

**DOES SPORTS BRA LIMIT METABOLIC PROFILES DURING
CONSTANT SPEED RUNNING?**

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ABSTRACT

The objective of this study was to investigate whether or not sports bras distress the metabolism during jogging. Fifteen healthy female subjects participated in three exercise trials of no bra (NB), casual bra (CB), and sports bra (SB) conditions. Exercise conditions were exercise conducted on a motor-driven treadmill at 4 mph, 0% grade, and up to 80% of age-predicted maximum heart rate with randomized bra conditions. Anthropometric data and maximum oxygen consumption were determined under the CB condition. The results revealed that there were no changes in metabolic profiles of SB at rest and during exercise when compared with that of CB and NB conditions. With the exception of respiratory exchange ratio (RER), all groups exhibited similar changing patterns of rate of oxygen consumption ($\dot{V}O_2$), rate of carbon dioxide production ($\dot{V}CO_2$) and energy expenditure (EE), which related to the intensity of exercise, and these changes declined during the recovery period. Between-group comparisons showed no significant differences of metabolic variables among NB, CB, and SB. However, while NB had immediate recovery, SB recovery was delayed for 1-2 min and CB was further delayed for 3 min. In addition, this study demonstrated the critical roles of the glycolytic pathway as a main energy substrate. In conclusion, sports bras do not limit metabolic profiles at rest and during exercise but may delay some recovery processes.

KEY WORDS: ENERGY EXPENDITURE/ EXERCISE/ BRASSIERE

60 pages

การใส่ชุดชั้นในกีฬามีผลต่อการเผาผลาญพลังงานของร่างกายระหว่างการวิ่งที่ความเร็วคงที่หรือไม่
DOES SPORTS BRA LIMIT METABOLIC PROFILES DURING CONSTANT SPEED RUNNING?

ธนาชัย สหัสโชคิ 5536652 SPSS/M

วท.ม. (วิทยาศาสตร์การกีฬา)

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บทคัดย่อ

เพื่อศึกษาผลกระทบของการใส่เสื้อชั้นในกีฬาที่มีต่อระบบเผาผลาญพลังงานของร่างกายขณะวิ่งในการศึกษานี้ใช้อาสาสมัครเพศหญิงที่มีสุขภาพดีจำนวน 15 คน ทำการทดสอบคนละ 3 ครั้ง โดยการสุ่มลำดับ (NB = ไม่สวมใส่เสื้อชั้นใน, CB = สวมเสื้อชั้นในปกติ, SB = สวมเสื้อชั้นในกีฬา) ซึ่งการทดสอบแต่ละครั้งจะห่างกันอย่างน้อย 1 สัปดาห์ ในการทดสอบจะให้ผู้เข้าร่วมการทดสอบทำการวิ่งบนลู่วิ่งกลที่ความเร็ว 4 ไมล์ต่อชั่วโมงจนกระทั่งถึง 80% ของอัตราการเต้นของหัวใจสูงสุด จากผลการศึกษาไม่พบความแตกต่างของระบบเผาผลาญพลังงานของร่างกายในกลุ่มที่สวมใส่เสื้อชั้นในกีฬาเมื่อเทียบกับกลุ่มที่สวมใส่เสื้อชั้นในปกติและกลุ่มที่ไม่สวมใส่เสื้อชั้นใน โดยทั้งสามกลุ่มแสดงให้เห็นถึงการเปลี่ยนแปลงในลักษณะเดียวกันของอัตราการใช้ออกซิเจน ($\dot{V}O_2$), อัตราการผลิตคาร์บอนไดออกไซด์ ($\dot{V}CO_2$) และการใช้พลังงาน (EE) ซึ่งเกิดขึ้นจากความหนักของการออกกำลังกาย และจะลดลงในช่วงการฟื้นฟูสภาพ ยกเว้นอัตราส่วนระหว่างปริมาณการผลิตคาร์บอนไดออกไซด์กับปริมาณการใช้ออกซิเจน (RER) เมื่อเปรียบเทียบระหว่างกลุ่ม ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติของตัวแปรทางระบบเผาผลาญพลังงานดังกล่าวทั้งในขณะพัก, ระหว่างและหลังออกกำลังกาย เมื่อเปรียบเทียบภายในกลุ่มพบว่า กลุ่มที่ไม่สวมใส่เสื้อชั้นในกีฬาสามารถฟื้นฟูสภาพได้ทันทีหลังจากออกกำลังกาย ในขณะที่กลุ่มที่สวมใส่เสื้อชั้นในกีฬาจะมีระยะเวลาการฟื้นฟูสภาพหลังออกกำลังกายล่าช้ากว่าประมาณ 1-2 นาที และกลุ่มที่สวมใส่เสื้อชั้นในปกติจะมีระยะเวลาการฟื้นฟูสภาพหลังออกกำลังกายล่าช้ากว่าประมาณ 3 นาที อย่างไรก็ตามการศึกษานี้แสดงให้เห็นถึงบทบาทที่สำคัญของกระบวนการสลายไกลโคเจนเพื่อนำมาใช้เป็นพลังงานหลัก กล่าวโดยสรุป การสวมใส่เสื้อชั้นในกีฬาไม่มีผลจำกัดการทำงานของระบบเผาผลาญพลังงานของร่างกายในขณะพักและระหว่างออกกำลังกาย แต่อาจมีผลทำให้กระบวนการฟื้นฟูสภาพบางอย่างหลังออกกำลังกายล่าช้าลงได้

60 หน้า

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CHAPTER I

INTRODUCTION

Sports and physical activities become popular for people throughout the world for the benefits of prevention and health promotion. It was suggested that the benefits are directly for improvement on body function and metabolism (ACSM, 2010). Benefits of exercise or physical activity on disease prevention include the reduction in risks of heart disease and diabetes (Abby King, 2003; Scott K. et al, 2009), decrease anxiety, depressive symptoms, improve the quality of life (King et al, 1993), and endurance exercise increases bone density in women (Blumenthal et al, 1989). As numbers of female participation in sports and physical exercise increase dramatically in Thailand where women at the age group between 15-59 years show the rate of 6.6 % increasing in exercise activities from 2004–2011. It was also found that walking and running are the popular activities among females (The National Statistical Office of Thailand, 2011). Despite the above benefits, exercise should be correctly done for injury prevention. Differences in gender come to consideration of investigations, particularly with breast injury.

Differences in human anatomy and physiology are important factors being considered during exercise between genders. Physiologically, females have heart size, heart volume, chest size and lung size smaller than males. On the anatomic differences, females have shorter limb lengths than males but have greater % body fat than males (Yurko-Griffin et al, 1999). It is obvious that female has breast bulge out over a male. Structure of woman's breasts contains mainly adipose tissue and suspended deep fascia, subcutaneous fat and skin. In the breast the subcutaneous fat layer is crossed by thin ligaments called the suspensory ligaments or Cooper's ligaments that run oblique from the skin to the deep pectoral fascia (Azar et al, 2001) and divides breast into lobules. Gefen & Dilomoney (2007) assumed that cooper's ligament are used to support female's breast by sharing tension load and transferring load to dorsal skin while pectoral fascia provides support to shear and ribs support compression. As name was implied, it was

long time misunderstand that Cooper's ligament might has high strength because "ligament" means the tissue that hold between bones and very strong. In fact, Cooper's ligament is the soft tissue that is arranged as a three-dimensional around the breast (Simonetti F. et al 2009). So Cooper's ligament may not sufficient to support if the breasts are excessively moved. It was evidenced that types of exercise such as running or jogging with bare breast can cause excessive breast motion (Mason et al, 1999), which resulting in Cooper's ligament jerked violently (Gefen & Dilomoney, 2007). In accordance to gravitational force (G), Mason et al found vertical accelerations of breast about 2.5–3 G when women exercise. Furthermore, Scurr et al (2010) also found that breast velocity and breast displacement were correlated with later breast discomfort. Appropriate breast support can reduce breast velocity and displacement (McGhee et al, 2007; Scurr et al, 2010). So females are usually encouraged to wear external support in the form of a bra to reduce breast motion during exercise, which more or less induces breast discomfort (Bowles et al, 2005; Mason et al, 1999).

Previous studies show that woman's bra helps to support, reduce excessive breast movement and breast discomfort during exercise (Mason et al, 1999; Starr et al, 2005). It was found that breast vertical movement of women who wear a normal or sports bra while exercise are decreased when compare with no bra (Haake & Scurr, 2010). This result is corresponded to the finding of Mason et al (1999). Previous studies show that sports bra reduces breast motion and exercise-induced breast discomfort (Haake & Scurr, 2010; Mason et al, 1999; Starr et al, 2005; White et al, 2009). Despite the benefits of sports bras, only 13% of adolescent females (McGhee et al, 2010) and 41% of adult females (Bowles et al, 2008) participate with physical activity. Also, wearing a sports bra that was strapped to the chest caused breast discomfort, furrow, breast pain. Additionally, respiratory limitations (Bowles et al, 2008) may be one reason that related with wearing sports bra for women.

Negative results for sports bras included restriction of chest motion and cause affect to respiratory function. K. Bowles et al suggested that normal bra might have negative impact on the respiratory function in smaller breast females during exercise because they found significantly reduction in expiratory reserved volume (ERV) during the normal bra trial. It was also indicated that smaller breast subjects was associated with not significant increases in inspiratory volumes and capacities (Bowles

et al, 2005). In addition, using bra's strapping showed negative effect on respiratory function, restriction of chest expansion, which reduce total lung capacity and it also increase respiratory frequency and result in decreased tidal volume (Caro et al, 1960). Moreover, O'Donnell et al have also reported significant decrease in resting lung volumes and exercise performance during exercise when compared with no chest strapping (O'Donnell et al, 2000). However, most research reported effects of bra on respiratory function. The researcher believes that limitation of chest motion may affect body's metabolism, for example rate of oxygen consumption ($\dot{V}O_2$), rate of carbon dioxide production ($\dot{V}CO_2$) and respiratory exchange ratio (RER). Therefore the aim of this study is to determine the effect of sports bra on the metabolic profiles during constant speed running in active female compare with normal bra.

Hypothesis

Sports bra may alter metabolic profiles during running.

Objectives

1. To explore the effect of sports bra on the metabolic profiles at rest, during running and recovery.
2. To compare metabolic profiles between casual and sports bras.

CHARTER II

LITERATURE REVIEW

2.1 Trend of Exercise

Good health is important. To have good health, then one way is participants in physical activities or exercise. There are numerous health benefits of physical activity and exercise. The benefits of regular physical activity and exercise such as increase bone mass, reduce risk of diabetes and heart disease, and improved psychological well-being.(Scott et al, 2009) From this reason, Nowadays people are interest to participant in exercises more. In Thailand, The National Statistical Office of Thailand reports numbers of women participated in exercise and physical activity have raised 6.6 % from 2004 - 2011(The National Statistical Office of Thailand, 2011). And in Northern Ireland, the numbers of sports participation were increase from 30% in 2001 to 44% in 2010/11 in men and increase from 26% to 35% in women (Weissberg, 2012).

2.1.1 Benefit of regular physical activity and exercise

In a survey of 6,928 adults from California, found a relationship of individual health practices and health and also to mortality statistics. The health practices surveyed have 7 items such as smoking, hours of sleep and physical activity. It was found that the average life expectancy of women who reported 6 - 7 good practices was more than 7 years greater than that women who reporting fewer than four. For men, the difference in life expectancy was 11 years (Herbert et al, 1994).

Data from the Harvard Alumni indicated that men who engaged in physical activity (recreational activities, sports play, stair climbing and walking), which resulted in the expenditure of greater than 2,000 kcal per week from 35-80 years of age, had a life expectancy that was 1.5 years greater than men who had been less active(less than 2,000 kcal per week)(Herbert et al, 1994).

Regular exercise can improve muscle tone, level of body fat, energy levels and ability to perform everyday tasks. It also reduces blood pressure, resting heart rate and increases bone strength by weight-bearing and high impact activities (Miles, 2007).

2.1.2 Risks associated with physical activity and exercise

Although exercise can make several benefits. However, people should not overlook the risk that can occur from physical activity and exercise. In general, the benefits of regular physical activity far outweigh risks to the heart and lungs. However, heart problem such as arrhythmias, sudden cardiac arrest, and heart attack often occur in people who have heart conditions(National Institutes of Health. Risks of Physical, 2014). Sudden cardiac death often occur during vigorous physical activity or exercise. In adults, risk of sudden cardiac death is higher than in younger individuals. Moreover, the study about sudden cardiac risk during vigorous physical activity or exercise has been estimated the risk of 0.3 to 2.7 events per 10,000 person-hours for men and 0.6 to 6.0 events for women(ACSM, 2010).

In addition to patients with heart problem, people with normal heart conditions should extremely beware vigorous exercise such as extreme and contact sports. Especially in women, excessive breast movement from exercise is the important factor that should be considered. Mason et al found women that walking with a bare breast caused vertical accelerations about 1.7 g when they set walking speed at 7 km/h(assume to a power walking experience of women). and women that running/jogging/aerobics with a bare breast caused vertical accelerations about 2.5–3 g (Mason et al, 1999). Excessive breast movement may risk of breast cancer.

2.2 Breast Anatomy

The women's breast sit over the pectoralis major and cover a large part of the chest wall. In front, the breast tissue may extend from the clavicle to the middle of the sternum. On the side, breast tissue may continue into the axilla (armpit) and reach as far as the latissimus dorsi. Structure of breast are contented of different tissue layers. However, fat and glandular tissue are the predominant tissue that support lactation.

The weight and dimensions of the breast can vary substantially between individuals. Some women have less glandular tissue in their breasts and some have more, and also, some have more fatty tissue or connective tissue than others, and the ratio of fat to connective tissue content determines the firmness of the breast. Moreover, the size and shape of breast in the same women can vary over time because of the changes during menstrual cycle, pregnancy, after weaning and during menopause.

The mammary gland in forms of cone, base at the chest wall and its apex at the nipple. In adult, the mammary gland have 15-20 irregular lobes that converging to the nipple through ducts 2-4.5 mm in diameter. These ducts are immediately surrounded by dense connective tissue, which acts as a supporting framework. At the menopause, the estrogen levels in women was decrease and the glandular tissue atrophies and eventually disappears because of the glandular tissue is supported by estrogen.

