investigation, the researchers discovered a strong, graded, and inverse relationship in the risk of both coronary and total cardiovascular events. The women who walked or exercised vigorously for 2.5 hours per week had a risk reduction in coronary disease of approximately 30%. Similar reduction in the risk of cardiovascular events was also occurred in all ethnic groups and was observed in those who increased in the level of walking and vigorous exercise. The investigators concluded that by engaging in more walking or vigorous form of exercise will likely reduced the chance of developing a new coronary or cardiovascular events.

Other investigators also explored into the effectiveness of walking on aerobic fitness. Asikainen et al. (2002) looked at the change in aerobic fitness as a result of a walking intervention in healthy postmenopausal women who were sedentary and non-obese. For this investigation, 121 females aged 48-63 were recruited and were randomized through a computer generated number into four low-dose walking groups or a control group. The low dose walking groups were obligated to walk five days per week for 24 weeks at certain percentage of VO_2max and a set amount of energy expenditure per week: group W1, 55% VO_2max/1500 kcal per week; group W2, 45% VO_2max /1,500 kcal per week; group W3, 55% VO_2max /1,000 kcal per week; group W4, 45% VO_2max /1,000 kcal per week. At the conclusion of the 24 weeks intervention, the investigators discovered that the aerobic fitness was improved in all walking groups. The net change (the differences between changes in each exercise group and the control group) in VO_2max was 2.9 ml/min/kg (95% confidence interval (CI) 1.5 to 4.2) in group W1; 2.6 ml/min/kg (95% CI 1.3 to 4.0) in group W2; 2.4 ml/min/kg (95% CI 0.9 to 3.8) in group W3; and 2.2 ml/min/kg (95% CI 0.8 to 3.5) in group W4. Walking at moderate intensity that corresponded to 45%-55% of VO_2 max with a minimum energy expenditure of 1,000 kcal per week was sufficient to improve aerobic fitness in health postmenopausal women who were sedentary and non-obese. Despite the improvement in aerobic fitness seen in this study, it is unknown whether the same physiological effect would be obtained in overweight individuals with risk factors for developing CHD if they were to engage in a walking program at moderate intensity. Overweight individuals may not response similarly to exercise as their non-obese counterpart. They may require more or less of a stimulus to cause changes; however, this will not be known unless future research is carried out.

Murtagh et al. (2004) investigated the effect of 60 minutes of brisk walking per week, accumulated in two different patterns (i.e. continuous or intermittent) on cardiovascular risk. For this study, 31 healthy women with mean age of 45.7±9.4 years old were recruited and were randomized into three walking groups (i.e. continuous, intermittent, or control). The subjects were instructed to walk 20 minutes; 3 times per week in the continuous group. The intermittent group were instructed to walk twice per day for 10 minutes each session; 3 times per week. The control group received no walking instruction. At the conclusion of the study, the investigators found significant difference ($p < 0.05$) of exercising heart rate at stages 2 and 3 of the treadmill test before and after intervention. However, the VO_2 utilization and the perception of tiredness during the treadmill test were not difference before and after the intervention. There were also no changes in body mass, level of fatness, waist and hip circumferences, or lipid profile when comparing the changes before and after intervention. The investigators concluded that 20 minutes of walking per session was not sufficient to alter the risk of cardiovascular disease. The unaltered cardiovascular disease risk may have resulted in the insufficient amount of training stimulus. This study utilized the walking program of 60 minutes per week accumulated in two different patterns (i.e. continuous or intermittent). The volume of walking was well below what was recommended amount of physical activity (i.e. 150 minutes per week) which may have been the reason why there were no changes.

Schwarz et al. (2005) conducted a study to examine the cardiovascular and metabolic loads of different walking intensity derived from maximal velocity walking during Incremental Treadmill Walking Test (ITWT). The investigators recruited 16 recreational athletes (ages: 53±9 years old; BMI: 23) and assessed their maximal walking velocity by having the subjects walked on the treadmill until the subjects were unable to maintain a walking pace. The result revealed that, on average, the maximal walking velocity obtained was 8.3 kmph. The subjects then underwent three 30 minutes of walking sessions at different walking velocity (i.e. 70%, 80%, and 90% of maximal walking velocity, respectively) in a random order to assess metabolic loads. The investigators discovered that different walking speed as expressed in relative percentage of maximal walking velocity yielded the different amount of heart rate response, blood lactate concentration, and oxygen uptake ($p < 0.001$).

Heart rate response was significantly different at 70% (66% HRmax), 80% (75% HRmax), and 90% (93% HRmax), respectively ($p < 0.001$). Blood lactate concentration increased relatively to the intensity of walking i.e. 70% (1.1±02 mmol/l), 80% (1.8±0.6 mmol/l), and 90% (3.9±2.0 mmol/l), respectively ($p < 0.001$). Additionally, oxygen uptake utilization at each relative walking speed was significantly different at 70% (18.2±2.3 ml/kg/min), 80% (22.3±3.1 ml/kg/min), and 90% (29.3±5.0 ml/kg/min), respectively ($p < 0.001$). The result demonstrated that walking at speed of 70% of maximal walking velocity was equivalent to the relative intensity of 55% of VO_2 max which was a sufficient threshold for the improvement in cardiorespiratory fitness (ACSM, 2014). If perform frequently, the 70% of maximal walking velocity can result in health benefits. Likewise, the walking speed of 80% of maximal walking velocity also showed change in physiological benefits and was superior to the 70% of maximal walking velocity in improving cardiorespiratory endurance.

The investigators suggested that if one is to improve health benefits, lower intensity maybe undertaken; however, if cardiorespiratory endurance is the main concern then the walking speed of 80% of maximal walking velocity should be sought after. On the contrary, the walking speed of 90% of maximal walking velocity resulted in higher metabolic load in terms of oxygen consumption (88% VO_2 max) and lactate concentration (3.9±2.0 mmol/l). This relative pace may be too stressful on the body for most overweight, sedentary, or elderly individuals. Despite its finding, the study did not reveal the chronic effects of walking velocity on health due to the fact that this study was conducted in as a single trial manner—not a training study. Therefore, the extent to which physiological benefits occur at different walking velocity will remain to be discovered.

Kodama et al. (2009) conducted the epidemiological studies to assess the association between cardiorespiratory fitness and coronary heart disease (CHD) and all-cause mortality in healthy participants. Previous research was extracted and 33 relevant data were analyzed for the association of cardiorespiratory fitness and mortality. In addition, cardiorespiratory fitness was classified as low (<7.9 METs), intermediate (7.9-10.8 METs), and high (≥10.9 METs). The subjects were rated for their cardiorespiratory fitness and risk of mortality was compared. The analysis data revealed that individuals with low cardiorespiratory fitness (<7.9 MET is maximal aerobic capacity) had a substantially higher risk of all-cause mortality and CHD/CVD compared with those with intermediate and high cardiorespiratory fitness. Every

MET higher in maximal aerobic capacity was associated with 13% and 15% reduction in risk of all-cause mortality and CHD/CVD, respectively. The analyses further suggested that a minimal cardiorespiratory fitness of 7.9 METs might be important for significant prevention of all-cause mortality and CHD/CVD. The investigators suggested that cardiorespiratory fitness should be assessed periodically by exercise stress test as it can be a useful prediction of CHD/CVD and mortality. Low cardiorespiratory fitness should be considered as a coronary risk factor similar to elevated blood pressure, diabetes, smoking, and obesity. It should be put into practical use because improve cardiorespiratory fitness was associated with longevity.

Walking and CHD risks

The cause of Coronary Heart Disease (CHD) is multifactorial. Numerous risk factors for the development of CHD have been identified and extensive studied. These risks factors are categorized into three classes (i.e. independent, predisposing, and conditional risk factors). NCEP ATP III, American Heart Association (AHA), and the American College of Sports Medicine (ACSM) all have encouraged individuals with established CHD or are predisposed to developing CHD to engage in a healthy lifestyle and aggressively modifying the CHD risk factors so that it could attenuate the clinical course of the disease progression and development. One of the means for targeting CHD risk factors is to engage in a regular exercise program. Frequently, walking has been recommended and encouraged as a form of exercise. Walking is easy to participate, require no special equipment, and extremely economical. Studies had been conducted on walking and its effects on CHD risks.

Jakicic et al. (2001) stated in the position statement for weight loss and prevention of weight regain in adults that participation in physical activity of 150 minutes per week at moderate intensity was required to prevent the onset of cardiovascular disease and chronic condition such as diabetes. This amount of translates to 30 minutes of physical activity—preferably most days of the week. Despite its effect on disease prevention, the author stated that 150 minutes of physical activity was not adequate for long-term weight reduction. Randomized trial also conducted by Jakicic et al. (2003) revealed that for long-term weight reduction to be effective, individuals must maintain an average of 280 minutes or more of physical activity per week. The author concluded that this increase in the duration of physical activity will further enhance the beneficial effects that could be obtain from physical activity.

Kelly et al. (2001) conducted a meta-analysis on walking and blood pressure (i.e. SBP and DBP) in adults. A total of sixteen studies that included 650 subjects (410 exercise & 240 control) were included in the analysis. The interventions utilized in these studies were walking and the subjects were predominantly healthy adults. The investigators found that on average the length of walking program was 25±12 weeks; frequency of walking was 4±1 days per week; intensity utilized was 63%±11% of VO_2max; and duration of walking per session was 42±11 minutes. The analysis found a reduction in blood pressure was 2% for both systolic and diastolic blood pressure. Despite the reduction in blood pressure, the analysis did not reveal the appropriate pace of walking for blood pressure alteration and whether structured and unstructured walking would produce different levels of improvement.

Kowler et al. (2002) assessed the effectiveness of lifestyle intervention in terms of reducing the incidence of developing diabetes in the individuals who are at risk. For this study, 3234 individuals who were overweight or obese individuals with impaired fasting plasma glucose were randomly assigned into 3 groups (i.e. lifestyle, medication, and placebo groups) and followed for 2.8 years. The intervention of the lifestyle group was aimed to reduce body weight by 7% and accumulate up to 150 minutes or more of physical activity per week. The medication group received 850 mg of metformin twice daily and standard medical intervention was given to the placebo group. After intervention, the results revealed that the incidence of diabetes was 11.0, 7.8, and 4.8 cases per 100 person years in the placebo, metformin, and lifestyle groups, respectively. The lifestyle intervention was able to reduce the outset of diabetes by 58% (95% CI: 48%-66%) and metformin was able to reduce the onset by 31% (95% CI: 17%-43%). Lifestyle intervention was significantly more effective in reducing the incidence of diabetes than metformin. The investigators concluded that lifestyle changes coupled with dietary modification were sufficient to reduce the outset of diabetes. They also further stated that 150 minutes of physical activity could be easily obtained by undertaking a daily walking for 30 minutes per day. This finding demonstrated that sufficient time accumulated throughout the week could be effective in reducing the development of diabetes in those who are at risk. Diabetes is considered to be a potent risk for CHD development.

Kelley et al. (2004) also conducted a meta-analysis on walking and lipid profile of twenty-five studies which included 1,176 subjects. They discovered that walking induced decreases 5% of LDL cholesterol and 6% TC/HDL cholesterol ratio. Moreover, changes in total cholesterol, HDL, and triglycerides were also observed but these changes were not statistically significant ($p > 0.05$). The analysis revealed that these changes in lipid profiles occurred independently of changes in body composition. Also, the greater reduction in lipid profiles was associated with increasing age, increases in VO_2max, and postmenopausal women. Despite the observed changes in lipid profiles, these changes may or may not be the same in clinical populations.

Tully et al. (2005) examined the effects of 30 minutes of brisk walking 5 days per week on fitness and cardiovascular risks. In this study, 31 overweight and sedentary 50-65 years old subjects were recruited for the study. The subjects underwent a 12 weeks of 30 minutes; 5 days per week of walking program on their own. The results yielded a significant reduction in blood pressure (SBP and DBP), reduction in stroke risk, reduction in CHD risk score, and increased in functional capacity. The researcher concluded that 30 minutes of brisk walking for 5 days per week appeared to improve fitness and cardiovascular risks. Regardless of the improvement that was observed, the walking program was an unstructured type of walking. Therefore, it is unknown to whether structured type of walking (i.e. prescribed walking intensity, duration, and controlled for energy expenditure) would be more beneficial than the unstructured one and the same benefits would yield in the clinical populations.

Murphy et al. (2007) conducted a meta-analysis of twenty-four randomized controlled trials to evaluate the treatment effects of walking on cardiovascular risk variables such as body weight, body mass index, percentage body fat, blood pressure, and aerobic fitness. They discovered that walking interventions produced changes in cardiovascular risk variables that were mentioned previously.

However, the findings were based on sedentary individuals and the majority of subjects that participated in the studies were females. It is unknown to what extent the same improvement in health and cardiovascular risk factors would incur in CHD patients or in male subjects. Furthermore, the majority of studies that were analyzed were not controlled for caloric expenditure of walking which could have certain influenced on the outcome of the study.

Houel et al. (2013) conducted a prospective study design to assess the amount of walking on CVD risk factors after an acute coronary syndrome. Forty-one subjects were recruited from the hospital following an episode of acute coronary syndrome. They were followed for 12 months on the amount of walking performed by using the pedometer to assess daily steps count and cardiovascular risk factors such as waist circumference, triglycerides, LDL, HDL, TG/HDL, and non-HDL cholesterol were assessed at baseline, 6, and 12 months. At the conclusion of the study, the investigators discovered the median steps of walking in this study was 7842 while the mean ± SEM was 8051 ± 3735 daily steps. Those who walked greater than 7500 steps per day throughout the 12 months showed significant improvement in CVD risk factors when compared to those that walked less than 7500 steps per day. The investigators concluded that in order to improve CVD risk factors profile, a minimum of 7500 steps per day is needed to for physiological change. Walking less than recommended may be an insufficient stimulus needed for positive changes. Despite the minimum threshold needed to alter physiological profile, the investigator did not assess the pattern and the velocity of walking in this population. The investigators did acknowledge that the intensity—which was not assessed during the walking—may have certain impact on the outcome of this investigation.

Bouchonville et al. (2014) conducted a study to investigate the independent and combined effects of weight loss and exercise on cardiometabolic risk factors in obese older adults. One hundred-seven (BMI 30 kg/m^2) older (65 yrs) adults with physical frailty were randomized to diet group, exercise group, and diet-exercise group, and control group for 1 year. The diet group was prescribed a balance diet that provide an energy deficit of 500-750 kcal/day with the goal of losing body weight. The exercise group received a stable weight diet and was prescribed an aerobic exercise program 3 times per week for 90 minutes per session. The intensity given was at 65% of peak heart rate initially and was titrated to 70-85% of peak heart rate. In addition, the exercise group was also prescribed a resistance training program with the initial resistance at 65% of 1 RM and the resistance was titrated to 70-85% of 1 RM. The diet-exercise group received diet and exercise counseling as it was metioned previously in the first two groups. The control group was instructed to maintain normal diet and physical activity routine. The outcomes of this investigation were change in insulin sensitivity index (ISI), glucose tolerance, central obesity, adipocytokines, and cardiometabolic syndrome. At the conclusion of the study, the investigators discovered that the insulin sensitivity index (ISI) improved more in the diet-exercise group than in the diet group at 12 months (2.4 vs. 1.2; between-group difference, 1.2; 95% CI, 0.2-2.1) and no change in ISI occurred in both exercise and control groups. The diet-exercise and diet groups had similar improvements in insulin area under the curve (AUC) (−2.9 and −2.9 ×103mg.min/dl), glucose AUC (−1.4 and −2.2×103mg.min/dl), visceral fat (−787 and −561 cm3), tumor-necrosis factor (−17.0 and −12.8 pg/mL), adiponectin (5.0 and 4.0 ng/mL), waist circumference (−8.2 and −8.4 cm), triglyceride (−30.7 and −24.3 g/dL), and systolic/diastolic BP (−15.9 and

−13.1/−4.9 and −6.7 mmHg), while no changes in these parameters occurred in both exercise and control groups. Body weight decreased similarly in the diet-exercise and diet groups (−8.6 and −9.7kg) but not in the exercise and control groups. The cardiometabolic syndrome prevalence decreased by 40% in the diet-exercise and by 15% in the diet group. From this study, the investigators concluded that the lifestyle interventions with weight loss improve insulin sensitivity and other cardiometabolic risk factors. This study demonstrated that regular exercise and diet that induced weight loss can enhanced cardiometabolic risk factors.

From the previous examination of literature, it can be concluded that walking is beneficial for ones' health. It brings many physiological, morphological, and psychological benefits. It has been repeatedly proven to be an effective mean in countering sedentariness and modifies certain categories of risk factors for the development of non-communicable diseases in sedentary individuals. To date, however, the benefits of walking in clinical populations such as overweight and obese with the risks for developing coronary heart disease (CHD) have not been thoroughly examine. The speed and the patterns of walking (i.e. structured and unstructured) utilize in walking remained to be explored. Therefore, the purpose of this study is to determine the effects of speed and patterns of walking on aerobic capacity and CHD risk profiles in overweight and obese individuals with risk factors for developing coronary heart disease (CHD).

Conceptual Framework

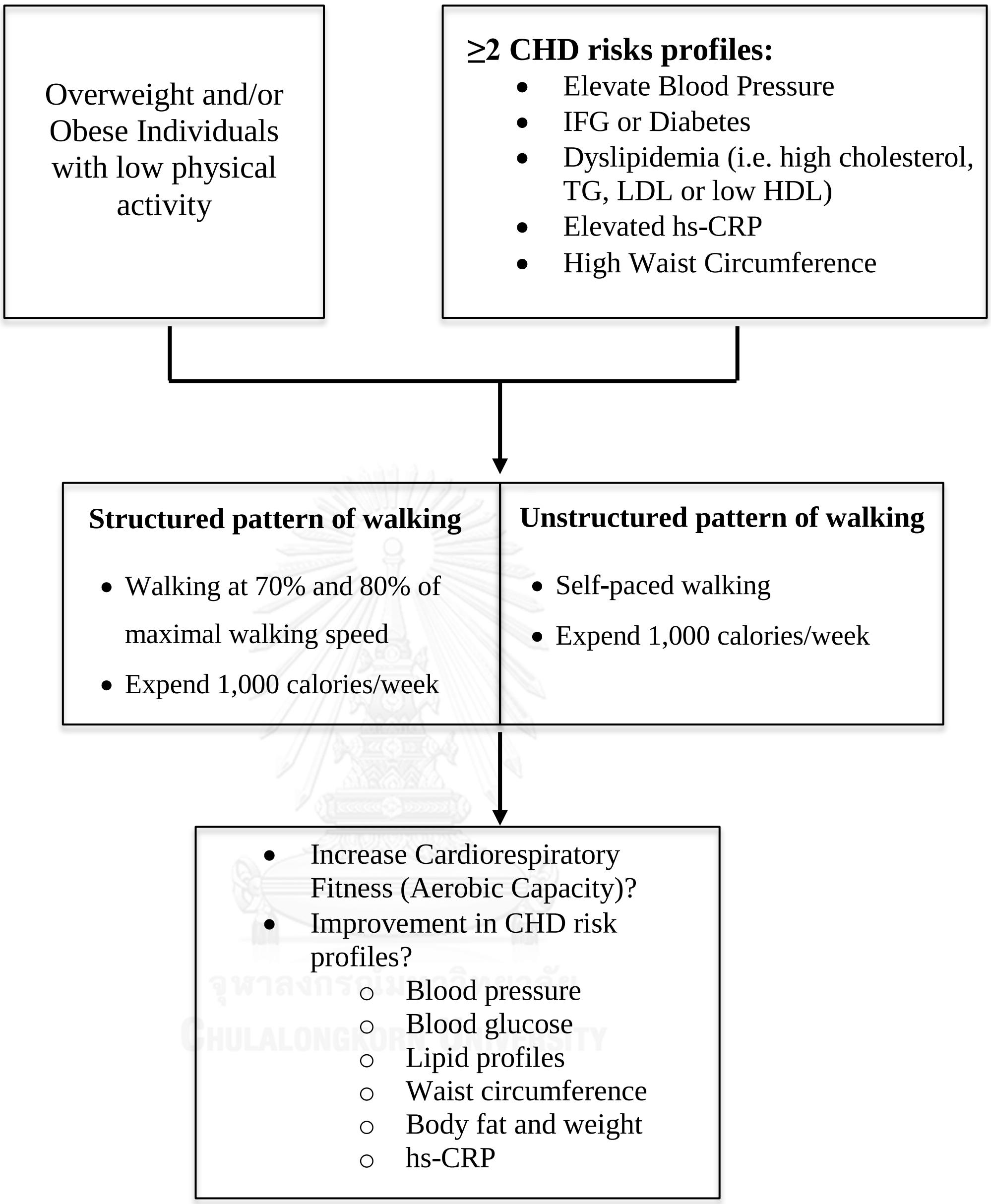


Figure 2.1 Conceptual Framework

CHAPTER III

METHODOLOGY

Subjects

This study a true experimental design employed two experimental groups with two different interventions and one control group. Sixty-nine overweight and obese volunteers, males (N = 16 [23%]) and females (N = 53[77%]), aged 40-60 years old who were health department personnel and hospitals staff from Rhamkamhaeng, Synphaet, and Banbung hospitals with at least 2 risk factors for CHD were recruited for this study. Sample size determination was based on Cohen (1988) power of test at 0.80 and the effect size of 0.40 with significant set at 0.05 which yielded 21 subjects per group. To account for the subjects' dropout, additional 2 subjects were added to each group which resulted in 23 subjects per group.

A simple randomization technique was employed in order to allocate the subjects into one of the three specific groups (Group A = 1; group B = 2; Group C = 3) by assigning number 1, 2, or 3 to each subject. This process was repeated until 69 subjects have been obtained and allocated. Each group consisted of 23 subjects according to the following: Group A (4 males and 19 females): a speed of 70% maximal walking speed; Group B (4 males and 19 females): a speed of 80% of maximal walking speed; Group C (8 males and 15 females): Self-paced walking. All the experimental protocols and procedures were approved by the Research Ethics Review Committee for Research Involving Research Participants, Health Science Group, Chulalongkorn University.

Inclusion criteria

The subjects were included in the study based on the following criteria:

1. Volunteer males and females age ≥40 - ≤60 years old

2. Possess 2 or more risk factors for developing CHD according to the ACSM (2014):

   2.1) Family history of Coronary Heart Disease (CHD)

   2.2) Elevated blood pressure or hypertension

   2.3) Impaired fasting glucose or diabetes

   2.4) High waist circumference

   2.5) Overweight and obese with BMI of ≥23 kg/m^2 - <25 kg/m^2, ≥25 kg/m^2 (WHO, 2000 & 2012: Asian Classification)

   2.6) Dyslipidemia

   2.7) Sedentary lifestyle (exercise ≤ 2 times/week for the last 6 months)

   2.8) Low HDL-Cholesterol

3. No significant arrhythmia, ischemia, or angina at rest or during physical exertion at all levels

4. Free from significant heart disease, shortness of breath, lightheadedness, or dizziness at rest or during physical exertion all levels

5. Not diagnosed with CHF; and metabolically well controlled

6. No physical limitations (e.g. knees or back pain) that will hinder ambulation

7. Having aerobic capacity >3 METs and < 10 METs

Exclusion criteria

The subjects were excluded from the study if they meet one of the following criteria:

1. Do not possess any risk factors for developing CHD
2. Possess an unstable medical conditions of cardiovascular, pulmonary, or metabolic disorder that will hinder physical activity or exercise participation
3. Illnesses, physical injury, or orthopedic condition that hinder exercise participation
4. Miss more than one week of exercise or >10% of total exercise session (10 weeks exercise total)
5. Do not interest or unable to participate in the full length of the study

The subjects who met the study criteria and agreed to participate were contacted via telephone by the principal investigator. Over the telephone conversation, the principal investigator explained the purpose of the study, its benefits, risks of involvement, time commitment, procedures, and protocols. Those who were still interested after a discussion about the study, they were invited to attend the orientation and screening session at the Faculty of Sports Science Laboratory or at the hospital's clinical fitness facility to further assess the risks and benefits ratios, signed an inform consent, and obtained anthropometric measurements prior to being schedule for an exercise testing.

Orientation and screening

The subject who volunteered and wished to participate in the study were invited to attend the orientation and screening at the Sports Science and Health Laboratory, Faculty of Sports Science, Chulalongkorn University or at the hospitals' clinical fitness centers where the subjects were further screened by the primary investigator. They were asked to complete Physical Activity Readiness Questionnaire (PAR-Q) and were inquired about their health, physical activity, and current and past medical conditions.

At the orientation and screening, the subject were briefed on the details of the study that includes the benefits, risk involvement, and the duration of the study; furthermore, questions and concerns that the subjects had were addressed by the investigator. After a thorough explanation of the study, the investigator asked the subjects to answer Physical Activity Readiness Questionnaire (PAR-Q) (ACSM, 2014), verbally asked the subject about his/her past and current medical status, and explained the inform consent process prior to participating in the study. The investigator asked the subject to sign an inform consent and performed an anthropometric measurement and body composition on the subjects.

The subject's demographic profile was recorded and input into a computer. The subject was then scheduled for an aerobic capacity testing, incremental treadmill walking test (ITWT), and blood chemistry determination a week from the orientation session. The total testing time required for all procedures was approximately 2 days.

All the assessments such as anthropometric measurement, body composition, resting heart rate, resting blood pressure, aerobic capacity evaluation, incremental treadmill walk test (ITWT), and caloric expenditure will be discussed in detail.

Anthropometric measurement

Waist and hip circumference was measured in centimeters with an anthropometric tape. Waist circumference was assessed at the horizontal plane of the iliac crest. The hip circumference was taken at the largest posterior extension of the buttocks. The waist/hip ratio was calculated from these measurements. The time required for anthropometric measurement was 5 minutes per subject.

Body composition

Body composition--which took 10 minutes to perform--was assessed by instructing the subjects to empty their pockets and to take off their shoes and socks. They were then instructed to step on the scale and remained on a digital body composition analyzer (Tanita BC-533, Japan) that measured and analyzed body weight (kg), fat-free mass (kg), fat mass (kg), and body fat (percentage). Body Mass Index (BMI) was calculated by dividing body weight in kilogram (kg) by height in meter square (m^2).

Resting heart rate

To assessing resting heart rate, the subject's chest was fitted with a wireless heart rate monitor (Polar H7, Finland). The subject was then asked to sit down quietly and disturbed for 5 minutes. The heart rate was then taken after it was stabilized at a low rate and was recorded by the investigator. The total time required for this measurement was 10 minutes per subject.

Resting blood pressure

The subject's was instructed to sit in a chair with the left arm resting on the table with the elbow slightly flexed. Blood pressure cuff was placed the left biceps and the resting blood pressure was taken with an automatic blood pressure monitor (Omron SEM-1, Japan). The blood pressure reading was recorded. The time required for this measurement was 2 minutes per subject.

Aerobic capacity evaluation

The subjects were asked to report to either to the Sports Science and Health laboratory at the Faculty of Sports Science, Chulalongkorn University or at the hospital's clinical fitness center for testing depending on their conveniences. Upon arrival, the subject was instructed to sit quietly and his/her resting physiological baseline was measured. The subject's chest was fitted with a wireless heart rate monitor (Polar H7, Finland) to assess the resting heart rate and blood pressure was taken with an automatic blood pressure monitor (Omron SEM-1, Japan). Exercising testing procedure and test precautions was informed; furthermore, questions that the subject had pertaining to the exercise test were answered and clarified prior to the test. Prior to testing, the open circuit spirometry metabolic system (Cortex Metamax 3BR2, Germany) was calibrated according to the manufacture specification and recommendations.

The subject was attached with a facemask, hooked up to the metabolic system, and was instructed to stand still for baseline physiological variables measurements. Once the baseline measurements was completed, the subject was instructed to stand on a motorized treadmill (hp-cosmo 4.0, Germany) or (StairMaster

ClubTrack 2100-LE, USA)—depending on the location where the assessment was made—and prepared for the aerobic capacity assessment. The subject underwent an exercise testing utilizing Ramped Bruce protocol (Will and Walter, 1999) with gas analysis to determine maximal aerobic capacity. The procedure for this protocol was described previous by Will and Walter (1999). In the Bruce ramped procedure, the treadmill's speed and incline were continually change every 15 seconds until individual's maximal capacity was reached. During the test, the subjects' blood pressure was assessed every two minutes with the palm aneroids sphygmomanometer (MDF Bravata, USA) and the exercising heart rate was recorded every 1 minute (Polar H7, Finland). The metabolic data such as oxygen consumption, carbon dioxide production, ventilation, respiratory exchange ratio (RER), and oxygen pulse were continually monitored. Verbal encouragement was provided throughout the test and maximal aerobic capacity was determined by averaging the highest 30 seconds of oxygen consumption that was obtained during the test. Testing was terminated upon subject's volitional fatigue or in accordance with the ACSM's test termination guidelines (2014) such as chest discomfort, lightheadedness, dizziness, drop in systolic blood pressure with increased workload, or severe shortness of breath. The time required for aerobic capacity assessment was 30 minutes per subject.

Incremental Treadmill Walk Test (ITWT)

Each subject underwent three walking tests. The first test was an Incremental Treadmill Walking Test (ITWT) to determine the maximal walking velocity (Schwartz, 2005*)*. Maximal walking velocity was defined as a condition in which an individual was unable to maintain appropriate walking pace, thus; the subject had to resort to running in order to keep up with the treadmill's speed. Prior to initiating the test, the subject was fitted with a wireless heart rate monitor (Polar H7, Finland) and a facemask was attached. The subject then was hooked up to the open circuit spirometry metabolic system (Cortex Metamax 3BR2, Germany) and was asked to stand still on the treadmill where resting physiological data was obtained. The subject instructed to walked on the treadmill starting at 2.5 mph with no incline and the velocity increased 0.4 mph every three minutes until the subject was unable to maintain appropriate walking technique (no race walking, jogging, or running was allowed). Gas analysis was utilized to determine the oxygen cost, caloric requirement, and physiological response at maximal walking velocity.

After the completion of ITWT, the subject rested for at least 15 minutes until physiological response (i.e. HR and BP) returned to baseline then subject underwent two additional tests in which he/she walked at 70% and 80% of maximal walking velocity that was obtained from ITWT for 15 minutes each to determine metabolic cost, caloric requirement, and physiological responses of walking at the each walking intensity. The subject rested for 15 minutes between the two tests. Oxygen cost and caloric requirement obtained from each walk test was used to determine appropriate exercise duration and frequency. The total time required for the Incremental Treadmill Walking Test (ITWT) was 120 minutes per subject.

Caloric expenditure determination

To determine caloric cost of walking at different speed (i.e. 70% and 80% of maximal walking velocity), previously obtained steady state oxygen cost of walking during the ITWT was used to calculate energy expenditure per minute for each subject. The steady state oxygen consumption (ml/kg/min) was plugged into the following equation to determine energy expenditure per minute (ACSM, 2014).

$$\text{Calorie/minute} = [\text{MET} * 3.5 * \text{body weight (kg)}]/200$$

The obtained calorie per minute was then used to determine the time required for each subject to walk per week in order to expend 1,000 calories. The calculation was achieved by dividing calorie per minute obtained from the previous calculation into 1,000 calories which yielded the duration of walking that each subject had to walk per week. Further calculation was also carried out to determine the time required for each subject to walk per session by dividing the total time of walking per week by 7 (i.e. 1 week equals 7 days) to yield the time required to walk per session.

To determine the amount of walking that the control group had to perform per week in order to expend 1,000 calories, the investigator conducted a pilot study prior to the actual investigation. In the pilot study, 5 subjects were put on the treadmill and were instructed to walk at their preferred speed for 15 minutes. The calories read out from the treadmill after 15 minutes of walking was recorded then multiply it by 4 in order to get total calorie per hour. Based on our pilot data, an hour of walking yielded approximately 150 calories per hour. Thus, to expend 1,000 calories of self-paced walking, the subject had to walk approximately 300 minutes per week.

