THE ASSOCIATION BETWEEN TOTAL PHYSICAL ACTIVITY, SCREEN TIME AND HS-CRP IN OVERWEIGHT AND OBESE ADULTS

SUCHANART TANGCHITNOB

MASTER OF SCIENCE
IN
ANTI-AGING AND REGENERATIVE MEDICINE

SCHOOL OF ANTI-AGING AND REGENERATIVE MEDICINE
MAE FAH LUANG UNIVERSITY
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Suchanart Tangchitnob

Thesis Title	The Association Between Total Physical Activity, Screen Time and Hs-CRP in Overweight and Obese Adults
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Degree	Master of Science (Anti-Aging and Regenerative Medicine)
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ABSTRACT

Nowadays, Thai population is starting to shift to a more sedentary lifestyle, while the prevalence of obesity, another serious health problem, had been increasing worldwide. This leads to an increased risk of non-communicable diseases, including cardiovascular diseases. Inflammation of adipose tissue can cause chronic low-grade systemic inflammation, which can be detected by an increase in high sensitivity C-reactive protein (hs-CRP), one of the biomarkers of cardiovascular disease risk prediction. According to previous studies, Hs-CRP is significantly higher in obese individuals, while lower physical activity is associated with higher levels of hs-CRP, however, the results may be mediated by the level of adiposity. Screen time, one of the measures for sedentary behavior, is also studied in this research.

Objectives: This study aimed to study the association between total physical activity, screen time and hs-CRP in overweight and obese adults.

Material and Methods: This research is a cross-sectional study conducted in 21 healthy normal weight, overweight and obese Thai adults aged between 20 and 40 years old. Subjects' body weight and height were measured, intravenous blood sample (5 mL) were collected after overnight fasting, and then interviewed to answer the GPAQ questionnaire and screen time questionnaire.

Results: Using Pearson correlation coefficient, total physical activity and screen time had no significant correlation with hs-CRP (P>0.05), while there was a significant, moderate positive correlation between BMI and hs-CRP (r=0.462, P=0.035).

Conclusion: Total physical activity and screen time had no significant correlation with hs-CRP in overweight and obese adults. However, BMI had a significant moderate negative correlation with hs-CRP.

Keywords: Hs-CRP, Physical Activity, Screen Time, Overweight, Obesity

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CHAPTER 1

INTRODUCTION

1.1 Background and Rationale

Nowadays, the Thai population is starting to shift to a more sedentary lifestyle. The amount of time spent on physical activity is replaced by sedentary behavior, leading to a more negative health outcome (Liangruenrom et al., 2023). Being sedentary, such as watching television, playing video games, using computers or tablets, and sitting or lying down, is one of the risk factors of many non-communicable diseases, including obesity (Park et al., 2020). Screen time, one of the measures for sedentary behavior, is also associated with higher risk of overweight and obesity (Nagata et al., 2023).

Obesity is a serious health problem in Thailand and has been increasing worldwide (Sakboonyarat et at., 2020). About 17.1% and 23.8% of Thai adults aged 19 and over are overweight and obese respectively, with the 40-59-year-old group found to have the highest prevalence, based on the Western Pacific Region of World Health Organization (WPRO) criteria for obesity (Jitnarin et al., 2011). An increase in BMI can lead to many health consequences, such as cardiovascular disease, musculoskeletal disorders, breathing difficulties, and even cancer (World Health Organization [WHO], 2021; Centers for Disease Control and Prevention [CDC], 2022).

Inflammation of adipose tissue in overweight and obesity can cause chronic low-grade systemic inflammation (Kunz et al., 2021), which can be detected by an increase in high sensitivity C-reactive protein (hs-CRP), an acute phase protein produced by the liver in response to proinflammatory cytokines (Polyakova & Mikhaylov, 2020). High sensitivity C-reactive protein (hs-CRP) is one of the biomarkers of cardiovascular disease risk prediction, and can be elevated in many conditions, such as acute infections, inflammation and trauma (Kamath et al., 2015).

Previous studies revealed that hs-CRP are significantly higher in obese individuals (Dayal et al., 2014), indicating a higher risk of cardiovascular disease. Another factor that could be affecting the level of hs-CRP is physical activity. Previous studies on the association between hs-CRP and physical activity showed that people with lower physical activity had higher levels of hs-CRP, however, this may be affected by the level of adiposity of the participants (Haapala et al., 2022; Aljaloud et al., 2022). Moreover, longer television screen time was significantly associated with higher C-reactive protein level, while computer and reading time had no association (Nang et al., 2013).