2.2.1 Cooper's ligament

The subcutaneous fat (0.5-2.5 cm) was separated between superficial layer(fascia) and skin. Tentacle-like prolongations of fibrous tissue extend in all directions from this fascia to skin, these were called the suspensory ligaments, or Cooper's ligaments. Misunderstanding, cooper's ligament was not strong tissue like the tissue that hold between bones. In fact, it is the soft tissue that was arranged as a three-dimensional around the breast (Simonetti F. et al 2009). The important function of these ligaments is help to support female's breast by sharing tension load and transferring load to dorsal skin and slightly limit breast motions. However, the Cooper's ligaments can change its fibrous frame with aging and due to the force of gravity and it was jerked violently when excessively breast motion(Gefen & Dilmoney , 2007). Reducing breast motion that occur from force of gravity should be considered. Mason et al found women that wear normal bras and sport bras can reduced the vertical acceleration by 0.2 g and 0.5 g, respectively. Furthermore, when running with normal bras can reduced the vertical acceleration by 0.7 g and sport bras reduced 1.2 g (Mason et al, 1999). So, the excessive breast motions that make loose breast tissue can be reduced by sports bra and normal bra.

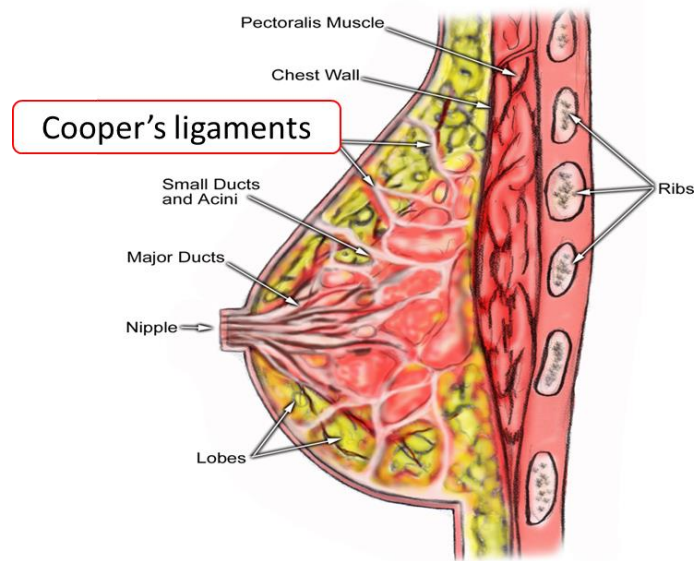


Figure 2.1 Breast anatomy and feature of Cooper's ligaments (Simonett *et al.*, 2009)

2.3 Sports bra

Sports bra is a bra that provides additional support to female breast during exercise. Currently, there are two main designs of sport bras, that are encapsulation bras and compression bras. The surveyed reported found 59% of adult females (Bowles *et al.*, 2008) and 87% of adolescent females (McGhee *et al.*, 2010) were not wearing a sports bra when participated in physical activity. The important reason is that sport bra may strap to the chest to cause breast discomfort, furrow, breast pain and respiratory limitations (Bowles, 2012).

However, sport bras had several advantages in exercise such as reducing excessive breast movement and breast discomfort (Mason *et al.*, 1999; Starr *et al.*, 2005). Mason *et al.* (1999) reported that greater breast supporting and pain reduction when participants wore fit sport bras. Furthermore, previous studies showed that sports bras were better than fashion bras in reducing breast displacement and exercise-induced breast discomfort (Haake & Scurr, 2010; Mason *et al.*, 1999; Starr *et al.*, 2005). Therefore, women should wear sport bra because it has some advantages.



Figure 2.2 Encapsulation (A) and compression (B) sports bras (Starr et al, 2005)

2.3.1 Identify bra size

It is commonly known that the size of bra varies between manufacturers. In fact, bra sizing is remarkably consistent because all manufacturers work to similar. However, size of bra may vary between bra styles, choosing the correct bra size is essential. The common and simple method to identify the bra sizing is divided into two steps. First measurement (Figure 2.3A) is around the back and thorax under the breasts at the level of the inframammary fold (the underband) to determine the band size and second measurement (Figure 2.3B) is around the back and breasts at their most prominent point (the overbust). Both measurements are used to identify cup size by

compared between overbust circumference and underband circumference; the cup size is "A" if they are equal, the cup size is "AA" if the underband is larger than the overbust and the cup size is up to "B C..." if the overbust is larger than the underband every one inch(Greenbaum et al, 2003).

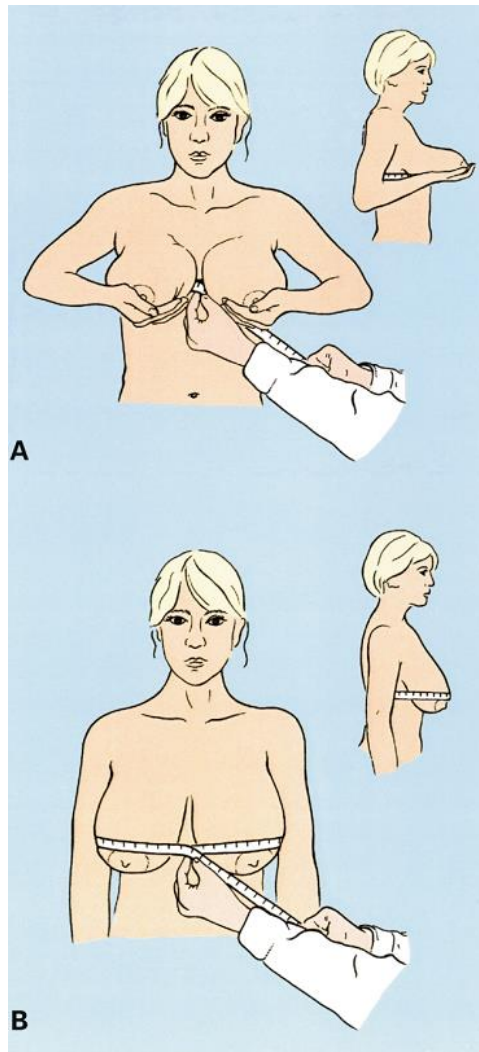


Figure 2.3 Underband (A) and overbust measurement (B)(Greenbaum et al, 2003)

2.4 Metabolic Profile

2.4.1 $\dot{V}O_2$ (oxygen consumption)

Oxygen consumption refers to the amount of oxygen that used by the body. Generally, values are presented as oxygen consumed per minute ($\dot{V}O_2$). The dot over the V(\dot{V}) indicates the rate of O_2 consumption (Kenney et al, 2012). Oxygen consumption is about 0.25 L O_2 /minute at rest. And the increase follow the work intensity rise during exercise.

In the past, Often used "Douglas Bag method" to evaluate oxygen consumption by collecting the exhaled air in large plastic bags and then measuring the volume and content of oxygen and carbon dioxide in the bag. Oxygen consumption can be calculate from the volume of O_2 inspired minus the volume of O_2 expired. The volume of O_2 inspired is equal the volume of air inspired multiply by the fraction of the inspired air that is composed of O_2 and the volume of O_2 expired is equal the volume of air expired multiply by the fraction of the expired air that is composed of O_2 .

$$\dot{V}O_2 = (\dot{V}_I \times F_{IO_2}) - (\dot{V}_E \times F_{EO_2})$$

Where: \dot{V}_I is the volume of inspired air ; \dot{V}_E is the volume of expired air ; F_{IO_2} is the oxygen fraction of the inspired air ; F_{EO_2} is the oxygen fraction of the expired air. F_{IO_2} is know to be 20.94%, and \dot{V}_E and F_{EO_2} are measured in the bag. \dot{V}_I can be assumed that equal to \dot{V}_E .

Alternatively, \dot{V}_I can be calculate :

$$\dot{V}_I = (1 - F_{EO_2} - F_{ECO_2}) \times \dot{V}_E / (1 - F_{IO_2} - F_{ICO_2})$$

Where: F_{ICO_2} is the carbon dioxide fraction in the inspired air(0.03%) and F_{ECO_2} is the carbon dioxide fraction in the expired air, which is measured (Bangsbo, 2011).

Furthermore, the oxygen consumption can also be estimated as by "Fick Principle". Oxygen consumption($\dot{V}O_2$, L/minute) = Cardiac output(L/minute) x A- $\dot{V}O_2$ difference(LO_2/L blood)

The relationship can calculate oxygen consumption from the cardiac output and the difference between the oxygen in arterial blood(O_2 content in the blood delivered to the tissues) and the oxygen in the venous blood(O_2 content in the blood returned to the tissues) that "Arterio-venous oxygen difference(A- $\dot{V}O_2$ difference)". So, A- $\dot{V}O_2$

difference is represents the amount of O₂ used by the tissue per liter of blood. During exercise, both cardiac output and A- $\dot{V}O_2$ difference are increased cause the raised oxygen consumption (Bangsbo, 2011).

At the present, there are many modern equipments can measure oxygen consumption comfortably, such as Oxygen Mobile, Germany. This modern equipment work by directly analysis the air that the subject exhales through a valve. The air is pumped into the online analysis, which instantly calculates the ventilation rate and the oxygen consumption (Bangsbo, 2011).

2.4.1.1 Oxygen transportation

Cardiovascular system is an important part in the process of oxygen transport to various parts of the body. By heart, blood vessels and blood act as a pump, pathway and gas carrier respectively. Approximately 3-5% oxygen dissolved in blood, while 95-97% combined with a compound in red blood cells that call "Hemoglobin". Hemoglobin, contain with iron(called "heme") and protein(called "globin") can match with 4 molecules of oxygen(Figure 2.4). Oxygen combine with hemoglobin in the blood is called "Oxyhemoglobin(HbO₂)". As following equation:

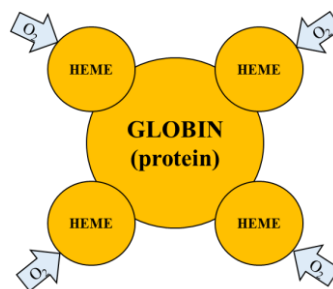
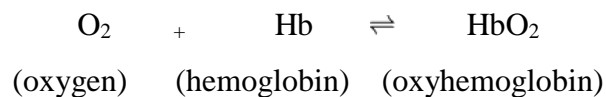


Figure 2.4 Hemoglobin structure

Mathews and Fox indicated that 1 gram hemoglobin was contain approximately 1.34 ml of oxygen. At sea level, male has hemoglobin 15 grams per 100 ml of blood. So in 100 ml of blood, oxygen was about 20.1 ml which was widely called "20.1 volume percent ". In summery, 20.1 volume% mean oxygen capacity of hemoglobin. During exercise, blood circulation was rapidly increase for transfer blood

to working muscle. As a result, hemoglobin concentration was increased from 15 to 16.5 grams or about 10% (Mathews & Fox, 1976).

2.4.1.2 Oxygen saturation of hemoglobin

Percent oxygen saturation of hemoglobin (%SO₂) used to measure the amount of received oxygen and oxygen that dissolved from hemoglobin to another cell. At resting, %SO₂ decreased about 22%, which represents the amount of dissolved oxygen from blood to working muscle was approximately 5 volume%. In addition, %SO₂ decreased to 77% or about 15.4 volume% in vigorous exercise. In conclusion, high intensity exercise, hemoglobin dissolves more oxygen to supported the working muscle requirement (Mathews & Fox, 1976).

2.4.2 $\dot{V}CO_2$ (Carbon dioxide production)

The carbon dioxide production ($\dot{V}CO_2$) can be calculated by using the same principle as that used for oxygen consumption. It maybe reported in mL/min or mL/kg/min. Carbon dioxide that content in the exhaled air is analysed including to determine the volume of air expired per time unit. So, the rate of carbon dioxide production can be calculated from the difference between the carbon dioxide that content in the exhaled and inhaled air:

$$\dot{V}CO_2 = (\dot{V}_E \times F_{ECO_2}) - (\dot{V}_I \times F_{ICO_2})$$

Where: \dot{V}_E is the expiratory volume per unit of time ; \dot{V}_I is the inspiratory volume per unit of time ; F_{ECO_2} is the carbon dioxide fraction of the expired air ; F_{ICO_2} is the carbon dioxide fraction of the inspired air (about 0.03%).

Currently, Carbon dioxide production ($\dot{V}CO_2$) can be measured by the modern equipments same oxygen consumption (Bangsbo, 2011).

2.4.2.1 Carbon dioxide transportation

Carbon dioxide is increasingly produced during exercise. Consequently, the body has to be eliminated or maintain normally carbon dioxide as possible. However, carbon dioxide transportation are more complicate than oxygen transportation. 7% of carbon dioxide dissolved into bloodstream. About 30%, CO₂ bind with hemoglobin become to carbinehemoglobin. Majority about 63%, CO₂ combined with H₂O in blood and converted to carbonic acid (H₂CO₃). However, carbonic acid is unstable, H₂CO₃ immediately dissociate into hydrogen ions (H⁺) and bicarbonate

ions(HCO_3^-). Hydrogen ions(H^+) is associated to change of pH in blood which lower pH indicated that “Acidosis”(Kenny et al, 2012)

2.4.3 BMR (Basal metabolic rate) and RMR

Basal metabolic rate is the amount of energy expended daily by humans to maintain normal physiologic process during rest(measured immediately after at least 8 hour of sleep and at least 12 hour of fasting in a thermoneutral environment). Indirect calorimetry using a mouthpiece to measure respiratory gas exchange is the most comfortably method for measure basal metabolic rate.

There are many factor that affect the change of BMR, including these:

- Fat-free mass : The higher fat-free mass made more total calories expended in a day. So men tend to have a higher BMR than women because mostly men have higher fat-free mass than women.
- Body surface area : The higher surface area made more heat loss occurs from the skin. So BMR was raise because human need more energy to maintain body temperature.
- Age : Increase in age the BMR is gradually decrease because of a decrease in fat-free mass.
- Body temperature : BMR increase with increasing temperature.
- Psychological stress : Activity of the sympathetic nervous system was increased by stress, which increase the BMR.
- Hormones : Increase release of epinephrine from the adrenal medulla can increase the BMR.

However, most researchers measure resting metabolic rate(RMR) instead of BMR. The resting metabolic rate values are closely with BMR values but does not require the stringent standardized condition associated with a true BMR (Kenney et al, 2012). Many researches study about the factors that affect to RMR values. Berke et al found RMR to be higher when elderly subjects had RMR measured using an outpatient protocol(Berke et al, 1992). Schmidt reported a positive correlation in young men between RMR values and values on the trait anxiety scale, so they suggest that RMR values are relate with psychology stress(Schmidt et al, 1996).

There are conflicting data regarding how physical activity affect RMR. Some studies that measure RMR and physical activity within the same timeframe show endurance-trained have higher RMR when compared with sedentary individuals (Burke et al, 1993; Poehlman et al, 1990). But other studies found no difference between endurance-trained and sedentary subjects (Broeder et al, 1992; Lundholm et al, 1986).