Blood chemistry analysis

Following a 10 hours fasted, a trained registered nurse performed a venipuncture procedure during the time of 7am to 10am to obtain a blood sample of 10 cc which was equivalent to 2 tea spoons from the subject. The procedure was performed in a seated position at pre- and post-training for analysis and to determine the impact of velocity and patterns of walking on fasting blood glucose, total cholesterol, triglycerides, LDL-cholesterol, HDL-cholesterol, cholesterol to HDL-cholesterol ratio, and high sensitivity C-reactive protein (hs-CRP). Pre-training blood samples was taken prior to the incremental treadmill walking test and the post-training blood sample was be taken one day after the completion of the last walking session at fasting state and prior to the final aerobic capacity assessment. All the blood drawn and collections were performed by a registered nurse who was trained in phlebotomy. Risks of blood drawn were explained to the subjects. The subjects' blood samples were sent for analysis at the Faculty of Allied Health Sciences laboratory, Chulalongkorn University. The time required for blood drawn was 15 minutes per subject.

Walking program

Sixty-nine overweight and obese subjects who possessed 2 or more risk factors for developing CHD were be randomized into three groups: Group A: walking at 70% of maximal walking speed (structured walking); Group B: walking at 80% of maximal walking speed (structured walking); and Group C: control group: self-regulated walking (unstructured). The two walking groups (Group A and Group B) that were regulated by walking speed underwent walking intervention at varying duration and frequency in attempting to expend the same amount of calories per week (i.e. 1,000 calories per week) at the Faculty of Sports Science fitness center, Chulalongkorn university or at the hospital's clinical fitness centers. To calculate the number of walking duration and frequency per week, the investigator divided 1,000 calories per week by the amount of calories utilizes per minute during the walking at 70% of maximal walking speed and at 80% of maximal walking speed to yield the number of walking duration and frequency per week for each subject. If the subject cannot engage in 3-5 sessions of walking at specified duration per week, then the additional duration of walking was added on equally to specific number of walking session.

Prior to each walking session in Group A and Group B, the investigator instructed each subject to engage in a lite warm-up prior to starting the walking exercise. Group C received instruction on how to walk on the daily basis and was be provided with a pedometer (OMRON HJ-323u-triaxis, Japan) to track the number of steps of walking. Basic instruction on how to operate the pedometer was given. The subjects engaged in self-regulated walking speed as preferred and were encouraged to accumulate up to 300 minutes of walking per week in order to expend 1,000 calories. The investigator contacted every subject in the Group C on the weekly basis by telephone to remind him/her to carry a pedometer and to engage in daily walking. In addition, the investigator met every subject in Groups C at the frequency of every 2 weeks to download the pedometer (OMRON HJ-323u-triaxis, Japan) data. The pedometer was capable of storing the data such as step count, distance, and calories up to 22 consecutive days. All subjects in the three groups underwent 10 weeks of intervention to determine the impact of walking speed and patterns on maximal aerobic capacity and coronary heart disease (CHD) risk profiles. The summary of the walking program was presented in Table 3.1.

All subjects were instructed to adhere to the prescribed time of walking per week and were strongly discouraged to exceed that time. In Group A and Group B, the subjects were monitored for their time spent walking by the fitness staff or the on-site nurses at the hospital clinical fitness centers. The control group, were instructed to keep track of their time of walking per week by logging it into a book.

Table 3.1 The walking program of Group A, Group B, and Control

Subjects	Weeks	Program Detail
All Groups	Testing	1. Screen for eligibility. Qualified subjects were given instruction about the study. 2. Subjects completed PAR-Q and baseline variables were measured (i.e. height, weight, waist, hip, body fat, and BMI). 3. Aerobic capacity assessment was performed utilizing Ramp Bruce Protocol with Gas Analysis to determine maximal individual's aerobic capacity. 4. Each subject underwent Incremental Treadmill Walk Test (ITWT) with Gas Analysis to determine individual's maximal walking speed, 70% and 80% of maximal walking speed, and energy utilization at the walking speed of 70% and 80% of maximal walking speed. 5. Blood sample was collected and sent to the laboratory for analysis.

Table 3.1 The walking program of Group A, Group B, and Control (continue)

Participants	Weeks	Program Detail
Group A: 70% of maximal walking speed	1 - 10	1. Prior to the initial walking session, resting heart rate and blood pressure was assessed. 2. The subjects were instructed to warm-up on the treadmill by walking slowly for 10 minutes and stretched major muscle groups as appropriate prior to the exercise session. 3. The maximal walking speed that was obtained from the test was used to calculate the walking speed at 70% of maximal walking speed. Each subject had different duration, frequency, and walking speed at 70% of maximal walking speed due to the varying rate of energy expenditure that was obtained from the treadmill walking test. 4. The subjects walked at 70% of maximal walking speed for a fixed amount of time several days per week in order to expend 1,000 calories per week for 10 weeks. 5. The subjects were instructed to cool down at the conclusion of each walking session by walking slowly and stretched major muscle groups. 6. Each subject was instructed to maintain normal physical activity of daily living and dietary habits.

Table 3.1 The walking program of Group A, Group B, and Control (continue)

Participants	Weeks	Program Detail
Group B: 80% of maximal walking speed	1 - 10	1. Prior to the initial walking session, resting heart rate and blood pressure was be assessed. 2. The subjects were instructed to warm-up on the treadmill by walking slowly for 10 minutes and stretched major muscle groups as appropriate prior to the exercise session. 3. The maximal walking speed that was obtained from the test was used to calculate the walking speed at 80% of maximal walking speed. Each subject had different duration, frequency, and walking speed at 80% of maximal walking speed due to the varying rate of energy expenditure that was obtained from the treadmill walking test. 4. The subjects walked at 80% of maximal walking speed for a fixed amount of time several days per week in order to expend 1,000 calories per week for 10 weeks. 5. The subjects was instructed to cool down at the conclusion of each walking session by walking slowly and stretched major muscle groups. 6. Each subject was instructed to maintain normal physical activity of daily living and dietary habits.
Group C: Control	1 - 10	1. The subjects were instructed to wear the pedometer (OMRON HJ-323u-triaxis, Japan) each day during the course of the 10 weeks. 2. The subjects were instructed to walk leisurely at his/her own selected pace as much as possible and attempt to accumulate up to 300 minutes per week in order to expend 1,000 calories. 3. Each subject was instructed to maintain normal physical activity of daily living and dietary habits.

Research procedure

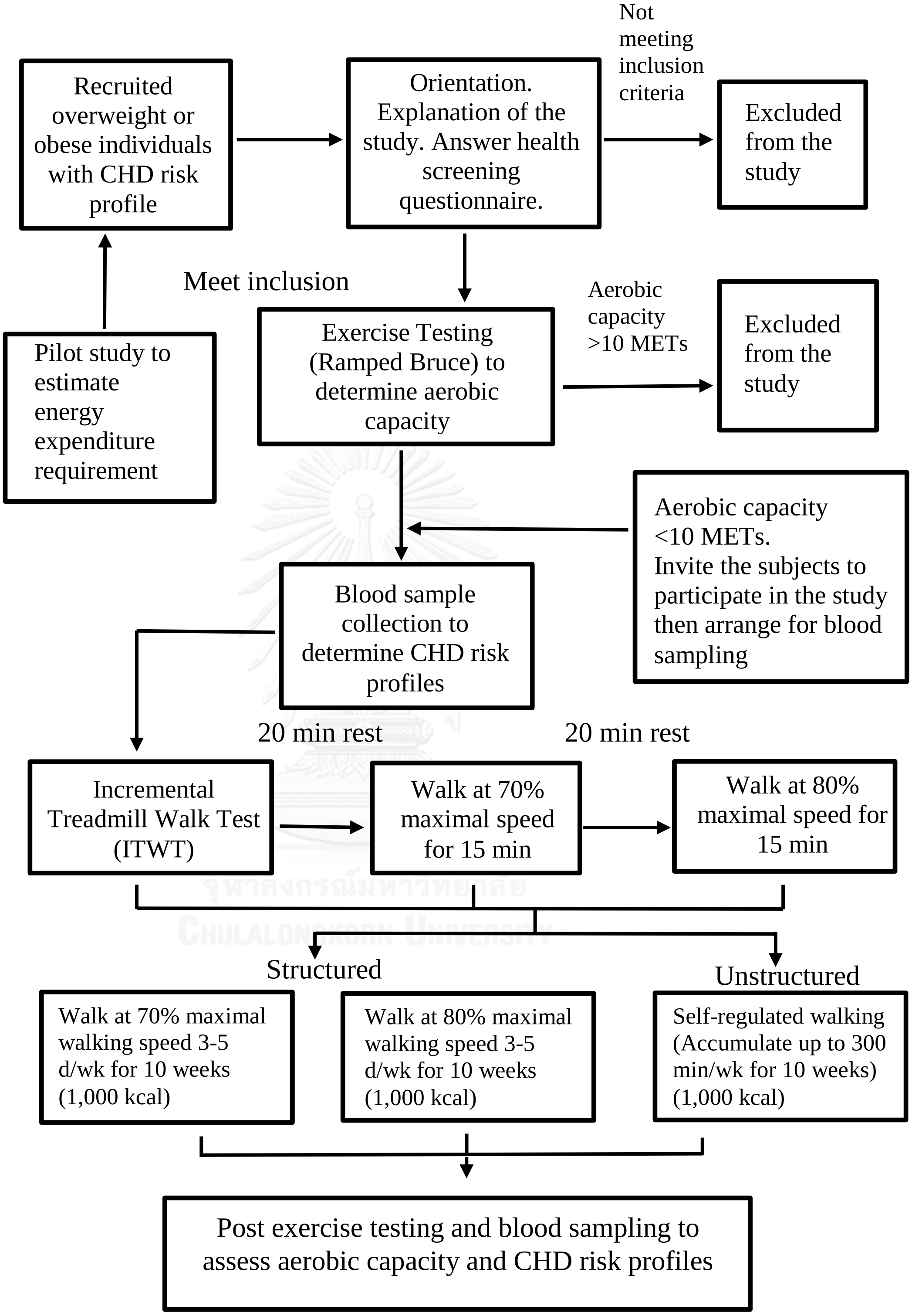


Figure 3.1 Research procedure

Statistical analysis

The data were analyzed using SPSS version 23. Descriptive data were evaluated for mean and standard deviation (SD). The differences in physiological and hematological variables within group (intra-group) at pre- and post-training were compared using a paried t-test. The one-way ANOVA was employed to determine the variability of the data among the three groups (70%, 80%, and self-regulated). The post-hoc test (LSD) was excuted to determine any significant differences between the three groups. The extent of the change in physiological and hematological variables was compared between the three groups by subtracting the pre-training results from the post-training results. The differences of these data of the three groups were compared using one-way ANOVA with LSD post hoc test to detect any significant differences. Differences were considered to be significant at $P < 0.05$.

To compare the effect of the walking patterns (structured vs unstructured), Group A (70% of maximal walking speed) and Group B (80% of maximal walking speed) were combined into the structured group and the Control was labeled as an unstructured group. The changes in physiological and hematological variables of each pattern of walking was calculated by subtracting the pre-training results from the post-training results which yielded the differences for each variable. The differences between the two patterns of walking was then analyzed using independent t-test. Differences were considered to be significant at $p < 0.05$.

CHAPTER IV

RESULTS

The results section comprised of eight major parts to elucidate the effects of the walking speed in the three groups of subjects (i.e. Group A [70%], Group B [80%], and Control) and to illustrate the effects of patterns of walking (i.e. structured and unstructured patterns) on aerobic capacity and Coronary Heart Disease (CHD) risk profiles. These eight major parts were as followed:

Part 1 Baseline characteristics of males and females.

Part 2 Baseline characteristics of Group A (70%), Group B (80%), and Control.

Part 3 Baseline maximal exercise testing peak values, physiological responses, and hematological variables of males and females.

Part 4 Baseline maximal exercise testing peak values, physiological responses, and hematological variables of Group A (70%), Group B (80%), and Control.

Part 5 Incremental treadmill walk test and physiological response variables of Group A (70%) and Group B (80%). The number of steps taken per day, the minute walked per week, and the intensity of walking of Control.

Part 6 The comparison of the effects of walking speed on morphological and physiological variables between pre- and post-training among all groups of subjects. Group A (70%), Group B (80%), and Control.

Part 7 The changes in aerobic capacity, ventilator threshold, total cholesterol, and triglycerides between pre- and post-training among Group A (70%), Group B (80%), and Control as a result of different walking speed.

Part 8 The comparison of the changes in morphological, physiological, and hematological variables between the two patterns of walking.

Part 1: Baseline characteristics of males and females

Baseline characteristics of male and female subjects were presented in Table 4.1. Independent t-test was employed to detect the differences between males and females. Males and females were comparable in age (51 ± 4 and 51 ± 5), BMI (28.0 ± 3.0 and 26.9 ± 3.2), hip circumference (100.6 ± 5.3 and 103.7 ± 7.8), percent body fat (36.0 ± 7.6 and 35.3 ± 4.2), resting heart rate (81 ± 11 and 84 ± 10), systolic blood pressure (139 ± 11 and 132 ± 32), and diastolic blood pressure (78 ± 8 and 78 ± 9) respectively. Despite certain similarity in baseline characteristics, male subjects were significantly ($p < 0.05$) heavier, taller, higher waist circumference, higher waist to hip ratio, and possessed greater fat free mass (81.3 ± 7.4 kg; 170.3 ± 3.1 cm; 98.4 ± 5.9 cm; 0.98 ± .04; & 51.7 ± 4.3 kg) than female counterpart (66.4 ± 9.1 kg; 156.6 ± 4.8 cm; 88.5 ± 6.9 cm; 0.86 ± 6.9; & 42.3 ± 4.3 kg) respectively.

Table 4.1 Baseline characteristics of males and females

	Males Mean ± SD n = 16	Females Mean ± SD n = 53	t	p-value
Age (yrs)	51 ± 4	51 ± 5	-.039	.969
Weight (kg)	81.3 ± 7.4*	66.4 ± 9.1	.542	.000
Height (cm)	170.3 ± 3.1*	156.6 ± 4.8	-10.646	.000
BMI (kg/m^2)	28.0 ± 3.0	26.9 ± 3.2	-1.187	.239
Waist (cm)	98.4 ± 5.9*	88.5 ± 6.9	-5.123	.000
Hip (cm)	100.6 ± 5.3	103.7 ± 7.8	1.515	.135
WHR	0.98 ± .04*	0.86 ± .05	-8.204	.000
Fat (%)	36.0 ± 7.6	35.3 ± 4.2	-.364	.720
FFM	51.7 ± 4.3*	42.3 ± 4.3	-7.275	.000
HRrest (bmp)	81 ± 11	84 ± 10	1.417	.161
SBPrest (mm Hg)	139 ± 11	132 ± 32	-1.967	.058
DBP (mm Hg)	78 ± 8	78 ± 9	-.283	.778

* $p < 0.05$, statistically significant from females

Part 2: Baseline characteristics of Group A (70%), Group B (80%), and Control

Baseline characteristics of the subjects in Group A (70%), Group B (80%), and Control were presented in Table 4.2 below. One-way analysis of variance (ANOVA) was used to detect the differences among groups. The results showed that the subjects in all three groups were similar in most of the variables except resting systolic blood pressure. The data showed that Group B (80%) had resting systolic blood pressure (128.0 ± 12.0 mm Hg) that was significantly lower than Control (138.0 ± 11.0 mm Hg) ($p < 0.05$), respectively. When the BMI (kg/m^2) was broken down into gender and level of overweight and obesity, the data revealed that all 16 male subjects in all three groups were obese. The level of obesity of the male subjects in all three groups were not significantly differ among groups. In the female subjects, 15 were overweight and 38 were obese. In the female overweight groups, females in Group A exhibited significantly lower BMI than the females in Group B ($p < 0.05$) and Control ($p < 0.01$) whereas the females in Group B showed significantly lower BMI than the females in the Control ($p < 0.05$). In the obese class of all three groups, the females in Group A had significantly lower BMI than the females in the Control ($p < 0.05$) while the females in Group B exhibited significantly BMI than the females in the Control.

Table 4.2 Baseline characteristics of Group A (70%), Group B (80%), and Control

	Structured		Unstructured		
	Group A (70%) Mean ± SD n = 23	Group B (80%) Mean ± SD n = 23	Control Mean ± SD n = 23	F	p-value
Age (yr)	51.0 ± 5.6	50.1 ± 4.8	50.9 ± 3.5	.261	.771
Weight (kg)	71.5 ± 11.3	69.7 ± 10.8	68.3 ± 10.4	.515	.600
Height (cm)	159.6 ± 6.8	159.3 ± 7.7	160.5 ± 7.6	.157	.855
BMI (kg/m^2)	27.9 ± 3.6	27.5 ± 3.3	26.4 ± 1.8	1.543	.221
Males Obese (Range)	29.2 ± 2.4 (27.7 – 32.8)	27.4 ± 1.4 (26.5 – 29.4)	27.8 ± 2.1 (25.0 – 30.7)	.869	.442
Females Overweight (Range)	23.3 ± .5*† (23.0 - 24.0)	23.9 ± .5** (23.2 - 24.8)	24.7 ± .3 (24.2 - 24.9)	9.359	.004
Females Obese (Range)	28.7 ± 3.4# (25.0 – 38.2)	29.5 ± 2.9* (25.7 – 35.1)	25.9 ± 1.1 (25.0 – 28.3)	5.319	.010
Waist (cm)	90.4 ± 3.6	90.4 ± 7.7	91.7 ± 7.9	.207	.814
Hip (cm)	102.1 ± 8.5	103.3 ± 8.3	103.5 ± 4.8	.252	.778
WHR	0.88 ± .06	0.88 ± .06	0.89 ± .10	.065	.938
% Fat	35.6 ± 5.3	35.8 ± 4.9	34.9 ± 5.4	.212	.810
FFM (kg)	45.5 ± 5.4	44.4 ± 5.7	44.3 ± 6.2	.302	.740
HRrest (bpm)	87.0 ± 11.0	83.0 ± 13.0	82.0 ± 7.0	1.711	.189
SBPrest (mm Hg)	134.0 ± 14.0	128.0 ± 12.0#	138.0 ± 11.0	3.563	.034
DBPrest (mm Hg)	79.0 ± 9.0	77.0 ± 7.0	78.0 ± 9.0	.221	.802

# $p < 0.05$, statistically significant from Control

*$p < 0.01$, statistically significant from Control

†$p < 0.05$, statistically significant from Group B

**$p < 0.05$, statistically significant from Control

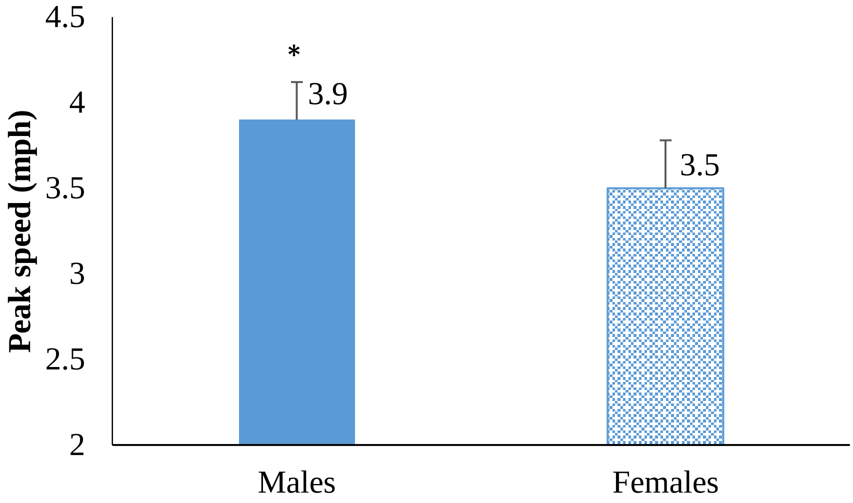
Part 3: Baseline maximal exercise testing peak values, physiological responses, and hematological variables of males and females

Baseline maximal exercise testing peak values, physiological responses, and hematological variables of male and female subjects were presented in Table 4.3. The significant variables were presented in Figure 4.1 through Figure 4.11. Independent t-test was employed to detect the differences between the two genders. The results revealed that the maximal exercise testing peak values and the physiological responses were significantly higher ($p < 0.05$) in male subjects. The data showed that males achieved higher peak treadmill speed (3.9 ± .22 mph), higher peak treadmill incline (15.5 ± .63 %), higher systolic blood pressure response (175.0 ± 10.3 mm Hg), higher peak oxygen consumption (2.45 ± .21 L/min; 31.0 ± 1.6 ml/kg/min), and higher rating of perceived exertion (18.3 ± .70) than female subject ($p < 0.05$). Male subjects also had significantly higher baseline in total cholesterol (270.5 ± 61.0 mg/dl), higher triglycerides (163.5 ± 41.3 mg/dl), lower HDL-Cholesterol (45.2 ± 7.2 mg/dl), higher CHOL/HDL ratio (6.22 ± 2.1), and higher hs-CRP (3.82 ± 1.87 mg/dl) ($p < 0.05$) than female counterpart ($p < 0.05$).

Table 4.3 Baseline maximal exercise testing peak values, physiological responses, and hematological variables of males and females

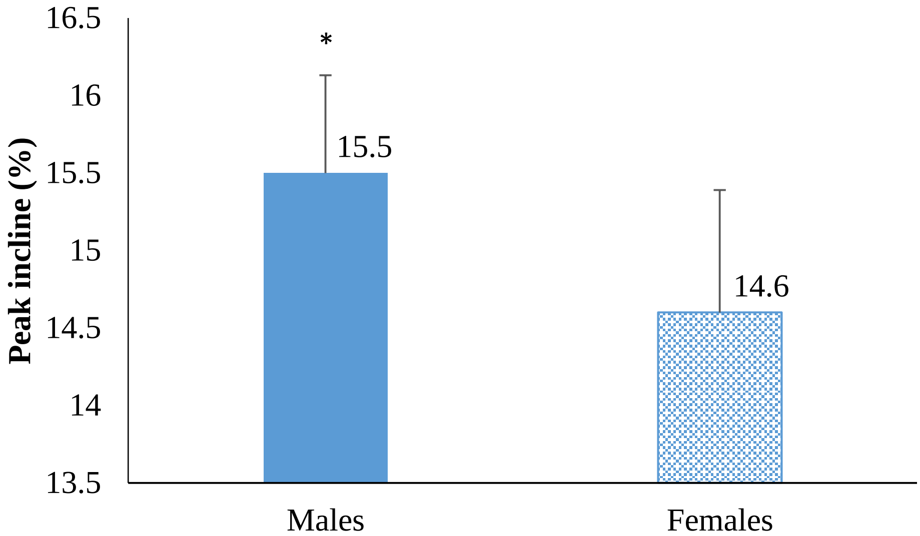
	Males Mean ± SD n = 16	Females Mean ± SD n = 53	t	p-value
Peak Exercise Testing Values:				
Peak Speed (mph)	3.9 ± .22*	3.5 ± .28	-4.062	.000
Peak Incline (%)	15.5 ± .63*	14.6 ± .79	-4.060	.000
Time Achieved (min)	10.6 ± .72	9.44 ± 1.04	-3.999	.416
HRmax (bpm)	165.3 ± 7.7	161.5 ± 12.9	-1.086	.281
SBPmax (mm Hg)	175.0 ± 10.3*	167.9 ± 10.1	-2.431	.018
DBPmax (mm Hg)	77.1 ± 6.5	77.3 ± 8.7	.067	.947
VO_2 peak (L/min)	2.45 ± .21*	1.48 ± .21	-16.426	.000
VO_2 peak (ml/kg/min)	31.0 ± 1.6*	22.3 ± 2.9	-15.468	.000
VT (%VO_2)	57.4 ± 8.1	56.2 ± 7.9	-.571	.570
RERpeak	1.15 ± .04	1.13 ± .06	-1.608	.116
RPEpeak	18.3 ± .70*	17.9 ± .69	-2.065	.043
Hematological variables:				
FBG (mg/dl)	105.9 ± 19.5	101.8 ± 17.8	-.781	.438
Cholesterol (mg/dl)	270.5 ± 61.0*	231.6 ± 52.5	-2.503	.015
Triglycerides (mg/dl)	163.5 ± 41.3*	125.9 ± 50.7	-2.703	.009
LDL-Chol (mg/dl)	147.8 ± 27.8	141.2 ± 38.3	-.639	.525
HDL-Chol (mg/dl)	45.2 ± 7.2*	58.3 ± 11.6	4.239	.000
Chol/HDL-Chol	6.22 ± 2.1*	4.12 ± 1.21	-3.785	.001
hs-CRP (mg/dl)	3.82 ± 1.87*	2.51 ± 2.37	-2.023	.047

* $p < 0.05$, statistically significant from females



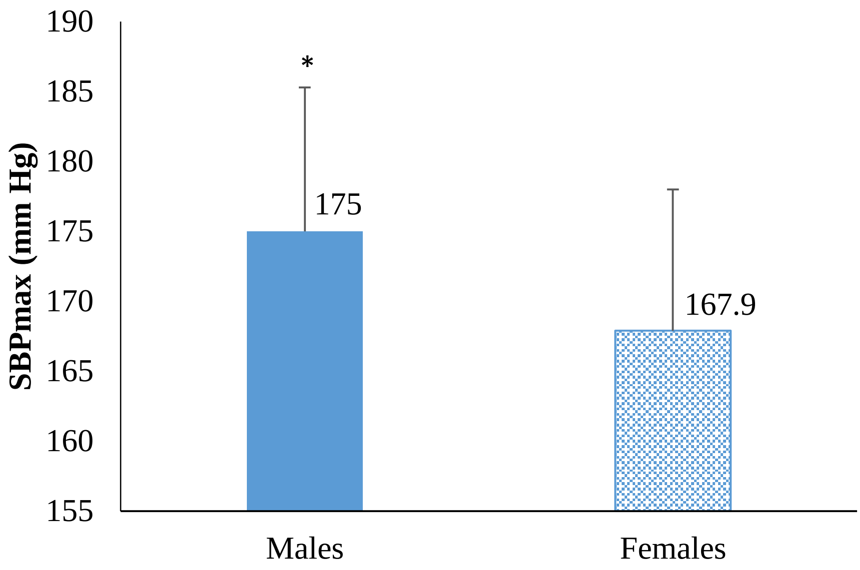
* $p < 0.05$, statistically significant from females

Figure 4.1 Peak treadmill speed during exercise testing comparison between male and female subjects



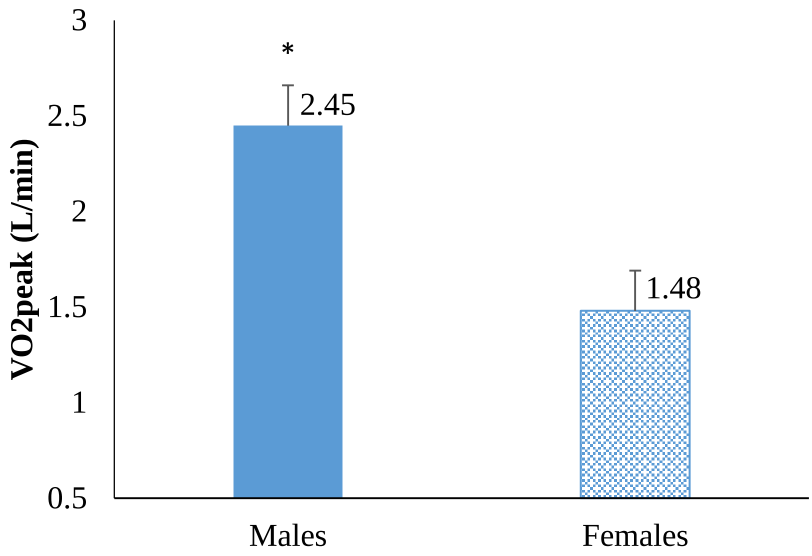
* $p < 0.05$, statistically significant from females

Figure 4.2 Peak treadmill incline during exercise testing comparison between male and female subjects



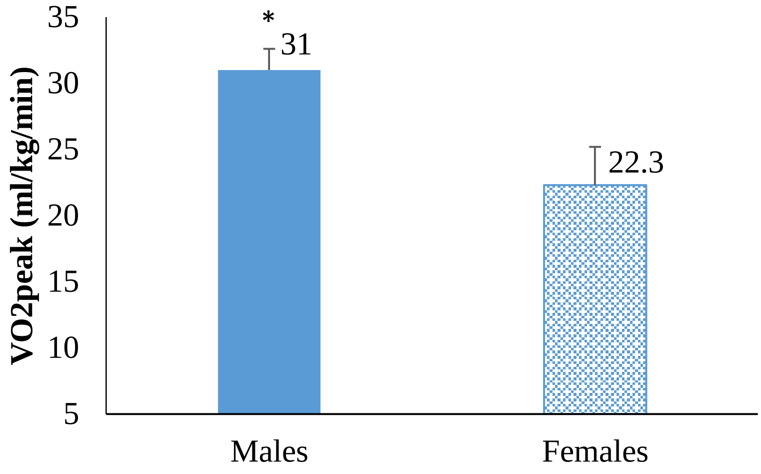
* $p < 0.05$, statistically significant from females

Figure 4.3 Maximal systolic blood pressure during exercise testing comparison between male and female subjects



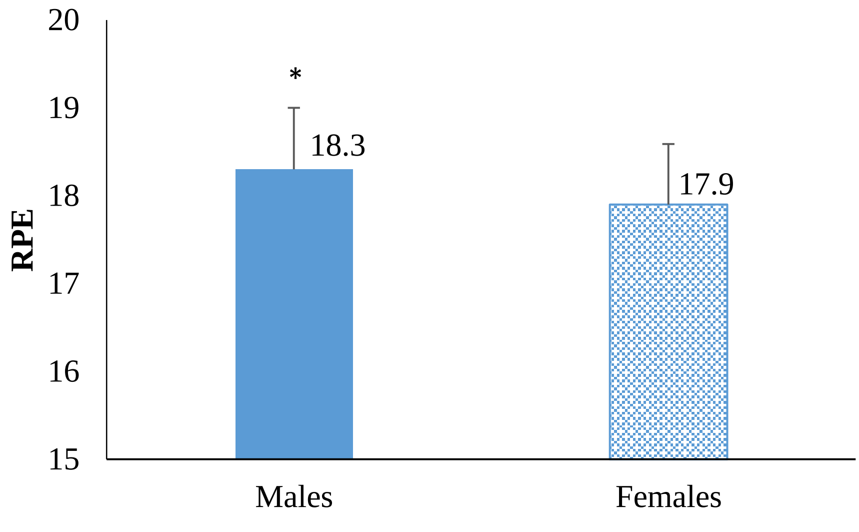
* $p < 0.05$, statistically significant from females

Figure 4.4 Peak oxygen consumption comparison between male and female subjects



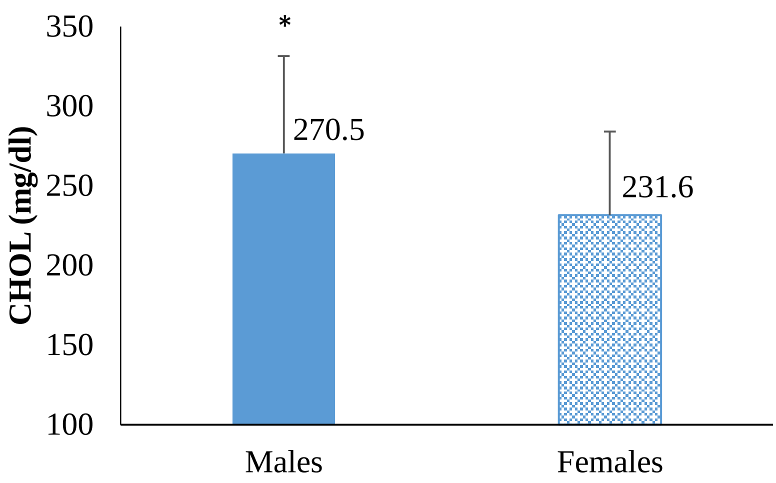
* $p < 0.05$, statistically significant from females

Figure 4.5 Peak oxygen consumption comparison between male and female subjects



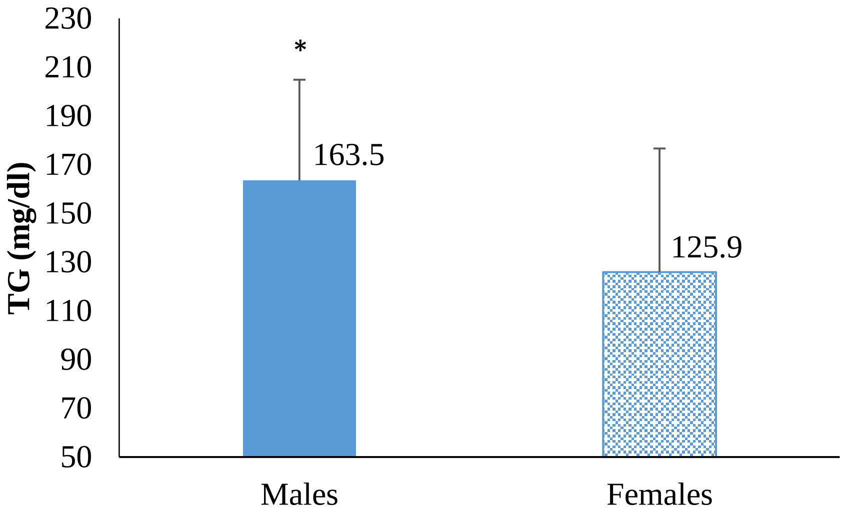
* $p < 0.05$, statistically significant from females