So, the objective of this research is to study the association between hs-CRP, total physical activity and screen time in overweight and obese adults in the Thai population.

1.2 Research Question

Is there an association between total physical activity, screen time and hs-CRP in overweight and obese adults?

1.3 Objectives

1.3.1 Primary Objective

1.3.1.1 To study the association between total physical activity and hs-CRP in overweight and obese adults.

1.3.1.2 To study the association between screen time and hs-CRP in overweight and obese adults.

1.3.2 Secondary Objective

1.3.2.1 To measure the level of hs-CRP in overweight and obese adults.

1.3.2.2 To study the association between BMI and hs-CRP.

1.4 Research Hypothesis

Total physical activity is negatively correlated with hs-CRP in overweight and obese adults.

Screen time is positively correlated with hs-CRP in overweight and obese adults.

1.5 The Scope of the Study

This research is a cross-sectional study in healthy normal weight, overweight and obese Thai adults aged between 20 and 40 years old to see the association between hs-CRP and total physical activity and the association between hs-CRP and screen time, and the association between BMI and hs-CRP. Moreover, the hs-CRP level was also measured to collect data as a reference for Thai population. Participants from Mae Fah Luang University Hospital are interviewed to answer the GPAQ questionnaire about their physical activity done in a week, and total physical activity is calculated. The amount of time spent on television, computer, tablets and mobile phone in one day is recorded. Additionally, the participants' hs-CRP are measured from venous blood after overnight fasting, along with their body weight, height, and vital signs, which all the procedures are done by nurses from Mae Fah Luang University Hospital. Blood analysis is performed at N Health Laboratory.

1.6 Conceptual Framework

Obesity and overweight are associated with low grade systemic inflammation, which can be detected by an increase in hs-CRP. Also, obesity is inversely correlated with physical activity. However, it is still unclear about the association between physical activity and hs-CRP, since its level can be mediated by obesity. Screen time, one of the measures for sedentary behavior, is also studied in this research.

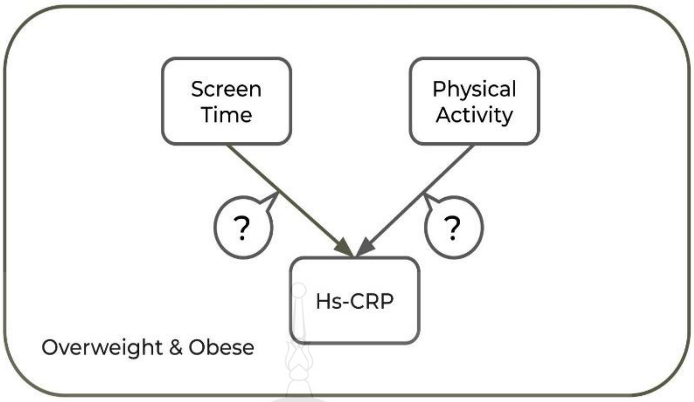

Figure 1.1 Conceptual Framework

1.7 Definition

1.7.1 Overweight: From the WPRO standard, overweight is classified as BMI between 23.0 and 24.9 kg/m2.

1.7.2 Obesity: From the WPRO standard, obesity is classified as BMI greater than or equal to 25.0 kg/m2.

1.7.3 Body mass index (BMI): BMI is calculated from the person's weight and height. The formula is body weight (kg) divided by the square of height (m^2).

1.7.4 High sensitivity C reactive protein (hs-CRP): Serum hs-CRP is one of the biomarkers for cardiovascular disease risk prediction. Serum hs-CRP levels less than 1 mg/l was classified as low risk groups, 1–3 mg/l as intermediate risk groups, and more than 3 mg/l as high-risk groups for global CVD (Kamath et al., 2015).

1.7.5 Sedentary lifestyle: Being sedentary is when you have any behavior with an energy expenditure of 1.5 metabolic equivalent of task (MET) or less, such as sitting, leaning, or lying down (Park et al., 2020).

1.7.6 Metabolic Equivalent of Task (MET): One MET is defined as the amount of oxygen consumed while sitting quietly at rest and is equal to 3.5 ml/min/kg or caloric consumption of 1 kcal/kg/hr (Jetté et al., 1990).

1.7.7 Total Physical activity (TPA): The sum of the total MET minutes of physical activity done in a typical week, collected by the GPAQ questionnaire.