Some of the discrepancy in study may be associated with the period after exercise bout in relation to measurement of RMR. Studies that found a higher RMR in exercise-trained subjects tended to measure RMR within 24 hours of these exercise bout, but no difference tended to measure RMR 48-56 hours after the last exercise bout. This suggests that an elevation of RMR in train athletes may reflect the acute perturbations of strenuous exercise, rather than an adaptation to training (Bouchard, 2000).

2.4.4 Respiratory exchange ratio (RER)

Carbohydrates and fats are the primary source of energy during exercise. Both carbohydrates and fats content of oxygen and carbon, but not equal. Indirect calorimetry can be used for estimate the amount of energy use by human body by measure the rate of CO₂ release ($\dot{V}CO_2$) and O₂ consumption ($\dot{V}O_2$). The ratio between the amount of $\dot{V}CO_2$ and $\dot{V}O_2$ is Respiratory exchange ratio (RER).

$$RER = \dot{V}CO_2 / \dot{V}O_2$$

However, the respiratory exchange ratio from the combustion of carbohydrates and fats are difference. For example, glucose (C₆H₁₂O₆) contains six carbon atoms. During glucose combustion, six molecules of oxygen are used to produce six CO₂ molecules, six H₂O molecules, and 32 ATP molecules:



So, the RER from the combustion of glucose is :

$$RER = \dot{V}CO_2 / \dot{V}O_2 = 6CO_2 / 6O_2 = 1.0$$

Free fatty acids have considerably more carbon and hydrogen but less oxygen than glucose. Consider palmitic acid (C₁₆H₃₂O₂) that contains sixteen carbon atoms. During palmitic acid combustion, thirty-two molecules of oxygen are used to produce sixteen CO₂ molecules, sixteen H₂O molecules, and 129 ATP molecules:



So, the RER from the combustion of palmitic acid is :

$$\text{RER} = \dot{V}\text{CO}_2 / \dot{V}\text{O}_2 = 16\text{CO}_2 / 23\text{O}_2 = 0.7$$

Once the RER values is determined from the calculated respiratory gas volumes, the values can be compared with a table (Table 2.1) to determine the food mixture being oxidized (Kenney et al, 2012).

Table 2.1 Respiratory Exchange ratio (RER) as a function energy derived from various fuel mixture(Kenney et al, 2012)

% KCAL FROM			
Carbohydrates	Fats	RER	Energy (kcal/L O2)
0	100	0.71	4.69
16	84	0.75	4.74
33	67	0.8	4.8
51	49	0.85	4.86
68	32	0.9	4.92
84	16	0.95	4.99
100	0	1	5.05

The respiratory exchange ratio can be used as an indicator that the participants are nearing exhaustion and the limits of their cardio-respiratory system. The RER greater than 1.1 is often used as a secondary endpoint criteria of a VO₂ Max Test.

In conclusion, the RER value of 0.70 indicates that fat is the predominant fuel source, RER of 0.85 suggests a mix of fat and carbohydrates, and a value of 1.00 or above is indicative of carbohydrate being the predominant fuel source(Kenney et al, 2012).

2.5 Measuring Energy Expenditure

2.5.1 Direct Calorimetry

One way to estimate the rate and quantity of energy production is to measure the body's heat production. During the metabolism of glucose and fats, 40% of the energy used to produce ATP and remaining 60% is converted the heat. So, the technique that measure the body's heat production is called direct calorimetry and the basic unit of heat is the calorie (cal). In the late 1800s, Zuntz and Hagemann have developed the room calorimetry(chamber) , which consists of an insulated, airtight chamber. The walls of the chamber contain copper tubing through which water is circulate. In the chamber, the heat produced by the body radiates to the walls and warms the water. The water temperature change is recorded, as are temperature changes of the air entering and leaving the chamber. These changes are caused by the heat the body generates. One's metabolism can be calculated from the resulting values.

However, although a calorimeter can provide an accurate measure of total-body energy expenditure over time, but this method is expensive to construct, to operate, slow to generate results and cannot follow rapid changes in energy expenditure. Therefore, while direct calorimetry is useful for measuring resting metabolism and energy expended during prolonged, steady-state aerobic exercise, energy metabolism during more typical exercise situations cannot be adequately studied with a direct calorimetry. Moreover, this method has severally weakness such as not all heat is released from the body; some is stored and cause body temperature to rise, exercise equipment such as a motor-driven treadmill gives off its own heat that must be accounted for in the calculations, sweating affects the measurements and the constants used in the calculations of heat produced. Consequently, this method is seldom used today because evaluation the energy expenditure by measuring the exchange of oxygen and carbon dioxide is easier and less expensive (Kenney et al, 2012).

2.5.2 Indirect Calorimetry

Energy expenditure can be determined by measuring respiratory gases. Because of the rate of O₂ and CO₂ exchanged in the lungs normally equals the rate of their usage and release by the body tissues. Therefore, This method of estimating total-

body energy expenditure is called “indirect calorimetry” because heat production is not measured directly. On the contrary, energy expenditure is calculated from the respiratory exchange of O₂ and CO₂.

Respiratory gas exchange is determined through measurement of the volume of O₂ and CO₂ that enters and leaves the lungs during a given period of time. Because O₂ is removed from the inspired air in the alveoli and CO₂ is added to the alveolar air, the expired O₂ concentration is less than the inspired, whereas the CO₂ concentration is higher in expired air than inspired air. Consequently, the differences in the concentrations of these gases between the inspired air can tell that how much O₂ is being taken up and how much CO₂ is being produced by the body. Because the body has only limited O₂ storage, the amount taken up at the lungs accurately reflects the body’s use of O₂.

Although, measuring the respiratory exchanges of O₂ and CO₂ is an expensive method but they offer a large time saving and multiple measurements. Unlike the simplest and oldest methods (i.e., Douglas bag and chemical analysis of collected gas sample) are relatively slow and permit only a few measurements during each session (Kenney et al, 2012).

2.5.3 Calculate energy expenditure

In this study, energy expenditure (EE) expressed in unit of kilo calories per minute (kcal/min). Weir's equation ($EE = (3.49 \times \dot{V}O_2) + (1.1 \times \dot{V}CO_2)$) was used to calculate EE values from oxygen consumption ($\dot{V}O_2$) and carbon dioxide production ($\dot{V}CO_2$) which derived from oxycon mobile analysis (Weir, 1949).

2.5.4 Oxycon Mobile

More than two centuries, the scientists were interest about measuring oxygen uptake ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$) and ventilation (\dot{V}_E) within a wide spectrum of physical activities and conditions in humans (Mitchell & Saltin, 2003). In the late 1800s, Nathan Zuntz (The German physiologist) had developed a mobile device for measure this purpose (Tipton, 2006).

The Douglas bag method (DBM) by Douglas (1911), a stable basis for measurements during physical exercise was considered to be the gold standard

(Macfarlane, 2001). However, this method has limitations such as it is movement confining, can impose additional airway resistance and limitations in sampling duration and measurement resolution. These drawbacks and technological progress have been major incentives for developing a wide range of portable metabolic gas analysis systems over the past 40 years (Macfarlane, 2001; Meyer et al, 2005).

In the present, shown that the Oxycon Mobile (OM), is a device that can accurately measure $\dot{V}O_2$ over a wide range of values (Rosdahl et al, 2010).

This study used the Oxycon Mobile by JAEGGER™ that was developed in cooperation with top triathletes and sports researchers. These device was compact and lightweight design, the unit which is comprised of a belt, a mask and batteries. Oxycon mobile can transmits the data to a Notebook Computer which can be up to 1000 meters away. So, it had ease of handling and freedom of movement.

2.6 Energy used during exercise

Carbohydrate(CHO) and Lipid are mainly energy substrate during exercise. Human's body used the energy from any source depends on two important factors: duration and intensity(Figure 2.5). Previous study showed that lipid cannot usually support to the main energy source at exercise intensity greater than 50-60% of maximal oxygen uptake(Davies et al, 1979) and the major substrate for oxidative metabolism in this exercise intensity was CHO(Romijn et al, 1993; Van Loon et al, 2001). CHO is stored as glycogen in liver and muscle cell and stored as glucose in bloodstream of human's body. Glycogen are converted into glucose through glycogenolysis pathway and then converted to energy through glycolysis pathway(Hargreaves et al, 2006). Muscle glycogen are mostly used for energy during exercise. As exercise continues, muscle glycogen depletion can be occurred(Davies et al, 1979). Nevertheless, muscle cells can obtain glucose by absorbing it from the bloodstream. In addition, maintain of blood glucose levels by glucogenolysis in the liver(Kraemer et al, 2012).

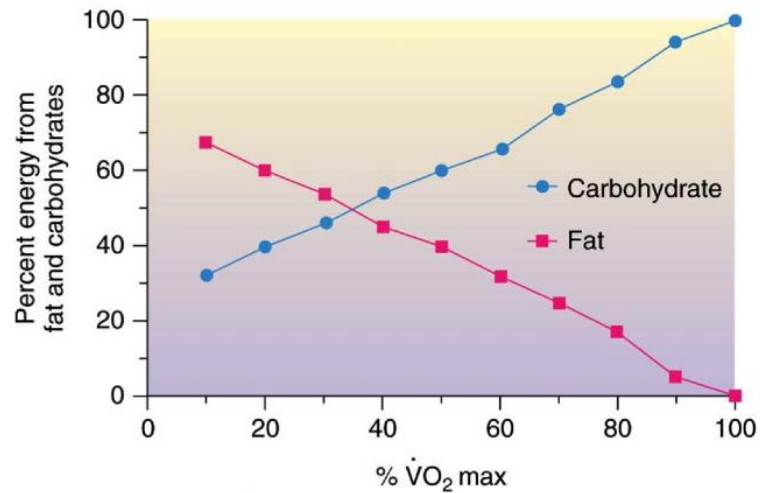


Figure 2.5 Percentage of energy from carbohydrate and fat at different exercise intensities. As the exercise intensity (expressed as a percentage of maximal oxygen consumption) increase, the percentage of energy obtained from fat decrease and that from carbohydrate increases (Kraemer et al, 2012)

2.7. Metabolic equivalent

Metabolic equivalent (MET) is the rate of oxygen which the body consume during exercise and associated with body weight. At rest, it is assumed that body uses approximately 3.5 ml/kg/min or equal to 1.0 MET. Moreover, metabolic equivalent is relate with human energy expenditure. One liter of oxygen is equal to 5 kcal (5 kcal/L or 0.005 kcal/ml) and corresponds to 0.0175 kcal/kg/min which is calculated from 0.005 kcal/ml multiply with 3.5 ml/kg/min. Therefore, in a woman who has 57 kilograms of body weight, a rate of energy expenditure at resting (1.0 MET) is 1.0 kcal/min (57 kg x 0.0175 kcal/kg/min) (McAuley, 2012)

MET system can be indicated the level of all activities according to their oxygen demand. For example, 2.0 MET have oxygen requirements approximately 7 ml/kg/min (3.5 ml/kg/min x 2 times) which nearby oxygen use of watering plants or showering or cooking activities (Fletcher, 2001; Kenny et al, 2012).

Table 2.2 Selected Activities and Their Respective MET Values (Ainsworth et al, 2011)

Activity	MET Value
REST AND SELF-CARE ACTIVITIES	
Rest (supine)	1.0
Sitting, Eating, Bathing	1.5
Showering	2.0
Dressing or undressing, standing	2.5
HOME ACTIVITIES	
washing dishes, ironing	1.8
Cooking or food preparation	2.0-3.5
Cleaning (washing car)	3.5
Scrubbing floor on hands and knees	6.5
OCCUPATIONAL	
Driving a delivery truck, taxi, school bus	2.0
Hotel housekeeper	4.0
Farming, light to vigorous effort	2.0-7.8
Fire fighter on the job	6.8-9.0

2.8. $\dot{V}O_{2peak}$ Testing

Peak oxygen consumption is the maximum rate of oxygen consumption that human use in 1 minute as measured during incremental exercise. $\dot{V}O_{2peak}$ reflects the aerobic physical fitness of the individual, and is an important determinant of their endurance capacity during prolonged and often used to compare the performance of endurance sports athletes. However, $\dot{V}O_{2peak}$ generally does not vary linearly with body mass, either among individuals within a species or among species. The units of $\dot{V}O_{2peak}$ is expressed in litres of oxygen per minute (L/min) or millilitres of oxygen per minute per kilogram of body mass (ml/min/kg). (Clemente et al, 2009 and Dlugosz et al, 2013)

$\dot{V}O_{2peak}$ testing in this study was evaluated by using treadmill with gas analyzer (Oxycon mobile device). Then, the rate between O_2 and CO_2 will be analysis

from breathe in and breathe out for counting O₂ used in body per a minute. The subjects must exercise on treadmill by adding the workload follow the Bruce's protocol (Table 2.3) until they could not be examined(Bruce, 1972).

Table 2.3 Bruce's treadmill protocol (Bruce, 1972)

Stage	Minute	% grade	km/h	MPH	METS
1	3	10	2.7	1.7	5
2	6	12	4	2.5	7
3	9	14	5.4	3.4	10
4	12	16	6.7	4.2	13
5	15	18	8	5	15
6	18	20	8.8	5.5	18
7	21	22	9.6	6	20

2.9. Rating of perceived exertion (RPE) scale

Rating of perceived exertion (RPE), was developed by the Swedish psychologist Gunnar Borg(Powers, 2007), is the visual analog scale that used to determined exercise intensity. A given numerical rating corresponds to the perceived relative intensity of exercise. RPE scale is start from 6 to 20 (Borg, 1998)(Table 2.4). However, previous study found the relationship between RPE, maximum heart rate, maximum oxygen consumption and classification of exercise intensity that show in Table 2.5 (Pollock, 1990). RPE value at 12 to 13 is equal to 60-79% of maximum heart rate(HR_{max}) or 50-74% of maximum oxygen consumption($\dot{V}O_{2max}$) or moderate exercise. RPE value at 14 to 16 is equal to 80-89% of maximum heart rate(HR_{max}) or 75-84% of maximum oxygen consumption($\dot{V}O_{2max}$) or heavy exercise.