Figure 4.6 Rating of perceived exertion comparison between male and female subjects



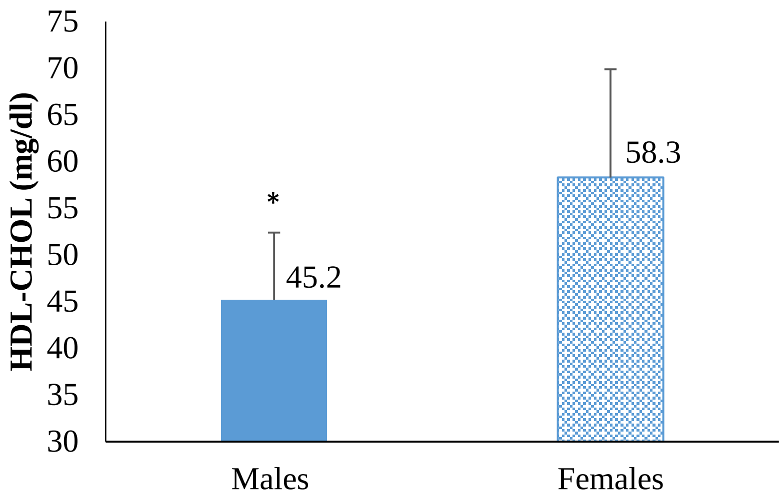
* $p < 0.05$, statistically significant from females

Figure 4.7 Total cholesterol comparison between male and female subjects



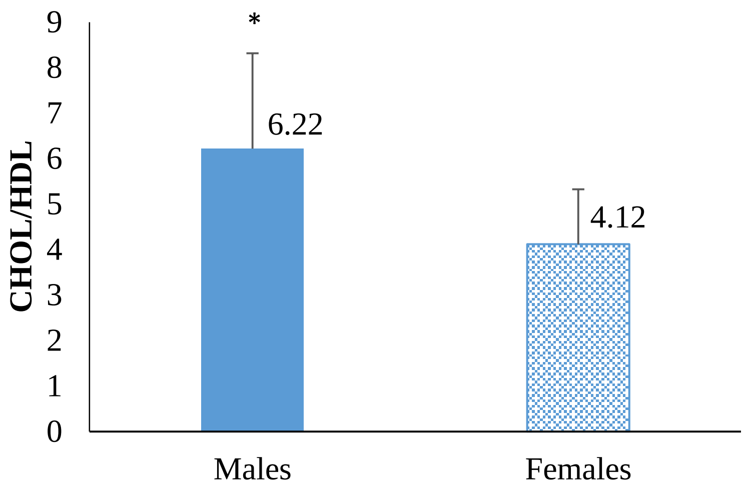
* $p < 0.05$, statistically significant from females

Figure 4.8 Triglycerides comparison between male and female subjects



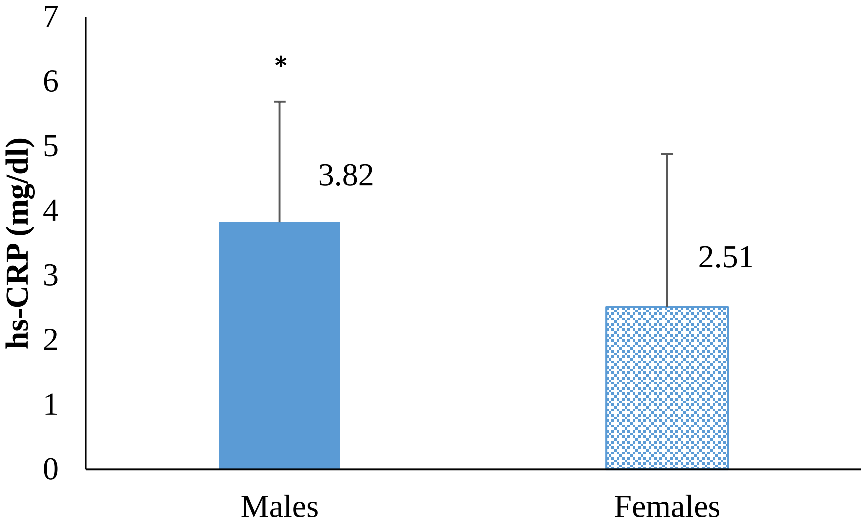
* $p < 0.05$, statistically significant from females

Figure 4.9 HDL-Cholesterol comparison between male and female subjects



* $p < 0.05$, statistically significant from females

Figure 4.10 Total cholesterol to HDL-cholesterol ratio comparison between male and female subjects



* $p < 0.05$, statistically significant from females

Figure 4.11 High sensitivity C-reactive protein comparison between male and female subjects

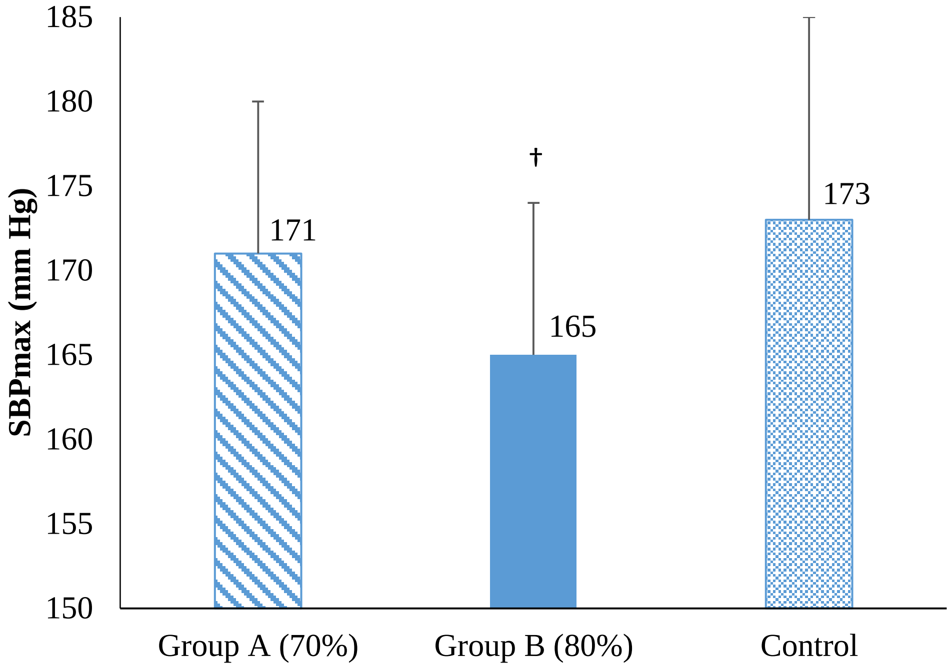
Part 4: Baseline maximal exercise testing peak values, physiological responses, and hematological variables of Group A (70%), Group B (80%), and Control

Baseline maximal exercise testing peak values, physiological responses, and hematological variables of Group A (70%), Group B (80%), and Control were represented in Table 4.4. One-way analysis of variance (ANOVA) was employed to detect differences among groups. All groups exhibited similar peak exercise values, physiological responses, and hematological variables except in the maximal systolic blood pressure response during exercise testing. However, Group B (80%) showed significantly lower systolic blood pressure response (165.0 ± 9.0 mm Hg) when compared to Group A (70%) (171.0 ± 9.0 mm Hg) and Control (173.0 ± 12.0 mm Hg) as represented in Figure 4.12.

Table 4.4 Baseline maximal exercise testing peak values, physiological responses, and hematological variables of Group A (70%), Group B (80%), and Control

	Structured		Unstructured		
	Group A (70%) Mean ± SD n = 23	Group B (80%) Mean ± SD n = 23	Control Mean ± SD n = 23	F	p-value
Peak Exercise Testing Values:					
Peak Speed (mph)	3.6 ± .37	3.6 ± .28	3.6 ± .21	.373	.690
Peak Incline (%)	14.7 ± .93	14.9 ± .92	14.9 ± .67	.425	.656
Time Achieved (min)	9.52 ± 1.40	9.75 ± 1.03	9.83 ± .74	.485	.618
HRmax (bpm)	161.0 ± 13.0	162.0 ± 15.0	164.0 ± 7.0	.376	.688
SBPmax (mm Hg)	171.0 ± 9.0	165.0 ± 9.0†	173.0 ± 12.0	4.393	.016
DBPmax (mm Hg)	76.0 ± 10.0	77.0 ± 7.0	78.0 ± 8.0	.174	.841
VO_2 peak (L/min)	1.66 ± .49	1.63 ± .39	1.81 ± .50	1.048	.356
VO_2 peak (ml/kg/min)	23.7 ± 4.6	23.5 ± 4.1	25.8 ± 4.7	1.850	.165
VT (%VO_2)	55.9 ± 8.4	56.7 ±7.9	56.7 ± 7.6	.067	.936
RERpeak	1.13 ± .05	1.13 ± .06	1.14 ± .05	.601	.552
RPEpeak	18.1 ± .73	18.2 ± .69	17.8 ± .67	1.685	.193
Hematological variables:					
FBG (mg/dl)	106.0 ± 24.0	99.0 ± 10.0	106.0 ± 16.0	2.325	.106
Cholesterol (mg/dl)	242.0 ± 58.0	244.0 ± 53.0	237.0 ± 61.0	.089	.915
Triglycerides (mg/dl)	123.0 ± 49.0	137.0 ± 54.0	144.0 ± 50.0	.951	.392
LDL-Chol (mg/dl)	135.0 ± 34.0	143.0 ± 33.0	150.0 ± 41.0	.959	.389
HDL-Chol (mg/dl)	53.0 ± 13.0	57.0 ± 13.0	55.0 ± 11.0	.689	.506
Chol/HDL-Chol (mg/dl)	4.78 ± 1.67	4.48 ± 1.51	4.57 ± 1.98	.189	.828
hs-CRP (mg/dl)	2.99 ± 2.28	2.76 ± 2.62	2.69 ± 2.14	.100	.905

† $p<0.05$, statistically significant from Group A (70%) and Control



† $p < 0.05$, statistically significant from Group A (70%) and Control

Figure 4.12 Maximal systolic blood pressure comparison among three groups of subjects. Group A (70%); Group B (80%); and Control

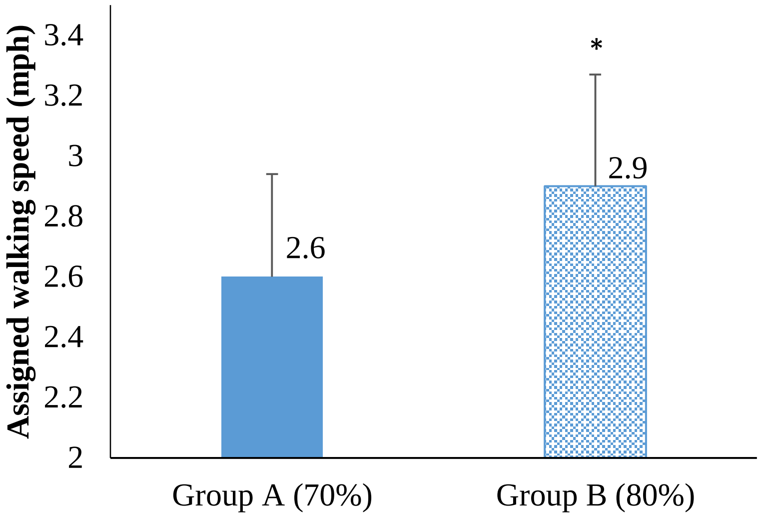
Part 5: Incremental treadmill walk test and physiological response variables of Group A (70%) and Group B (80%). The number of steps taken per day, the minute walked per week, and the intensity of walking of Control

Incremental treadmill walk test and physiological response variables between Group A (70%) and Group B (80%) were presented in Table 4.5 below. Independent t-test was utilized to detect the differences between the two groups. Group B (80%) had significantly higher ($p < 0.05$) assigned walking speed (2.9 ± .37 mph), higher relative walking intensity of percentage VO_2 peak (71.2 ± 8.3 %VO_2 peak), and higher heart response at assigned walking speed (131 ± 10.6 bpm) than Group A (70%) (2.6 ± .34 mph; 62.5 ± 9.5 %VO_2 peak; 124.4 ± 12.5 bpm) as presented in Figure 4.13 through Figure 4.15. In addition, Table 4.6 and Figure 4.16 showed the number of steps taken per day and the minutes walked per week of the Control group.

Table 4.5 Incremental treadmill walk test and physiological response variables between Group A (70%) and Group B (80%)

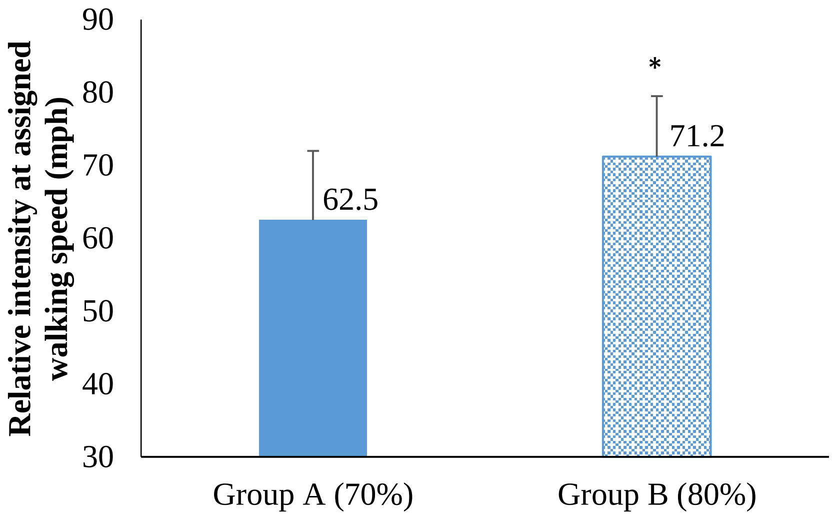
	Incremental Treadmill Walk Test (ITWT) Structured					
	Group A (70%) Mean ± SD n = 23	(Range)	Group B (80%) Mean ± SD n = 23	(Range)	t	p-value
Maximal walk test variables:						
Maximal walking speed (mph)	3.7 ± .49	(2.2 – 4.4)	3.6 ± .47	(2.5 – 4.4)	.608	.546
VO_2 at max walking speed (L/min)	1.28 ± .32	(.60 – 2.1)	1.21 ± .30	(.75 – 1.90)	.723	.473
VO_2 at max walking speed (ml/kg/min)	17.7 ± 3.6	(12.0 – 26.0)	17.6 ± 4.3	(12.0 – 26.0)	.037	.970
Relative intensity of max walking speed (% VO_2 peak)	77.9 ± 9.5	(61.9 – 93.2)	74.9 ±10.6	(51.4 – 91.0)	1.038	.305
HR at max walking speed (bpm)	138.3 ± 16.0	(94.0 – 163.0)	137.2 ± .12.1	(108.0 – 156.0)	.270	.788
70% and 80% walking test variables:						
Assigned walking speed (mph)	2.6 ± .34	(1.6 – 3.1)	2.9 ± .37*	(2.0 – 3.5)	-2.796	.008
VO_2 at assigned walking speed (L/min)	1.03 ± .29	(.58 – 1.56)	1.18 ± .37	(.82 – 2.04)	-1.582	.121
VO_2 at assigned walking speed (ml/kg/min)	14.8 ± 2.8	(10.0 – 20.0)	16.6 ± 3.6	(12.0 – 24.0)	-1.872	.068
Relative intensity at assigned walking speed (% VO_2 peak)	62.5 ± 9.5	(51.0 – 93.0)	71.2 ± 8.3*	(57.6 – 82.8)	-3.310	.002
HR at assigned walking speed (bpm)	124.4 ± 12.5	(90.0 – 142.0)	131.6 ± 10.6*	(107.0 – 150.0)	-2.106	.041
Energy expenditure @ assigned walking speed (kcal/min)	5.4 ± 1.5	(3.0 – 8.0)	5.9 ± 1.9	(4.0 – 10.0)	-.876	.386
Minute assigned of walking (min/wk)	202.5 ± 52.6	(122.0 – 313.0)	185.6 ± .45.6	(100.0 – 244.0)	.1.164	.251
Minute assigned of walking (min/session)	28.9 ± 7.6	(17.0 – 45.0)	26.6 ± .6.5	(14.0 – 35.0)	1.080	.286

* $p < 0.05$, statistically significant from Group A (70%)



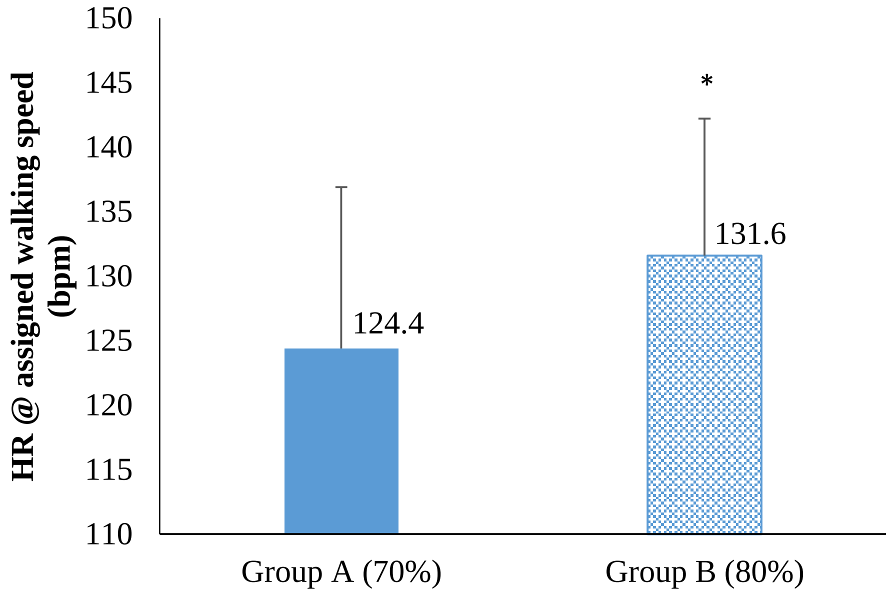
* $p < 0.05$, statistically significant from Group A (70%)

Figure 4.13 Assigned walking speed comparison between Group A (70%) and Group B (80%)



* $p < 0.05$, statistically significant from Group A (70%)

Figure 4.14 Assigned walking speed comparison between Group A (70%) and Group B (80%)



* $p < 0.05$, statistically significant from Group A (70%)

Figure 4.15 Heart rate at assigned walking speed comparison between Group A (70%) and Group B (80%)

The descriptive data of the control group on the number of steps walked per day, the minutes walked per week, and the intensity of walking were presented in Table 4.6. The data was shown in mean ± SD and minimum and maximum.

Table 4.6 The number of steps taken per day, minutes achieved of walking per week, and intensity of walking of Control

Walking	Mean ± SD	Min	Max
Steps walked/day	7708 ± 1923	5239	11931
Minutes walked/week	254.5 ± 48.6	168	335
Intensity of walking (MET)	3.1 ± 1.2	2.4	3.8

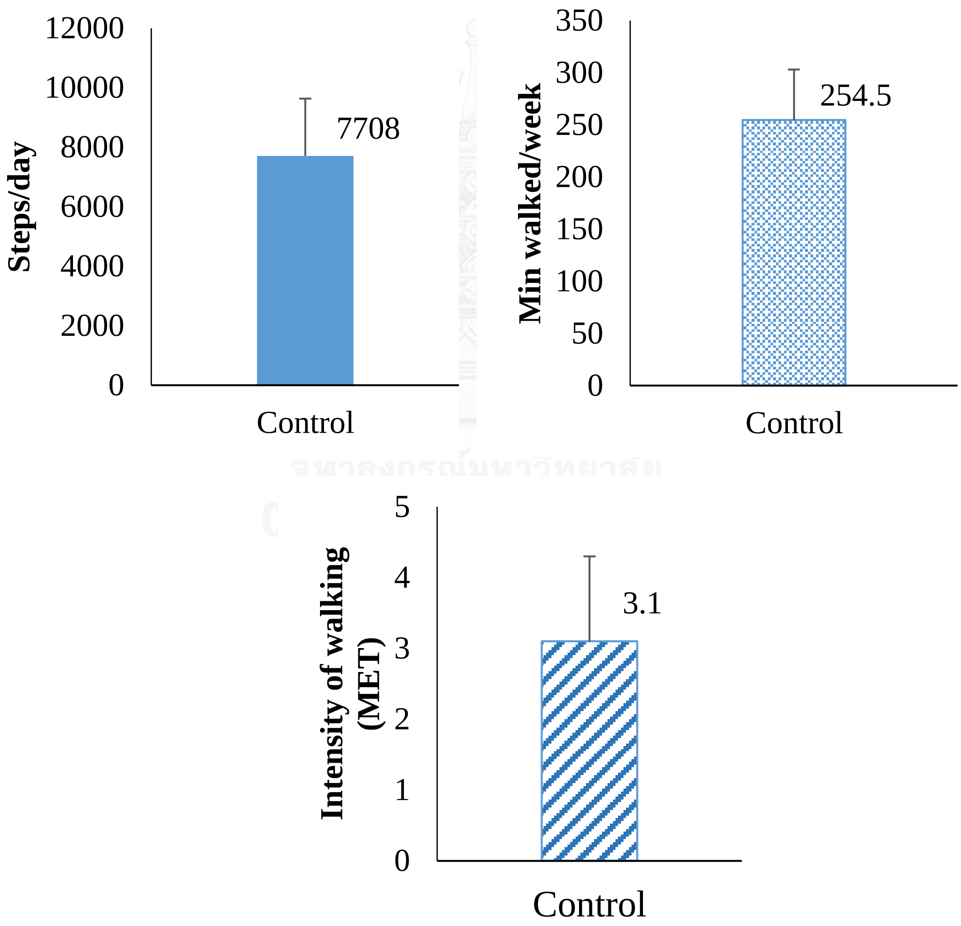


Figure 4.16 The number of steps taken per day and minutes achieved of walking per week, and intensity of walking of Control

Part 6: The comparison of the effects of walking speed on morphological, physiological, and hematological variables between pre- and post-training among all groups of subjects. Group A (70%), Group B (80%), and Control

The effects of walking speed on morphological and physiological variables between pre- and post-training among all groups of subjects were presented in Table 4.7. Variables between pre- and post-training were analyzed via paired t-test and the significant level was set at $p < 0.05$. Significnat variables were presented in Figure 4.17 through Figure 4.33.

After 10 weeks of training, Group A (70%) and Group B (80%) showed a significant change in body weight ($p < 0.05$) when compared to Control as shown in Figure 4.17. Despite the change in body weight in both groups (A & B), other morphological variables such as BMI, waist circumference, hip circumference, WHR, and percent body fat were significantly reduced ($p < 0.05$) at post-training only in Group B (80%) as presented in Figure 4.18 through Figure 4.22.

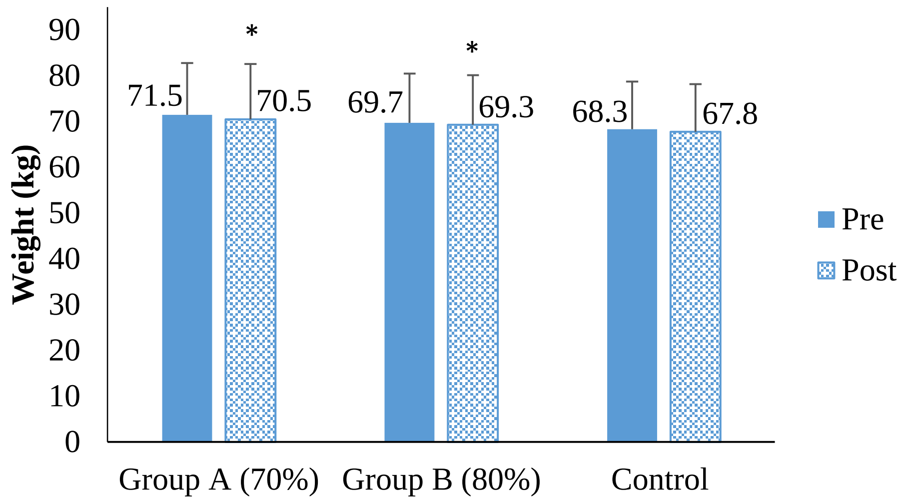
The resting heart rate of all three groups were significantly lowered ($p < 0.05$) after 10 weeks of intervention as shown in Figure 4.23. Resting systolic blood pressure of Group A (70%) and Control were significantly lowered ($p < 0.05$) at post-training (Figure 4.24). However, the resting diastolic blood pressure was significantly lowered ($p < 0.05$) in only Group A (70%) as shown in Figure 4.25 and maximal diastolic blood pressure was significantly lowered ($p < 0.05$) only in Control as shown in Figure 4.26.

After 10 weeks of training, peak oxygen consumption was significantly increased ($p < 0.05$) in Group A (70%) and Group B (80%) as presented in Figure 4.27 and Figure 4.28. All groups significantly improved ($p < 0.05$) in ventilatory threshold (Figure 4.29) and only the Control had significantly higher ($p < 0.05$) in the rating of perceieved exertion (Figure 4.30). The maximal treadmill speed and peak treadmill time were significantly improved ($p < 0.05$) in all three groups (Figure 4.31 and Figure 4.33). However, the peak treadmill incline was significantly higher in only Group B (80%) as shown in Figure 4.32.

Table 4.7 The comparison of morphological and physiological variables between pre- and post-training among all groups of subjects. Group A (70%), Group B (80%), and Control

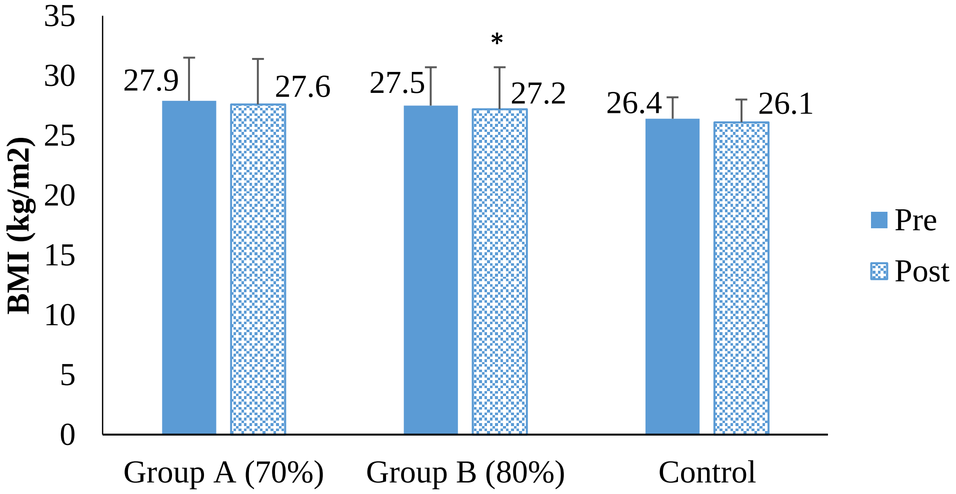
	Structured								Unstructured			
	Group A (70%)				Group B (80%)				Control			
	Pre-training	Post-training	t	p-value	Pre-training	Post-training	t	p-value	Pre-training	Post-training	t	p-value
Weight (kg)	71.5 ± 11.3	70.5 ± 12.1*	2.561	.018	69.7 ± 10.8	69.3 ± 10.8*	2.430	.024	68.3 ± 10.4	67.8 ± 10.4	1.598	.124
BMI (kg/m^2)	27.9 ± 3.6	27.6 ± 3.8	1.680	.107	27.5 ± 3.2	27.2 ± 3.5*	2.436	.023	26.4 ± 1.8	26.1 ± 1.9	1.563	.132
Waist (cm)	90.4 ± 8.4	89.3 ± 8.9	1.913	.069	90.4 ± 7.7	87.5 ± 6.1*	3.204	.004	91.7 ± 7.9	91.1 ± 8.1	1.071	.296
Hip (cm)	102.1 ± 8.5	101.8 ± 8.4	.366	.718	103.3 ± 8.3	101.8 ± 7.1*	2.842	.009	103.5 ± 4.4	103.0 ± 5.1	1.091	.287
WHR	.88 ± .06	.88 ± .05	1.472	.155	.88 ± .06	.86 ± .06*	2.469	.022	.89 ± .09	.88 ± .09	.500	.622
% Body fat	35.6 ± 5.3	34.3 ± 5.6	1.747	.095	35.8 ± 4.9	34.9 ± 4.1*	2.198	.039	34.9 ± 5.4	34.4 ± 5.6	.922	.367
FFM (kg)	45.5 ± 5.4	46.0 ± 7.1	-.798	.434	44.4 ± 5.6	44.9 ± 5.8	-1.582	.128	44.3 ± 6.2	44.3 ± 6.5	.036	.972
HR_{rest} (bpm)	87.1 ± 11.1	81.1 ± 7.1*	3.027	.006	83.3 ± 12.5	78.7 ± 9.6*	2.516	.020	81.5 ± 6.7	76.7 ± 5.1*	4.217	.000
SBP_{rest} (mm Hg)	133.8 ± 13.9	127.2 ± 11.9*	2.870	.009	128.4 ± 12.5	123.7 ± 11.7	1.778	.089	138.4 ± 11.2	131.7 ± 9.8*	4.731	.000
DBP_{rest} (mm Hg)	78.7 ± 8.9	74.5 ± 6.7*	2.476	.021	77.0 ± 7.4	76.5 ± 6.4	.317	.755	77.8 ± 8.9	76.4 ± 7.5	1.268	.218
HR_{max} (bpm)	161.0 ± 12.5	159.7 ± 11.9	1.251	.224	162.0 ± 15.3	164.5 ± 9.9	-1.228	.232	164.1 ± 7.0	164.8 ± 5.8	-.711	.485
SBP_{max} (mm Hg)	170.9 ± 8.8	169.6 ± 8.4	.806	.429	164.7 ± 9.5	166.3 ± 9.9	-.870	.394	173.1 ± 11.6	172.1 ± 10.8	.993	.332
DBP_{max} (mm Hg)	76.4 ± 9.8	75.8 ± 6.6	.392	.699	77.5 ± 6.8	75.9 ± 6.4	.855	.402	77.8 ± 8.1	75.3 ± 6.8*	2.393	.026
VO_{2peak} (L/min)	1.66 ± .49	1.73 ± .48*	-4.092	.000	1.63 ± .39	1.78 ± .42*	-5.269	.000	1.81 ± .49	1.80 ± .46	.733	.472
VO_{2peak} (ml/kg/min)	23.7 ± 4.6	25.2 ± 4.6*	-5.430	.000	23.4 ± 4.1	26.4 ± 4.9*	-6.492	.000	25.8 ± 4.7	25.8 ± 3.9	-.109	.914
VT (%VO_2)	55.9 ± 8.4	63.5 ± 6.1*	-5.309	.000	56.7 ± 7.9	67.9 ± 8.9*	-5.521	.000	56.7 ± 7.6	60.7 ± 6.1*	-3.397	.003
RER_{peak}	1.13 ± .05	1.14 ± .05	-.889	.384	1.13 ± .06	1.13 ± .06	-.074	.941	1.14 ± .05	1.16 ± .04	-1.343	.193
RPE_{peak}	18.1 ± .73	18.3 ± .86	-.940	.357	18.1 ± .69	18.5 ± .59	-2.006	.057	17.8 ± .67	18.3 ± .86*	-2.121	.045
Speed max (mph)	3.6 ± .38	3.6 ± .33*	-2.075	.050	3.6 ± .28	3.7 ± .36*	-3.284	.003	3.6 ± .21	3.7 ± .25*	-2.594	.017
Incline max(%)	14.7 ± .93	14.7 ± .81	-.371	.714	14.9 ± .92	15.1 ± 1.1*	-2.313	.030	14.9 ± .67	15.0 ± .67	-1.447	.162
Time max (min)	9.52 ± 1.4	9.89 ± 1.2*	-2.501	.020	9.74 ± 1.0	10.4 ± 1.3*	-5.203	.000	9.82 ± .74	10.15 ± .89*	-3.381	.003

Values are mean ± SD * $p < 0.05$, statistically significant from pre-test



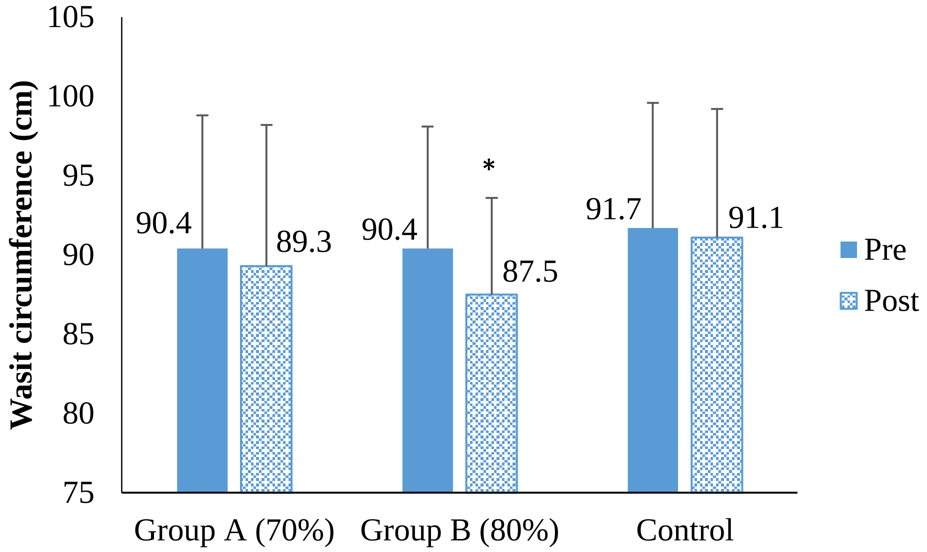
* $p < 0.05$, statistically significant from pre-test.