1.7.8 Global Physical Activity Questionnaire (GPAQ): Collects information on physical activity done in three domains: activity at work, travel to and from places, recreational activity (developed by WHO)

1.7.9 Screen time: The amount of time used on mobile phones, tablets, computer and television

1.7.10 Pearson Correlation: A statistical method that measures the correlation between two continuous variables

The level of Pearson correlation coefficient and the interpretation are shown as follows (Schober et al., 2018):

Table 1.1 Interpretation of Pearson Correlation Coefficient

P	Strength
0.00-0.09	Negligible
0.10-0.39	Weak
0.40-0.69	Moderate
0.70-0.89	Strong
0.90-1.00	Very Strong

CHAPTER 2

LITERATURE REVIEW

The contents studied in this thesis are divided into 5 parts:

1. Overweight and Obesity
2. High Sensitivity C-Reactive Protein (Hs-CRP)
3. Association Between Obesity and Hs-CRP
4. Sedentary Lifestyle and Physical Inactivity
5. Association Between Physical Activity and Hs-CRP

2.1 Overweight and Obesity

2.1.1 Definition

Overweight and obesity are conditions with abnormal or excessive fat accumulation that may impair health (WHO, 2021). Overweight is defined as a BMI greater than or equal to 25 kg/m^2, and obesity is defined as a BMI greater than or equal to 30 kg/m^2 by the World Health Organization (WHO, 2021).

There is another classification from the WHO Western Pacific Region (WPRO) standard, which is more appropriate for Asians due to different body fat percentage and body composition from Caucasians. The WPRO criteria classified overweight with BMI between 23.0 and 24.9 kg/m^2 and obese with BMI greater than or equal to 25.0 kg/m^2 (Jitnarin et al., 2011).

While in Thailand, overweight is when the BMI is between 23.0-24.9 kg/m^2, and obesity is divided into levels as follow:

Obesity level 1a BMI is between 25.0-29.9 kg/m^2

Obesity level 1b BMI is between 30.0-34.9 kg/m^2

Obesity level 2 BMI is between 35.0-39.9 kg/m^2

Obesity level 3 BMI is greater than or equal to 40 kg/m^2

(National Health Security Office [NHSO], 2010)

The criteria used in this research is the WPRO standard, which is widely used in Asians, including this study.

2.1.2 Prevalence

The prevalence of overweight and obesity has been increasing worldwide (Sakboonyarat et at., 2020). It is also considered a serious health problem in Thailand. From a study in 2018, the prevalence of overweight and obesity in Thai adults aged 19 and over was 17.1% and 23.8% respectively, based on the WRPO criteria, but only 19.0% and 4.8% based on the WHO criteria. From the WPRO criteria, adults in the 40-59-year-old group were found to have the highest prevalence, and the population in Bangkok had the highest prevalence of obesity (Jitnarin et al., 2011).

2.1.3 Causes

The main cause of obesity and being overweight is when there is an energy imbalance between calories intake and calories expended (WHO, 2021), leading to excess weight gain and abnormal accumulation of fat in the body (Omer, 2020). Many factors contribute to obesity, including genetics, individual factors and environmental factors (Omer, 2020).

2.1.3.1 Genetic

Obesity can be classified into 3 groups according to different genetic contributing mechanisms: monogenic, polygenic or syndromic. Monogenic obesity, which involves chromosomal deletion or single gene defects, contribute to rare and early onset obesity; for example, gene defects that are related to leptin deficiency, proopiomelanocortin (POMC) deficiency and melanocortin-4 receptor (MC4R) deficiency (Loos & Yeo, 2022).

Polygenic obesity, which involves hundreds of polymorphisms with small effects, is more common (Loos & Yeo, 2022). People with a genetic profile at risk have a higher chance of becoming obese. According to the genome-wide association studies (GWAS), more than 300 single nucleotide polymorphisms (SNPs) are associated with traits related to obesity, for example, BMI, waist-to-hip ratio, and other adiposity traits (Goodarzi, 2018), and more than 500 genetic loci associated with obesity have been identified. (Young et al., 2019). SNPs in FTO (fat mass and obesity associated gene) are found in multiple populations, and studies showed that FTO are associated with appetite and feeding behavior, however the mechanism is not well understood (Fawcett & Barroso, 2010) The FTO gene can cause an increase in hunger level, caloric intake, body fat storage and tendency to sedentary lifestyle. Moreover, it can reduce satiety and lead to over-eating (Obesity Medicine Association, 2023).