Table 2.4 Rating of perceived exertion(RPE) scale(Borg, 1998)

Borg's RPE Scale	
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Table 2.5 Classification of exercise intensity based on 20 to 60 min of endurance activity: comparing three methods(Pollock, 1990)

RELATIVE INTENSITY			
Classification of intensity	HR_{max}	VO_{2max}	Rating of perceived exertion
Very light	<35%	<30%	<9
Light	35-59%	30-49%	10-11
Moderate	60-79%	50-74%	12-13
Heavy	80-89%	75-84%	14-16
Very heavy	≥90%	≥85%	>16

2.10. Dyspnea scale

Dyspnea scale (Table 2.6) is widely used in exercise science experimentation to determine “How hard you are breathing”. The dyspnea scale has a scale of 0-10: 0 in scale is “No symptoms” that means “no shortness of breath” and 10 in scale is “Maximal” that means “so much shortness of breath” (Borg, 1982).

Table 2.6 Modified Dyspnea scale (Borg, 1982)

Rating	Intensity of sensation
0	No symptoms
0.5	Very, very slight sensation of symptoms
1	Very Slight
2	Slight
3	Moderate
4	Somewhat Severe
5	Severe
6	
7	Very Severe
8	
9	Very, Very Severe
10	Maximal

CHAPTER III

MATERIALS AND METHODS

3.1 Subjects

To study effects of sports bras on body metabolisms, this study will be run only in those females with cup size B and C. Subjects in this study consisted of 15 healthy single females (age range between 18–30 years), who are students from Mahidol University.

Inclusion criteria: Subject will be included as follows

- Have history and currently exercise regularly for at least 30 min/d, 3 d/wk.
- Have normal range of BMI(between 18.5 – 24.9 kg·m⁻²)
- Free from diseases or syndromes which may limit exercise activity.
- Have quite regular menstruation cycle(Eumenorrhea).
- Have bra cup size B and C
- Have no experience/never used any commercial sports bra at least 6

months prior to the test.

- Never had thoracic or abdominal surgery.
- No hormone replacement therapy.
- No previous or current pregnancies.
- Non-smoking and non-alcoholic.

Exclusion criteria: Subject will be screened out from the test if later found

to

- Cannot exercise at the pre-determined intensity
- Have accident which limits exercise activity
- Absence any experiments
- Use any contraceptive, muscle relaxant, and/ or bronchodilator pills/

medication during the study period

- Pregnant

3.2 Instrumentations

The following equipment were used in this study :

1. Gas O₂ and CO₂ analyzer (Oxycon Mobile, Germany)
2. Ear-clip Heart rate sensor
3. Motor-drive treadmill (Marquette, USA)
4. Signal Morphology-based Impedance Cardiography (PhysioFlow, France)
5. Tape Measurement
6. Casual bras, Sports bras(researcher provide (same type of bra))
7. Sportswear
8. 70% alcohol solution
9. Absorbent cotton
10. Digital weighing scale (AND AD-6201, Japan)
11. Stadiometer
12. Sphygmomanometer (Spirit, Taiwan)
13. Stethoscope (MDF, China)
14. Body composition monitor (Omron, Japan)
15. Rating of perceived exertion (RPE) scale
16. Dyspnea scale
17. Physical activity questionnaires

3.3 Design of this study

This study was designed to investigate the effect of sports bra on metabolic profile in active female during speed exercise compare with casual bra and no bra condition.

3.4 Parameters

1. Absolute oxygen consumption (absolute $\dot{V}O_2$) ($\text{ml}\cdot\text{min}^{-1}$)
2. Relative oxygen consumption (relative $\dot{V}O_2$) ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)
3. Carbon dioxide production ($\dot{V}CO_2$) ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)
4. Respiratory exchange ratio (RER)
5. Energy expenditure (EE) ($\text{kcal}\cdot\text{min}^{-1}$)
6. Rating of perceived exertion (RPE)
7. Dyspnea scale

3.5 Experimental procedures

One week before testing, subjects will fill in the physical activity questionnaires to screen their health and were interviewed about their personal and medical history. Then, they will identify their bra sizes and their physical examinations will be performed. Anthropometric measurements including chest, waist, and hip circumferences, quadriceps and cubitus angle, range of motion of back, hip, knee, and ankle, feet shape (flatfeet), and vertebral column posture (lordosis, kyphosis, and scoliosis) will be measured by physician. All subjects will sign inform consent forms before participate in this study. The peak of oxygen consumption ($\dot{V}O_{2\text{peak}}$) was tested for recruitment of participants in this experiment. In $\dot{V}O_{2\text{peak}}$ testing, subjects must exercise on treadmill by adding the workload follow the Bruce's protocol (Bruce, 1972) until they could not be examined. Subject wear casual bra (usual bra of subject) when testing.

On the day prior to the test, they will be instructed about experiment protocol as follows:

- Consume regular dietary and enough water intake.
- Avoid coffee, tea, tobacco or alcohol 48 hours before test.
- Avoid vigorous or strenuous physical activity 48 hours before test.
- Have sleep at least 8 hours before test.
- Prepare their own sports shoes.

Subjects will be advised to follow the above instructions for 48 hours before testing. They will visit the laboratory on the same time, afternoon, of the day for three

randomized interventions of exercises with no bra (NB), with casual bra (CB), and with sports bra (SB). For privacy, at least two female investigators will conduct the experiment in the confidential section of the laboratory. To standardize testing condition, subjects will be tested in follicular phase of menstrual cycle to avoid the dysmenorrhea symptoms and the hormonal changes effect during menstrual period (Kraemer, 2012; Powers, 2007; Xanne, 2003). When subject arrives at laboratory on testing day, they will rest for 15 minutes and be assessed resting vital signs and anthropometric data. The experiment protocol was approved by Human Research Ethics Committee of Mahidol University

3.5.1 Resting Vital Sign assessment

3.5.1.1 Resting heart rate will be measured by Signal Morphology-based Impedance Cardiography (PhysioFlow, France) while subjects sit quietly on the chair.

3.5.1.2 Blood pressure will be measured by manual blood pressure monitor as Sphygmomanometer (Spirit, Taiwan), Stethoscope (MDF, China).

3.5.2 Anthropometrics and Body mass index

3.5.2.1 Body size

Body weight and height will be measured by Digital weighing apparatus and a height stadiometer respectively.

3.5.2.2 Body composition

Body Mass Index (BMI) will be calculated by body weight and height of each subject. The percentage of body fat mass and fat free mass will be assessed using body composition monitor (OMRON, Japan).

3.5.3 Bras

Bras that used in this study are divided into two types: casual bra (those are usually wore), and the manufactured sports bra. Both two types of bra were previously measured to fit the size of each subject by Thai Wacoal company's criteria.

3.5.4 Running testing protocol

Exercise test using the 4 mph treadmill running testing protocol. The researchers used the intensity of exercise at speed 4 mph to simulate the intensity of exercise as close to the intensity of exercise in the most women.

3.6 Experimental protocol

On the experimental day, subject arrives at The Sports Physiology Laboratory (College of Sports Science and Technology, Mahidol University, Salaya campus). Subject will be measured for anthropometry and vital signs under no bra condition. Subject will be supplied the same types of sportswear over the three experiments (NB, CB, and SB). On the exercise testing, subject will start with callisthenic warm up that including 2 minutes of static stretching and 3 minutes of 2.5 mph walking on treadmill. Next, they will attempt to perform 4 mph treadmill running testing protocol until 80% of age-predicted maximal heart rate and followed by 5 minutes recovery by sitting on the chair. The temperature is 25°C and humidity less than 60%.

Absolute and relative oxygen consumption ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$), respiratory exchange ratio (RER) and energy expenditure (EE) will be collected using computer analysis (Oxycon Mobile, Germany). Heart rate will be collected using Signal Morphology-based Impedance Cardiography (PhysioFlow, France). Subjective evaluations including RPE scales and dyspnea scales will be recorded every 10 minutes between the test. All equipment will be calibrated before each experiment. All parameters will be analysed to compare for each bra conditions at 60%, 70%, and 80% of maximal heart rate. Finally, subject's cool down after finishing all data collection will be performed.

Exercise termination : Participants will stop the test from following conditions:

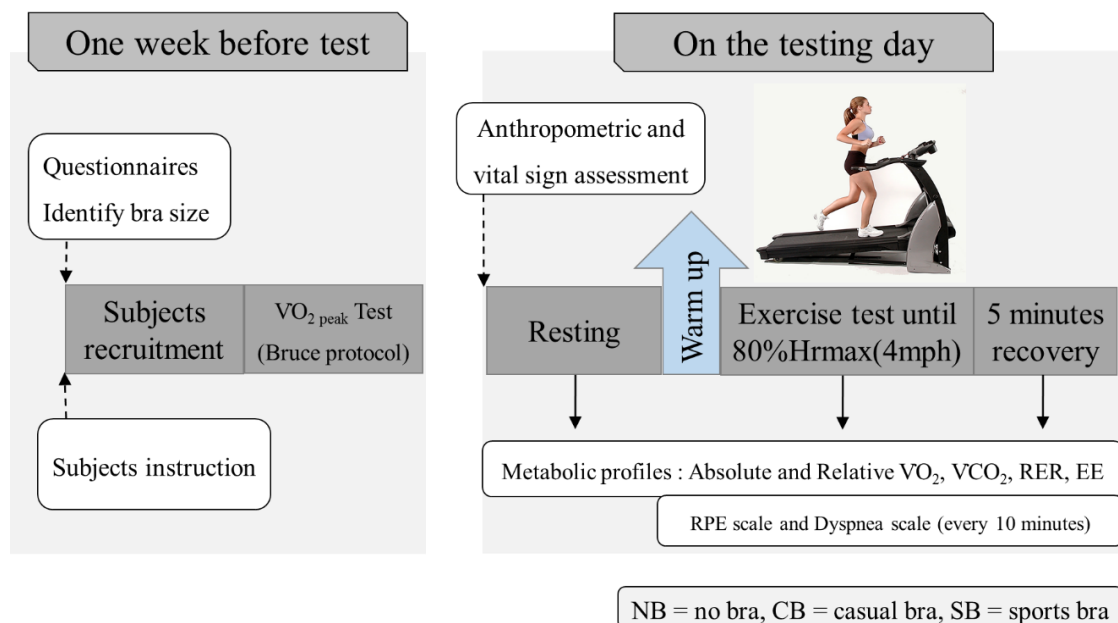
- Volitional termination
- Heart rate reaches age-predicted maximum range
- Drop in systolic blood pressure ≥ 10 mmHg from baseline

- More than 250 mmHg of systolic blood pressure and/or more than 115 mmHg of diastolic blood pressure
- Increasing chest pain
- Shortness of breath, or wheezing
- Fatigue, leg cramps, or cannot sustain pace

3.7 Statistical analysis

All data were presented as mean \pm SEM, otherwise were stated. Normal distribution were tested using the *Kolmogorov–Smirnov test* (K–S test). One-way repeated measurement ANOVA were used to evaluate significant differences analysis. Significance differences were set at $P < 0.05$. If a significant main effect was achieved, Bonferroni’s *post hoc* test were applied to identify the different couple. The statistical tests were performed using a SPSS software program version 16.0.

Figure 3.1 Experimental protocol



CHAPTER IV

RESULTS

The purposes of this study were to investigate the effect of sports bra at rest, during and after exercise on metabolic profiles compared with casual bra. Fifteen volunteers, who met the criteria, and abled to participate for 3 randomized sessions of no bra (NB), casual bra (CB), and sports bra (SB). All conditions were conducted confidentially in a closed room.

4.1 General characteristics of subjects

The general characteristics including weight, BMI, body fat, lean body mass, waist, hip, resting heart rate, resting systolic blood pressure, resting diastolic blood pressure and resting respiratory rate were presented in Table 4.1. All anthropometric and physiological data revealed the normal healthy status of subjects and were considerably in average values of Thai females at this age (Surasak et al, 2000). No significant differences were found for all resting variables among three conditions ($p>0.05$).

4.2 Metabolic profiles rest, during and after exercises

Subjects in the present study performed constant speed running at 4 mph. Oxygen consumption ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$), respiratory exchange ratio (RER) and energy expenditure (EE) were collected and the data were showed at rest, at 60%, 70% and 80% of age-predicted maximal heart rates and at 5 minutes of recovery period. Since data were in narrow ranges, the present study shows between group comparisons using graphs and within group comparisons using a table.

Table 4.1 General characteristics of female subjects in control no bra (NB), casual bra (CB) and sports bra (SB) trials. Values are mean \pm SD (Age(yr.) = 22.80 \pm 2.48)

Variables	NB (n = 15)	CB (n = 15)	SB (n = 15)
Weight (kg)	56.15 \pm 5.87	55.99 \pm 5.67	56.25 \pm 5.37
BMI (kg.m⁻²)	21.79 \pm 1.79	21.73 \pm 1.73	21.83 \pm 1.62
Body fat (%)	23.08 \pm 2.77	22.83 \pm 2.76	22.97 \pm 2.56
Lean body mass (%)	27.89 \pm 1.62	28.18 \pm 1.75	28.04 \pm 1.57
Waist (cm)	74.40 \pm 6.62	75.03 \pm 6.89	73.83 \pm 6.24
Hip (cm)	94.73 \pm 5.16	94.37 \pm 5.37	94.23 \pm 4.69
Resting HR (bpm)	71.02 \pm 8.58	71.69 \pm 9.17	71.93 \pm 9.36
Resting SBP (mmHg)	102.33 \pm 8.55	102.87 \pm 11.62	105.67 \pm 9.07
Resting DBP (mmHg)	62.07 \pm 6.23	63.53 \pm 5.94	65.93 \pm 5.23
Resting RR (times/min)	16.00 \pm 3.74	16.07 \pm 4.61	16.13 \pm 4.07

4.2.1 Oxygen consumption

No significant differences of resting $\dot{V}O_2$, either in absolute (245.60 \pm 13.57, 246.87 \pm 13.15 and 250.53 \pm 22.45 ml/min in NB, CB and SB groups) or relative values (4.41 \pm 0.24, 4.41 \pm 0.25 and 4.48 \pm 0.39 ml/min/kg in NB, CB and SB groups respectively), between NB, CB and SB conditions. As exercise started, all groups showed similarly and abruptly increased from its corresponding resting absolute (Figure 4.1A) and relative (Figure 4.1B) $\dot{V}O_2$ levels to 60% of age-predicted maximal heart rates (MHR). After that patterns of changes in absolute and relative $\dot{V}O_2$ values were gradually increased at 70 and 80% (MHR). No significant differences of $\dot{V}O_2$ during exercise, either in absolute (ml/min) or relative values (ml/min/kg), between NB, CB and SB conditions were detected ($p < 0.05$). Even recovery oxygen consumptions had similar patterns of changes in all groups, however NB showed immediate non-significant difference from its resting value whereas SB showed higher than resting values $\dot{V}O_2$ than its resting values only at 1st, and CB showed higher than resting values $\dot{V}O_2$ than its resting values at 2nd minute ($p > 0.05$).