Figure 4.17 Body weight comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



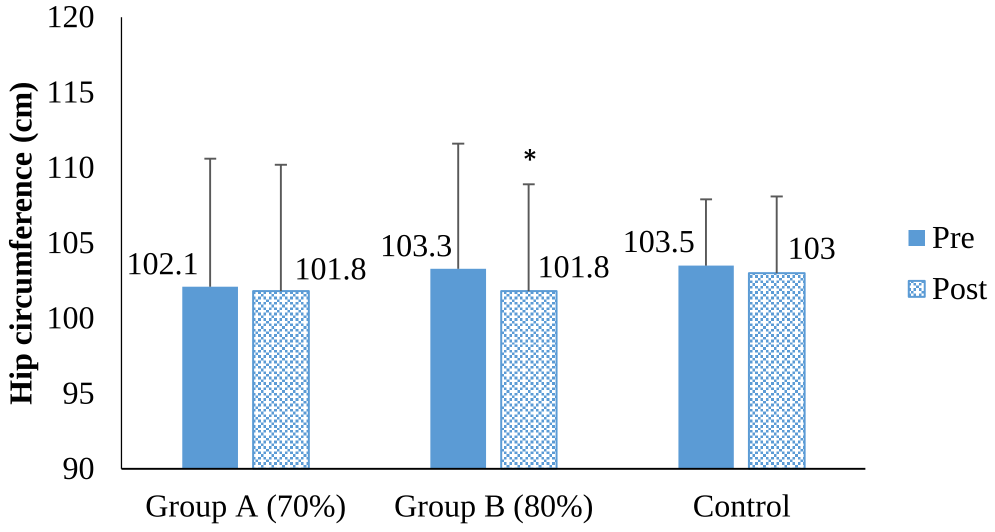
* $p < 0.05$, statistically significant from pre-test.

Figure 4.18 Body mass index comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



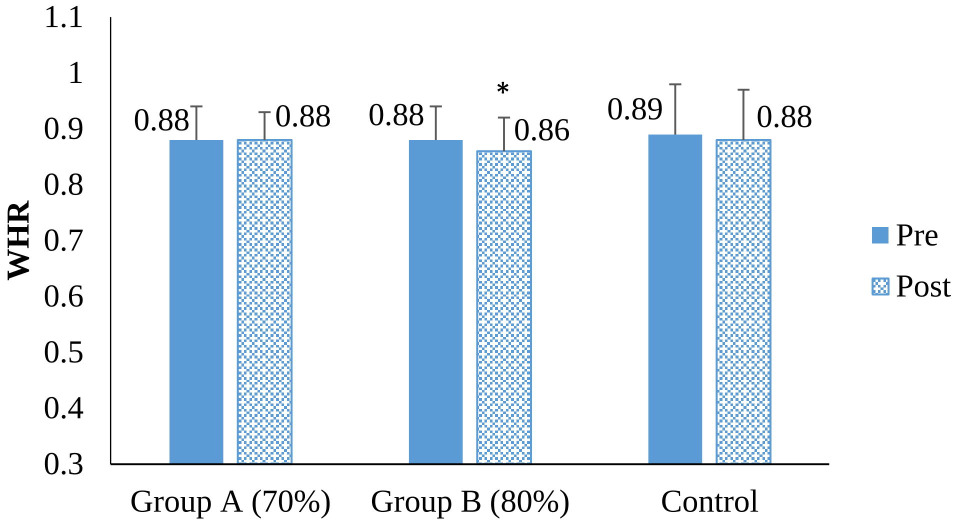
* $p < 0.05$, statistically significant from pre-test.

Figure 4.19 Waist circumference comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



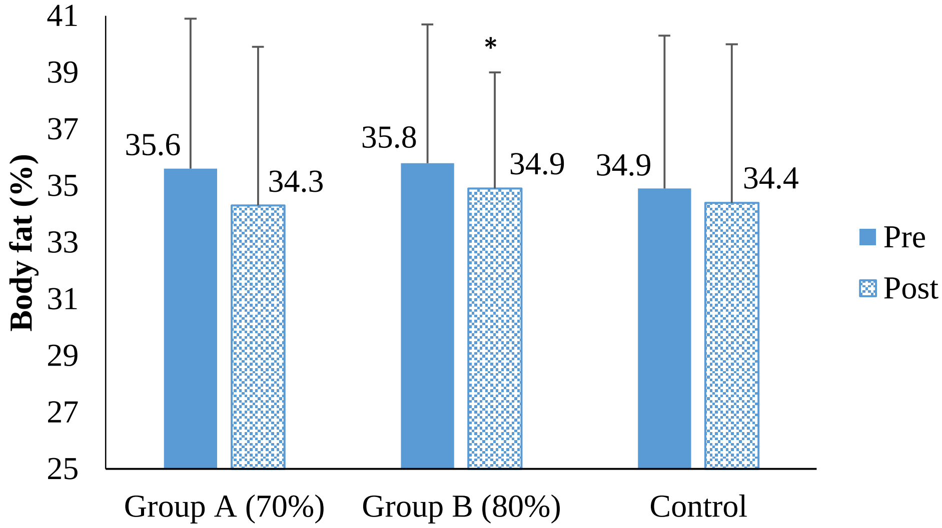
* $p < 0.05$, statistically significant from pre-test.

Figure 4.20 Hip circumference comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



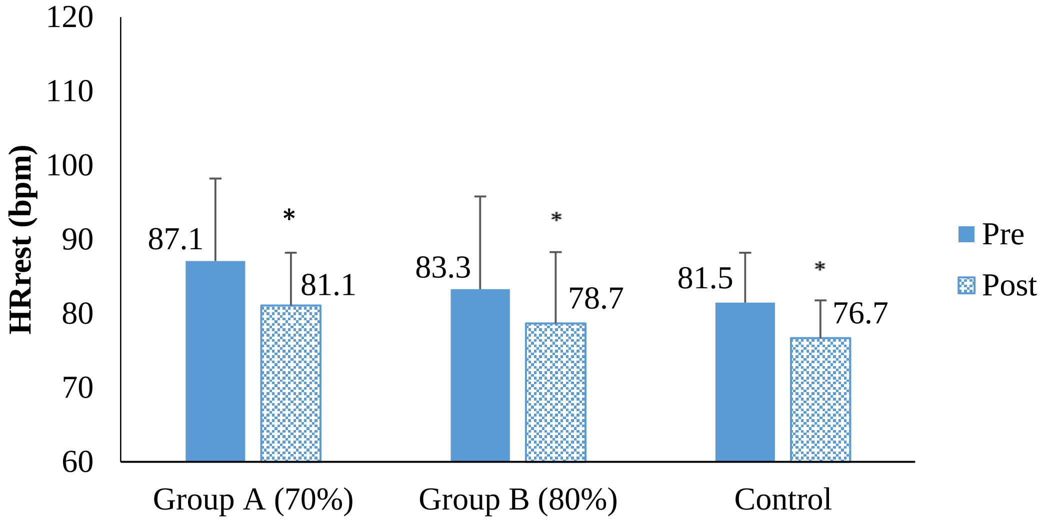
* $p < 0.05$, statistically significant from pre-test.

Figure 4.21 Waist to Hip ratio comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



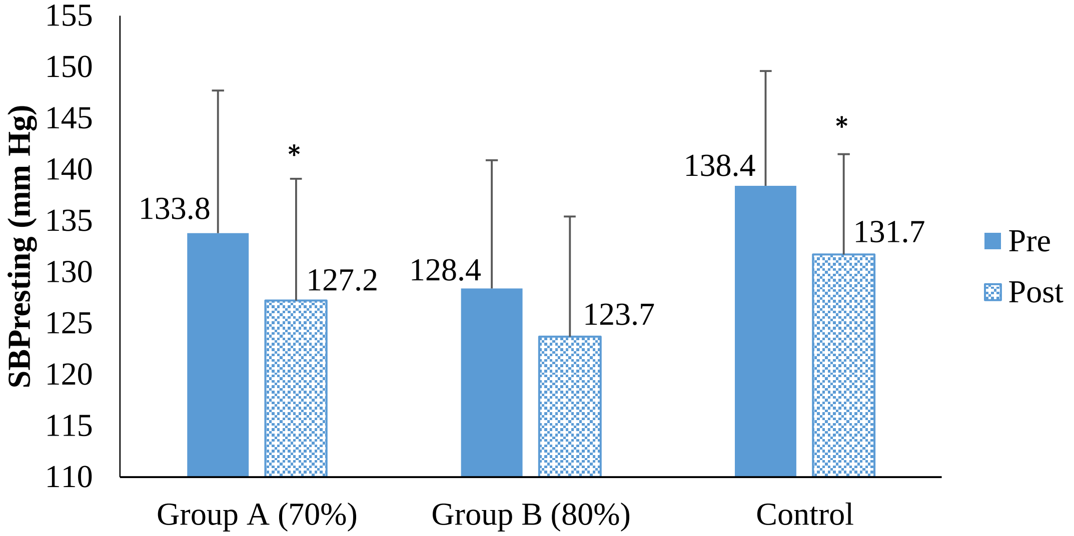
* $p < 0.05$, statistically significant from pre-test.

Figure 4.22 Body fat comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



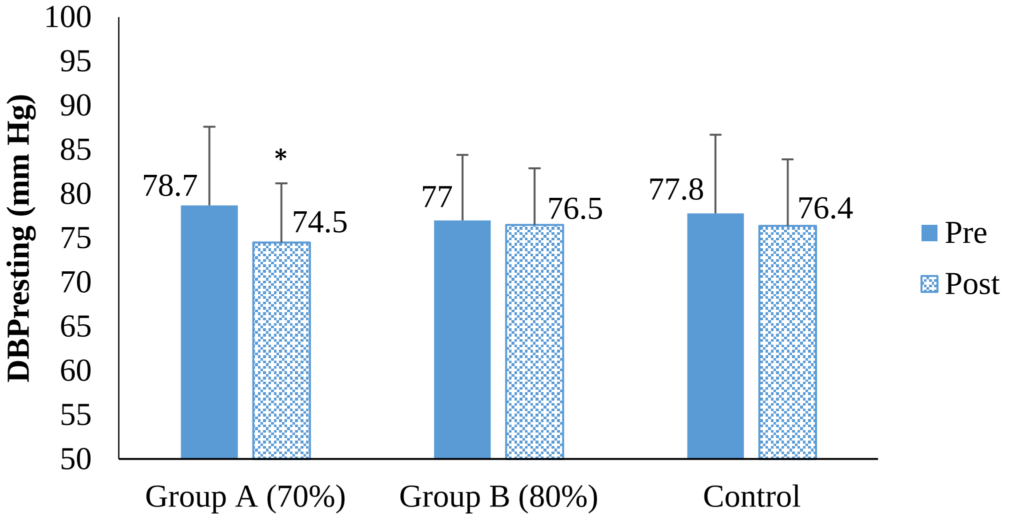
* p < 0.05, statistically significant from pre-test.

Figure 4.23 Resting heart rate comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



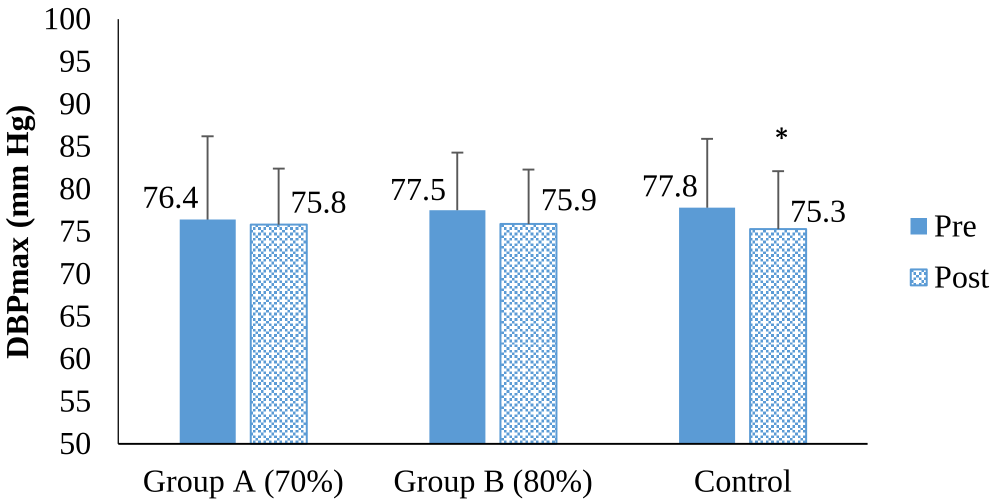
* p < 0.05, statistically significant from pre-test.

Figure 4.24 Resting systolic blood pressure comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



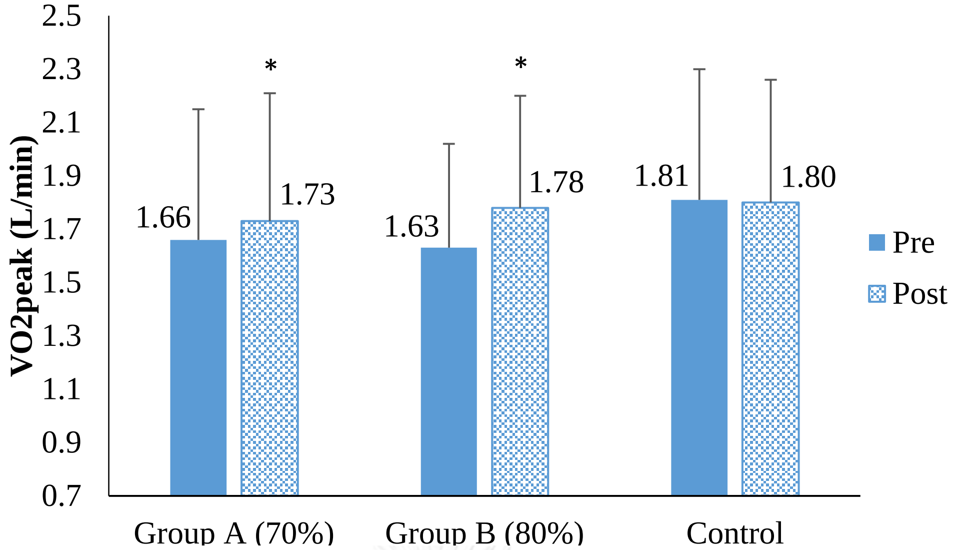
* $p < 0.05$, statistically significant from pre-test.

Figure 4.25 Resting diastolic blood pressure comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



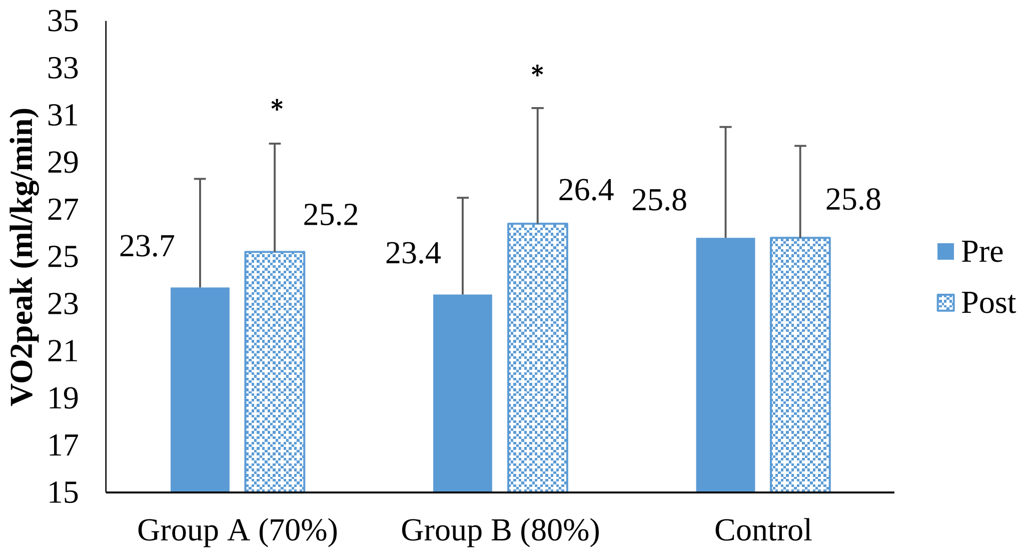
* $p < 0.05$, statistically significant from pre-test.

Figure 4.26 Maximal diastolic blood pressure comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



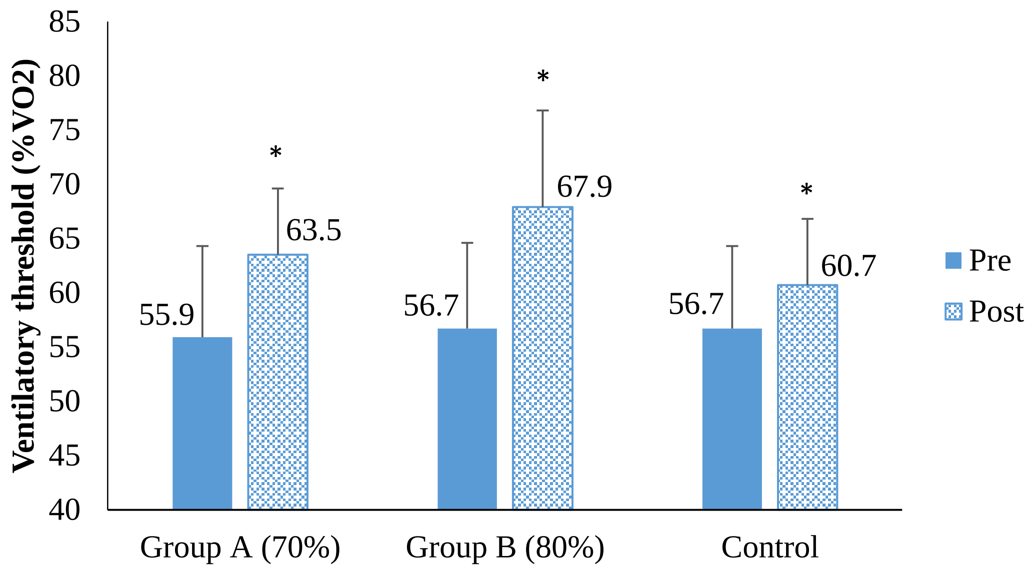
* $p < 0.05$, statistically significant from pre-test.

Figure 4.27 Peak oxygen consumption comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



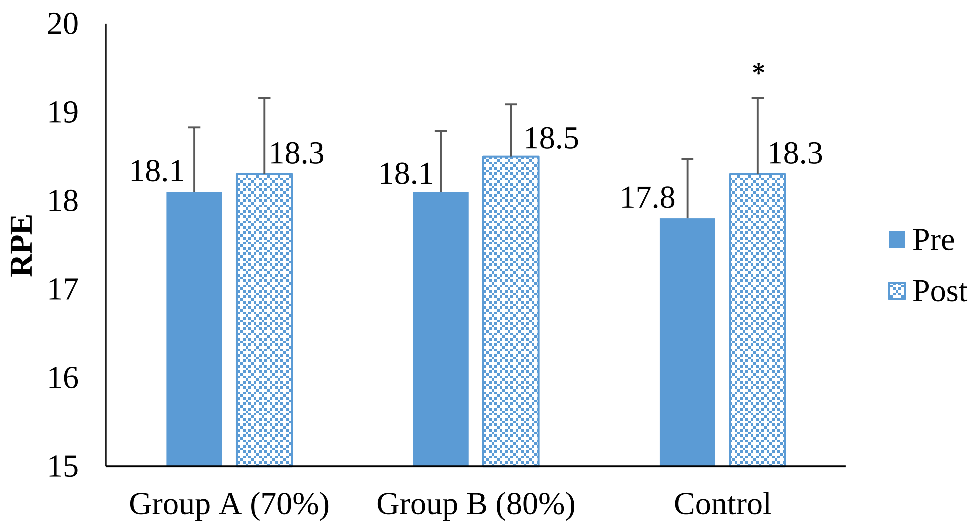
* $p < 0.05$, statistically significant from pre-test.

Figure 4.28 Peak oxygen consumption comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



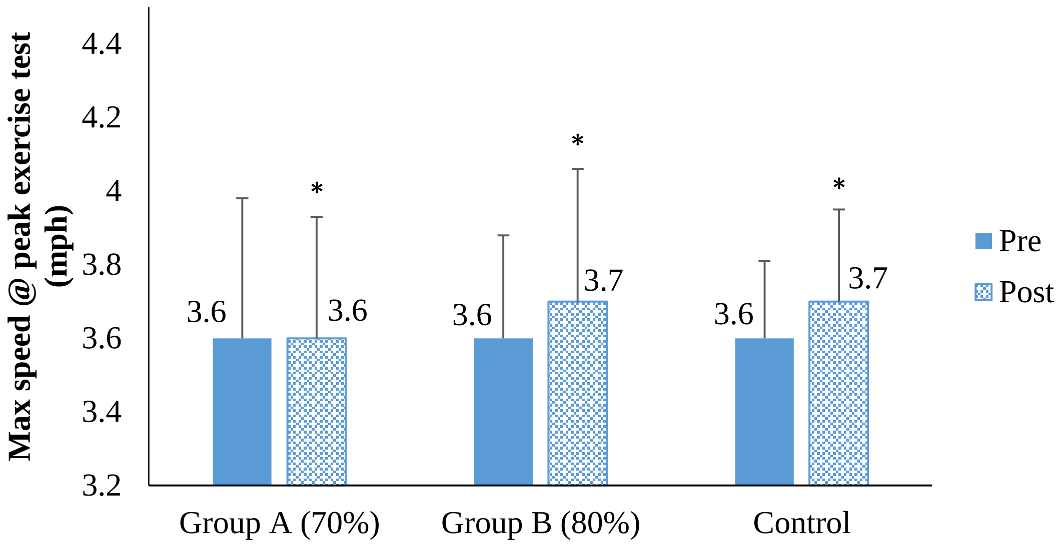
* p < 0.05, statistically significant from pre-test.

Figure 4.29 Ventilatory threshold comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



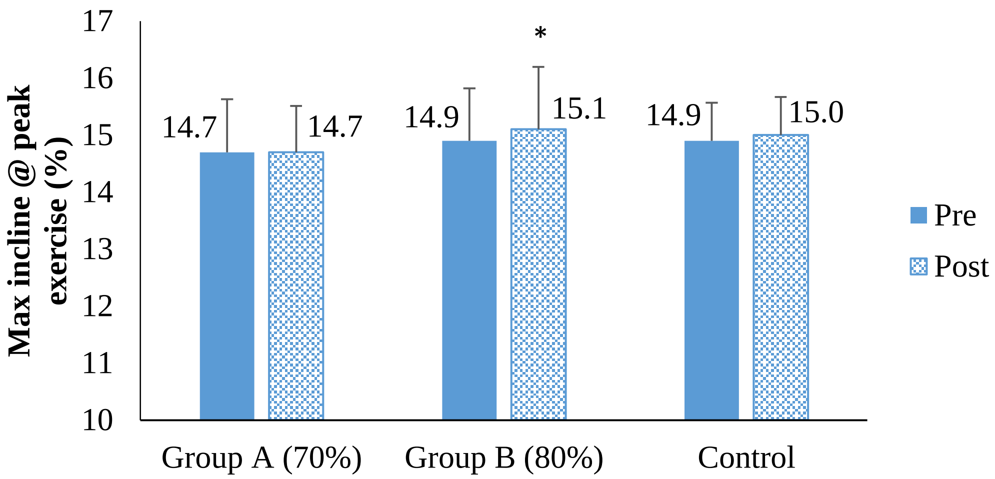
* p < 0.05, statistically significant from pre-test.

Figure 4.30 Rating of perceived exertion comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



* $p < 0.05$, statistically significant from pre-test.

Figure 4.31 Maximal treadmill speed at peak exercise comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



* $p < 0.05$, statistically significant from pre-test.

Figure 4.32 Maximal incline at peak exercise comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control

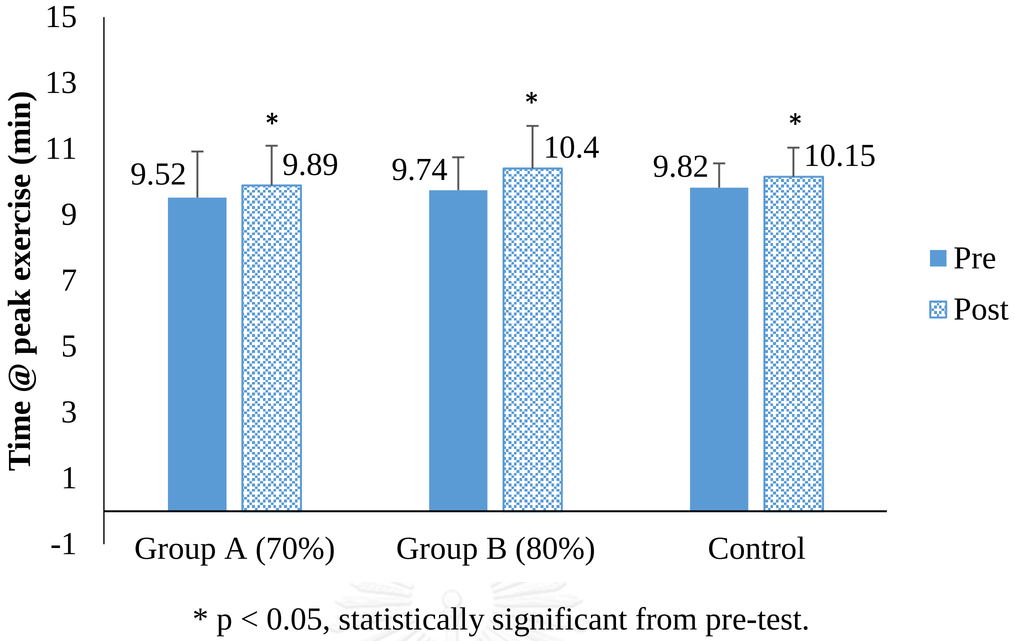


Figure 4.33 Time at peak exercise comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control

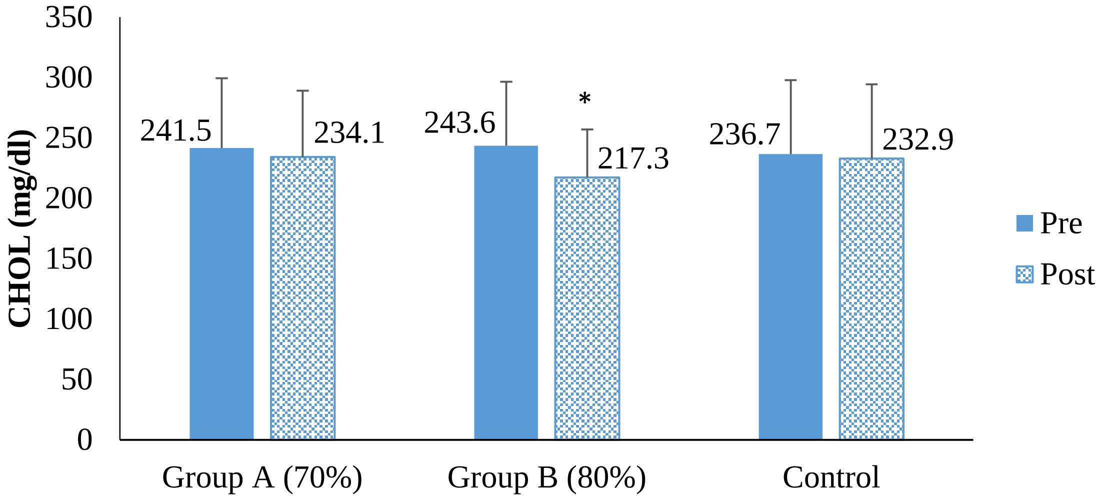
The effects of walking speed on hematological variables between pre- and post-training among all groups of subjects were presented in Table 4.8. Variables between pre- and post-training were analyzed via paired t-test and the significant variables ($p < 0.05$) were shown in Figure 4.34 through Figure 4.37.

After10 weeks of intervention, only Group B (80%) showed a significant decreased in total cholesterol, triglycerides, LDL-cholesterol, and total cholesterol and HDL-cholesterol ratio ($p < 0.05$) as presented in Figure 4.34 through Figure 4.37.

Table 4.8 The comparison of hematological variables between pre- and post-training among all groups of subjects. Group A (70%), Group B (80%), and Control

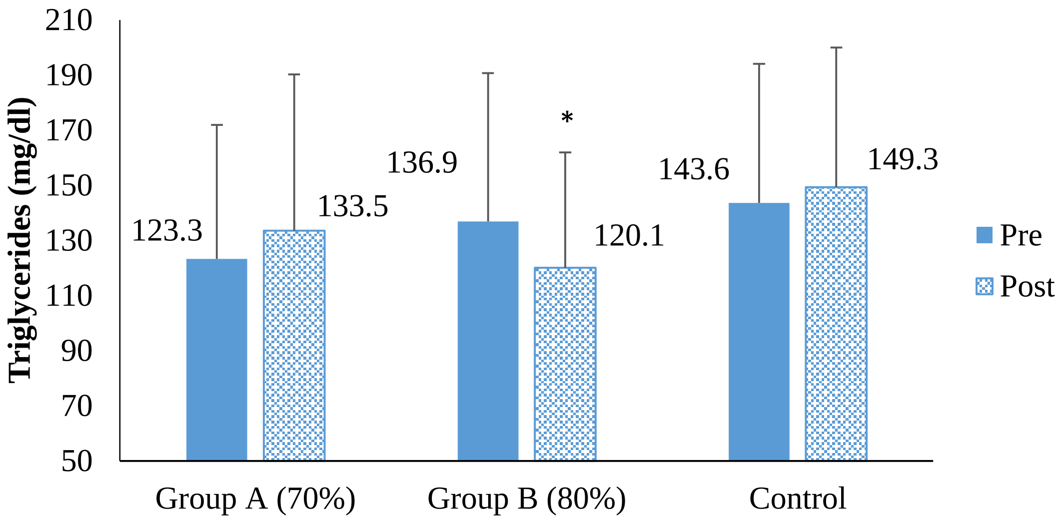
	Structured								Unstructured			
	Group A (70%)				Group B (80%)				Control			
	Pre-training	Post-training	t	p-value	Pre-training	Post-training	t	p-value	Pre-training	Post-training	t	p-value
FBG (mg/dl)	105.7 ± 24.1	105.4 ± 31.7	.091	.928	96.3 ± 10.1	93.2 ± 13.2	1.721	.099	106.4 ± 16.2	107.5 ± 17.0	-.822	.420
CHOL (mg/dl)	241.5 ± 57.9	234.1 ± 54.9	1.168	.255	243.6 ± 52.9	217.3 ± 39.8*	3.208	.004	236.7 ± 61.0	232.9 ± 61.5	1.330	.197
TG (mg/dl)	123.3 ± 48.6	133.5 ± 56.8	-1.233	.231	136.9 ± 53.9	120.1 ± 41.9*	2.161	.042	143.6 ± 50.5	149.3 ± 50.7	-1.575	.130
LDL-CHOL (mg/dl)	135.1 ± 33.9	132.8 ± 42.1	.689	.498	143.2 ± 33.2	124.3 ± 27.1*	2.161	.042	149.8 ± 40.5	146.1 ± 40.2	1.355	.189
HDL-CHOL (mg/dl)	53.0 ± 12.7	52.6 ± 10.7	.278	.783	57.2 ± 12.8	56.4 ± 12.4	.414	.683	55.5 ± 10.8	56.2 ± 9.6	-1.025	.316
CHOL/HDL	4.78 ± 1.67	4.68 ± 1.08	.414	.683	4.48 ± 1.51	3.56 ± 1.06*	2.384	.026	4.56 ± 1.97	4.34 ± 1.66	1.685	.106
hs-CRP (mg/dl)	2.99 ± 2.28	2.78 ± 2.74	.523	.606	2.76 ± 2.62	2.22 ± 1.82	1.897	.071	2.68 ± 2.14	2.45 ± 2.02	1.094	.286

Values are mean ± SD   * $p < 0.05$, statistically significant from pre-test



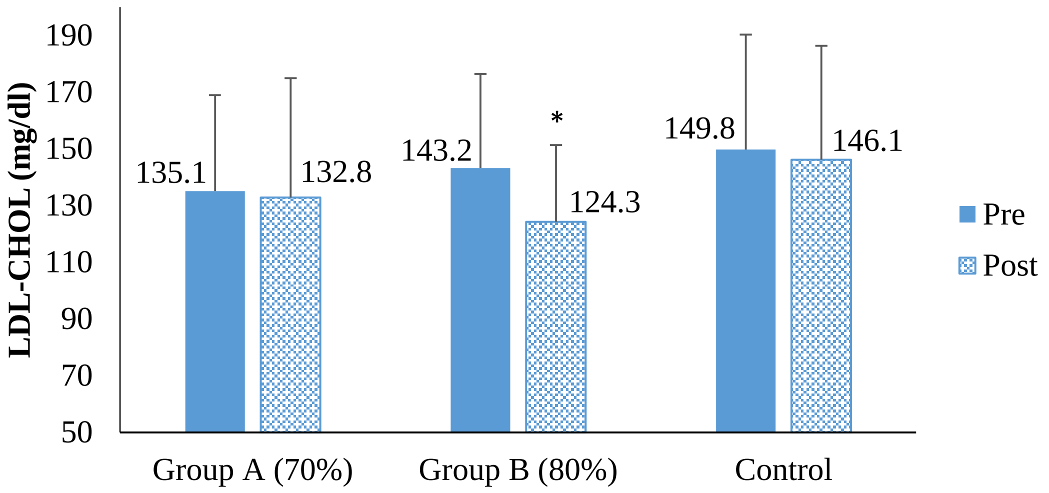
* $p < 0.05$, statistically significant from pre-test.

Figure 4.34 Total cholesterol comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



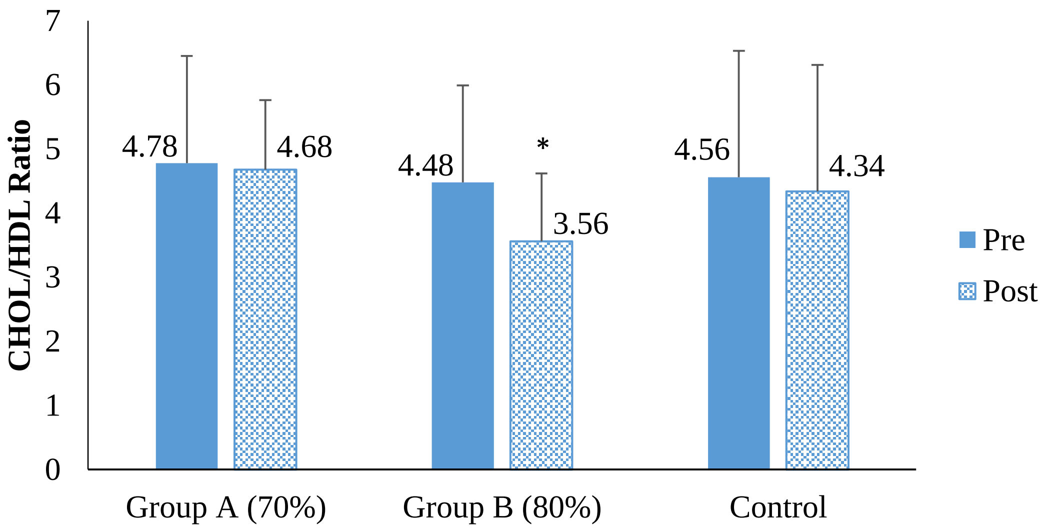
* $p < 0.05$, statistically significant from pre-test.

Figure 4.35 Triglycerides comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



* p < 0.05, statistically significant from pre-test.

Figure 4.36 LDL-Cholesterol comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control



* p < 0.05, statistically significant from pre-test.

Figure 4.37 Total cholesterol to HDL-cholesterol ratio comparison between pre- and post-training among three groups of subjects. Group A (70%), Group B (80%), and Control

Part 7: The changes in aerobic capacity, ventilator threshold, total cholesterol, and triglycerides between pre- and post-training among Group A (70%), Group B (80%), and Control as a result of different walking speed

The changes in aerobic capacity, ventilator threshold, total cholesterol, and triglycerides between pre- and post-training as the result of walking speed among Group A (70%), Group B (80%), and Control were presented in Table 4.9. The changes in physiological and hematological variables of each group were calculated by subtracting the pre-training results from the post-training results. The acquired difference of variables among the three groups were compared using One-way ANOVA with LSD post hoc test to detect significant differences between groups. On the significant variables will be presented in Figure 4.38 through Figure 4.43.

After 10 weeks of training, the results revealed significant increase in VO_2 peak ($p < 0.05$) in Group A (70%) and Group B (80%) when compared to Control as presented in Figure 4.38 through Figure 4.40. The ventilator threshold, on the other hand, increased significantly ($p < 0.05$) in only Group B (80%) as shown in Figure 4.41. In addition, the total cholesterol and the triglycerides level significantly decreased ($p < 0.05$) in only Group B (80%) as presented in Figure 4.42 and Figure 4.43.

Table 4.9 The comparison of changes in aerobic capacity, ventilator threshold, total cholesterol, and triglycerides between pre- and post-training among all groups of subjects. Group A (70%), Group B (80%), and Control

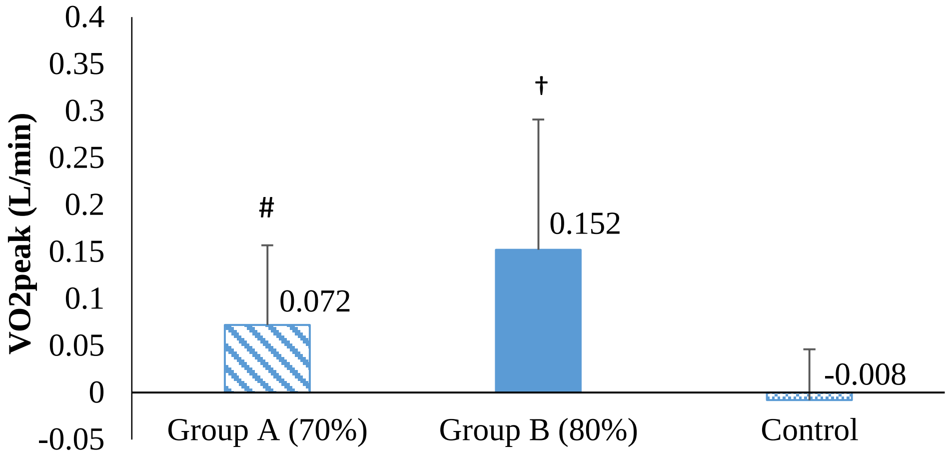
	Group A (70%)			Group B (80%)			Control				
	Pre-training	Post-training	% diff	Pre-training	Post-training	% diff	Pre-training	Post-training	% diff	F	Sig
VO_2 peak (L/min)	1.66 ± .49	1.73 ± .48*#	4.2%	1.63 ± .39	1.78 ± .42*†	9.2%	1.81 ± .49	1.80 ± .46	-0.6%	15.175	.000
VO_2 peak (ml/kg/min)	23.7 ± 4.6	25.2 ± 4.6*#	6.3%	23.4 ± 4.1	26.4 ± 4.9*†	12.8%	25.8 ± 4.7	25.8 ± 3.9	0%	14.272	.000
VO_2 peak (ml/min)	1661.7 ± 485.6	1733.9 ± 481.4*#	4.3%	1631.3 ± 394.8	1783.5 ± 416.0*†	9.3%	1814.8 ± 495.0	1806.5 ± 463.7	-0.5%	15.175	.000
VT (%VO_2)	55.9 ± 8.4	63.5 ± 6.1*	13.6%	56.7 ± 7.9	67.9 ± 8.9*#	19.8%	56.7 ± 7.6	60.7 ± 6.1*	7.0%	5.031	.009
CHOL (mg/dl)	241.5 ± 57.9	234.1 ± 54.9	-3.1%	243.6 ± 52.9	217.3 ± 39.8*†	-10.8%	236.7 ± 61.0	232.9 ± 61.5	-1.6%	3.837	.027
TG (mg/dl)	123.3 ± 48.6	133.5 ± 56.8	8.3%	136.9 ± 53.9	120.1 ± 41.9*†	12.3%	143.6 ± 50.5	149.3 ± 50.7	3.9%	4.428	.016

Values are means ± SD

* $p<0.05$, statistically significant from pre-test

# $p<0.05$, statistically significant from Control

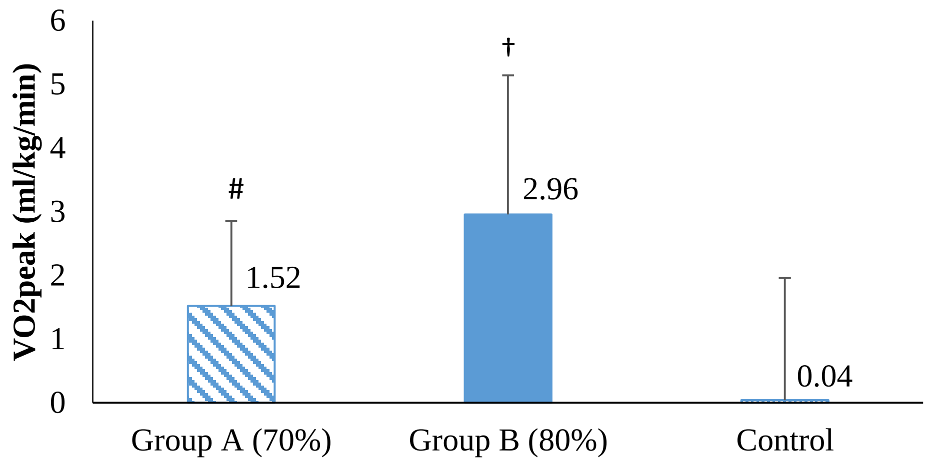
† $p<0.05$, statistically significant from Group A and Control



# p<0.05, statistically significant from Control

† p<0.05, statistically significant from Group A and Control

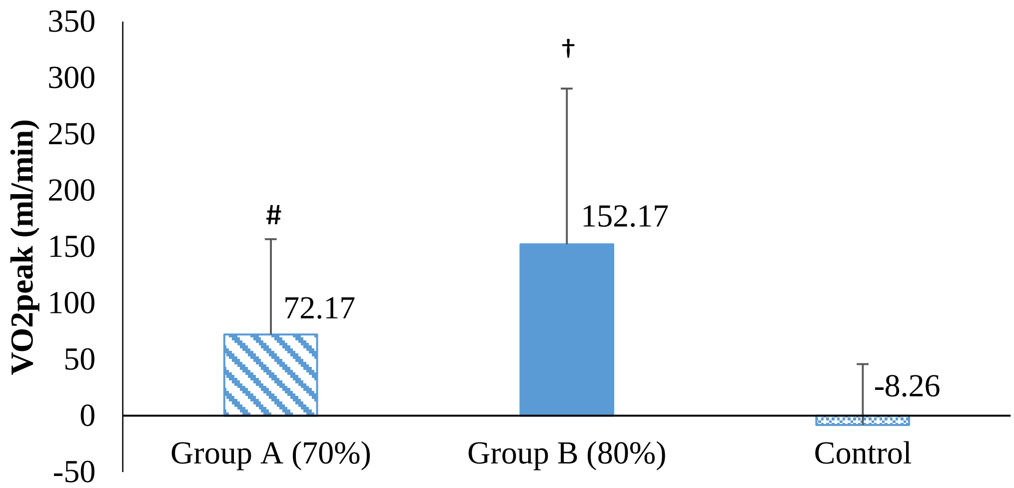
Figure 4.38 The change in peak oxygen consumption between all groups of subjects. Group A (70%), Group B (80%), and Control



# p<0.05, statistically significant from Control

† p<0.05, statistically significant from Group A and Control

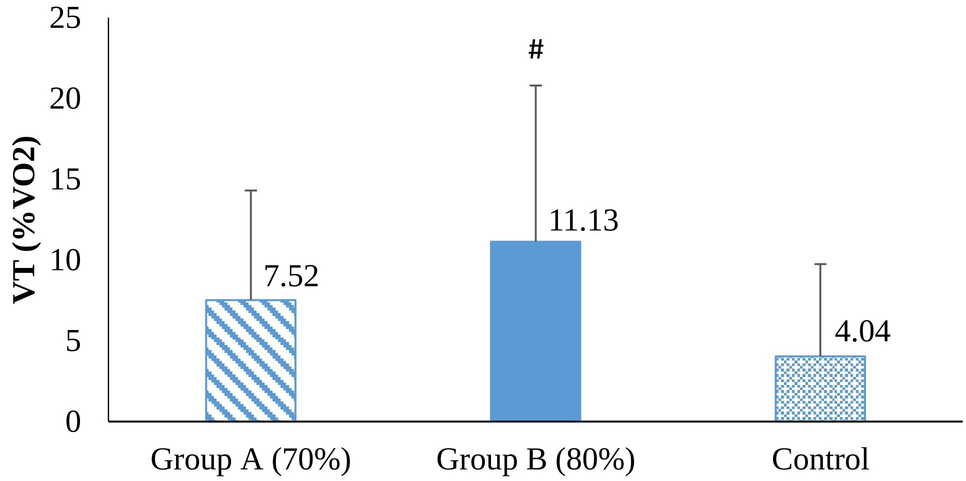
Figure 4.39 The change in peak oxygen consumption between all groups of subjects. Group A (70%), Group B (80%), and Control



# $p<0.05$, statistically significant from Control

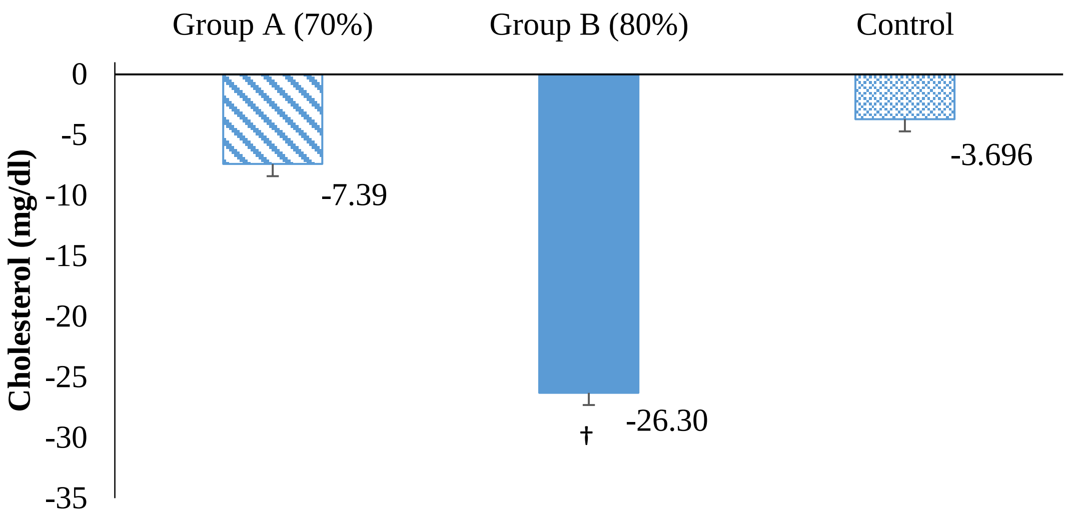
† $p<0.05$, statistically significant from Group A and Control

Figure 4.40 The change in peak oxygen consumption between all groups of subjects. Group A (70%), Group B (80%), and Control



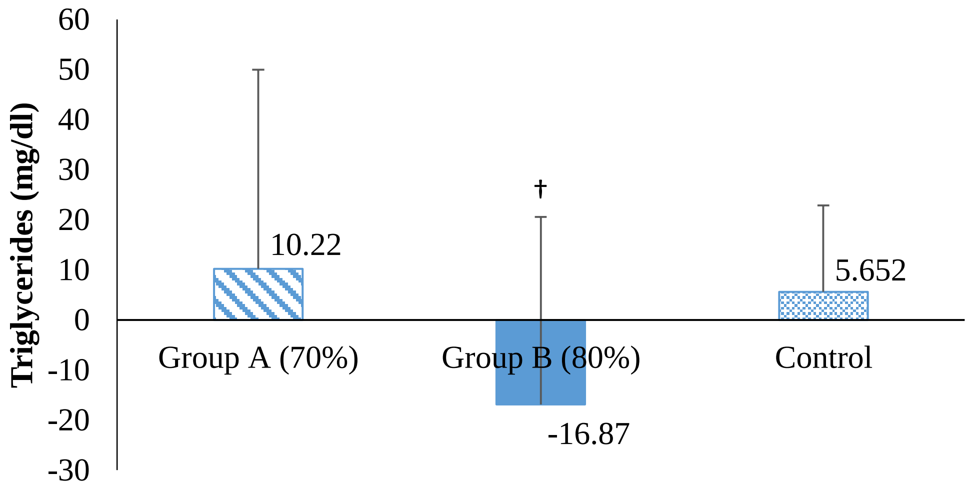
# $p<0.05$, statistically significant from Control

Figure 4.41 The change in ventilator threshold between all groups of subjects. Group A (70%), Group B (80%), and Control



† p<0.05, statistically significant from Group A and Control

Figure 4.42 The change in total cholesterol between all groups of subjects. Group A (70%), Group B (80%), and Control



† p<0.05, statistically significant from Group A and Control

Figure 4.43 The change in triglycerides between all groups of subjects. Group A (70%), Group B (80%), and Control

Part 8: The comparison of the changes in morphological, physiological, and hematological variables between the two patterns of walking

The changes in morphological, physiological, and hematological variables as a result of patterns of walking (structured and unstructured) were presented in Table 4.10 and Figure 4.44 through Figure 4.49. To compare the effect of walking patterns between the structured and unstructured groups, Group A (70%) and Group B (80%) were combined into the structured group and the Control was labeled as an unstructured group.

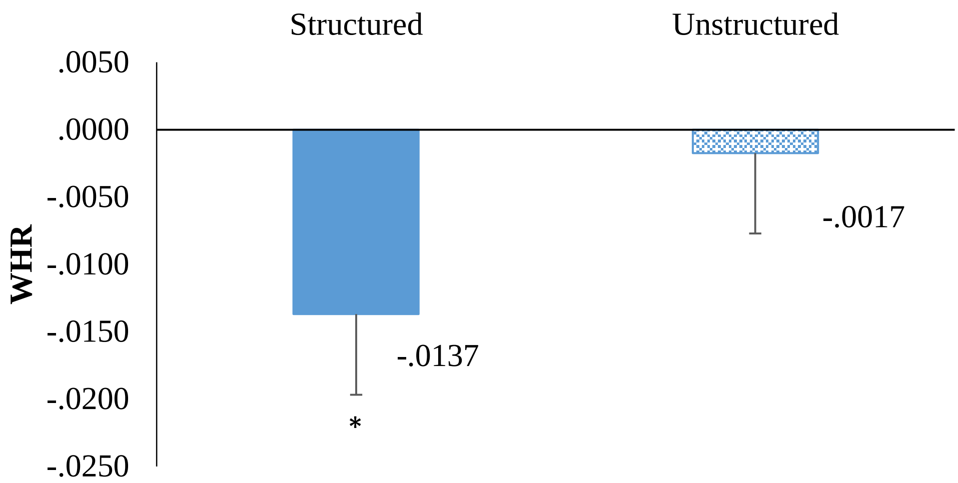
After 10 weeks of training, the changes in morphological, physiological, and hematological variables between the two patterns of walking were calculated by subtracting pre-training results from post-training results which yielded the differences for each variable. The data were then analyzed via independent t-test with the significant value at $p < 0.05$.

The results showed that the structured pattern had significantly lower waist to hip ratio and total cholesterol ($p < 0.05$) as shown in Figure 4.44 and Figure 4.49. Furthermore, the group also exhibited significantly higher peak oxygen consumption and ventilator threshold ($p < 0.05$) (Figure 4.45 through Figure 4.48) than the unstructured pattern of walking.

Table 4.10 The comparison of changes in morphological, physiological, and hematological variables between the two patterns of walking: the structured (Group A & Group B) and the unstructured (Control) groups

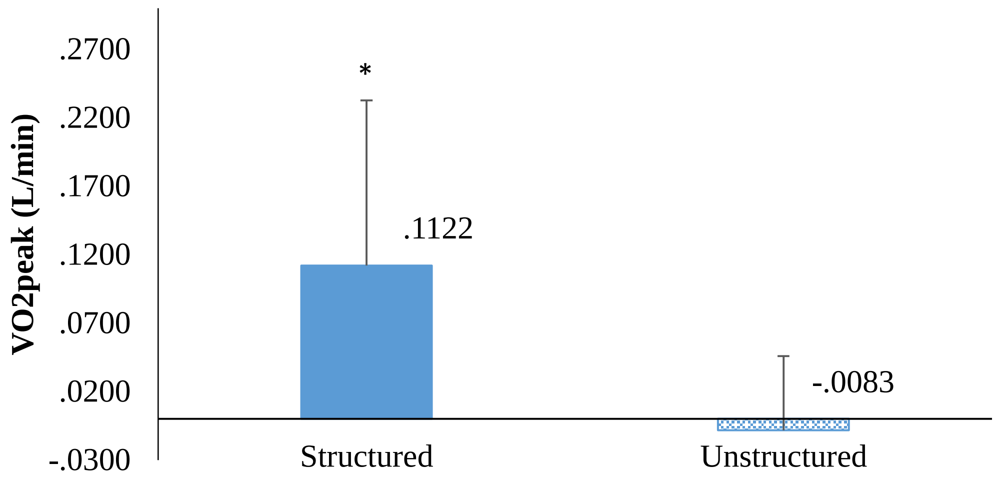
	Structured (Group A & Group B)	Unstructured (Control)	t	p-value
Morphological & Physiological variables:				
Weight (kg)	-0.75 ± 1.52	-0.55 ± 1.58	-.575	.567
Height (cm)	159.5 ± 7.2	160.5 ± 7.6	-.548	.586
BMI (kg/m^2)	-.26 ± .65	-.21 ± .63	-.301	.764
Waist (cm)	-1.99 ± 3.7	-.61 ± 2.7	-1.588	.117
Hip (cm)	-.88 ± 3.0	-.52 ± 2.3	-.499	.619
WHR	-.0137 ± .03*	-.0017 ± .02	-2.028	.047
Fat (%)	-1.13 ± 2.9	-.49 ± 2.6	-.895	.374
FFM	.461 ± 2.3	-.013 ± 1.2	1.147	.255
VO_2peak (L/min)	.1122 ± .12*	-.0083 ± .05	5.725	.000
VO_2peak (ml/kg/min)	2.24 ± 1.9*	.04 ± 1.9	4.457	.000
VO_2peak (ml)	112.2 ± 120.5*	-8.26 ± 54.1	5.725	.000
VT (%VO_2)	9.33 ± 8.5*	4.0 ± 5.7	2.698	.009
Hematological variables:				
FBG (mg/dl)	-3.4 ± 15.9	1.1 ± 6.3	-1.290	.201
Cholesterol (mg/dl)	-16.8 ± 36.0*	-3.7 ± 13.3	-2.194	.032
Triglycerides (mg/dl)	-3.3 ± 40.6	5.7 ± 17.2	-1.287	.202
LDL-CHOL (mg/dl)	-10.6 ± 30.6	-3.7 ± 12.9	-1.039	.303
HDL-CHOL (mg/dl)	-.57 ± 7.6	.70 ± 3.3	-.960	.340
CHOL/HDL	-.51 ± 1.60	-.22 ± .63	-1.066	.291
hs-CRP (mg/dl)	-.57 ± 7.62	.70 ± 3.25	-.364	.717

Values are mean ± SD *$p<0.05$, statistically significant from unstructured group



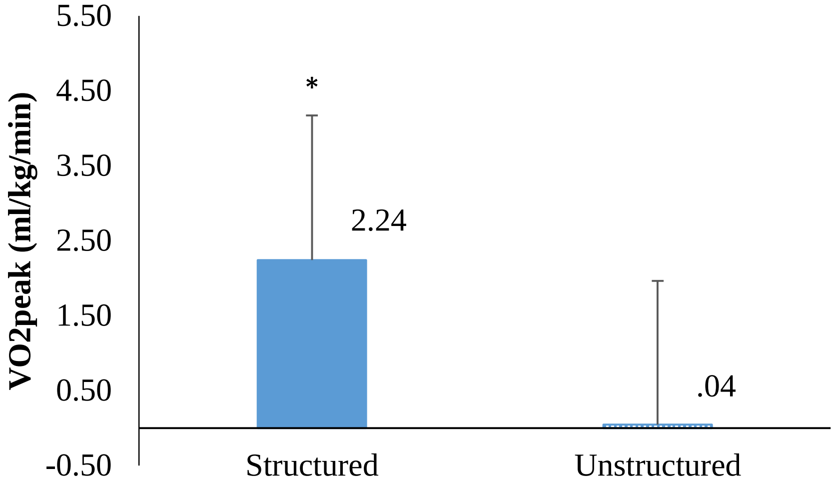
*p<0.05, statistically significant from unstructured group

Figure 4.44 The change in waist to hip ratio between structured and unstructured patterns of walking



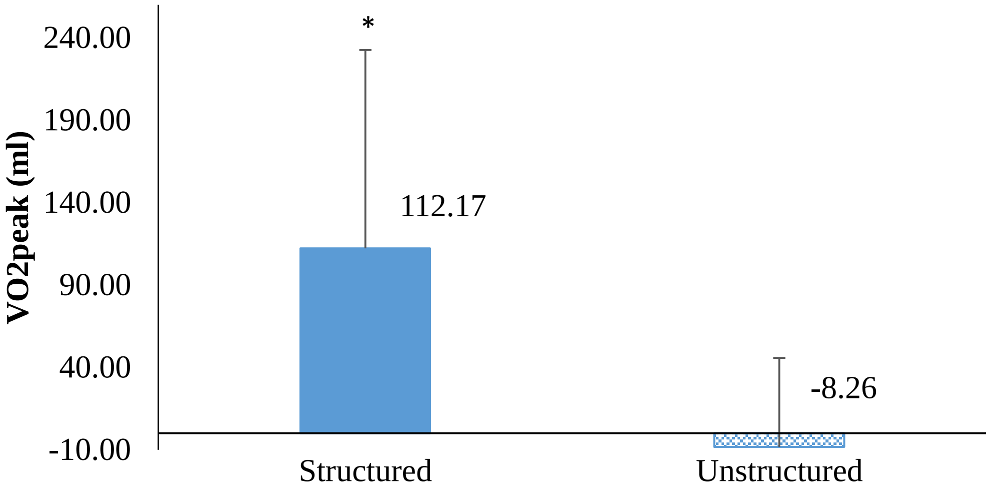
*p<0.05, statistically significant from unstructured group

Figure 4.45 The change in peak oxygen consumption between structured and unstructured patterns of walking



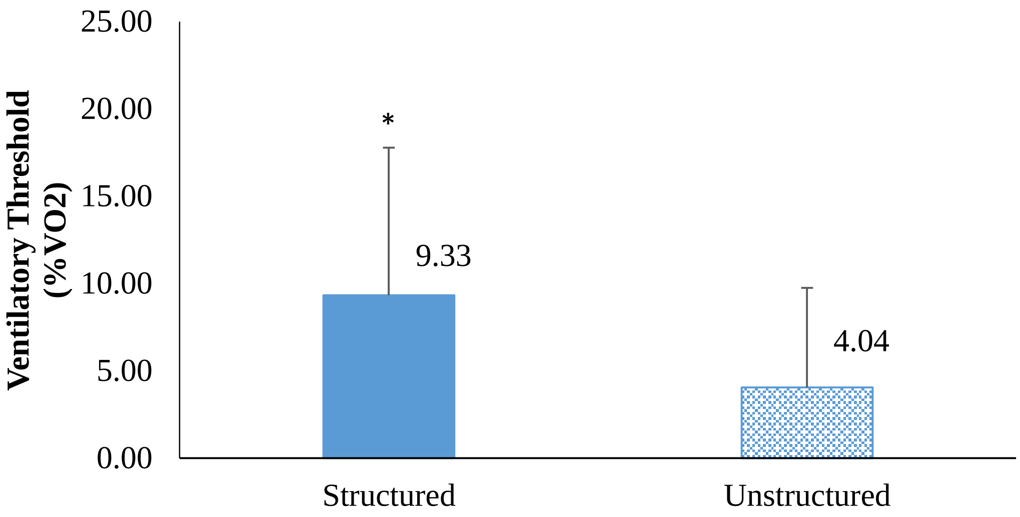
*p<0.05, statistically significant from unstructured group

Figure 4.46 The change in peak oxygen consumption between structured and unstructured patterns of walking



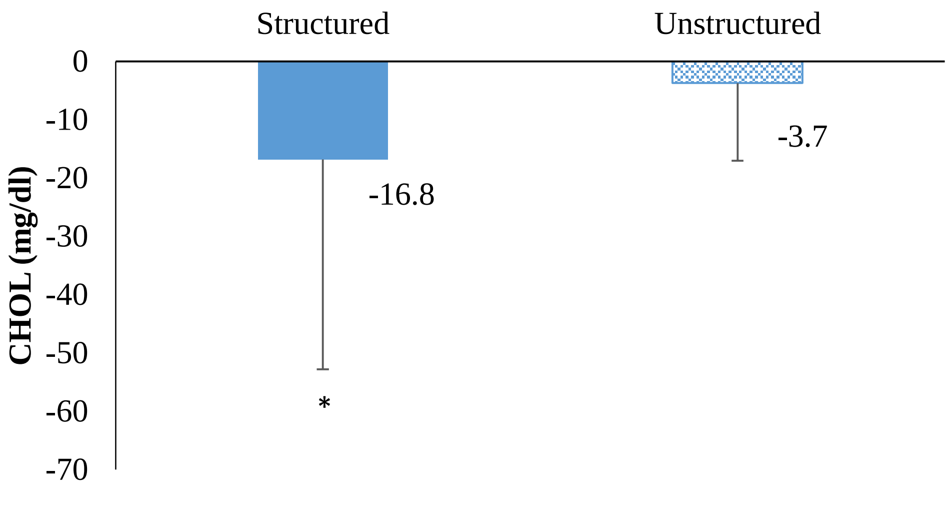
*p<0.05, statistically significant from unstructured group

Figure 4.47 The change in peak oxygen consumption between structured and unstructured patterns of walking



*p<0.05, statistically significant from unstructured group

Figure 4.48 The change in ventilatory threshold between structured and unstructured patterns of walking



*p<0.05, statistically significant from unstructured group

Figure 4.49 The change in total cholesterol between structured and unstructured patterns of walking

CHAPTER V

DISCUSSION, CONCLUSION, AND RECOMMENDATION

The purpose of this investigation was to compare the effects of walking speed and walking patterns (i.e. structured and unstructured) on aerobic capacity and Coronary Heart Disease (CHD) risk profiles in overweight and obese middle-aged males and females. The result of this study showed that male subjects were significantly differ from the female subjects in some variables prior to the study. In addition, the findings from this investigation also revealed that the prescribed walking resulted in different levels of improvement in morphological, physiological, and hematological variables among all three groups (Group A: 70% of maximal walking speed; Group B: 80% of maximal walking speed; Control: walking in daily activity). The prescribed walking speed resulted a significant improvement in aerobic capacity (VO_2 peak) in both Group A and Group B ($p < 0.05$). In addition, the improvement in aerobic capacity was significantly more pronounced in Group B than Group A. Whereas the Control group did not show any improvement in aerobic capacity at post-training. This investigation also showed that the speed of walking significantly affected the Coronary Heart Disease (CHD) risk profiles ($p < 0.05$) of Group B in terms of total cholesterol, triglycerides, LDL-Cholesterol, and HDL/CHOL ratio. Group A and Control, however, did not demonstrate significant improvement in these parameters.