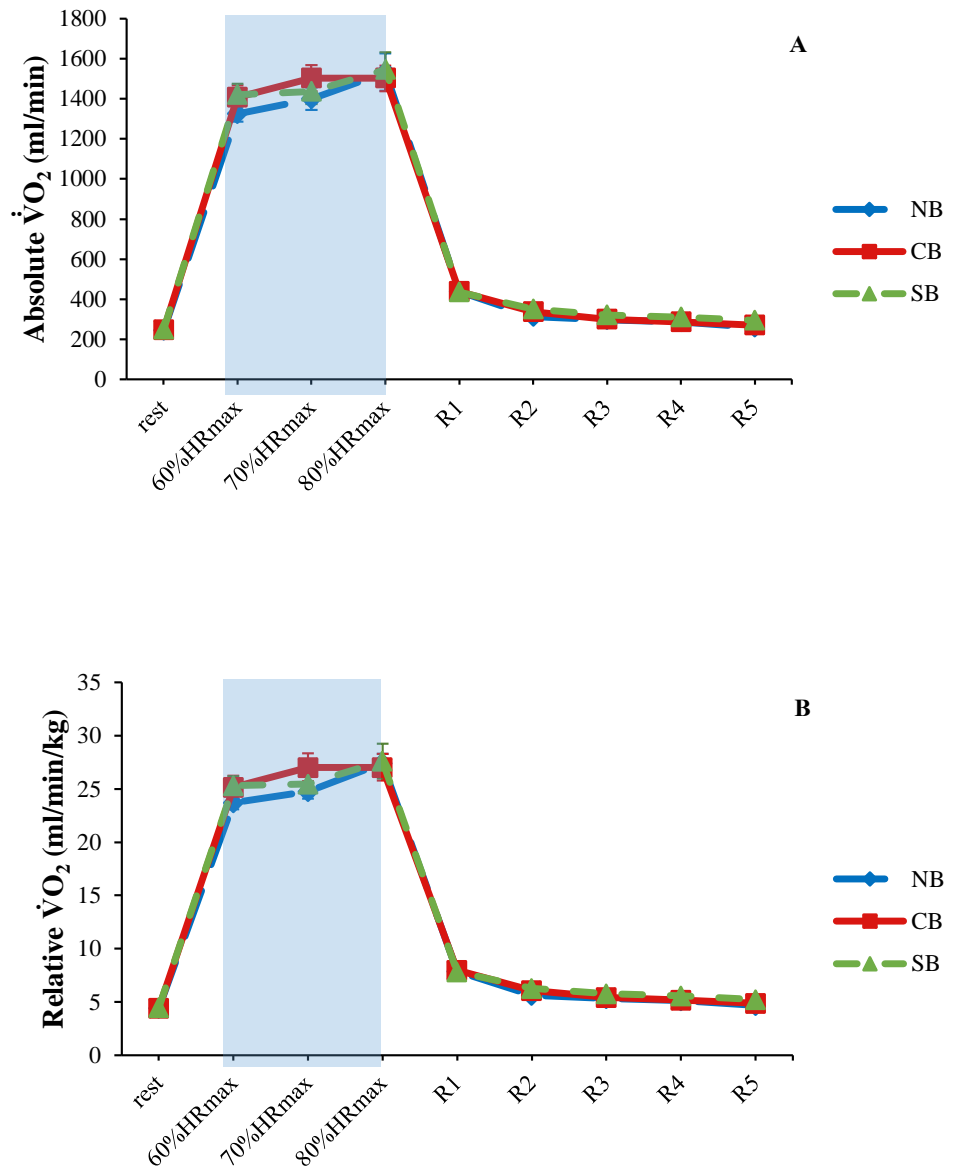


Figure 4.1 Between-groups comparisons of changes in absolute oxygen consumption ($\dot{V}O_2$)(A) and relative oxygen consumption ($\dot{V}O_2$)(B) of subjects at rest, during exercise at 60%, 70% and 80% of age-predicted maximal heart rates (shaded area), and during 5 min. recovery period(R1- R5). Abbreviations: ^a represents significant between NB-CB, ^b significant between NB-SB and ^c significant between CB-SB. All values are compared at ($p < 0.05$)

4.2.2 Carbon dioxide production

Absolute $\dot{V}CO_2$ at rest were 221.40 ± 12.93 , 220.22 ± 14.18 and 217.98 ± 16.09 ml/min in NB, CB and SB groups respectively which showed no significant differences among the groups. As exercise started, carbon dioxide production ($\dot{V}CO_2$), abruptly and significantly increased from corresponding resting values ($p < 0.05$, Figure 4.2) to $1,345.58 \pm 48.06$, $1,412.60 \pm 63.38$ and $1,412.73 \pm 53.65$ ml/min at 60% MHR in NB, CB and SB groups respectively. After that the rates of increasing in $\dot{V}CO_2$ were slow down to 70 and 80% MHR. No significant differences in carbon dioxide production among the groups were found during exercise. At recovery period, $\dot{V}CO_2$ remarkably declined to 313.76 ± 14.69 , 323.92 ± 17.47 and 334.02 ± 14.67 ml/min. Groups of CB and SB showed higher than resting values $\dot{V}CO_2$ than its resting values at 1st, 2nd and 3rd minutes ($p > 0.05$) but $\dot{V}CO_2$ in NB showed no significant difference from its resting value from 1st minutes. No significant differences in carbon dioxide production among the groups were found during recovery period ($p < 0.05$)

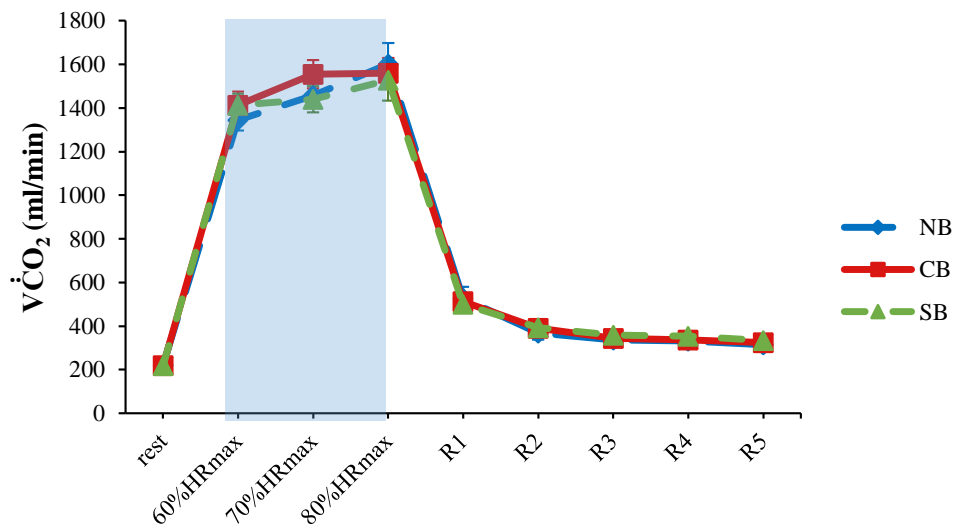


Figure 4.2 Between-groups comparisons of changes in carbon dioxide production ($\dot{V}CO_2$) of subjects at rest, during exercise at 60%, 70% and 80% of age-predicted maximal heart rates (shaded area), and during 5 min. recovery period (R1- R5). Abbreviations: ^a represents significant between NB-CB, ^b significant between NB-SB and ^c significant between CB-SB. All values are compared at ($p < 0.05$).

4.2.3 Respiratory exchange ratio

Respiratory exchange ratio (RER) values at resting were 0.90 ± 0.02 , 0.89 ± 0.02 and 0.88 ± 0.02 in NB, CB and SB respectively with no significant differences between groups. As exercise started, at 60% of age-predicted maximal heart rates, RER values increased abruptly to 1.02 ± 0.02 , 1.01 ± 0.04 and 1.00 ± 0.02 in NB, CB and SB respectively (Figure 4.3). These were gradually declined at 70 and 80% MHR. Patterns of changes in RER during exercise in all groups showed no significant differences. During recovery periods, RER were further increased, from 80% MHR, to 1.19 ± 0.03 , 1.18 ± 0.06 and 1.14 ± 0.04 in NB, CB and SB respectively at 1st minute and nearly constant until 5th minute of recovery.

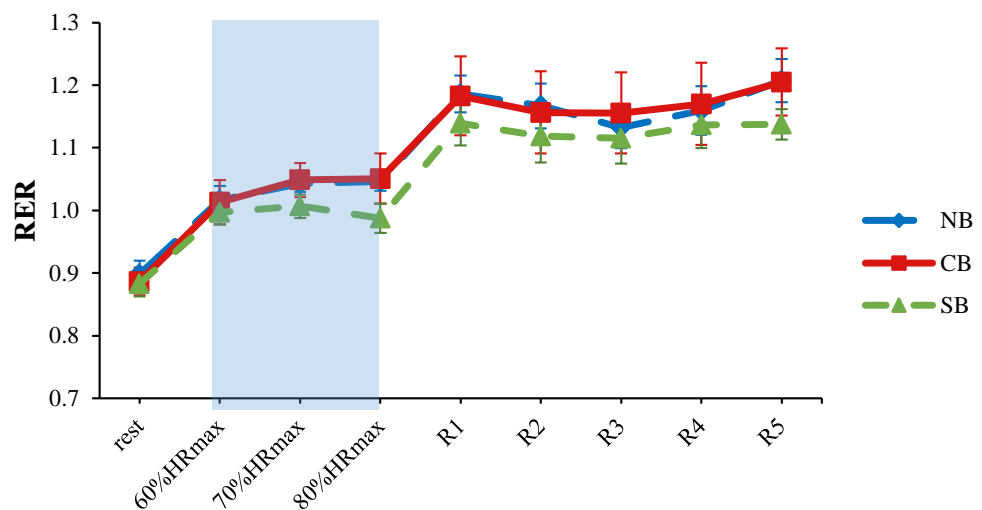


Figure 4.3 Between-groups comparisons of changes in respiratory exchange ratio(RER) of subjects at rest, during exercise at 60%, 70% and 80% of age-predicted maximal heart rates (shaded area), and during 5 min. recovery period(R1- R5). Abbreviations: ^a represents significant between NB-CB, ^b significant between NB-SB and ^c significant between CB-SB. All values are compared at ($p < 0.05$)

4.2.4 Energy expenditure

Resting EE were 1.20 ± 0.07 , 1.21 ± 0.07 and 1.22 ± 0.10 kcal/min in NB, CB and SB respectively with no significant differences between groups. As exercise started, at 60% of MHR, EE values were significantly increased from corresponding resting values ($p < 0.05$) to 6.64 ± 0.19 , 7.04 ± 0.29 and 7.09 ± 0.27 kcal/min in NB, CB and SB respectively (Figure 4.4) and then slow down at 70 and 80% MHR with no significant differences between groups. EE remarkably declined, at 1st minute after exercise, and decreased gradually but no significant differences between groups. EE remained quite high even at 5th minutes of recovery period, 1.36 ± 0.05 , 1.41 ± 0.06 and 1.51 ± 0.06 kcal/min in NB, CB and SB respectively. Recovery EE in NB group showed no significant difference at 1st minute and throughout the study, SB showed higher EE at 1st minute ($p < 0.05$) and CB showed higher EE at 1st to 3rd minute ($p < 0.05$). In addition, this results can be used to estimate the intensity of exercise by using Metabolic equivalent(MET). At resting(1.0 MET) is equal to 1.0 kcal/min. Therefore, at 80% of age-predicted maximal heart rates is equal 7.7 MET.

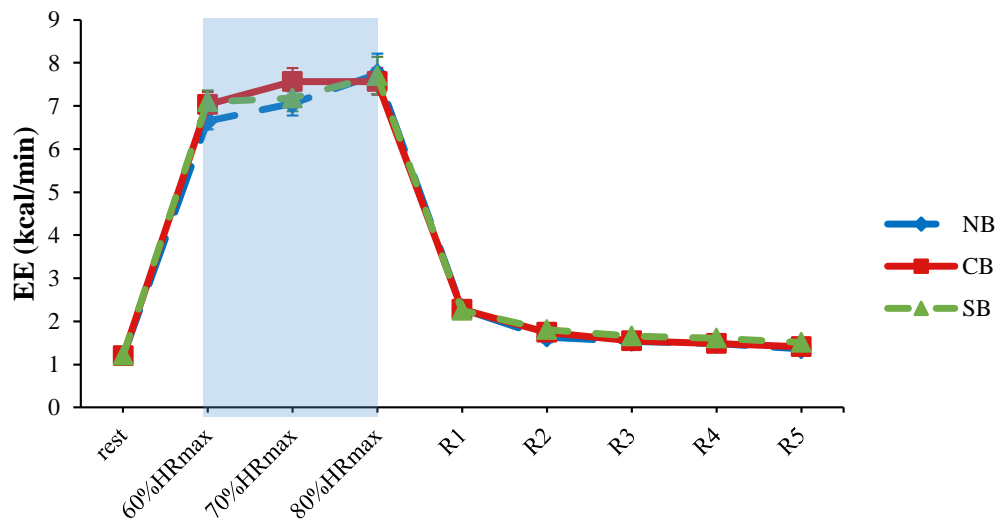


Figure 4.4 Between-groups comparisons of changes in energy expenditure(EE) of subjects at rest, during exercise at 60%, 70% and 80% of age-predicted maximal heart rates (shaded area), and during 5 min. recovery period(R1- R5). Abbreviations: ^a represents significant between NB-CB, ^b significant between NB-SB and ^c significant between CB-SB. All values are compared at ($p < 0.05$)

Table 4.2 Rating of perceived exertion (RPE) scale of female subjects in control no bra (NB), casual bra (CB) and sports bra (SB) trials. Values are mean \pm SEM. No significant differences between no bra (NB), casual bra (CB) and sports bra (SB) groups

Times	NB	CB	SB
start	6.33 \pm 0.21	6.20 \pm 0.11	6.20 \pm 0.11
10min	9.73 \pm 0.58	10.20 \pm 0.59	10.47 \pm 0.70
20min	11.87 \pm 0.77	11.73 \pm 0.75	11.93 \pm 0.72
30min	10.60 \pm 1.29	11.91 \pm 0.97	12.45 \pm 0.94
R1	10.60 \pm 0.62	10.13 \pm 0.70	10.80 \pm 0.45
R2	9.20 \pm 0.56	8.93 \pm 0.64	9.33 \pm 0.55
R3	8.07 \pm 0.47	7.87 \pm 0.50	8.40 \pm 0.51
R4	7.47 \pm 0.46	7.53 \pm 0.42	7.53 \pm 0.42
R5	7.07 \pm 0.41	6.87 \pm 0.27	7.27 \pm 0.37