The findings of this study, likewise, demonstrated that patterns of walking affected certain outcome parameters. The study showed that walking in a fixed setting (i.e. exercise facility) at prescribed intensity was superior than walking in the form of daily activity. The structured walking pattern group (Group A and Group B) led to a reduction in waist and hip circumference that resulted in significant improvement waist to hip ratio ($p < 0.05$). The structured walking group also significantly improved in aerobic capacity (VO_2 peak) and ventilator threshold ($p < 0.05$). Conversely, the unstructured walking pattern group did not show any improvement in the aerobic capacity or ventilator threshold. In terms of CHD risk profiles, the structured walking group showed a significant reduction in total cholesterol ($p < 0.05$) when compared to the unstructured walking group.

In this chapter, the discussion will be broken down into three sections in order to elaborate the discussion of the findings. These sections will be in the following order:

1. The baseline morphology and physiological responses between males and females.

2. The speed of walking on morphology, physiological responses, aerobic capacity, and CHD risk profiles.

3. The patterns of walking on morphology, physiological responses, aerobic capacity, and CHD risk profiles.

The baseline morphology and physiological responses between males and females

The data showed that the male subjects were significantly heavier ($p < 0.01$), taller ($p < 0.01$), higher waist circumference ($p < 0.01$), higher waist to hip ratio ($p < 0.01$), and possess greater fat-free mass than the female subjects prior to the investigation. The differences in these parameters can be explained due to the physical characteristic in gender differences. Males are typically larger in stature than female counterpart (ACSM, 2014). The study data also showed that male subjects had significantly higher baseline peak aerobic capacity (VO_2 peak) ($p < 0.01$) than the female subjects. This significant difference was attributed to the gender difference between males and females which can result in higher cardiorespiratory fitness. Male subjects had higher fat-free mass which contributed to higher oxygen consumption (ACSM, 2014). Male subjects also were able to achieved higher peak treadmill walking speed ($p < 0.01$) and peak treadmill incline ($p < 0.01$) than their female counterpart during the aerobic capacity assessment. This differences were attributed to the differences in physical stature between male and female subjects. Our figures showed that the male subjects were significantly taller and had higher fat-free mass than the female subjects at baseline which may have explained the ability to achieve higher peak walking treadmill speed and incline.

The speed of walking on morphology, physiological responses, aerobic capacity, and CHD risk profiles

The speed of walking on morphology

This study showed that after 10 weeks of walking intervention, the resultant body weight of Group A (70% of maximal walking speed) and Group B (80% of maximal walking speed) were significantly lower than pre-training and significantly lower when compared to Control ($p < 0.05$). Despite the reduction in body weight in both prescribed walking groups, only Group B had a significant decreased in body mass index, waist and hip circumference, waist to hip ratio, and percent body fat from pre-training and when compared to Group A and Control ($p < 0.05$). However, the improvement in these parameters were not seen in Group A and Control after 10 weeks of walking intervention.

Overweight and obesity increase the risk for early mortality and bring about the undesirable health conditions such as hypertension, diabetes, heart diseases, etc. (Poirier et al., 2003; Gaesser et al., 2011). In the past decade, the prevalence of overweight and obesity has increased dramatically around the world. For example, in the United States, 35% of US adults were classified as obese and many were overweight (Flegal et al., 2010). This trend is likely to increase as the technology is advancing and more people are becoming sedentary which in turn will raise the number of individual who will suffer from non-communicable diseases. Furthermore, overweight and obesity have been shown to worsen prognosis in those with cardiovascular disease and metabolic syndrome (Jakicic et al., 2003). The data also showed that obese persons had 36% higher inpatient and outpatient expenditures and

77% higher medication costs than normal weight person (Ostbye et al., 2007; Blackburn et al., 2008). This epidemic is a big public health concern in every part of the world. Therefore, finding ways to deal with overweight and obesity problems is an essential matter.

Intentional weight loss is proven to be beneficial for those who are overweight and obese (Gaesser et al., 2015). Past meta-analysis showed that intentional weight loss in obese individuals with obesity-related risk factors was associated with 13% reduction in mortality (Harrington et al., 2009). Similar finding from the Diabetes Prevention Program also showed that an average weight loss of 5.6 kg through diet and physical activity was able to reduce the incidence of diabetes in those who were considered high risk (Knowler et al., 2002). Body weight reduction is valuable for disease management and can be achieved through lifestyle changes (i.e. diet and exercise). Exercise is one of the components that has been shown to influence a number of physiological parameters that affect body weight, body composition, and energy balance (Jakicic et al., 2003).

When it comes to exercise for overweight and obese individuals, walking seems to be the most appropriate mode of intervention as it is easy on the joints and the body. It requires no special training or skills and can be perform anywhere at any time (Jakicic et al., 2003; Houel et al., 2013). In our study, the two groups of overweight and obese participants were prescribed walking at the intensity of 70% and 80% of maximal walking speed. The result showed that both groups demonstrated significant change in body weight after 10 weeks of walking intervention when compared to Control ($p < 0.05$). Group A (70% of maximal walking speed) loss -1.02 ± 1.91 kg and Group B (80% of maximal walking speed) loss -.48 ± .95 kg at post-training. The data also showed that Group A and Group B were not significantly difference in terms of weight loss between groups. The walking protocol consisted of 70% and 80% of maximal walking speed which was equivalent to 62.5% and 71.2% of VO_2 peak, respectively. The prescribed speed corresponded to exercising in the moderate to vigorous zone and the participants in both groups had to walk for at least 30 minutes several times per week in order to expend 1,000 calories. The amount of walking was sufficient enough to create energy deficit and when accumulated throughout the week can result in body weight reduction. Despite the change in body weight observed in our investigation, meta-analysis of randomized control trial on the effect of walking on risk factors showed that body weight reduction with walking is inconsistent (Murtagh et al., 2015).

Aside for body weight reduction, this study also showed that Group B exhibited significant reduction in body mass index, waist and hip circumference, waist to hip ratio, and percent body fat ($p < 0.05$) at post-training. However, these reductions were not evident in Group A or Control. The possible reason for significant decreased in these parameters had to do with the speed of walking. Group B walked at a higher relative intensity of VO_2 peak (71.2%) which was considered to be vigorous (ACSM, 2014). The prescribed walking speed could have elicited higher energy expenditure and greater nutrients partitioning. Previous study showed that high intensity exercise above lactate threshold but below VO_2 peak 3 times per week for 16 weeks resulted in a significant reduction of abdominal fat (Irving et al., 2008). In consistent with Irving et al. (2008), our study showed that the 80% of maximal walking speed fell into the vigorous zone and was above lactate threshold. This intensity zone was more effective in reducing abdominal fat which can be assessed indirectly through waist circumference. Decreasing abdominal fat brings desirable health benefits such as improvement in metabolic profiles, thus exercise can serves as a mean for reducing excess body weight and abdominal fat and can affect other morphological parameters.

The speed of walking on physiological responses

The results demonstrated that Group A (70% of maximal walking speed), Group B (80% of maximal walking speed), and Control had a significant decreased in resting heart rate after 10 weeks of intervention ($p < 0.05$). In addition, Group A showed a significant improvement in resting systolic and diastolic blood pressure at post-training ($p < 0.05$); whereas, Control showed significant improvement in resting systolic and maximal diastolic blood pressure the 10 weeks study ($p < 0.05$). Group B did not demonstrate any improvements in physiological parameters.

Consistent aerobic exercise training produces beneficial physiological effects. Some of these effects are morphological change, neuroendocrine adjustment, cardiovascular adaptation, etc. (ACSM, 2014). Walking is considered an aerobic exercise and, when perform frequently enough, it can result in physiological change. Our study showed that after 10 weeks of walking, a decreased in resting heart rate was observed in all 3 groups of participants (Group A, Group B, and Control). The reduction in resting heart rate was due to the increased in parasympathetic activation at rest and reduced sympathetic stimulation (Farrell, 2012). Furthermore, the increased in stroke volume also contribute to the cardiovascular change. Walking resulted in an increased in plasma volume which in turn increased the amount of blood to be returned to the right heart, and subsequently, to the left heart. When more blood is available (increased end diastolic volume), the myocardial wall of the heart is stretched resulting in forceful elastic recoil which increased the stroke volume thus the heart can function more efficiently (Seals et al., 1994). Data showed that exercise regular exercise participation resulted in cardiovascular improvement (Thompson et al., 2001; Kodama, 2009; ACSM, 2014). Our study showed an improvement in resting heart rate across all groups as a result of walking during the 10 weeks of intervention which signified the improvement in cardiovascular function.

Aerobic exercise also influences the blood pressure response at rest and during exercise. Research showed that regular walking reduced blood pressure in hypertensive individuals (Murphy et al., 2007; Pescatello et al., 2004; Smelker et al., 2004). Our investigation revealed that 10 weeks of walking decreased resting systolic blood pressure significantly from pre-training ($p < 0.05$) in Group A and Control. In addition, Group A and Control also significantly reduced resting diastolic blood pressure and maximal diastolic blood pressure, respectively ($p < 0.05$). However, the change in resting systolic and diastolic blood pressure were not significantly enough to be detected in Group B. This unaltered in blood pressure at post-training in Group B maybe due to the fact that Group B entered into the study with already optimal systolic and diastolic blood pressure thus blood pressure adjustment at post-training was not visibly evident. Scientific evident accumulated in the past decade showed that any type of aerobic exercise training with sufficient intensity and frequency has an acute and chronic effects on resting and ambulatory blood pressure (Thompson et al., 2001; Pescatello et al., 2004; Smelker et al., 2004). In our investigation, the subjects in Group A and Group B engaged in weekly walking at the intensity of 62.5% and 71.2% of VO_2 peak, respectively. These levels of intensity were sufficient enough to explain the reduction in blood pressure that was observed. According to Wallance et al. (2003), effective aerobic exercise intensity that reduces blood pressure is 40% - 70% of VO_2 peak. The current intensity of walking prescribed in our study coincided with the intensity recommendation. Furthermore, this level of exertion is considered moderate to slightly vigorous and has been advocated to be an effective intensity in managing hypertension (Pescatello et al., 2004; Smelker et al., 2004; ACSM, 2014)

The Control group, however, engaged in a self-paced walking during the 10 weeks intervention. Despite that the subjects in this group did not walk at the same intensity as the other two intervention groups, the Control did engage in more walking throughout the day as shown by the average number of steps taken per day (7708 ± 1923 steps) and the time spent walking per week (254.5 ± 48.6 minutes). The number of steps taken per day reported in our findings was well above the accumulated mean walking per day reported by Bassett et al. (2010). Furthermore, our findings of walking in the Control group falls within the range of 6,200 ± 220 to 7,891 ± 540 steps per day which is reported by those who exercise strenuously. Despite the high number of steps reported in our study, the amount is still fall short of the 10,000 steps per day (Tudor-Locke et al., 2004; Choi et al., 2007).

More frequent walking which resulted in greater number of steps taken reduce systolic and diastolic blood pressure just as effective as regular aerobic exercise at specified intensity (Tully et al., 2005). The reduction in blood pressure observed in all three groups is speculated to be due to the change in baroreflex control which in turn decreases sympathetic nerve activity and increases vasodilator substances. Thus, vascular resistance goes down and arterial pressure decreases

(Halliwill, 2001). In addition, body weight reduction may have not affected the reduction in resting blood pressure in our study due to the fact that Group A and Group B decreased in body weight at post-training but only Group A showed a significant decreased in resting blood pressure; however, Group B did not exhibit any change in resting blood pressure as observed in Group A. The Control group, on the other hand, did not show any significant decreased in body weight but the significant reduction in resting blood pressure was observed. Resting and ambulatory blood pressure improvement can occur independently of weight loss (Gasser et al., 2011). A reduction in both systolic and diastolic blood pressure from walking can prevent or delay the onset of coronary heart disease (CHD) or early mortality from cardiovascular disease (CVD).

The speed of walking on aerobic capacity

Aerobic capacity (i.e. VO_2 peak) has been reported to be an important predictor for survival in many populations (e.g. healthy and disease) (Arena et al., 2010; Gaesser et al., 2015). This study demonstrated that Group A (70% of maximal walking speed) and Group B (80% of maximal walking speed) had significantly high VO_2 peak and after 10 weeks of walking intervention ($p < 0.05$). However, similar improvement in VO_2 peak did not occur in Control group. In addition, the change in VO_2 peak within groups was more pronounced in Group B at the conclusion of the study ($p < 0.05$). The improvement in aerobic capacity in our study is speculated to be related to the intensity of walking. Group A and Group B were prescribed walking speed that corresponded to the intensity of 62.5% and 71.2% of VO_2 peak, respectively. These levels of intensity are considered moderate to slightly vigorous which in turn improve VO_2 peak. The Control group, on the other hand, did not show any improvement in VO_2 peak. This unchanged in the aerobic capacity of the Control group may be due to the fact that the walking stimulus may have not been hard enough to elicit any changes in cardiorespiratory fitness as the relative intensity was at 3.1 ± 1.2 MET.

Aerobic capacity has been shown to increase in a dose-response manner and is related to the intensity of exertion (Tully et al., 2005; ACSM, 2014; Arena, 2010). In addition, the improvement in aerobic capacity as a result of exercise occurs in all range of populations—from healthy to disease (Arena et al., 2010). Our study showed that our participants in the two intervention groups were able to increased aerobic capacity despite being middle-aged. This is in agreement with the previous study that showed an increased in cardiorespiratory fitness in the older adults (i.e. 50 – 60 years old) as a result of 12 weeks of brisk walking (Tully et al., 2005).

Low aerobic capacity is a powerful predictor of health problems and premature death in all groups of population (Arena et al., 2010; Gaesser et al., 2011; Gaesser et al., 2015; Murtagh et al., 2015). Risk of death is more evident in those with chronic heart failure. Study by Mancini et al. (1991) showed that the chronic heart failure patients with peak oxygen consumption of less than 14 ml/kg/min had survival rate of 47% at 1 year and 32% at 2 years. The chance of survival decreased progressively as the peak oxygen consumption gone down (Mancini et al., 1991).

Studies have shown that each MET increased in aerobic capacity translates to 13% to 15% reduction in all causes of mortality and cardiovascular events (Lauer et al., 2005; Arena et al., 2010). The risk reduction associated with increased aerobic capacity was comparable to 7 cm, 5 mm Hg, 1 mmol/l and 1mmol/l reduction in waist circumference, systolic blood pressure, triglycerides level, and fasting plasma glucose level (Kodama et al., 2009). Improvement in aerobic capacity or VO_2 peak is a product of cardiovascular adaptation. This adaptation is a result of resting and submaximal heart rate alteration, preload improvement, and reduction in vascular resistance (Fletcher et al., 2013).

Aside from an improvement in aerobic capacity observed, the results also showed that ventilator threshold among all three groups significantly increased after 10 weeks of training ($p < 0.05$). However, when the change in ventilator threshold was calculated within group by subtracting pre-training result from post-training result then the changes were compared among the three groups, the results showed that Group A and Group B demonstrated significant changes in ventilator threshold then the Control ($p < 0.05$). Group A and Group B showed a greater increase in ventilator threshold may be due to the higher walking intensity of walking that they had undertaken during the 10 weeks study. The Control group, however, showed an improvement in ventilator threshold at post-training but when the net changes were compared, the Control group exhibited a non-significant change in ventilator threshold. This can be speculate that the walking they engaged during the 10 weeks was not powerful enough to incite significant change in ventilator threshold as this group was instructed to walk as much as possible at their own pace.

In agreement with our findings, Sullivan et al. (1989) demonstrated that patients with severe left ventricular dysfunction engaged in a walking program at 75% of peak VO_2 for 16 – 20 weeks showed an improvement in ventilator threshold. This improvement is shown in the decreased in ventilation, VCO_2 production, and respiratory exchange ratio. Ventilatory threshold is the point at which ventilation begins to increase at the rate faster than the oxygen consumption (Wasserman, 1984; Beaver et al., 1986; Sietsema et al., 1989). This is the point where ventilation surpasses normal ventilation rate and it reflects the onset of anaerobic metabolism and the buffering of lactate (Wasserman, 1984; Beaver et al., 1986; Sullivan et al., 1989). The cause of ventilation threshold is multifactorial such as muscle fibers recruitment, air entering and exiting the lungs, partial pressure of O_2 and CO_2 difference in the blood, exercise work rate, and cardiorespiratory fitness (Holloszy et al., 1984; Beaver et al., 1986; Sietsema et al., 1989). Increased in ventilator threshold will increase individual's physical endurance, performance, and eventually delay the onset of fatigue.

The study also revealed that all three groups (Group A, Group B, and Control) significantly increased in peak treadmill test walking speed and peak treadmill test time (in minute) at post-training ($p < 0.05$). However, only in Group B that the peak treadmill test incline (in percent) increased significantly at post-test ($p < 0.05$). All three groups engaged in a walking program over the 10 weeks period; however Group A and Group B walked more intensely than the Control. Regular walking over the 10 weeks period increases physical endurance and improves in cardiorespiratory fitness as a result the subjects in our study were able to walk longer on the treadmill at post-training. Previous study have shown that subjects who engaged in regular walking briskly over the 12 weeks period improved treadmill time (Murphy et al., 2007; Roca-Rodrigriguez et al., 2014). Similarly, study showed that patients with heart failure who engaged in a 12 weeks of 40 minutes 3 times per week of upper-body arm exercise improved test time in the arm ergometry testing by 22%

at post-test (Nyquist-Battie et al., 2007). Improvement in testing time at post-training translates to better physical capacity and enhanced resistance to fatigue.

The speed of walking on CHD risk profiles

The results showed that total cholesterol, triglycerides, LDL-Cholesterol, and HDL/CHOL ratio were significantly decreased in Group B (80% of maximal walking speed) ($p < 0.05$) after 10 weeks of walking. The reduction in CHD risk profiles were not evident in Group A or Control at post-training. When the net changes were compared between groups, changes in total cholesterol and triglycerides were more evident in Group B when compared to Group A and Control ($p < 0.05$). Evidence to date shows that total cholesterol reduction as a result of exercise is equivocal. Some showed no changes in total cholesterol or demonstrated a non-significant reduction despite exercise intervention, while other reports demonstrated that a significant reduction in total cholesterol was related to body weight and BMI change ($r = 0.90$, $p = 0.0002$) and the adherence to exercise protocol ($r = 0.88$, $p = 0.0004$) (Rubins et al., 1999; Durstine et al., 2002; Durstine et al., 2008; Gordon et al., 2014)

Our results, however, showed that total cholesterol in Group B decreased significantly from pre-training. This change may be attributed to the body weight and body fat reduction. As our data showed that Group B exhibited significant changes in most of the morphological variables such as BMI, waist and hip circumference, waist to hip ratio, and body fat. The reduction is these parameters may also be due to the fact that Group B walked at a higher intensity (i.e. 71.2% of VO_2 peak) than the other two groups. When walking or exercising at higher intensity of oxygen consumption, more energy is expended per unit of time which could have resulted in greater body weight and body fat reduction in Group B. Changes in total cholesterol have clinical importance especially those who are obese or with coronary heart disease. The reduction will likely decrease the risk of developing premature coronary heart disease.

Triglycerides reduction was often reported with exercise training and the result was associated with the exercise compliance ($r = 0.82$, $p = 0.003$). In addition, the past data also showed that greater reduction tend to occur in those with higher baseline level ($r = 0.58$, $p = 0.07$) (Durstine et al., 2002; Durstine et al., 2008). Our study showed that triglycerides level significantly decreased from pre-training in Group B. This effect was not apparent in Group A and Control. Studies have shown that those who were physically inactive with high triglycerides level often receive greater reduction with exercise (Durstine et al., 2008; Fletcher et al., 2005). Our study subjects in all groups were previously sedentary. Prior to the study enrollment, these subjects did not engage in regular exercise program for the past 6 months. The level activity was assessed by questionnaire and personal interview was conducted prior to accepting the subjects into the study. This may also have been the result of the reduction in triglycerides concentration in Group B since the participants were previously sedentary. In addition, Group B exercised at the intensity equivalent to mildly vigorous (i.e. 71.2% of VO_2 peak) (ACSM, 2014). This intensity would have caused the triglycerides to be hydrolyzed into glycerol and free-fatty acid at a greater rate which would result in more of free-fatty acid available in the blood stream for uptake and utilization. Group A and Control, however, exhibited a non-significant change in triglycerides concentration at post-test due to the entry level of triglycerides that was already optimal and also the intensity of walking may not have been optimal enough to elicit any changes. Changes in lipid and lipoprotein level have clinical importance especially in those with coronary heart disease. Reduction of triglycerides has clinical importance and have been shown to reduce nonfatal myocardial infarction and coronary heart disease death by 22% even in the absence of change in LDL-Cholesterol (Rubins et al., 1999).

LDL-Cholesterol is often regarded as a “bad cholesterol”. Evidence shows that LDL-Cholesterol is a powerful predictor of coronary heart disease (CHD) (Fletcher et al., 2005; Durstine et al., 2008). Studies reported that LDL-Cholesterol do not change with aerobic exercise (Ziogas et al., 1997). In addition, Williams et al. (1990) reported no significant change in LDL-Cholesterol after 1 year of aerobic exercise in healthy but overweight men. However, other studies demonstrated a reduction in LDL-Cholesterol following a decrease in body weight and also correlates with the distance of running per week (Williams et al., 1989; Durstine et al., 2008). The results of our study found that LDL-Cholesterol was reduced following 10 weeks of walking with significant reduction observed in only Group B. The change in LDL-Cholesterol concentration may be related to the intensity of walking engaged by this group of participants which also resulted in significant change in body weight at post-training. In addition, the subjects may have modified their daily diet to the point that have affected the LDL-Cholesterol concentration. However, our study did not assess the dietary behavior of the subjects, therefore, it is inconclusive to endorse that the dietary pattern affected the LDL-Cholesterol reduction. The data on the change in LDL-Cholesterol is still debatable (Fletcher et al., 2005; Durstine et al., 2008). Nevertheless, reduction in LDL-Cholesterol will reduce the risk of future premature coronary heart disease (CHD).

CHOL/HDL ratio was found to decrease in our study after 10 weeks of walking intervention. The reduction in the ratio was due to the change in total cholesterol that was seen at post-training in Group B. Despite the unchanging HDL-Cholesterol concentration, the change in total cholesterol level do bring down CHOL/HDL ration closer to the optimal level (i.e. 1.0 – 3.5). Higher CHOL/HDL ratio that is higher than 3.5 puts one's at risk for heart disease (AACVPR, 2006; Kelley et al., 2006; Arena et al., 2010). Ades et al. (2007) found that exercise program with higher energy expenditure resulted in greater reduction of CHOL/HDL ratio. Other study showed an inverse relationship between CHOL/HDL ration and increased in physical activity (Sillah et al., 2014). These investigators concluded that the change in CHOL/HDL ratio was due to greater weight loss, body fat reduction, and decreased waist circumference. In agreement with the previous findings, our study showed that Group B has changed in most of the morphological parameters which could have affected the CHOL/HDL ration. The reduction in CHOL/HDL ration decrease the risk of early onset of heart disease.

Despite the changes in some of the CHD risk profiles that were observed in our study, no significant increase in the HDL-Cholesterol concentration was observed in all groups. Past studies have shown that changes in HDL-Cholesterol concentration occurred when the exercise program is 12 weeks or longer and it often increases in a dose-response manner as measured by energy expenditure (Ducan et al., 1991; Durstine et al., 2002; Coghill et al., 2008; Durstine et al., 2008). Evidence reported that energy expenditure of greater than 1,200 calories per week of physical activity is needed in order to alter the HDL-Cholesterol concentration (Coghill et al., 2008). Our walking program was only 10 weeks long, thus the duration of the intervention may not have been long enough to affect HDL-Cholesterol concentration in ours subjects. In addition, our subjects were instructed to walk in an accumulated manner in order to expend 1,000 calories per week. This amount of caloric expenditure may fall short of what is needed for HDL-Cholesterol concentration improvement. Report also suggested an inverse correlation between initial HDL-Cholesterol concentration and HDL-Cholesterol change at post exercise program (Kelley et al., 2006). Our subjects' HDL-Cholesterol concentration at pre-training—according to the data—was in the optimal range thus this may have resulted in the unchanging HDL-Cholesterol concentration at post-training. We also speculate that our subjects may have reduced their habitual physical activity due to greater amount of walking exercise that they have to endure during the 10 weeks period which may have some effect on total daily energy expenditure. High level of HDL-Cholesterol is likely to decrease the risk of heart disease and is considered to be a negative risk factor to CHD (ACSM, 2014)

Aside from lipids and lipoproteins, high sensitivity C-Reactive Protein (hs-CRP) is a biomarker that signifies inflammation in the body. The hs-CRP is the low level of detection method for C-Reactive Protein (CRP) and it is considered to be an inexpensive and sensitive for detecting and predicting of future incident of myocardial infarction, stroke, PAD, and sudden cardiac death (Ridker, 2003; Pepys et al., 2003; Yates et al., 2008). The hs-CRP is categorized into the following levels: <1 (low); 1 to 3 (moderate); and >3 (high). Prospective study demonstrated that CRP is a stronger predictor of risk than low-density lipoprotein (Ridher, 2003). However, to date, the evidence on the interaction between hs-CRP on exercise, body weight, and aerobic capacity are poorly understood and inconclusive (Yates et al., 2008; Gray et al., 2009).

Our study showed that after 10 weeks of walking intervention (i.e. prescribed velocity and self-paced), all three groups of subjects did not exhibit any significant reduction in hs-CRP concentration. The results showed that the velocity of walking at relative percentage of VO_2 peak did not affect the hs-CRP concentration at post-training despite other changes that occurred such as body weight reduction, increased aerobic capacity, and improved in certain lipids and lipoproteins. In addition, the self-paced control also showed a non-significant change in hs-CRP concentration at post-training. The unchanging in hs-CRP concentration among all groups may have been due to the length of the study that was not long enough to produce a significant change. Previous walking study on markers of insulin resistance and systemic inflammation showed a lack of change in inflammatory markers due to the fact that the progressive 12 weeks intervention given was not long enough duration for positive health benefits to occur (Gray et al., 2009). Other study also demonstrated an inverse relationship between inflammation and cardiorespiratory fitness (Qureshi et al., 2014). However, our study did not yield a similar result as the previous study. Our subjects in Group A and Group B improved in their cardiorespiratory fitness—with Group B being the highest of the two—but the hs-CRP concentration of those two groups did not change significantly despite the improvement in aerobic capacity. Our finding is also in disagreement with Tuite et al. (2013) who found that weight reduction and intensity of exercise affected hs-CRP concentration. They discovered that the intensity of exercise of at least moderate level is needed to affect the hs-CRP levels and also the reduction in body weight influences inflammatory marker. We found that the intensity of exercise (i.e. walking) did not significantly affect the hs-CRP concentration as our subjects walked at 62.5% and 71.2% of VO_2 peak which was in the moderate to mildly vigorous. In addition, the reduction in body weight and other morphological parameters such as the changes in waist and hip circumference, BMI, and body fat did not affect hs-CRP like the findings from other study.

Currently, the evidence on the interaction of hs-CRP concentration and exercise program is still questionable and definitive conclusion is yet to be reached; nevertheless, clinical data suggests that high circulating C-Reactive Protein can contribute to the progression of many pathogenesis and it has a possible relation to artherosclerosis (Pepys et al., 2003). Therefore, effective therapeutic measures to reduce CRP level may be needed to prevent the potential onset of chronic conditions.

The patterns of walking on morphology, aerobic capacity, and CHD risk profiles

The patterns of walking on morphology

When the results of the study were compared in term of patterns of walking (i.e. structured and unstructured walking). The data showed that waist to hip ratio in the structured walking group (Group A & Group B) was significantly reduced ($p < 0.05$) when compared to the unstructured walking group (Control) after 10 weeks of training. The reduction was a product of the changes in waist and hip circumferences. Other morphological variables of the structured and unstructured groups such as body weight, BMI, waist and hip circumference, and percent body fat were all reduced but these variables were not statistically significant between groups.

Structured walking pattern group resulted in significant reduction in waist to hip ratio ($p < 0.05$) due to greater decrease in waist and hip circumference than the unstructured group. The structured walking group walked at a specific speed at the intensity equivalent to moderate to vigorous which induced greater energy expenditure and resulted reduction in morphological variables. In addition, the subjects in the structured were provided with feedbacks and encouragement during the treadmill walking session throughout the 10 weeks walking program by the fitness trainers or nurses that were on staff at the fitness center. The verbal encouragements could have affected the subjects' intention and motivation to exercise. Previous study showed that encouragement prevents dropout and was essential for successful exercise rehabilitation (Hansen et al., 2009). Despite the walking exercise intensity being moderate to vigorous, the subjects in the structured group seemed to adhere to the walking program fairly well with great compliance rate. Previous evidence also showed that higher exercise intensity lower exercise participation (Hasen et al., 2009). This evidence is in contradiction to our finding which shows that the subjects adhered to the prescribed walking program despite it being mildly vigorous. The control group, on the other hand, walked at a self-paced velocity and received no encouragement. They had to rely on self-encouragement which may have some influences on how much this group of subjects were able to walk. Despite no feedbacks and encouragements given to this group of participants, they were still able to increase their steps per day to an acceptable that resulted in a non-significant changes in morphological parameters. Positive verbal cues are useful for improving exercise participation which can lead to post exercise improvement.

The patterns of walking on aerobic capacity

When the two structured walking groups (i.e. Group A and Group B) were combined and the differences between pre- and post-training were calculated and compared with the unstructured walking (Control), the change in aerobic capacity (VO_2 peak) and the change in percent of ventilator threshold were significantly higher in the structured walking group than the unstructured group at the conclusion of the study ($p < 0.05$). Our study demonstrated that walking in a structured setting at a set velocity for 10 weeks yielded significant improvement in cardiorespiratory fitness as exhibited by increased in VO_2 peak. The data showed that the structured walking pattern increased VO_2 peak in relative to body weight of 2.24 ± 1.9 ml/kg/min whereas the unstructured walking pattern did not showed any improvement in VO_2 peak. This improvement is approximately to 1 MET of functional capacity gain. The evidence shows that for every MET increase in functional capacity, the risk of all-cause mortality and cardiovascular event decreases by 13% - 15% (Arena et al., 2010). This translates into a meaningful improvement and will likely influence the overweight and obese individual's risk for cardiovascular event. In addition, if the walking program were to be carried out in a long session duration, the improvement in VO_2 peak could have been higher then what is achieved during this 10 weeks intervention. The subjects had access to the treadmills for walking which made it easier to regulate the prescribed walking speed and they walked at a set velocity in specific amount of time that elicited improvement in cardiorespiratory fitness. Conversely, the subjects in the unstructured group walked at a slower pace in a longer duration in order to achieve similar energy expenditure as the structured pattern. However, the findings showed that the unstructured group did not result in similar improvement in cardiorespiratory fitness at the end of the study. This may be due to the intensity of the walk was not challenging enough to influence cardiorespiratory fitness.

The structured group walked in the fitness facility that was supervised by trained staff. This is likely to enhance exercise adherence and resulted in better cardiorespiratory fitness outcome. Previous exercise study demonstrated that patients with COPD who underwent 8 weeks of structured exercise intervention 3 times per week improved in aerobic capacity and maximal time on constant workload test (Mador et al., 2012). The supervised exercise in structured setting required the COPD patients to engage in exercise regimen that is slightly uncomfortable for them in order to gain improvement. Typically these patients would have stopped exercise training earlier than prescribed due to breathlessness (Mador et al., 2012). Gardner et al. (2011) also showed that supervised-based versus home-based 12 weeks walking program resulted in improvement in claudication onset time ($p < 0.001$) and peak walk time ($p < 0.01$) the results did not differ significantly between the two interventions ($p > 0.05$). However, the non-significant difference in the results between the two types of walking was due to the fact that both types of intervention the subjects received patients monitoring and periodic feedbacks (Gardner et al., 2011). Providing monitoring and feedbacks to the patients help to improve exercise adherence and compliance to the prescribed walking program which results in health benefits and improves threshold to fatigue and pain. This finding appears to be in consistence to our investigation that our subjects in the structured walking significantly improved in the change of ventilator threshold when compared to the unstructured walking. This change indicates that the subjects increased the threshold of fatigue. Ventilatory threshold is the point at which the ventilation begins to increase disproportionately to the oxygen consumption (Wasserman et al., 2012) as the work gets more challenging, the body cannot supply sufficient energy through aerobic metabolism alone thus it begins to rely more on anaerobic metabolism to supply energy demand of the working muscles. The reliance of anaerobic metabolism can be delayed as the result of regular exercise (Sietsema et al., 1989; Wasserman et al., 2012). During the 10 weeks walking program, the subjects in the structured walking group were consistently being monitored about their walking regimen and were counseled on ways to increase their walking session. This may have an effect on the change in ventilator threshold as the subjects had access to the treadmill which made it convenience for them to exercise. The unstructured group, on the other hand, were not being monitored thus the subjects in this group may not have walked at the intensity adequate enough to induce significant change in ventilator threshold. Nevertheless, the unstructured still show some improvement in ventilator threshold but the change was not statistically significant. The improvement in aerobic capacity (i.e. VO_2 peak) and ventilator threshold as a result of structured walking pattern means that walking in a fixed setting yields better outcome due to social support. In addition, the improvement in these variables will delay the onset of CHD and improve survival in those with morbidity.

The pattern of walking on CHD risk profiles

In terms of CHD risk profiles, the total cholesterol was significantly affected by the structured walking pattern ($p < 0.05$) when compared to the unstructured walking pattern. Other CHD parameters appeared not to be influenced by the patterns of walking. The subjects in the structured group showed a significant decrease in total cholesterol concentration ($p < 0.05$) when compared to the unstructured group. This change is speculated to be due to the intensity of walking that this group of subjects participated. Both patterns of walking engaged in different modality of walking (i.e. treadmill walking vs ground walking) that resulted in different intensity domain. The structured group walked at relative intensity equates to moderate to vigorous while the unstructured group walked at a self-pace. These differences in the type of walking and the intensity employed may have explained the change in total cholesterol. Furthermore, the subjects in the structured group have to walk continuously during the exercise session which may resulted in more fatty-acid mobilization and higher yield of energy expenditure. Some evidence suggests that exercise should be undertaken at moderate to high intensity, 5 to 7 days per week, for at least 30 minutes in order to reduce the total cholesterol (Fletcher et al., 2005). Despite the change in the total cholesterol observed in our study, some investigations did not exhibit the same total cholesterol reduction when the confounding factors such as initial body weight, body fat, dietary habit, and physical activity were controlled (Durstine et al., 2001; Durstine et al., 2002). Most studies showed that when diet is modified, the concentration of total cholesterol tend to decrease (Durstine et al., 2008). Our study did not control for dietary intake but the change in total cholesterol concentration is, however, still noticeable. Improvement in total cholesterol will likely influence CHD risk profile in overweight and obese.

Conclusions

The purpose of this study was to investigate the effects of speed and the patterns of walking on aerobic capacity and CHD risk profiles in overweight and obese middle-aged individuals. Our findings shows that the speed of walking significantly affected the aerobic capacity in overweight and obese middle-aged individuals. The improvement in aerobic capacity is related to the speed of walking (i.e. higher the speed, higher the change in VO_2 peak). The change at post-training was more evidence in those that were prescribed walking at relative percentage of maximal walking capacity, conversely, those that engaged in self-paced walking did not result in aerobic capacity improvement. The results also further shows that the speed of walking significantly affect total cholesterol, triglycerides, LDL-Cholesterol, and CHOL/HDL ratio which are considered to be the significant CHD risk profiles.

The study also revealed that the patterns of walking (i.e. structured and unstructured) affected the aerobic capacity and CHD risk profiles in overweight and obese middle-aged individuals. The structured pattern of walking resulted in a significant improvement in aerobic capacity and CHD risk profiles such as total cholesterol. The unstructured pattern, however, did not exhibit any significant changes in these parameters. The velocity and patterns of walking have significant effects on aerobic capacity and CHD risk profiles in overweight and obese middle-aged individuals. The walking program can be applied and use in those who are looking improve cardiorespiratory fitness or intending to modify CHD risk factors.

This study also highlighted the practical use of walking at specific speed. It is easily to use and can be applied in the field setting. Walking at certain percentage of maximal walking speed can result in many physiological benefits including improve cardiorespiratory fitness. Most recommendation by renowned organizations such as the American College of Sports Medicine (ACSM), the American Heart Association (AHA), the American Council on Exercise (ACE), etc. advocate the use of a relative percentage of peak heart rate or peak oxygen consumption for gauging exercise intensity. However, in the reality, gauging exercise intensity at certain percentage of peak heart rate or peak oxygen consumption is hard to perform without the use of a heart rate monitor or previous exercise testing information. Most exercising individuals do not possess a heart rate monitor or have the luxury of undergoing an exercise test to obtain valuable information for exercise training, thus making it difficult to correctly gauge an exercise program. Walking at a relative percentage of maximal walking speed, such as demonstrated in this study, can make it simple for an individual to exercise at an optimal intensity to obtain health benefits without posing an undue risk of injury or adverse cardiovascular event.

Study limitations

Despite the significant improvement in aerobic capacity and CHD risk profiles that were observed, our study is presented with few limitations. The lack of equal monitoring and support between the groups may have an effect on the subjects' motivation and intention to adhere to the walking program especially in the Control group. This may somehow affects how much the subjects in this group walked on the daily basis. Furthermore, our study did not control the subjects' dietary intake thus it may had affected certain outcome. The subjects in all groups were given instructions on how to adhere and maintain their normal dietary pattern. However, the dietary recall was not assessed thus we do not know what is the subjects' normal dietary pattern.

Recommendation

1. This study have assessed the effects of the speed and patterns of walking on aerobic capacity and CHD risk profiles in overweight and obese middle-aged individuals. The findings shows that walking at a faster pace and in a fixed setting resulted in favorable health outcome in aerobic capacity and CHD risk profiles. In a practical sense, prescribe a walking pace in relation to one's maximal walking speed can be applied safely to any group of individuals. Our study in overweight and obese individuals did not resulted in any walking related injuries due to the 10 weeks of walking intervention. The subjects tolerated the given walking pace very well despite the intensity was in the range of moderate to quite hard.

2. The walking speed prescribed can be easily converted into minute per kilometer thus the individual can utilize the information and apply it to the real life situation for the field walking where the treadmill is not available. The following are the example of practical use: If the walking was prescribed at 5.0 kmph then the individual would divide 60 minutes by 5.0 kmph which will yield 12 minutes per kilometer. Meaning that a person has to cover a kilometer in 12 minutes. This is equivalent to walking at 5.0 kilometer per hour.

3. In this study, the average time of walking was roughly around 20 -30 minutes per session thus if an individual would walk at a faster pace for 30 minutes,

will he/she improves his/her cardiorespiratory fitness and some of the CHD risk profiles.

4. Future research should assess the walking speed and patterns on cardiopulmonary responses such as oxygen kinetic and ventilator efficiency in patients with heart and lungs diseases. In addition, further study should also be carried out in those with diabetes to assess the magnitude of change in insulin sensitivity and blood glucose response.

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APPENDIX

Appendix A

The Institution Review Board: Certificate of Approval

AF 02-12

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University
Jamjuree 1 Building, 2nd Floor, Phyathai Rd., Patumwan district, Bangkok 10330, Thailand,
Tel/Fax: 0-2218-3202 E-mail: eccu@chula.ac.th

COA No. 166/2015

Certificate of Approval

Study Title No.117.1/58 : **THE EFFECTS OF VELOCITY AND PATTERNS OF WALKING ON AEROBIC CAPACITY AND CORONARY HEART DISEASE RISK PROFILES IN MIDDLE-AGED OVERWEIGHT AND OBESE INDIVIDUALS**

Principal Investigator : MR.SITHA PHONGPHIBOOL

Place of Proposed Study/Institution : Faculty of Sports Science, Chulalongkorn University

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University, Thailand, has approved constituted in accordance with the International Conference on Harmonization – Good Clinical Practice (ICH-GCP) and/or Code of Conduct in Animal Use of NRCT version 2000.

Signature: Prida Tasanapradit Signature: Nuntaree Chaichanawongsaroj

(Associate Professor Prida Tasanapradit, M.D.) (Assistant Professor Nuntaree Chaichanawongsaroj, Ph.D.)
Chairman Secretary

Date of Approval : 28 September 2015 Approval Expire date : 27 September 2016

The approval documents including

1) Research proposal
2) Patient/Participant Information Sheet and Informed Consent Form
3) Researcher
4) Questionnaire

Protocol No. 117.1/58
Date of Approval 28 SEP 2015
Approval Expire Date 27 SEP 2016

The approved investigator must comply with the following conditions:

1. *The research/project activities must end on the approval expired date of the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University (RECCU). In case the research/project is unable to complete within that date, the project extension can be applied one month prior to the RECCU approval expired date.*
2. *Strictly conduct the research/project activities as written in the proposal.*
3. *Using only the documents that bearing the RECCU's seal of approval with the subjects/volunteers (including subject information sheet, consent form, invitation letter for project/research participation (if available).*
4. *Report to the RECCU for any serious adverse events within 5 working days*
5. *Report to the RECCU for any change of the research/project activities prior to conduct the activities.*
6. *Final report (AF 03-12) and abstract is required for a one year (or less) research/project and report within 30 days after the completion of the research/project. For thesis, abstract is required and report within 30 days after the completion of the research/project.*
7. *Annual progress report is needed for a two- year (or more) research/project and submit the progress report before the expire date of certificate. After the completion of the research/project processes as No. 6.*

Appendix B

Item Objective Congruence Index : IOC

ผลการประเมินการตรวจสอบค่าความตรงเชิงเนื้อหา

การหาค่าดัชนีความสอดคล้องของข้อมูลในการทำงานวิจัยเป็นการคำนวณความสอดคล้องระหว่างประเด็นที่ต้องการวัดและศึกษา ดัชนีที่ใช้แสดงค่าความสอดคล้อง เรียกว่า **ดัชนีความสอดคล้องของวัตถุประสงค์** (Item-Objective Congruence Index : IOC) โดยผู้เชี่ยวชาญจะประเมินด้วยคะแนน 3 ระดับ คือ

+1 = สอดคล้อง รายละเอียดในหัวข้อนั้นๆสามารถนำไปใช้ในการวิจัยได้
0 = ไม่แน่ใจ รายละเอียดในหัวข้อนั้นๆไม่แน่ใจว่าจะสามารถนำไปใช้ในการวิจัยได้
-1 = ไม่สอดคล้อง รายละเอียดในหัวข้อนั้นๆไม่สามารถนำไปใช้ในการวิจัยได้

สูตรในการคำนวณ

$$IOC = \frac{\sum R}{N}$$

IOC	คือ	ดัชนีความสอดคล้องระหว่างข้อสอบกับจุดประสงค์
R	คือ	คะแนนของผู้เชี่ยวชาญ
$\sum R$	คือ	ผลรวมของคะแนนผู้เชี่ยวชาญแต่ละคน
N	คือ	จำนวนผู้เชี่ยวชาญ

ผลลัพธ์จากการประมวลผล ค่า IOC จะปรากฏในช่องผลการพิจารณา โดยอัตโนมัติ

0.67 – 1.00	นำไปใช้ได้
0.33	ปรับปรุง
0.00 หรือมีค่าเป็นลบ	ตัดทิ้ง

วิชาการ. กรม. **เอกสารประกอบหลักสูตรการศึกษาขั้นพื้นฐาน พุทธศักราช 2544 การวิจัยเพื่อพัฒนาการเรียนรู้ตามหลักสูตรการศึกษาขั้นพื้นฐาน**. กรุงเทพฯ : โรงพิมพ์คุรุสภาลาดพร้าว, 2545.หน้า 65

รายนามผู้ทรงคุณวุฒิ

คนที่ 1	รศ.นพ.ชาญวิทย์ โคธีรานุรักษ์	จุฬาลงกรณ์มหาวิทยาลัย
คนที่ 2	นพ.อี๊ด ลอประยูร	รพ.กรุงเทพ (BASEM Center)
คนที่ 3	นพ.ดร.ฉกาจ ผ่องอักษร	มหาวิทยาลัยมหิดล
คนที่ 4	ผศ.ดร.ราตรี เรืองไทย	มหาวิทยาลัยเกษตรศาสตร์
คนที่ 5	อ.ร.ต.อ.หญิง ดร. ระพิณ ผลสุข	จุฬาลงกรณ์มหาวิทยาลัย

Item Objective Congruence (IOC): For the study of the effects of velocity and patterns of walking on aerobic capacity and Coronary Heart Disease (CHD) risk profiles in middle-aged overweight and obese individuals

Content	Experts' Score					Total Score	IOC Score
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5		
1. Initial Screening							
1.1 PAR-Q	1	1	1	1	1	5	1
1.2 Health history questionnaire	1	1	0	1	1	4	0.8
2. Exercise Testing							
2.1 Aerobic capacity assessment utilizing Ramp Bruce Protocol with Gas Analysis	1	1	0	1	1	4	0.8
2.2 Incremental Treadmill Walk Test (ITWT) with Gas Analysis to determine maximal walking velocity, 70% and 80% walking speed of maximal walking velocity, and energy expenditure at each walking pace	1	1	1	1	1	5	1
3. Blood Chemistry Analysis (CHD risk profiles)							
3.1 Analyze Cholesterol	1	1	1	1	1	5	1
3.2 Analyze LDL-Cholesterol	1	1	1	1	1	5	1
3.3 Analyze HDL-Cholesterol	1	1	1	1	1	5	1
3.4 Analyze Triglycerides	1	1	1	1	1	5	1
3.5 Analyze Glucose	1	1	1	1	1	5	1
3.6 Analyze high sensitivity C-reactive protein (hs-CRP)	1	1	1	1	1	5	1

Content	Experts' Score					Total Score	IOC Score
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5		
3. Blood Chemistry Analysis (CHD risk profiles)							
3.7 Blood sample will be collected at pre and post walking intervention	1	1	1	1	1	5	1
4. Walking Intervention							
Baseline assessment 4.1 Resting heart rate and resting blood pressure	1	1	1	1	1	5	1
4.2 Warm-up (10 minutes)	1	1	1	1	1	5	1
4.2.1 Stretch major muscle groups for 5 minutes	1	1	1	1	1	5	1
4.2.2 Slow walking on the treadmill for 5 minutes	1	1	1	1	1	5	1
4.3 Group A: Walking speed will be determined after the subjects completed the ITWT by multiplying 70% to the maximal walking velocity achieved to yield walking speed for exercise	1	1	1	1	1	5	1
4.3.1 Group A: Energy expended during the assessment of the 70% ITWT will be used to determine the walking duration/week and frequency/week	1	1	1	1	1	5	1

Content	Experts' Score					Total Score	IOC Score
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5		
4. Walking Intervention							
4.3.2 <u>Group A:</u> Walk on the treadmill at 70% of maximal walking velocity for a fixed amount of time and frequency per week for 10 weeks	1	1	1	1	1	5	1
4.4 <u>Group B:</u> Walking speed will be determined after the subjects completed the ITWT by multiplying 80% to the maximal walking velocity achieved to yield walking speed for exercise	1	1	1	1	1	5	1
4.4.1 <u>Group B:</u> Energy expended during the assessment of the 80% ITWT will be used to determine the walking duration/week and frequency/week	1	1	1	1	1	5	1
4.4.2 <u>Group B:</u> Walk on the treadmill at 80% of maximal walking velocity for a fixed amount of time and duration per week for 10 weeks	1	1	1	1	1	5	1
4.5 <u>Group C:</u> Walk at their own self-selected pace on the daily basis and accumulate up to 300 minutes of walking per week	1	1	1	1	1	5	1

Content	Experts' Score					Total Score	IOC Score
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5		
4. Walking Intervention							
4.5.1 Group C: Attach a pedometer (OMRON HJ-323u-triaxis, Japan) to track numbers of steps taken per day	1	1	1	1	1	5	1
4.5.2 Group C: A pedometer (OMRON HJ-323u-triaxis, Japan) will be attached at the hip in line with Anterior Superior Iliac Spine (ASIS)	1	1	1	1	1	5	1
4.6 All groups will be instructed to maintain normal physical activity of daily living and dietary habits	1	1	1	1	1	5	1
4.7 Cool down (10 minutes)	1	1	1	1	1	5	1
4.7.1 Slow walking on the treadmill for 5 minutes	1	1	1	1	1	5	1
4.7.2 Stretch major muscle groups for 5 minutes	1	1	1	1	1	5	1
Experts' IOC Result	0.98						

Appendix C

Participant's Informed Consent: Orientation and Research Participation for Intervention and Control Groups

หนังสือแสดงความยินยอมเข้าร่วมการวิจัย

(การปฐมนิเทศและการคัดกรอง)

เลขที่ ประชากรตัวอย่างหรือผู้มีส่วนร่วมในการวิจัย: ____________________

ข้าพเจ้าได้รับทราบจากผู้วิจัย ชื่อนายสิทธา พงษ์พิบูลย์ นิสิตปริญญาเอกประจำสาขาวิทยาการส่งเสริมสุขภาพ คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย หมายเลขโทรศัพท์สำหรับติดต่อ 081-820-5174 ซึ่งได้ลงนามด้านท้ายของหนังสือนี้

ชื่อโครงการ:	ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
ชื่อผู้วิจัย	นายสิทธา พงษ์พิบูลย์
อาจารย์ที่ปรึกษา	ศาสตราจารย์ ดร. ถนอมวงศ์ กฤษณ์เพ็ชร์
อาจารย์ที่ปรึกษาร่วม	พญ. อรชุมา หุตะโกวิท
สถานที่ติดต่อผู้วิจัย	คณะวิทยาศาสตร์การกีฬา
โทรศัพท์เคลื่อนที่	081-820-5174 e-mail: phongphibool@hotmail.com

ข้าพเจ้าได้ทราบถึงวัตถุประสงค์ ลักษณะและขั้นตอนการศึกษาวิจัยเรื่อง "ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน" ซึ่งผู้วิจัยได้ชี้แจงและอธิบายให้ข้าพเจ้าทราบแล้ว และข้าพเจ้ายังทราบถึงประโยชน์ของการศึกษานี้ได้แก่ ทำให้สุขภาพของข้าพเจ้าดีขึ้น มีสุขภาพร่างกายที่แข็งแรง และยังสามารถรู้ถึงสมรรถภาพการใช้ออกซิเจนสูงสุดของข้าพเจ้า ผลกระทบข้างเคียงที่อาจจะเกิดขึ้นได้ ได้แก่ อาการเหนื่อย ปวดเมื่อยกล้ามเนื้อ หรือ เมื่อยขา หลังการทดสอบการเดินสายพาน และการทดสอบความสามารถในเดินซึ่งอาการเหล่านี้จะหายไปเมื่อผู้เข้ารับการทดสอบนั่งพักประมาณ 20 นาที

ข้าพเจ้าจึงสมัครใจเข้าร่วมในโครงการวิจัยนี้ และยินยอมที่จะได้รับการคัดกรองและการตรวจสุขภาพขั้นพื้นฐานจากแพทย์อายุรกรรมที่มีความเชี่ยวชาญทางด้านเวชศาสตร์ฟื้นฟูโรคหัวใจที่ห้องปฏิบัติการวิทยาศาสตร์การกีฬาและสุขภาพ คณะวิทยาศาสตร์การกีฬาเพื่อให้แน่ใจว่าข้าพเจ้านั้นไม่มีปัญหาทางด้านสุขภาพที่จะเป็นอุปสรรคต่อการออกกำลังกาย

ข้าพเจ้าได้รับการรับรองจากผู้วิจัยว่าข้อมูลของข้าพเจ้าจะถูกเก็บรักษาเป็นความลับโดยมิให้บุคคลอื่นเข้าถึงข้อมูลนี้ได้ การนำเสนอข้อมูลหรือผลการศึกษาจะนำเสนอในภาพรวมเท่านั้นโดยจะไม่ระบุหรืออ้างอิงถึงข้อมูลของข้าพเจ้า

ข้าพเจ้าได้ซักถามทำความเข้าใจเกี่ยวกับการศึกษาดังกล่าวนี้ และข้าพเจ้าสมัครใจเข้าร่วมการศึกษาวิจัยครั้งนี้เพื่อเป็นประโยชน์ต่อการศึกษา และมีสิทธิที่จะปฏิเสธจากการเข้าร่วมการวิจัยได้ตามความต้องการ โดยไม่จำเป็นต้องแจ้งเหตุผล ซึ่งจะไม่มีผลใดๆต่อข้าพเจ้า

หากข้าพเจ้าไม่ได้รับการปฏิบัติตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าสามารถร้องเรียนได้ที่คณะกรรมการพิจารณาจริยธรรมการวิจัยในคน *254 อาคารจามจุรี 1 ชั้น 2 ห้อง 210-211 ถ. พญาไท แขวงวังใหม่ เขตปทุมวัน กรุงเทพฯ 10330 โทรศัพท์/โทรสาร 02-218-3202 email: eccu@chula.ac.th*

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

หนังสือแสดงความยินยอมเข้าร่วมการวิจัย

(กลุ่มทดลอง)

เลขที่ ประชากรตัวอย่างหรือผู้มีส่วนร่วมในการวิจัย: ___________________

ข้าพเจ้าได้รับทราบจากผู้วิจัย ชื่อนายสิทธา พงษ์พิบูลย์ นิสิตปริญญาเอกประจำสาขาวิทยาการส่งเสริมสุขภาพ คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย หมายเลขโทรศัพท์สำหรับติดต่อ 081-820-5174 ซึ่งได้ลงนามด้านท้ายของหนังสือนี้

ชื่อโครงการ:	ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
ชื่อผู้วิจัย	นายสิทธา พงษ์พิบูลย์
อาจารย์ที่ปรึกษา	ศาสตราจารย์ ดร. ถนอมวงศ์ กฤษณ์เพ็ชร์
อาจารย์ที่ปรึกษาร่วม	พญ. อรชุมา หุตะโกวิท
สถานที่ติดต่อผู้วิจัย	คณะวิทยาศาสตร์การกีฬา
โทรศัพท์เคลื่อนที่	081-820-5174 e-mail: phongphibool@hotmail.com

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

ข้าพเจ้าได้ทราบถึงวัตถุประสงค์ ลักษณะและขั้นตอนการศึกษาวิจัยเรื่อง "ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน" ซึ่งผู้วิจัยได้ชี้แจงและอธิบายให้ข้าพเจ้าทราบแล้ว และข้าพเจ้ายังทราบถึงประโยชน์ของการศึกษานี้ได้แก่ ทำให้สุขภาพของข้าพเจ้าดีขึ้น มีสุขภาพร่างกายที่แข็งแรง และยังสามารถรู้ถึงสมรรถภาพการใช้ออกซิเจนสูงสุดของข้าพเจ้า ผลกระทบข้างเคียงที่อาจจะเกิดขึ้นได้ ได้แก่ อาการเหนื่อย ปวดเมื่อยกล้ามเนื้อ หรือ เมื่อยขา หลังการทดสอบการเดินสายพาน และการทดสอบความสามารถในเดินซึ่งอาการเหล่านี้จะหายไปเมื่อผู้เข้ารับการทดสอบนั่งพักประมาณ 20 นาที

ข้าพเจ้าจึงสมัคใจเข้าร่วมในโครงการวิจัยนี้ ตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมวิจัย โดยข้าพเจ้ายินยอมปฏิบัติตามกิจกรรมที่กำหนดในโครงการวิจัย ซึ่งประกอบด้วย การทดสอบความสามารถการใช้ออกซิเจนสูงสุดจากการเดินสายพาน การทดสอบความสามารถในการเดินบนสายพาน *การเข้าร่วมโปรแกมการเดินออกกำลังกายตามรูปแบบที่กำหนดเป็นเวลา 10 สัปดาห์* และการเจาะเลือดโดยพยาบาลวิชาชีพเพื่อวิเคราะห์ เอชดีแอล -โคเลสเตอรอล แอลดีแอล-โคเลสเตอรอล ไตรกลีเซอไรด์ โคเลสเตอรอล ระดับน้ำตาลในเลือดเมื่ออดอาหาร และ ไฮเซนซิทิฟวิที ซี รีแอคทีฟวโปรตีน 2 ครั้ง (ก่อนและหลังการทดลอง) ครั้งละ 2 ช้อนชา ซึ่งจะมีการทำลายเลือดโดยผู้เชี่ยวชาญด้านเทคนิคการแพทย์เมื่อสิ้นสุดการวิจัย *รวมระยะเวลาในการเข้าร่วมการเข้าร่วมวิจัยทั้งสิ้น 10 สัปดาห์* และข้าพเจ้ามีสิทธิถอนตัวออกจากการวิจัยเมื่อใดก็ได้ตามความประสงค์ โดยไม่ต้องแจ้งเหตุผล ซึ่งการถอนตัวออกจากการวิจัยนั้น จะไม่มีผลกระทบในทางใดๆ ต่อข้าพเจ้าทั้งสิ้น

ข้าพเจ้ารับทราบจากผู้วิจัยว่า หากข้าพเจ้าได้รับการบาดเจ็บจากการศึกษาทดลองนี้ ข้าพเจ้าต้องแจ้งให้ผู้วิจัยทราบทันทีซึ่งจะได้รับความช่วยเหลือเบื้องต้น เช่น ให้คำแนะนำโดยให้หยุดพักสังเกตอาการ หรือปฐมพยาบาลเบื้องต้น และจะนำส่งไปยังโรงพยาบาล โดยผู้วิจัยจะเป็นผู้ดูแลรับผิดชอบให้ผู้มีส่วนร่วมในการวิจัยได้รับการดูแลรักษาอย่างเหมาะสม

หนังสือแสดงความยินยอมเข้าร่วมการวิจัย

(กลุ่มควบคุม)

เลขที่ ประชากรตัวอย่างหรือผู้มีส่วนร่วมในการวิจัย: ____________________

ข้าพเจ้าได้รับทราบจากผู้วิจัย ชื่อนายสิทธา พงษ์พิบูลย์ นิสิตปริญญาเอกและอาจารย์ประจำสาขาวิทยาการส่งเสริมสุขภาพ คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย หมายเลขโทรศัพท์สำหรับติดต่อ 081-820-5174 ซึ่งได้ลงนามด้านท้ายของหนังสือนี้

ชื่อโครงการ:	ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
ชื่อผู้วิจัย	นายสิทธา พงษ์พิบูลย์
อาจารย์ที่ปรึกษา	ศาสตราจารย์ ดร. ถนอมวงศ์ กฤษณ์เพ็ชร์
อาจารย์ที่ปรึกษาร่วม	พญ. อรชุมา หุตะโกวิท
สถานที่ติดต่อผู้วิจัย	คณะวิทยาศาสตร์การกีฬา
โทรศัพท์เคลื่อนที่	081-820-5174 e-mail: phongphibool@hotmail.com

เลขที่โครงการวิจัย 117.1/58
วันที่รับรอง 28 ก.ย. 2558
วันหมดอายุ 27 ก.ย. 2559

ข้าพเจ้าได้ทราบถึงวัตถุประสงค์ ลักษณะและขั้นตอนการศึกษาวิจัยเรื่อง "ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน" ซึ่งผู้วิจัยได้ชี้แจงและอธิบายให้ข้าพเจ้าทราบแล้ว และข้าพเจ้ายังทราบถึงประโยชน์ของการศึกษานี้ได้แก่ ทำให้สุขภาพของข้าพเจ้าดีขึ้น มีสุขภาพร่างกายที่แข็งแรง และยังสามารถรู้ถึงสมรรถภาพการใช้ออกซิเจนสูงสุดของข้าพเจ้า ผลกระทบข้างเคียงที่อาจจะเกิดขึ้นได้ ได้แก่ อาการเหนื่อย ปวดเมื่อยกล้ามเนื้อ หรือ เมื่อยขา หลังการทดสอบการเดินสายพาน และการทดสอบความสามารถในเดินซึ่งอาการเหล่านี้จะหายไปเมื่อผู้เข้ารับการทดสอบนั่งพักประมาณ 20 นาที

ข้าพเจ้าจึงสมัคใจเข้าร่วมในโครงการวิจัยนี้ ตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่ามวิจัย โดยข้าพเจ้ายินยอมปฏิบัติตามกิจกรรมที่กำหนดในโครงการวิจัย ซึ่งประกอบด้วยก การทดสอบความสามารถการใช้ออกซิเจนสูงสุดจากการเดินสายพาน การทดสอบความสามารถในการเดินบนสายพาน *การเข้าร่วมโปรแกมการเดินออกกำลังกายตามรูปแบบที่กำหนดเป็นเวลา 10 สัปดาห์* และการเจาะเลือดโดยพญาบาลวิชาชีพเพื่อวิเคราะห์ เอชดีแอล -โคเลสเตอรอล แอลดีแอล-โคเลสเตอรอล ไตรกลีเซอไรต์ โคเลสเตอรอล ระดับน้ำตาลในเลือดเมื่ออดอาหาร และ ไฮเซนซิทิฟวิที ซี รีแอคทิฟวโปรตีน 2 ครั้ง (ก่อนและหลังการทดลอง) ครั้งละ 2 ช้อนชา ซึ่งจะมีการทำลายเลือดโดยผู้เชี่ยวชาญด้านเทคนิคการแพทย์ เมื่อสิ้นสุดการวิจัย รวมระยะเวลาในการเข้าร่วมการเข้าร่วมวิจัยทั้งสิ้น 10 สัปดาห์ และข้าพเจ้ามีสิทธิถอนตัวออกจากการวิจัยเมื่อใดก็ได้ตามความประสงค์ โดยไม่ต้องแจ้งเหตุผล ซึ่งการถอนตัวออกจากการวิจัยนั้น จะไม่มีผลกระทบในทางใดๆ ต่อข้าพเจ้าทั้งสิ้น

ข้าพเจ้ารับทราบจากผู้วิจัยว่า หากข้าพเจ้าได้รับการบาดเจ็บจากการศึกษาทดลองนี้ ข้าพเจ้าต้องแจ้งให้ผู้วิจัยทราบทันทีซึ่งจะได้รับความช่วยเหลือเบื้องต้น เช่น ให้คำแนะนำโดยให้หยุดพักสังเกตอาการ หรือปฐมพยาบาลเบื้องต้น และจะนำส่งไปยังโรงพยาบาล โดยผู้วิจัยจะเป็นผู้ดูแลรับผิดชอบให้ผู้มีส่วนร่วมในการวิจัยได้รับการดูแลรักษาอย่างเหมาะสม

Appendix D

Participant's Research Information: Intervention and Control Groups

ข้อมูลสำหรับกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย
กลุ่มทดลอง

ชื่อโครงการวิจัย: ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน

ชื่อผู้วิจัย: นายสิทธา พงษ์พิบูลย์ **ตำแหน่ง:** นิสิตปริญญาเอกและอาจารย์ประจำ

สถานที่ติดต่อผู้วิจัย *(ที่ทำงาน):* คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย

(ที่บ้าน): หมู่บ้าน Plus City Park เลขที่ 1/68 ซอยหัวหมาก 23 ถ.กรุงเทพกรีฑาตัดใหม่ แขวงหัวหมาก เขตบางกะปิ กรุงเทพ 10240