Table 4.3 Dyspnea scale of female subjects in control no bra (NB), casual bra (CB) and sports bra (SB) trials. Values are mean \pm SEM. No significant differences between no bra (NB), casual bra (CB) and sports bra (SB) groups

Times	NB	CB	SB
start	0.57 \pm 0.23	0.47 \pm 0.16	0.97 \pm 0.33
10min	1.77 \pm 0.33	2.30 \pm 0.36	2.47 \pm 0.52
20min	2.90 \pm 0.53	3.17 \pm 0.46	3.33 \pm 0.48
30min	2.80 \pm 1.20	3.36 \pm 0.61	3.91 \pm 0.53
R1	2.10 \pm 0.42	2.80 \pm 0.51	2.43 \pm 0.35
R2	1.50 \pm 0.36	1.80 \pm 0.34	1.93 \pm 0.40
R3	1.10 \pm 0.32	1.40 \pm 0.30	1.40 \pm 0.30
R4	0.93 \pm 0.28	0.93 \pm 0.28	1.00 \pm 0.30
R5	0.67 \pm 0.21	0.77 \pm 0.26	0.90 \pm 0.28

Table 4.4 Within-groups comparisons of changes in absolute oxygen consumption ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$), respiratory exchange ratio (RER), relative oxygen consumption ($\dot{V}O_2/kg$) and energy expenditure (EE) at rest, during exercise at 60%, 70% and 80% of age-predicted maximal heart rates, and during 5 minutes of recovery period (R1, R2, R3, R4 and R5) in control (no bra, NB), casual (CB) and sports (SB) bra. Values are mean \pm SEM

Variable	$\dot{V}O_2$ (ml·min ⁻¹)			$\dot{V}CO_2$ (ml·min ⁻¹)			RER			$\dot{V}O_2/kg$ (ml·kg ⁻¹ ·min ⁻¹)			EE (kcal·min ⁻¹)		
	NB	CB	SB	NB	CB	SB	NB	CB	SB	NB	CB	SB	NB	CB	SB
Rest	245.60 \pm 13.57	246.87 \pm 13.15	250.53 \pm 22.45	221.4 \pm 12.93	220.22 \pm 14.18	217.98 \pm 16.09	0.90 \pm 0.02	0.89 \pm 0.02	0.88 \pm 0.02	4.41 \pm 0.24	4.41 \pm 0.25	4.48 \pm 0.39	1.20 \pm 0.07	1.21 \pm 0.07	1.22 \pm 0.10
60%MHR	1323.78 \pm 37.30*	1405.44 \pm 60.72*	1419.69 \pm 54.67*	1345.58 \pm 48.06*	1412.60 \pm 63.38*	1412.73 \pm 53.65*	1.02 \pm 0.02	1.01 \pm 0.04	1.00 \pm 0.02	23.72 \pm 0.62*	25.16 \pm 1.10*	25.32 \pm 0.86*	6.64 \pm 0.19*	7.04 \pm 0.29*	7.09 \pm 0.27*
70%MHR	1399.25 \pm 56.11*	1502.03 \pm 64.89*	1435.36 \pm 61.72*	1457.03 \pm 54.71*	1555.28 \pm 65.51*	1439.79 \pm 59.16*	1.04 \pm 0.01*	1.05 \pm 0.03	1.01 \pm 0.02*	24.76 \pm 0.65*	27.03 \pm 1.31*	25.47 \pm 1.06*	7.06 \pm 0.28*	7.57 \pm 0.32*	7.18 \pm 0.30*
80%MHR	1532.38 \pm 93.97*	1500.93 \pm 63.89*	1545.00 \pm 85.01*	1602.33 \pm 96.56*	1560.63 \pm 68.41*	1528.26 \pm 94.29*	1.05 \pm 0.01*	1.05 \pm 0.04	0.99 \pm 0.02*	27.45 \pm 0.87*	27.04 \pm 1.26*	27.64 \pm 1.63*	7.74 \pm 0.47*	7.57 \pm 0.31*	7.71 \pm 0.43*
R1	439.31 \pm 32.39*	439.57 \pm 26.70*	435.80 \pm 21.32*	528.42 \pm 50.46*	513.60 \pm 34.98*	499.69 \pm 32.79*	1.19 \pm 0.03*	1.18 \pm 0.06	1.14 \pm 0.04*	7.85 \pm 0.52*	7.98 \pm 0.54*	7.80 \pm 0.41*	2.29 \pm 0.18*	2.28 \pm 0.14*	2.25 \pm 0.12*
R2	312.98 \pm 19.55	337.82 \pm 14.08*	350.73 \pm 15.19*	369.24 \pm 30.38	390.74 \pm 26.84*	393.13 \pm 23.01*	1.17 \pm 0.04	1.16 \pm 0.07	1.12 \pm 0.04*	5.61 \pm 0.33	6.08 \pm 0.33*	6.27 \pm 0.26*	1.63 \pm 0.11	1.75 \pm 0.08*	1.80 \pm 0.08*
R3	296.49 \pm 12.02	299.13 \pm 15.96	322.35 \pm 14.64	337.78 \pm 19.78	343.00 \pm 21.33*	358.38 \pm 18.40*	1.13 \pm 0.03	1.16 \pm 0.06	1.12 \pm 0.04*	5.32 \pm 0.21	5.42 \pm 0.37	5.77 \pm 0.26	1.53 \pm 0.07	1.54 \pm 0.08*	1.65 \pm 0.07
R4	285.98 \pm 9.21	286.72 \pm 13.38	311.04 \pm 15.92	332.89 \pm 17.67	337.26 \pm 26.22	353.64 \pm 21.17	1.16 \pm 0.04	1.17 \pm 0.07	1.14 \pm 0.04*	5.12 \pm 0.15	5.17 \pm 0.32	5.55 \pm 0.27	1.48 \pm 0.05	1.49 \pm 0.08	1.60 \pm 0.08
R5	260.98 \pm 10.55	270.15 \pm 11.93	293.96 \pm 12.31	313.76 \pm 14.69	323.92 \pm 17.47	334.02 \pm 14.67	1.21 \pm 0.03*	1.20 \pm 0.05*	1.14 \pm 0.02*	4.68 \pm 0.19	4.89 \pm 0.31	5.24 \pm 0.20	1.36 \pm 0.05	1.41 \pm 0.06	1.51 \pm 0.06

Abbreviations * represents from initial (resting) values and † significant from previous value at $p < 0.05$

CHAPTER V

DISCUSSION

To investigate the effect of sports bra at rest, during and after exercise on metabolic profiles, this study enlisted fifteen healthy female subjects for the tests. All subjects have normal ranges of anthropometric variables.

5.1 Metabolic profiles at rest, during running and recovery periods using sports bra.

This study was designed to contain two interventions including putting on bra and exercises. We hypothesized that limitation of chest motion may affect body's metabolism. We, therefore, will discuss the effect of sports bra in comparison to casual bra and no bra condition and compare the effect of exercise with resting condition. Resting values of absolute and relative $\dot{V}O_2$, $\dot{V}CO_2$, RER and EE values are in normal ranges (Kraemer et al, 2012) which indicate that unusual breathing via breathing mask were not affect and this study recruited normal subjects.

Our study suggests that wearing sports and casual bras had no effect on metabolic profiles when compared with no bra condition according with no significant differences were found among NB, CB and SB conditions at rest, during and after exercise. Although, previous study indicated the negative effect of sports bra for example; reduction in expiratory reserved volume (ERV) (Bowles et al, 2005), restriction of chest expansion and reduction in total lung capacity (Caro et al, 1960). In addition, chest strapping, which is similar to wearing sports bra may reduce metabolic profiles in some circumstances, for example in chest strapping with lung diseases (O'Donnell D.E. et al, 1998) and severe thoracic limitation. The latter example was on the severe chest wall restriction model when external restriction pressure was progressively increased from 20 to 60 mmHg, there was reduction of maximum oxygen uptake from 41.9 ± 1.3 to 39.4 ± 1.3 ml/kg/min (Coast et al, 2004). However, In the present study

sports bra covers about 0.15-0.16 m² of chest wall area (Yuen-Jong, 2009) and it has compressive force about 0.6 gm/cm². Sports bra used in this study showed no limit chest motion for two reasons: a) area covered by sports bra is minimal and b) elastic recoil of bra's garment is not strong enough.

Interestingly, RER in the present study indicated that subjects most likely utilized glycolytic processes as main energy substrate. During exercise, increasing in RER values demonstrated shifting from mix diet into more carbohydrate utilization (Kenney et al, 2012). At recovery period, increasing in RER in all groups was most likely due to the interferences of anaerobic processes. Coinciding with previous study, Sedlock et al indicated that even though exercise intervention had been ceased, metabolism remained work since biochemical processes remained in activation stage (Sedlock et al, 2010). After an exercise bout, heart rate, breathing rate, and metabolic rate remain elevated because aerobic metabolism is used to recover from the preceding exercise bout. Lactic acid, the waste product from metabolism was produced during exercise and then after exercise, muscle tissue need more oxygen for reconvert lactic acid to glucose that call "Oxygen debt" (Borsheim et al, 2003). Actually, the oxygen debt refer to process that provide the energy to perform particular exercise intensity (Kraemer et al, 2012).

Despite, all changed above were probably effect of exercise rather than effect of wearing bra, it seems to be corresponded with previous studies showed that there was no significant difference in respiratory function when exercise with sports bra (Bowles, 2005).

5.2 Effects of exercise intensities on metabolic profiles

During exercise, dynamic metabolic profiles in our study showed similar patterns in all three conditions. It is noted that as exercise was intervened, metabolic profile was subsequently increased. Maybe effect of increased in exercise intensity, this result supports the study of Prado et al that metabolic profiles are an intensity-dependent response. For example at light exercise intensity, metabolic profiles are enhanced minimally, at moderate exercise intensity metabolic profiles are further stimulated and at heavy exercise intensity metabolic profiles are possibly augmented up to the peak

(Prado et al, 2010). Exercise intensity influence changes in metabolic profiles. While the exercise intensity was increased, working muscle need more energy supply. Therefore, metabolic profiles such as oxygen were increased to support working muscle need(Kraemer et al, 2012).

Our study used running speed at 4 mph as exercise protocol. However, it seems subjects in this study used carbohydrate(CHO) as main energy substrate during exercise when observe at RER values. Relatively, previous study showed that lipid cannot usually support to the main energy source at exercise intensity greater than 50-60% of maximal oxygen uptake(Davies et al, 1979) and the major substrate for oxidative metabolism in this exercise intensity was CHO(Romijn et al, 1993; Van Loon et al, 2001).

However, changing of metabolic profiles on intensity of exercise seemly explain from pulmonary ventilation. Pulmonary ventilation increased under control of central and peripheral chemoreceptors, joints and muscles proprioceptive receptors are activated during exercise to meet the greater needs for oxygen delivery and carbon dioxide removal. At the exercise, pulmonary ventilation was dramatically increased to reach steady-state as a plateau pattern and then drop down at recovery period(Kraemer et al, 2012). Therefore, this evidence can be used to describe our results(Figure 1-4).

In our study metabolic profiles confirm the same principle of intensity-dependent. With this intensity-dependent pattern, no matter which type of sports bra were put on, effects of exercise intervention seems likely override effects of bra types.

In addition, our studies also assess the intensity of 4 mph constant speed running from the Rating of perceived exertion(RPE) and Metabolic equivalent methods. In term of RPE scale, the higher average value during exercise is about "13" that mean "somewhat hard" (Borg, 1998). The "13" in RPE scale is correlate with exercise intensity at "moderate"(Pollock, 1990). However, the average of RPE values during exercise in sports bra group was higher than casual bra and no bra group. The researcher believes that maybe effect of psychological of subjects when they wearing sports bra such as: sports bra must be tight, sports bra have more pressure to their chest although no significant differences between SB, CB and SB. In term of Dyspnea scale assessment, no significant differences between all three groups. Dyspnea scale were highest about 4 that mean "somewhat severe"(Borg, 1982). Identically with RPE values, Dyspnea scale

during exercise in sports bra group was higher than casual bra and no bra group. The minimal value in no bra group maybe effect from feeling good in subjects that nothing pressure on their chest.

It is well know that the rate of oxygen which the body consume during exercise can used to estimate the intensity of exercise by using Metabolic equivalent(MET)(McAuley, 2012). Nevertheless, the MET value is widely used to compare with another activites. In our study, the 7.7 MET is nearby with climbing hills(5-kg load)(Fletcher et al, 2001) or farming(vigorous effort) or fire fighter on the job or heavy exercise intensity(Ainsworth et al, 2011).

5.3 Difference of wearing sports bras, casual bra and no bra on recovery time

During recovery period, CB condition showed higher absolute and relative $\dot{V}O_2$ at 2rd minute recovery ($p<0.05$) and higher $\dot{V}CO_2$ and EE at 3nd minute recovery ($p<0.05$) whereas SB condition showed higher absolute and relative $\dot{V}O_2$ and EE at 1rd minute recovery ($p<0.05$) and higher $\dot{V}CO_2$ at 3nd minute recovery ($p<0.05$). Thus, wearing sports bra expresses full recovery within the 3 minutes post-exercise which was in an acceptable range. No bra condition exhibits full recovery immediately after exercise. However, this is not recommended for safety since excessive breast motion was indicated in female athletes (Mason et al, 1999; Gefen & Dilomoney, 2007).

CHAPTER VI

CONCLUSION

This study indicates that there was no limitation of sports bra on metabolic profiles during constant speed running since there was no detected change in either oxygen consumption or carbon dioxide production. Additionally, the present study indicates that the body utilized mostly glycolysis as main energy substrate during constant speed running at 4 miles per hour. In addition, this running speed seems likely that intensities used in this study were at moderate to heavy levels. The study presents that sports bra can be put on safely and effectively during constant speed running. There was no limitation in body metabolism for progressive workloads from 60-80% age-predicted maximum heart rate.

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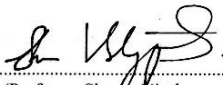

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APPENDICES

APPENDIX A
CERTIFICATE OF APPROVAL MAHIDOL UNIVERSITY
INSTITUTIONAL REVIEW BOARD (MU-IRB)

	
COA. No. 2014/167.2312	
Certificate of Approval Central Institutional Review Board, Mahidol University (MU-CIRB)	
Protocol No.:	MU-CIRB 2014/165.2910
Title of Project:	Does Sports Bra Limit Metabolic Profiles during Constant Speed Running? (Thesis for Master Degree)
Principal Investigator:	Mr.Thanachai Sahaschot
Co-Investigators:	Associate Professor Dr. Thyon Chentanez Associate Professor Dr. Rungechai Chuanchaiyakul Dr.Metta Pinthong
Affiliation:	College of Sports Science and Technology
Approval includes	1) MU-IRB Submission form version date 23 December 2014 2) Research Protocol version date 23 December 2014 3) Participant Information Sheet version date 23 December 2014 4) Informed Consent form version date 23 December 2014 5) Data Record Form version date 29 October 2014 6) Questionnaire version date 29 October 2014 7) Recruitment Material version date 23 December 2014
Central Institutional Review Board, Mahidol University is in full compliance with International Guidelines for Human Research Protection such as Declaration of Helsinki, The Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP)	
Date of Approval:	23 December 2014
Date of Expiration:	22 December 2015
Signature of MU-CIRB Chair:	 (Professor Shusze Visalyaputra)
	23 December 2014 version date
Signature of Institute Representative:	 (Professor Prasit Palittapongarnpim) Vice President for Research
	23 December 2014 version date
Office of the President, Mahidol University, 999 Phuttamonthon 4 Rd., Salaya, Phuttamonthon District, Nakhon Pathom 73170. Tel. (662) 8496224-5 Fax. (662) 8496274	

APPENDIX B

เอกสารชี้แจงผู้เข้าร่วมวิจัย

ในเอกสารนี้อาจมีข้อความที่ท่านอ่านแล้วยังไม่เข้าใจ โปรดสอบถามหัวหน้าโครงการวิจัย หรือผู้แทนให้ช่วยอธิบายจนกว่าจะเข้าใจดี ท่านจะได้รับเอกสารนี้ 1 ฉบับ นำกลับไปอ่านที่บ้านเพื่อปรึกษาหารือกับญาติพี่น้อง เพื่อนสนิท หรือผู้อื่นที่ท่านต้องการปรึกษา เพื่อช่วยในการตัดสินใจเข้าร่วมการวิจัย

ชื่อโครงการ เสื่อชั้นในกีฬาที่มีผลต่อการเผาผลาญพลังงานของร่างกายระหว่างการวิ่งที่ความเร็วคงที่หรือไม่

ชื่อผู้วิจัย นายธนาชัย สหัสโชติ

สถานที่วิจัย และสถานที่ทำงาน

ห้องวิจัย ชั้น 1 วิทยาลัยวิทยาศาสตร์และเทคโนโลยีการกีฬา มหาวิทยาลัยมหิดล ศาลายา

หมายเลขโทรศัพท์ 02 – 441 – 4297- 8 ต่อ 207 (เวลาราชการ) และ 089-7760011 (ตลอดเวลา)

E-mail address: zartae@gmail.com

โครงการวิจัยนี้ทำขึ้นเพื่อศึกษาผลของการใส่เสื่อชั้นในกีฬาที่มีต่อการเผาผลาญพลังงานของร่างกายระหว่างการวิ่งที่ความเร็วคงที่ เปรียบเทียบกับการใส่เสื่อชั้นในปกติ ท่านอาจจะไม่ได้รับประโยชน์โดยตรงจากการเข้าร่วมการวิจัยนี้ นอกจากจะได้เรียนรู้การวัดขนาดหน้าอก วิธีการดูแลหน้าอกในระหว่างการออกกำลังกายโดยการสวมใส่เสื่อชั้นในที่มีการออกแบบมาโดยเฉพาะ แต่หากการวิจัยได้ผลดีจะทำให้ทราบถึงความสามารถในการทำงานของระบบเผาผลาญพลังงานของร่างกายในขณะออกกำลังกายระหว่างสวมใส่เสื่อชั้นในกีฬาและเสื่อชั้นในปกติ

ท่านได้รับเชิญให้เข้าร่วมวิจัยนี้เพราะ ท่านเป็นเพศหญิง มีอายุระหว่าง 18-30 ปี มีสุขภาพดี ออกกำลังกายเป็นประจำ (อย่างน้อยวันละ 30 นาทีต่อวัน 3 วันต่อสัปดาห์ มาต่อเนื่องอย่างน้อย 3 เดือน) มีหน้าอกขนาด B – C, ไม่เคยใส่เสื่อชั้นในกีฬามาก่อนอย่างน้อย 6 เดือน, มีประจำเดือนสม่ำเสมอเป็นปกติ, ไม่เป็นโรคหรือมีอาการบาดเจ็บที่เกี่ยวกับระบบกระดูกและกล้ามเนื้อที่จะเป็นอุปสรรคต่อการออกกำลังกาย, ไม่เคยได้รับการผ่าตัดใหญ่บริเวณทรวงอกและช่องท้อง, ไม่เคยตั้งครรภ์มาก่อน, ไม่ดื่มแอลกอฮอล์และไม่สูบบุหรี่

จะมีผู้เข้าร่วมการวิจัยนี้ทั้งสิ้นประมาณ 15 คน

หากท่านตัดสินใจเข้าร่วมการวิจัยแล้ว จะมีขั้นตอนการวิจัยดังต่อไปนี้คือ

- ผู้วิจัยจะขอนัด วัน และเวลาที่ท่านสะดวก ในการเข้าร่วมการวิจัยที่ห้องวิจัย ชั้น 1 วิทยาลัยวิทยาศาสตร์และเทคโนโลยีการกีฬา มหาวิทยาลัยมหิดล ศาลายา จำนวน 4 ครั้ง โดยมีรายละเอียดดังต่อไปนี้

ครั้งที่ 1 ขั้นตอนการคัดกรอง (ใช้เวลาประมาณ 5 - 10 นาที)

- ผู้วิจัยจะขอให้ท่านเข้ารับการคัดกรองเพื่อเข้าร่วมการวิจัย ดังนี้
 - 1) ผู้วิจัยจะขอให้ท่านตอบแบบสอบถามข้อมูลสุขภาพและการออกกำลังกาย จำนวน 16 ข้อ
 - 2) ผู้วิจัยจะขอให้ท่านเข้ารับการวัดขนาดเส้นผมในขณะที่ไม่สวมเสื้อชั้นใน โดยผู้เชี่ยวชาญผู้หญิงจากบริษัทผลิตชุดชั้นในจะเป็นผู้วัดขนาดเส้นผมของท่าน และจะทำในห้องที่มิดชิด
- หากท่านผ่านเกณฑ์การคัดกรอง ผู้วิจัยจะขอให้ท่านเข้าร่วมการวิจัยในขั้นตอนต่อไป

การเตรียมตัวก่อนทดสอบ

- ผู้วิจัยจะขอให้ท่านปฏิบัติดังนี้
 - 1) รับประทานอาหารตามปกติและดื่มน้ำให้เพียงพอ
 - 2)งดกิจกรรมการออกกำลังกายหนักหรือที่จะทำให้เกิดอาการอ่อนเพลียและอ่อนล้า เป็นเวลา 2 วันก่อนวันนัดมาทำการทดสอบ
 - 3) งดดื่มชา, กาแฟ, และเครื่องดื่มแอลกอฮอล์ อย่างน้อย 48 ชั่วโมง ก่อนวันนัดมาทำการทดสอบ
 - 4) พักผ่อนให้เพียงพออย่างน้อย 8 ชั่วโมง
 - 5) เตรียมรองเท้ากีฬา มาด้วยทุกครั้ง

ครั้งที่ 2 – 4 ขั้นตอนการทดสอบ (ใช้เวลาครั้งละประมาณ 1 ชั่วโมง 30 นาที - 2 ชั่วโมง)

- ผู้วิจัยจะขอให้ท่านเข้ารับการทดสอบการเผาผลาญพลังงานของร่างกายระหว่างการวิ่งที่ความเร็วคงที่ จำนวน 3 ครั้ง (ห่างกันอย่างน้อย 2 วัน) ใช้เวลาครั้งละประมาณ 1 ชั่วโมง 30 นาที - 2 ชั่วโมง
- การทดสอบแต่ละครั้งจะทำในช่วงบ่าย และในช่วงวันที่ 1-14 ของรอบประจำเดือนของท่านโดยนับวันที่ประจำเดือนมาวันแรกเป็นวันที่ 1
- ในการทดสอบแต่ละครั้งผู้วิจัยจะขอให้ท่านสวมใส่เสื้อชั้นใน 1 ลักษณะจาก 3 ลักษณะ ตามลำดับที่ได้จากการสุ่มดังนี้

ลักษณะที่ 1 เสื้อชั้นในกีฬา (ผู้วิจัยจัดเตรียมไว้ให้)

ลักษณะที่ 2 เสื้อชั้นในปกติ (ท่านสวมใส่มา)

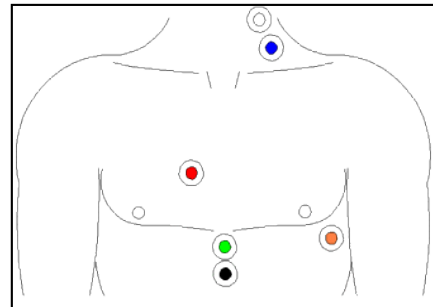
ลักษณะที่ 3 ไม่สวมใส่เสื้อชั้นใน

- ขั้นตอนการทดสอบทั้งหมดจะทำในห้องทดลองที่ปิดมิดชิด และจะมีเพียงผู้วิจัยผู้หญิงเท่านั้นที่เข้าร่วม และดำเนินการทดสอบภายในห้องร่วมกับท่านได้
- หากวันที่ทำการทดสอบ ท่านมีอาการไม่สบาย หรือต้องการงดทำการทดสอบ ขอให้ท่านแจ้งผู้วิจัยเพื่องดการเข้ารับการทดสอบ และนัดหมายวัน และเวลาในการเข้ารับการทดสอบครั้งต่อไป เมื่อท่านหายเป็นปกติแล้ว
- การเข้ารับการทดสอบในแต่ละครั้งผู้วิจัยจะขอให้ท่านปฏิบัติ ดังนี้
 - 1) ผู้วิจัยจะขอให้ท่านสวมใส่เสื้อชั้นใน (หรือไม่สวมใส่เสื้อชั้นใน) ตามลักษณะที่ได้จากการสุ่ม จากนั้นให้ท่านสวมชุดกีฬาที่ผู้วิจัยจัดเตรียมไว้ให้

- 2) ผู้วิจัยจะขอติดเครื่องวิเคราะห์ที่แก๊สจากลมหายใจเข้าออก และเครื่องวัดปริมาตรเลือดที่ออกจากหัวใจและอัตราการไหลของร่างกายของท่าน โดยอุปกรณ์ดังกล่าวจะวัดการทำงานของร่างกายของท่านโดยอัตโนมัติในขณะที่พัก ตลอดช่วงการออกกำลังกาย และช่วงของการฟื้นฟูสภาพที่นาที่ที่ 1,2,3,4 และ 5 ดังนี้
 - 2.1) เครื่องวิเคราะห์ที่แก๊สจากลมหายใจเข้าออก ผู้วิจัยจะขอให้ท่านสวมใส่หน้ากากครอบบริเวณจมูกและปาก ซึ่งมีสายต่อเข้าเครื่องวิเคราะห์ที่แก๊สน้ำหนักเบาซึ่งติดอยู่ที่ตัวของท่านโดยใช้สายสะพายหลัง ดังรูปที่ 1 และเพื่อความปลอดภัยของท่านอุปกรณ์ที่ใช้ในการทดลองจะแช่น้ำยาฆ่าเชื้อไว้ค้างคืน และทำความสะอาด-ปล่อยในแห้ง เก็บรักษาในถุงปิดมิดชิดก่อนการใช้งานทุกครั้ง
 - 2.2) เครื่องวัดปริมาตรเลือดที่ออกจากหัวใจและอัตราการไหล ผู้ช่วยวิจัยหญิงติดแผ่นอิเล็กโทรดจำนวน 6 จุด ดังนี้ 1. บริเวณกล้ามเนื้อคอด้านหน้า (2 จุด) 2. บริเวณกึ่งกลางหน้าอก (1 จุด) 3. บริเวณใต้ราวนม (1 จุด) และ 4. บริเวณกึ่งกลางหลัง (2 จุด) ดังรูปที่ 2 และมีสายต่อเข้ากับเครื่องที่ใส่กับตัวคาดเอว โดยเครื่องจะไม่เคลื่อนหลุดออกจากตัวท่าน



รูปที่ 1 การสวมใส่หน้ากากครอบบริเวณจมูกและปากและเครื่องวิเคราะห์ที่แก๊สน้ำหนักเบาซึ่งติดอยู่บริเวณด้านหลัง



รูปที่ 2 ตำแหน่งการติดอิเล็กโทรดของเครื่องวัดปริมาตรเลือดออกจากหัวใจ

- 3) ผู้วิจัยจะขอให้ท่านยืดเหยียดกล้ามเนื้อ เป็นเวลา 2 นาที
- 4) ผู้วิจัยจะขอให้ท่านวิ่งเหยาะๆ บนลู่วิ่ง โดยวิ่งเพื่อเป็นการอบอุ่นร่างกายที่ความเร็ว 3.2 กิโลเมตร/ชั่วโมง เป็นเวลา 3 นาที และตามด้วยการวิ่งที่ความเร็ว 6.5 กิโลเมตร/ชั่วโมง เป็นระยะเวลาประมาณ 15-30 นาที หรือจนกว่าอัตราการเต้นหัวใจของท่านจะเพิ่มขึ้นถึง 80% ของอัตราการเต้นหัวใจสูงสุด
- 5) ขณะที่ท่านกำลังวิ่งบนลู่วิ่ง ผู้วิจัยจะขอให้วัดระดับความรู้สึกเหนื่อยและระดับความสบายในการหายใจ โดยแสดงแผ่นค่าระดับความเหนื่อยของท่าน ด้านหน้าในระดับสายตา เพื่อให้ท่านสามารถมองเห็นได้ชัดเจน ตลอดช่วงการออกกำลังกายทุกๆ 10 นาที ขณะพัก และช่วงของการฟื้นฟูสภาพที่นาที่ที่ 1,2,3,4 และ 5 และผู้วิจัยจะขอให้ท่านบอกคะแนนระดับความเหนื่อย ตั้งแต่ 6 - 20 (6 คือ รู้สึกสบาย และ 20 คือ เหนื่อยมากที่สุด) และบอกระดับความสบายในการหายใจ ตั้งแต่ 0 - 10 (0 คือ ไม่มีอาการเลย และ 10 คือ มากที่สุด)