โทรศัพท์ที่ทำงาน: 02-218-1032 **โทรศัพท์มือถือ:** 081-820-5174

Email: phongphibool@hotmail.com

เลขที่โครงการวิจัย 117.1/58
วันที่รับรอง 28 ก.ย. 2558
วันหมดอายุ 27 ก.ย. 2559

ขอเรียนเชิญท่านเข้าร่วมในการวิจัยก่อนที่ท่านจะตัดสินใจเข้าร่วมในการวิจัย มีความจำเป็นที่ท่านควรทำความเข้าใจว่างานวิจัยนี้ทำเพราะเหตุใด และเกี่ยวข้องกับอะไร กรุณาใช้เวลาในการอ่านข้อมูลต่อไปนี้อย่างละเอียดรอบคอบ และสอบถามข้อมูลเพิ่มเติมหรือข้อมูลที่ไม่ชัดเจนได้ตลอดเวลา

1. โครงการนี้เกี่ยวข้องกับการศึกษา ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
2. วัตถุประสงค์ของการวิจัยนี้เพื่อศึกษาผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
3. กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยคือเพศชายและเพศหญิงวัยกลางคนที่ภาวะน้ำหนักตัวเกินและอ้วน จำนวน 75 คน อายุ 40-60 ปี ออกกำลังกาย 2 วันหรือน้อยกว่าในช่วง 6 เดือนที่ผ่านมา
4. ผู้วิจัยจะให้กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัย ตอบแบบสอบถามที่เกี่ยวกับสุขภาพทั่วไป*(ซึ่งจะใช้เวลาในการกรอกประมาณ 10 นาที)* และผ่านการตรวจสุขภาพขั้นพื้นฐานจาก*แพทย์อายุรกรรมที่มีความเชี่ยวชาญทางด้านเวชศาสตร์ฟื้นฟูโรคหัวใจซึ่งเป็นที่ปรึกษาร่วมที่ห้องปฏิบัติการวิทยาศาสตร์การกีฬาและสุขภาพ คณะวิทยาศาสตร์การกีฬา* เพื่อให้แน่ใจว่ากลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยนั้นไม่มีปัญหาทางด้านสุขภาพที่จะเป็นอุปสรรคต่อการออกกำลังกาย

    4.2 เกณฑ์การคัดเลือกผู้เข้าร่วมการวิจัย

    4.2.1 เพศชายหรือเพศหญิงอายุ 40-60 ปี มีภาวะน้ำหนักเกินและอ้วน

    4.2.2 ดัชนีมวลกายมากกว่า 23 และน้อยกว่า 35

    4.2.3 มีปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจอย่างน้อย 2 อย่าง *เช่น ความดันโลหิตสูง* น้ำตาลใน*เลือดสูง* ไขมันในเลือดสูง *รอบเอวเกิน หรือ ไฮเซนซิทิฟวิที ซี รีแอคทิฟว* โปรตีนสูง

    4.2.4 ไม่มีปัญหาในด้านระบบหัวใจและหลอดเลือด ปอด และเมแทบอลิซึม เช่น *ไม่มีภาวะหัวใจเต้นผิดจังหวะ ไม่มีภาวะของกล้ามเนื้อหัวใจขาดเลือดหรืออาการแน่นหรือเจ็บหน้าอก ไม่มีอาการหอบเหนื่อย หน้ามืด หรือเวียนศรีษะ ในขณะพักหรือในขณะที่ทำกิจกรรมทางกายในทุกระดับ*

    4.2.5 ไม่มีข้อจำกัดทางกายที่จะเป็นอุปสรรคต่อการออกกำลังกาย *เช่น อาการปวดหลัง ปวดเข่า ปัญหาเรื่องการทรงตัว หรือโรคประจำตัวที่ทำให้ออกกำลังกายไม่ได้*

เมื่ออดอาหาร และ ไฮเซนซิทิฟวิที ซี รีแอคทิฟว โปรตีน 2 ครั้ง (ก่อนและหลังการทดลอง) ครั้งละ 2 ช้อนชา (ประมาณ 10 cc) *ซึ่งผลเลือดที่ได้จะมีการแจ้งให้ผู้เข้าร่วมวิจัยทราบเป็นราย ๆ ไป และหลังจากที่ได้ข้อมูลจากการวิเคราะห์ผลเลือดแล้ว* จะมีการทำลายเลือดโดยผู้เชี่ยวชาญด้านเทคนิคการแพทย์เมื่อสิ้นสุดการวิจัย รวมระยะเวลาในการเข้าร่วมการเข้าร่วมวิจัยทั้งสิ้น 10 สัปดาห์ *การเจาะเลือดอาจมีความเสี่ยงอยู่บ้าง เช่น การติดเชื้อ หรืออาจจะมีเลือดออกบริเวณที่เจาะเลือด ดังนั้น ก่อนที่จะทำการเจาะเลือดพยาบาลวิชาชีพจะมีการเช็ดด้วยแอลกอฮอล์ฆ่าเชื้อบนบริเวณที่จะเจาะเลือด หรือถ้ามีเลือดออกหลังการเจาะเลือด จะมีการห้ามเลือดโดยการกดเพื่อให้เลือดหยุดและติดแบนดิจเพื่อห้ามเลือด*

5.4 ผู้วิจัยจะทำการทดสอบการความสามารถในการเดินโดยให้ผู้ร่วมวิจัยเดินบนลู่วิ่งเพื่อหาความเร็วที่สามารถเดินได้สูงสุด การทดลองจะเริ่มโดยให้ผู้มีส่วนร่วมวิจัยเริ่มเดินในความเร็วที่ 4 กิโลเมตร/ชั่วโมง โดยไม่มีความชัน หลังจากนั้น ความเร็วจะถูกเพิ่มขึ้น 0.7 กิโลเมตร/ชั่วโมงทุก ๆ 3 นาที จนผู้เข้าร่วมวิจัยไม่สามารถที่จะเดินได้อย่างสบายหรือเปลี่ยนเป็นวิ่ง ผู้วิจัยจะวัดค่าการใช้ออกซิเจนในขณะเดินเพื่อคำนวนพลังงาน

5.5 ผู้วิจัยจะทำการทดสอบการเดินในความเร็วที่ 70% และ 80% จากความเร็วที่ผู้เข้าร่วมวิจัยสามารถทำได้ก่อนหน้านี้ ผู้เข้าร่วมวิจัยจะต้องเดินเพื่อหาความเร็ว 2 รอบ ซึ่งหลังจากเสร็จสิ้นการทดลองในแต่ละรอบ ผู้วิจัยจะได้พัก 20 นาทีแล้วถึงจะทำการทดลองครั้งต่อไป ผู้วิจัยจะวัดค่าการใช้ออกซิเจนในขณะที่เดินเพื่อคำนวนพลังงาน

5.6 ผู้วิจัยจะแบ่งกลุ่มผู้เข้าร่วมวิจัยแบบสุ่มโดยจะจัดให้แต่ละกลุ่มมีความเท่าเทียมกันให้เป็น 3 กลุ่ม คือ กลุ่ม A (เดินที่ 70% ของความเร็วสูงสุด); กลุ่ม B (เดินที่ 80% ของความเร็วสูงสุด); และกลุ่ม C (เดินในชีวิตประจำวัน)

5.7 ผู้เข้าร่วมวิจัยในกลุ่ม A จะต้องเดินบนลู่วิ่งในความเร็วที่ 70% ของความเร็วสูงสุดที่ทดลองได้ เป็นเวลา 60 นาที 5 วัน/สัปดาห์ เพื่อที่จะเผาผลาญ 1,000 แคลอริ ผู้เข้าร่วมวิจัยจะต้องออกกำลังกายเป็นเวลา 10 สัปดาห์

5.8 ผู้เข้าร่วมวิจัยในกลุ่ม B จะต้องเดินบนลู่วิ่งในความเร็วที่ 80% ของความเร็วสูงสุดที่ทดลองได้ เป็นเวลา 50 นาที 5 วัน/สัปดาห์ เพื่อที่จะเผาผลาญ 1,000 แคลอริ ผู้เข้าร่วมวิจัยจะต้องออกกำลังกายเป็นเวลา 10 สัปดาห์

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

5.9 สรุปกิจกรรม

กิจกรรม	*จำนวนครั้ง*	*ระยะเวลา*
ปฐมนิเทศ	*1 ครั้ง*	*20 นาที*
การคัดกรอง	*1 ครั้ง*	*20 นาที*
การทดสอบสมรรถภาพการใช้ออกซิเจน	*1 ครั้ง*	*20 นาที*
การเจาะเลือด	*1 ครั้ง*	*10 นาที*
การทดสอบความเร็วในการเดิน	*1 ครั้ง*	*60 นาที*
โปรแกรมการเดิน	*30 ครั้งตลอดการทดลอง*	*10 สัปดาห์*
การเจาะเลือด	*1 ครั้ง*	*10 นาที*

ข้อมูลสำหรับกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย
กลุ่มควบคุม

ชื่อโครงการวิจัย: ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน

ชื่อผู้วิจัย: นายสิทธา พงษ์พิบูลย์ **ตำแหน่ง:** นิสิตปริญญาเอกและอาจารย์ประจำ

สถานที่ติดต่อผู้วิจัย *(ที่ทำงาน):* คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย

(ที่บ้าน): หมู่บ้าน Plus City Park เลขที่ 1/68 ซอยหัวหมาก 23 [illegible]ทาตัดใหม่ แขวงหัวหมาก เขตบางกะปิ กรุงเทพ 10240

โทรศัพท์ที่ทำงาน: 02-218-1032 **โทรศัพท์มือถือ:** 081-820-517[illegible]

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เลขที่โครงการวิจัย 117.1/58
วันที่รับรอง 2 8 ก.ย. 2558
วันหมดอายุ 2 7 ก.ย. 2559

ขอเรียนเชิญท่านเข้าร่วมในการวิจัยก่อนที่ท่านจะตัดสินใจเข้าร่วมในการวิจัย มีความจำเป็นที่ท่านควรทำความเข้าใจว่างานวิจัยนี้ทำเพราะเหตุใด และเกี่ยวข้องกับอะไร กรุณาใช้เวลาในการอ่านข้อมูลต่อไปนี้อย่างละเอียดรอบคอบ และสอบถามข้อมูลเพิ่มเติมหรือข้อมูลที่ไม่ชัดเจนได้ตลอดเวลา

1. โครงการนี้เกี่ยวข้องกับการศึกษา ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
2. วัตถุประสงค์ของการวิจัยนี้เพื่อศึกษาผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
3. กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยคือเพศชายและเพศหญิงวัยกลางคนที่ภาวะน้ำหนักตัวเกินและอ้วน จำนวน 75 คน อายุ 40-60 ปี ออกกำลังกาย 2 วันหรือน้อยกว่าในช่วง 6 เดือนที่ผ่านมา
4. ผู้วิจัยจะให้กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัย ตอบแบบสอบถามที่เกี่ยวกับสุขภาพทั่วไป*(ซึ่งจะใช้เวลาในการกรอกประมาณ 10 นาที)* และผ่านการตรวจสุขภาพขั้นพื้นฐานจาก*แพทย์อายุรกรรมที่มีความเชี่ยวชาญทางด้านเวชศาสตร์ฟื้นฟูโรคหัวใจซึ่งเป็นที่ปรึกษาร่วมที่ห้องปฏิบัติการวิทยาศาสตร์การกีฬาและสุขภาพ คณะวิทยาศาสตร์การกีฬา* เพื่อให้แน่ใจว่ากลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยนั้นไม่มีปัญหาทางด้านสุขภาพที่จะเป็นอุปสรรคต่อการออกกำลังกาย

4.2 เกณฑ์การคัดเลือกผู้เข้าร่วมการวิจัย

4.2.1 เพศชายหรือเพศหญิงอายุ 40-60 ปี มีภาวะน้ำหนักเกินและอ้วน

4.2.2 ดัชนีมวลกายมากกว่า 23 และน้อยกว่า 35

4.2.3 มีปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจอย่างน้อย 2 อย่าง *เช่น ความดันโลหิตสูง น้ำตาลในเลือดสูง ไขมันในเลือดสูง รอบเอวเกิน หรือ ไฮเซนซิทิฟวิที ซี รีแอคทีฟว โปรตีนสูง*

4.2.4 ไม่มีปัญหาในด้านระบบหัวใจและหลอดเลือด ปอด และเมแทบอลิซึม *ไม่มีภาวะหัวใจเต้นผิดจังหวะ ไม่มีภาวะของกล้ามเนื้อหัวใจขาดเลือดหรืออาการแน่นหรือเจ็บหน้าอก ไม่มีอาการหอบเหนื่อย หน้ามืด หรือเวียนศรีษะ ในขณะพักหรือในขณะที่ทำกิจกรรมทางกายในทุกระดับ*

4.2.5 ไม่มีข้อจำกัดทางกายที่จะเป็นอุปสรรคต่อการออกกำลังกาย *เช่น อาการปวดหลัง ปวดเข่า ปัญหาเรื่องการทรงตัว หรือโรคประจำตัวที่ทำให้ออกกำลังกายไม่ได้*

เมื่ออดอาหาร และไฮเซนซิทิฟวิที ซี รีแอคทิฟว โปรตีน 2 ครั้ง (ก่อนและหลังการทดลอง) ครั้งละ 2 ช้อนชา (ประมาณ 10 cc) *ซึ่งผลเลือดที่ได้จะมีการแจ้งให้ผู้เข้าร่วมวิจัยทราบเป็นราย ๆ ไป และหลังจากที่ได้ข้อมูลจากการวิเคราะห์ผลเลือดแล้ว* จะมีการทำลายเลือดโดยผู้เชี่ยวชาญด้านเทคนิคการแพทย์เมื่อสิ้นสุดการวิจัย รวมระยะเวลาในการเข้าร่วมการเข้าร่วมวิจัยทั้งสิ้น 10 สัปดาห์ *การเจาะเลือดอาจมีความเสี่ยงอยู่บ้าง เช่น การติดเชื้อ หรืออาจจะมีเลือดออกบริเวณที่เจาะเลือด ดังนั้น ก่อนที่จะทำการเจาะเลือดพยาบาลวิชาชีพจะมีการเช็ดด้วยแอลกอฮอล์ฆ่าเชื้อบนบริเวณที่จะเจาะเลือด หรือถ้ามีเลือดออกหลังการเจาะเลือดจะมีการห้ามเลือดโดยการกดเพื่อให้เลือดหยุดและติดแบนดิจเพื่อห้ามเลือด*

5.4 ผู้วิจัยจะทำการทดสอบการความสามารถในการเดินโดยให้ผู้ร่วมวิจัยเดินบนลู่วิ่งเพื่อหาความเร็วที่สามารถเดินได้สูงสุด การทดลองจะเริ่มโดยให้ผู้มีส่วนร่วมวิจัยเริ่มเดินในความเร็วที่ 4 กิโลเมตร/ชั่วโมง โดยไม่มีความชัน หลังจากนั้น ความเร็วจะถูกเพิ่มขึ้น 0.7 กิโลเมตร/ชั่วโมงทุก ๆ 3 นาที จนผู้เข้าร่วมวิจัยไม่สามารถที่จะเดินได้อย่างสบายหรือเปลี่ยนเป็นวิ่ง ขณะเดียวกันผู้วิจัยก็จะวัดค่าการใช้ออกซิเจนในขณะเดินเพื่อคำนวนพลังงาน

5.5 ผู้วิจัยจะทำการทดสอบการเดินในความเร็วที่ 70% และ 80% จากความเร็วที่ผู้เข้าร่วมวิจัยสามารถทำได้ก่อนหน้านี้ ผู้เข้าร่วมวิจัยจะต้องเดินเพื่อหาความเร็ว 2 รอบ ซึ่งหลังจากเสร็จสิ้นการทดลองในแต่ละรอบผู้วิจัยจะได้พัก 20 นาทีแล้วถึงจะทำการทดลองครั้งต่อไป ผู้วิจัยจะวัดค่าการใช้ออกซิเจนในขณะที่เดินเพื่อคำนวนพลังงาน

5.6 ผู้วิจัยจะแบ่งกลุ่มผู้เข้าร่วมวิจัยแบบสุ่มโดยจะจัดให้แต่ละกลุ่มมีความเท่าเทียมกันให้เป็น 3 กลุ่ม คือ กลุ่ม A (เดินที่ 70% ของความเร็วสูงสุด); กลุ่ม B (เดินที่ 80% ของความเร็วสูงสุด); และกลุ่ม C (เดินในชีวิตประจำวัน)

5.7 ผู้เข้าร่วมวิจัยในกลุ่ม C จะทำการเดินด้วยตนเองในเวลาที่ว่าง ผู้เข้าร่วมวิจัยจะต้องเดินให้ได้ 300 นาทีต่อสัปดาห์ เป็นเวลา 10 สัปดาห์ และในแต่ละวันผู้เข้าร่วมวิจัยจะต้องติดเครื่องนับก้าวที่เอวเพื่อเก็บข้อมูลจำนวนก้าวในแต่ละวัน *ผู้วิจัยจะทำการโทรเตือนผู้เข้าร่วมวิจัยสัปดาห์ละสองครั้งในช่วงบ่ายระหว่างเวลา 15:00 นาฬิกา ถึง 18:00 นาฬิกา หลังจากสิ้นสุดการศึกษาแล้ว ผู้วิจัยจะทำการเก็บคืนเครื่องนับก้าวจากผู้เข้าร่วมวิจัยทุกคน*

5.8 *สรุปกิจกรรม*

กิจกรรม	*จำนวนครั้ง*	*ระยะเวลา*
ปฐมนิเทศ	*1 ครั้ง*	*20 นาที*
การคัดกรอง	*1 ครั้ง*	*20 นาที*
การทดสอบสมรรถภาพการใช้ออกซิเจน	*1 ครั้ง*	*20 นาที*
การเจาะเลือด	*1 ครั้ง*	*10 นาที*
โปรแกรมการเดิน	*300 นาทีต่อสัปดาห์*	*10 สัปดาห์*
การเจาะเลือด	*1 ครั้ง*	*10 นาที*

Appendix E

Participant's Orientation Information

ข้อมูลสำหรับกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย
การปฐมนิเทศและการคัดกรอง

ชื่อโครงการวิจัย: ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน

ชื่อผู้วิจัย: นายสิทธา พงษ์พิบูลย์ **ตำแหน่ง:** นิสิตปริญญาเอกและอาจารย์ประจำ
สถานที่ติดต่อผู้วิจัย *(ที่ทำงาน):* คณะวิทยาศาสตร์การกีฬา จุฬาลงกรณ์มหาวิทยาลัย
(ที่บ้าน): หมู่บ้าน Plus City Park เลขที่ 1/68 ซอยหัวหมาก 23 ถ. กรุงเทพกรีฑาตัดใหม่ แขวงหัวหมาก เขตบางกะปิ กรุงเทพ 10240
โทรศัพท์ที่ทำงาน: 02-218-1032 **โทรศัพท์มือถือ:** 081-820-5174
Email: phongphibool@hotmail.com

เลขที่โครงการวิจัย 117.1/58
วันที่รับรอง 28 ก.ย. 2558
วันหมดอายุ 27 ก.ย. 2559

ขอเรียนเชิญท่านเข้าร่วมในการวิจัยก่อนที่ท่านจะตัดสินใจเข้าร่วมในการวิจัย มีความจำเป็นที่ท่านควรทำความเข้าใจว่างานวิจัยนี้ทำเพราะเหตุใด และเกี่ยวข้องกับอะไร กรุณาใช้เวลาในการอ่านข้อมูลต่อไปนี้อย่างละเอียดรอบคอบ และสอบถามข้อมูลเพิ่มเติมหรือข้อมูลที่ไม่ชัดเจนได้ตลอดเวลา

1. โครงการนี้เกี่ยวข้องกับการศึกษา ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
2. วัตถุประสงค์ของการวิจัยนี้เพื่อศึกษาผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจในวัยกลางคนที่มีน้ำหนักเกินและอ้วน
3. กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยคือเพศชายและเพศหญิงวัยกลางคนที่ภาวะน้ำหนักตัวเกินและอ้วน จำนวน 75 คน อายุ 40-60 ปี ออกกำลังกาย 2 วันหรือน้อยกว่าในช่วง 6 เดือนที่ผ่านมา
4. ผู้วิจัยจะให้กลุ่มประชากรหรือผู้มีส่วนร่วมวิจัย ตอบแบบสอบถามที่เกี่ยวกับสุขภาพทั่วไป*(ซึ่งจะใช้เวลาในการกรอกประมาณ 10 นาที)* และผ่านการตรวจสุขภาพขั้นพื้นฐานจาก*แพทย์อายุรกรรมที่มีความเชี่ยวชาญทางด้านเวชศาสตร์ฟื้นฟูโรคหัวใจซึ่งเป็นที่ปรึกษาร่วมที่ห้องปฏิบัติการวิทยาศาสตร์การกีฬาและสุขภาพ คณะวิทยาศาสตร์การกีฬา* เพื่อให้แน่ใจว่ากลุ่มประชากรหรือผู้มีส่วนร่วมวิจัยนั้นไม่มีปัญหาทางด้านสุขภาพที่จะเป็นอุปสรรคต่อการออกกำลังกายและสามารถเข้าร่วมการออกกำลังกายได้

4.2 เกณฑ์การคัดเลือกผู้เข้าร่วมการวิจัย

4.2.1 เพศชายหรือเพศหญิงอายุ 40-60 ปี มี*ภาวะ*น้ำหนักเกินและอ้วน

4.2.2 ดัชนีมวลกายมากกว่า 23 และน้อยกว่า 35

4.2.3 มีปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจอย่างน้อย 2 อย่าง *เช่น ความดันโลหิตสูง น้ำตาลในเลือดสูง ไขมันในเลือดสูง รอบเอวเกิน หรือ ไฮเซนซิทิฟวิที ซี รีแอคทิฟว โปรตีนสูง*

4.2.4 ไม่มีปัญหาในด้านระบบหัวใจและหลอดเลือด ปอด และเมแทบอลิซึม เช่น *ไม่มีภาวะหัวใจเต้นผิดจังหวะ ไม่มีภาวะของกล้ามเนื้อหัวใจขาดเลือดหรืออาการแน่นหรือเจ็บหน้าอก ไม่มีอาการหอบเหนื่อย หน้ามืด หรือเวียนศีรษะ ในขณะพักหรือในขณะที่ทำกิจกรรมทางกายในทุกระดับ*

4.2.5 ไม่มีข้อจำกัดทางกายที่จะเป็นอุปสรรคต่อการออกกำลังกาย *เช่น อาการปวดหลัง ปวดเข่า ปัญหาเรื่องการทรงตัว หรือโรคประจำตัวที่ทำให้ออกกำลังกายไม่ได้*

ที่เกี่ยวข้องกับท่านจะถูกเก็บเป็น**ความลับ** หากมีการเสนอผลการวิจัย จะนำเสนอเป็นภาพรวม ข้อมูลใดที่สามารถระบุถึงตัวท่านได้จะไม่ปรากฏในรายงาน *ผู้ที่มีสิทธิเข้าร่วมวิจัยถ้าผ่านการคัดกรองและได้เข้าร่วมการศึกษา ผู้มีส่วนร่วมวิจัยจะได้รับค่าตอบแทนสำหรับการเดินทางที่มาทดสอบที่ห้องปฏิบัติการวิทยาศาสตร์การกีฬาและสุขภาพ คณะวิทยาศาสตร์การกีฬา 2 ครั้ง เป็นเงินทั้งหมดจำนวน 400 บาท และในการออกกำลังกาย ผู้วิจัยจะเตรียมน้ำดื่มและของว่างไว้บริการให้ผู้เข้าร่วมวิจัยหลังจากเสร็จสิ้นการทดสอบและการออกกำลังกาย* หากท่านมีข้อสงสัยให้สอบถามเพิ่มเติมได้โดยสามารถติดต่อผู้วิจัยได้ตลอดเวลา และหากผู้วิจัยมีข้อมูลเพิ่มเติมที่เป็นประโยชน์หรือโทษเกี่ยวกับการวิจัย ผู้วิจัยจะแจ้งให้ท่านทราบอย่างรวดเร็ว

หากท่านไม่ได้รับการปฏิบัติตามข้อมูลดังกล่าวสามารถร้องเรียนได้ที่ คณะกรรมการพิจารณาจริยธรรมการวิจัยในคน *254 อาคารจามจุรี 1 ชั้น 2 ห้อง 210-211 ถ.พญาไท แขวงวังใหม่ เขตปทุมวัน กรุงเทพฯ 10330 โทรศัพท์/โทรสาร 02-218-3202 email: eccu@chula.ac.th*

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

Appendix F

Physical Activity Readiness Questionnaire (PAR-Q)

Physical Activity Readiness Questionnaire (PAR-Q)

โปรดตอบคำถามต่อไปนี้

ใช่	ไม่ใช่	คำถาม
		แพทย์ที่ตรวจรักษาเคยบอกหรือไม่ว่าท่านมีความผิดปกติของหัวใจ และควรออกกำลังกายภายใต้คำแนะนำของแพทย์เท่านั้น
		ท่านมีความรู้สึกเจ็บ ปวด หรือแน่นบริเวณหน้าอกขณะที่ออกกำลังกายหรือไม่
		ในเดือนที่ผ่านมา ท่านมีอาการเจ็บหน้าอกขณะที่อยู่เฉยๆ โดยไม่ได้ออกกำลังกายหรือไม่
		ท่านมีอาการสูญเสียการทรงตัว (ยืนหรือเดินเซ) เนื่องจากอาการวิงเวียนศรีษะหรือไม่ หรือท่านเคยเป็นลมหมดสิตหรือไม่
		ท่านมีปัญหากระดูกหรือข้อต่อ ซึ่งจะมีอาการแย่ลงถ้าออกกำลังกายหรือไม่
		แพทย์ที่ตรวจรักษามีการสั่งยารักษาความดันโลหิต หรือความผิดปกติของหัวใจให้ท่านหรือไม่
		เท่าที่ท่านทราบ ยังมีเหตุผลอื่นๆอีกหรือไม่ที่ทำให้ท่านไม่สามารถออกกำลังกายได้

รหัสโครงการวิจัย 117-1/58
วันที่รับรอง 28 ก.ย. 2558
วันหมดอายุ 27 ก.ย. 2559

ข้าพเจ้าขอยืนยันว่าข้อมูลที่ให้นั้นเป็นไปตามความจริงตามที่ข้าพเจ้าทราบทุกประการ

ลงชื่อ _______________ วัน/เดือน/ปี _______________

พยาน _______________ วัน/เดือน/ปี _______________

Appendix G

Subject's Heath Questionnaire

ข้อมูลเกี่ยวกับสุภาพ

ลขที่โครงการวิจัย......117.1/58......
วันที่รับรอง......28 ก.ย. 2553......
วันหมดอายุ......27 ก.ย. 2559......

เพศ: ชาย_____ หญิง _____ อายุ: _______ ปี

วัน เดือน ปีเกิด:_______________ น้ำหนักตัว:_________ ส่วนสูง:_________ BMI:______ รอบเอว:_________

ที่อยู่ปัจจุบัน: ____

____

เบอร์โทรศัพท์: (บ้าน)________________(ที่ทำงาน)_______________(มือถือ)_________________

กรณีฉุกเฉินติดต่อ:_______________ เบอร์โทรศัพท์:______________ ความสัมพันธ์:_____________

ข้อมูลทางการแพทย์

ประวัติครอบครัว

_____ กล้ามเนื้อหัวใจขาดเลือดฉับพลัน
_____ หลอดเลือดหัวใจตีบ
_____ ความดันโลหิตสูง
_____ ไขมันในเลือดสูง
_____ เบาหวาน
_____ หลอดเลือดสมองตีบ
_____ มะเร็ง
_____ กระดูกพรุน
_____ หอบหืด
_____ อ้วน

อื่นๆ โปรดระบุ ____

ประวัติการรักษา

_____ ผ่าตัดเส้นเลือดหัวใจเปลี่ยนลิ้นหัวใจ
_____ ขยายหลอดเลือดหัวใจ
_____ โรคหัวใจ
_____ โรคปอด
_____ หอบหืด
_____ หลอดเลือดสมอง
_____ เบาหวาน
_____ โรคข้ออักเสบ
_____ ภูมิแพ้
_____ อื่นๆ ______________

อาการที่เป็นอยู่ปัจจุบัน

_____ แน่น เจ็บหน้าอก
_____ ซึมเศร้า
_____ เวียนศรีษะ หน้ามืด
_____ อ่อนเพลีย
_____ ใจสั่น
_____ เสียการทรงตัว
_____ หายใจติดขัด
_____ ปวดข้อ ปวดหลัง
_____ อื่นๆ ______________

คุณเคยผ่าตัดหรือป่วยถึงขั้นเข้าโรงพยาบาลหรือไม่: เคย (ยกเว้นคลอดบุตร)____ ไม่เคย____

ปี	อาการ/โรคที่เข้ารับการรักษา	ผลการรักษา
____________	______________________________	________________
____________	______________________________	________________

การออกกำลังกาย

คุณออกกำลังกายบ่อยแค่ไหน _____ ครั้งต่อสัปดาห์ คุณออกกำลังกายนานแค่ไหนต่อครั้ง _____ นาที

_____ ออกกำลังกายเป็นประจำด้วยตนเอง _____ ออกกำลังกายในฟิตเนส

_____ เข้าร่วมกิจกรรมออกกำลังกายต่างๆ เช่น เต้นแอโรบิก โยคะ เป็นต้น

คุณคิดว่าสุขภาพของคุณเป็นอย่างไรในขณะนี้

_____ ดีมาก _____ ดี _____ พอใช้ _____ ต้องปรับปรุง

ข้าพเจ้าขอยืนยันว่าข้อมูลที่ให้ไปนั้นเป็นไปตามความจริงตามที่ข้าพเจ้าทราบทุกประการ

_________________________ _________________________

ลงชื่อ วัน/เดือน/ปี

_________________________ _________________________

พยาน วัน/เดือน/ปี

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

Appendix H

Recruitment Flyer

ขอเชิญชวนประชาชนผู้ที่มีน้ำหนักตัวเกินและอ้วน

เข้าร่วมโครงการ

ผลของความเร็วและรูปแบบในการเดินที่มีต่อความสามารถ

ในการใช้ออกซิเจนและปัจจัยเสี่ยงของโรคหลอดเลือดหัวใจ

ในวัยกลางคนที่มีน้ำหนักตัวเกินและอ้วน

ผู้ที่เข้าร่วมต้องมีเกณฑ์ดังต่อไปนี้

1. **เพศชาย และ หญิง ที่มีอายุระหว่าง 40 – 60 ปี**
2. **ออกกำลังกายน้อยกว่า 2 วัน/สัปดาห์**
3. **มีปัจจัยเสี่ยงต่อโรคหลอดเลือดหัวใจ เช่น** ***ความดันโลหิตสูง น้ำตาลในเลือดสูง ไขมันในเลือดสูง รอบเอวเกิน หรือ ไฮเซนซิทิฟวิที ซี รีแอคทิฟว โปรตีนสูง***
4. **ไม่มีโรคประจำตัวที่เป็นอุปสรรคต่อการออกกำลังกาย**
5. **เปิดรับสมัครตั้งแต่ 1 ตุลาคม 2558 ถึง 30 พฤศจิกายน 2558**
6. ***มีค่าเดินทางให้ 400 บาท***

เลขที่โครงการวิจัย 117.1/58

วันที่รับรอง 28 ก.ย. 2558

วันหมดอายุ 27 ก.ย. 2559

ผู้ที่สนใจกรุณาติดต่อ

ผศ. สิทธา พงษ์พิบูลย์ โทร. 081-820-5174

VITA

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Bachelor of Science in Exercise Science

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Certifications and Trainings:

-Laboratory Practice in Cardiopulmonary Exercise Testing (CPET) at Harbor-UCLA Medical Center.

-Cardiorespiratory Diagnostics Seminar held by MGC Diagnostics at Las Vegas, Nevada

-Cardiopulmonary Exercise Testing (CPET) training at Harbor-UCLA Medical Center.

-Clinical Exercise Physiologist certified by the American College of Sports Medicine (ACSM).

-Electrocardiography (ECG) Arrhythmia training/certified by University of Pittsburgh Medical Center (UPMC).

-Advance Cardiac Life Support (ACLS) training/certified by American Heart Association (AHA).

-Cardio-Pulmonary Resuscitation and Emergency First Aid for Professional Rescuer by American Red Cross.

-Health/Fitness Instructor Workshop (ACSM) held at the University of Pittsburgh.

-Automated External Defibrillator (AED) and Emergency Management, AHA.

-Institutional Review Broad for Human Subject Research training certification, UPMC.