- 6) จากนั้นผู้วิจัยจะขอให้ท่านนั่งพักนิ่งๆ เป็นเวลา 5 นาที
 - 7) ผู้วิจัยจะขอให้ท่านยืดเหยียดกล้ามเนื้อ เป็นเวลา 5-10 นาที
- ข้อมูลต่างๆ ที่ได้จากการวิจัยจะถูกเก็บรักษาไว้จนกว่าจะเสร็จสิ้นการวิจัย โดยมีเพียงผู้วิจัยเท่านั้นที่สามารถเข้าถึงข้อมูลได้ หลังจากนั้นข้อมูลทั้งหมดจะถูกทำลายทิ้งโดยการลบข้อมูลทั้งหมดออกจากคอมพิวเตอร์ และทำลายเอกสารหรือแบบสอบถามต่างๆทั้งหมด

ความเสี่ยงที่อาจเกิดขึ้นระหว่างเข้าร่วมการวิจัย คือ ท่านอาจมีอาการปวดเมื่อยกล้ามเนื้อ ซึ่งมักเกิดขึ้นภายหลังการออกกำลังกายอย่างหนักเป็นเวลา 1-2 วัน ซึ่งการคลายอุ่นและการยืดเหยียดกล้ามเนื้อภายหลังการออกกำลังกายจะช่วยป้องกันหรือบรรเทาอาการดังกล่าวได้ในระดับหนึ่ง และหากท่านมีอาการปวดเมื่อยกล้ามเนื้อ และต้องการได้รับยาหรือการรักษา ขอให้ท่านแจ้งผู้วิจัยเพื่อทำการนัดหมายและเข้ารับการรักษาที่คลินิกการกีฬา วิทยาลัยวิทยาศาสตร์และเทคโนโลยีการกีฬา มหาวิทยาลัยมหิดลต่อไป นอกจากนี้ผู้วิจัยมีการเตรียมแพทย์และอุปกรณ์กู้ชีพขั้นพื้นฐานไว้ตลอดเวลา ณ สถานที่ทำการวิจัย (สถานที่ทำการวิจัยอยู่บริเวณเดียวกับคลินิกการกีฬา) อนึ่งหากเกิดเหตุที่ไม่พึงประสงค์จากการวิจัย เช่น มีอาการหน้ามืด เวียนศีรษะ จุกแน่นหน้าอก ผู้วิจัยจะยุติการทดสอบทันที ท่านจะได้รับการปฐมพยาบาล เพื่อช่วยประหม่นและแก้ไขกรณีเกิดเหตุการณ์ไม่พึงประสงค์ และทำการกู้ชีพขั้นพื้นฐานได้ทันที หากอาการไม่ดีขึ้นผู้วิจัยจะนำท่านส่งศูนย์แพทย์กาญจนาภิเษกต่อไป โดยนายธนาชัย สหัสโชติ (ผู้วิจัย) และ รศ.ดร. ไถ่อ่อน ชินธเนศ (อาจารย์ที่ปรึกษาวิทยานิพนธ์) และวิทยาลัยวิทยาศาสตร์และเทคโนโลยีการกีฬาจะเป็นผู้รับผิดชอบค่าใช้จ่ายในการรักษาพยาบาลที่เกิดขึ้นทั้งหมด

การเข้าร่วมการวิจัยครั้งนี้ ท่านจะได้รับค่าเดินทางมายังสถานที่ดำเนินการวิจัยจำนวน 3 ครั้ง ครั้งละ 200 บาท รวมเป็นเงิน 600 บาท โดยจะตอบแทนเป็นครั้งๆ ไป และไม่เสียค่าใช้จ่ายใดๆ ทั้งสิ้น

หากท่านมีอาการผิดปกติ รู้สึกไม่สบายกาย หรือมีผลกระทบต่อจิตใจของท่านเกิดขึ้นระหว่างการวิจัย ขอให้ท่านแจ้งผู้วิจัยโดยเร็วที่สุด และหากท่านมีข้อสงสัยที่จะสอบถามเกี่ยวกับการวิจัย หรือเมื่อบาดเจ็บ/เจ็บป่วย หรือหากเกิดเหตุการณ์ไม่พึงประสงค์จากการวิจัย ท่านสามารถติดต่อ นายธนาชัย สหัสโชติ (ผู้วิจัย) ได้ที่หมายเลขโทรศัพท์ 089-7760011 (ตลอด 24 ชั่วโมง) หรือ รศ.ดร. ไถ่อ่อน ชินธเนศ (อาจารย์ที่ปรึกษาวิทยานิพนธ์) ได้ที่หมายเลขโทรศัพท์ 089-0709804 (ตลอด 24 ชั่วโมง) ผศ. ดร. รุ่งชัย ชวนไชยะกุล (อาจารย์ที่ปรึกษาวิทยานิพนธ์ร่วม) ได้ที่หมายเลขโทรศัพท์ 089-1993193 (ตลอด 24 ชั่วโมง)

หากมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ทราบโดยรวดเร็ว ไม่ปิดบัง

ข้อมูลส่วนตัวของท่านจะถูกเก็บรักษาไว้ ไม่เปิดเผยต่อสาธารณะเป็นรายบุคคล แต่จะรายงานผลการวิจัยเป็นข้อมูลส่วนรวม ข้อมูลของผู้เข้าร่วมการวิจัยเป็นรายบุคคลอาจมีคณะบุคคลบางกลุ่มเข้ามาตรวจสอบได้ เช่น ผู้ให้ทุนวิจัย, สถาบัน หรือองค์กรของรัฐที่มีหน้าที่ตรวจสอบ, คณะกรรมการจริยธรรมฯ เป็นต้น

ท่านมีสิทธิ์ถอนตัวออกจากโครงการวิจัยเมื่อใดก็ได้ โดยไม่ต้องแจ้งให้ทราบล่วงหน้า และการไม่เข้าร่วมการวิจัยหรือถอนตัวออกจากโครงการวิจัยนี้จะไม่มีผลกระทบใดๆต่อท่าน

โครงการวิจัยนี้ได้รับการพิจารณารับรองจาก คณะกรรมการจริยธรรมการวิจัยในคนส่วนกลาง มหาวิทยาลัยมหิดล ซึ่งมีสำนักงานอยู่ที่ สำนักงานอธิการบดีมหาวิทยาลัยมหิดล ถนนพหลุทมนชพล สาย 4 ตำบล

สาขาสายาาเภอพุทธมณฑล จังหัดนครปฐม 73170 หมายเลขโทรศัพท 02-849-6224-5 โทรสาร 02-849-6274 หาก
ท่านได้รับการปฏิบัติไมตรงตามที่ระบุไว้ ท่านสามารถติดต่อกับประธานคณะกรรมการฯ หรือผูแทน ไดตาม
สถานที่และหมายเลขโทรศัพทข้างตั้น

ข้าพเจ้าไดอ่านรายละเอียดในเอกสารนี้ครบถ้วนแล้

ลงชื่อ.....ผูเข้าร่วมวิจัย

(.....)

วันที่.....

APPENDIX C

หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัยที่ได้รับการบอกกล่าวและเต็มใจ

วันที่..... เดือน..... พ.ศ.....

ข้าพเจ้า.....อายุ.....ปี อาศัยอยู่บ้านเลขที่.....

ถนน.....ตำบล.....อำเภอ.....

จังหวัด.....รหัสไปรษณีย์..... โทรศัพท์.....

ขอแสดงเจตนายินยอมเข้าร่วมโครงการวิจัย เรื่อง “**เลื้อยชั้นในกีฬามีผลต่อการเผาผลาญพลังงานของร่างกายระหว่างการวิ่งที่ความเร็วคงที่หรือไม่**”

โดยข้าพเจ้าได้รับทราบรายละเอียดเกี่ยวกับที่มา และจุดมุ่งหมายในการทำวิจัยรายละเอียดขั้นตอนต่างๆ ที่จะต้องปฏิบัติหรือได้รับการปฏิบัติ ประโยชน์ที่คาดว่าจะได้รับของการวิจัย และความเสี่ยงที่อาจเกิดขึ้นจากการเข้าร่วมการวิจัย รวมทั้งแนวทางป้องกันและแก้ไขหากเกิดอันตรายขึ้น ค่าตอบแทนที่จะได้รับ โดยได้อ่านข้อความที่มีรายละเอียดอยู่ในเอกสารชี้แจงผู้เข้าร่วมการวิจัยโดยตลอด อีกทั้งยังได้รับคำอธิบายและตอบข้อสงสัยจากหัวหน้าโครงการวิจัยเป็นที่เรียบร้อยแล้ว โดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ข้าพเจ้าจึงสมัครใจเข้าร่วมในโครงการวิจัยนี้ :

ข้าพเจ้าได้ทราบถึงสิทธิ์ที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติมทั้งทางด้านประโยชน์และโทษจากการเข้าร่วมการวิจัย และสามารถถอนตัวหรืองดเข้าร่วมการวิจัยได้ทุกเมื่อ โดยจะไม่มีผลกระทบใดๆ ต่อข้าพเจ้า และยินยอมให้ผู้วิจัยใช้ข้อมูลส่วนตัวของข้าพเจ้าที่ได้รับจากการวิจัย แต่จะไม่เผยแพร่ต่อสาธารณะเป็นรายบุคคล โดยจะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

หากข้าพเจ้ามีอาการผิดปกติ รู้สึกไม่สบายกาย หรือมีผลกระทบต่อจิตใจของข้าพเจ้าเกิดขึ้นระหว่างการวิจัยข้าพเจ้าจะแจ้งผู้วิจัยโดยเร็วที่สุด และหากข้าพเจ้ามีข้อสงสัยเกี่ยวกับขั้นตอนของการวิจัย หรือเมื่อบาดเจ็บ/เจ็บป่วย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์จากการวิจัยขึ้นกับข้าพเจ้า ข้าพเจ้า จะสามารถติดต่อกับนายธนาชัย สหัสโชติ (ผู้วิจัย) ได้ที่ หมายเลขโทรศัพท์ 08-9776-0011 (ตลอด 24 ชั่วโมง) หรือ ติดต่อ รศ.ดร. ใถ้ออน ชินชนศ (อาจารย์ที่ปรึกษาวิทยานิพนธ์) ได้ที่ หมายเลขโทรศัพท์ 08-9070-9804 (ตลอด 24 ชั่วโมง)

หากข้าพเจ้าได้รับการปฏิบัติไม่ตรงตามที่ได้ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าจะสามารถติดต่อกับประธานคณะกรรมการจริยธรรมการวิจัยในคนฯ หรือผู้แทน ใต้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคนส่วนกลาง สำนักงานอธิการบดีมหาวิทยาลัยมหิดล โทร. 02-849-6224-5 โทรสาร 02-849-6274

ข้าพเจ้าเข้าใจข้อความในเอกสารชี้แจงผู้เข้าร่วมการวิจัย และหนังสือแสดงเจตนายินยอมนี้โดยตลอดแล้ว จึงลงลายมือชื่อไว้

ลงชื่อ.....ผู้เข้าร่วมการวิจัย

(.....)

วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม/หัวหน้าโครงการวิจัย

(.....)

วันที่.....

APPENDIX D

แบบสอบถามข้อมูลสุขภาพและการออกกำลังกาย

คำชี้แจง: โปรดกรอกข้อมูลและตอบคำถามต่อไปนี้ตามความเป็นจริง ข้อมูลทั้งหมดในแบบสอบถามนี้จะถูกเก็บเป็นความลับและใช้ในงานวิจัยนี้เท่านั้น

-
1. น้ำหนัก.....กิโลกรัม ส่วนสูง.....เซนติเมตร
 2. วัน เดือน ปีเกิด.....อายุ.....ปี
 3. สถานภาพการสมรส โสด สมรส หย่าร้าง จำนวนบุตร.....คน
 4. ขนาดเต้านม A B C D มากกว่า D
 5. ท่านเคยใช้เสื้อชั้นในกีฬามาก่อนหรือไม่ ไม่เคย เคย ระบุยี่ห้อ.....
 6. กรณีถูกเงินติดต่อ.....เกี่ยวข้องกับ.....
เบอร์โทรศัพท์ติดต่อ.....e-mail.....
 7. โรคประจำตัว ไม่มี มี ระบุ.....ยาที่ใช้.....
 8. ประวัติการเจ็บป่วย

โรคหลอดเลือดและโรคหัวใจ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
โรคความดันโลหิต	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ <input type="checkbox"/> สูง <input type="checkbox"/> ต่ำ
โรคเกี่ยวกับสมองและระบบประสาท	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
โรคเกี่ยวกับระบบทางเดินหายใจ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
โรคลมชัก ลมบ้าหมู	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
ปัญหาที่เกี่ยวข้องกับกระดูกและข้อ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
ต่อมไร้ท่อ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
โรคติดเชื้อหรือโรคติดต่อ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
ปัญหาสุขภาพอื่นๆ	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....
ประวัติการผ่าตัด	<input type="checkbox"/> ไม่มี <input type="checkbox"/> มี ระบุ.....(ตำแหน่ง,วันที่ผ่าตัด)
 9. การมีประจำเดือนใน 1 ปีที่ผ่านมา.....ครั้ง/ปี ระบุวันที่มากที่สุดท้าย.....

10. ประวัติการสูบบุหรี่ ไม่สูบบุหรี่ สูบเป็นครั้งคราว
 สูบเป็นประจำ ระบุ.....มวน/วัน
11. การดื่มเครื่องดื่มแอลกอฮอล์ ไม่ดื่ม ดื่มเป็นครั้งคราว
 ดื่มเป็นประจำ ระบุ.....วัน/สัปดาห์
12. ประวัติการออกกำลังกายในระยะเวลา 3เดือนที่ผ่านมา
13. การออกกำลังกายหรือเล่นกีฬาใน 1 สัปดาห์
 ไม่ออกกำลังกายหรือเล่นกีฬาเลย
 1-2 วัน/สัปดาห์
 3-5 วัน/สัปดาห์
 6-7 วัน/สัปดาห์
14. เวลาที่ใช้ในการออกกำลังกายหรือเล่นกีฬาใน 1 วัน
 น้อยกว่า30 นาที/วัน
 30-60 นาที/วัน
 มากกว่า60 นาที/วัน
15. ประเภทของการออกกำลังกายหรือชนิดกีฬาที่ท่านปฏิบัติ ระบุ.....
16. คุณเคยบาดเจ็บจากการออกกำลังกายหรือการเล่นกีฬาหรือไม่
 ไม่เคย เคย ระบุ.....

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