Syndromic obesity, which is a rare inherited condition, is present at birth and usually associated with comorbidities, such as impaired cognitive function, dysmorphic features or organ abnormalities. This includes Prader-Willi syndrome, Bardei-Bietl syndrome and Cohen syndrome (Obesity Medicine Association, 2023).

2.1.3.2 Calorie intake and Energy expenditure

An imbalance between caloric intake and energy expenditure causes bodyweight change. When caloric intake exceeds energy expenditure, a state of positive energy balance leads to an increase in body mass, which is usually body fat. On the other hand, when energy expenditure exceeds energy intake, a state of negative energy balance leads to a loss of body mass. (Hill et al., 2012)

Individual factors that can affect obesity are the factors that play an important role in energy expenditure. These include the basal metabolic rate (BMR), the energy used in breaking down food, and the energy used in physical activity (Omer, 2020). Also, excessive energy from calorie intake can contribute to fat accumulation, especially from high energy dense food (Lin & Li, 2021). High energy dense diets, which are high in energy and fat, but low in fruits, vegetables and fiber (Pour-Abbasi et al., 2023), are positively correlated with increased weight gain and excess adiposity (Rouhani et al., 2016).

2.1.3.3 Weight gain secondary to medical conditions and medications

Some diseases or endocrine disorders are related to obesity, for example, Cushing’s disease, hypothyroid and polycystic ovary syndrome (Omer, 2020). Also, a study on medication induced weight gain indicated that antipsychotics, antidepressants, antihyperglycemics, antihypertensives and corticosteroids all contain medications that were significantly associated with weight gain (Wharton et at., 2018).

2.1.3.4 Socioeconomic Factors

Obesity is more prevalent in people from lower socioeconomic classes in developing countries without food scarcity, presumably from high fat diets which are more affordable. On the other hand, in low income countries with food scarcity, the rich are more susceptible to obesity because of more accessibility to excess food and less involvement in labor work (Omer, 2020). A study in Ghana and Nigeria, which are low-to-middle income countries, showed that older adults in the urban with higher income and education were associated with a higher chance of obesity (Akpa et al., 2023).

2.1.3.5 Environmental Factors

Workplace environments can also affect obesity. Long working hours can lead to increased sitting time, reduced time for exercise and other physical activities, resulting in an increase in BMI. Also, it can affect the meal to processed food or fast food instead of healthier homemade food (Omer, 2020). Nowadays, the improvement in labor-saving technology such as communication devices and internet media platforms are related to a decrease in work-related energy expenditure and weight gain (Lee et al., 2019).

Neighborhoods also have an effect on obesity. A study in Canada found that high neighborhood walkability is associated with decreased prevalence of overweight and obesity (Creatore et al., 2016). Neighborhood deprivation or a neighborhood with crime are associated with an increased probability of being overweight (Lee et al., 2019).

2.1.3.6 Lifestyle Factors

Recently, an improvement in socioeconomic status leads to a more sedentary lifestyle, which contributes to an increase in noncommunicable diseases, including obesity. Studies show that physical inactivity is associated with weight gain and sedentary behavior is associated with abdominal obesity. However, the association between screen time and obesity is still inconclusive (Kerkadi et al., 2019).

2.1.4 Consequences

People with obesity have an increased risk for many diseases and health problems compared to normal weight people (CDC, 2022). Being obese has an impact on all aspects, including physical health, mental health, and social aspects and others (Djalalinia et al., 2015).

2.1.4.1 Physical Health

An increase in BMI can lead to noncommunicable diseases such as the followings:

1. Cardiovascular diseases especially heart disease and stroke, diabetes type 2 (WHO, 2021)

2. Musculoskeletal disorders, especially osteoarthritis (WHO, 2021)

3. Cancers, including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon (WHO, 2021)

4. Gallstones and gallbladder disease (CDC, 2022)

5. Breathing difficulties, such as asthma and sleep apnea (CDC, 2022)

While the BMI increases, the risk for these noncommunicable diseases also increases (WHO, 2021).

Obesity in childhood and adolescence are associated with an increased risk of premature morbidity and mortality, specifically cardio-metabolic morbidity (Djalalinia et al., 2015). They also have an increased risk of fractures, metabolic syndrome, and breathing problems in the future (WHO, 2021).

2.1.4.2 Psychosocial Health

Being obese may create stigma and obesity discrimination may lead to some mental disorders (Djalalinia et al., 2015). From previous studies, obesity is related to depression, eating disorders, anxiety, substance abuse, sexual abuse and more. They also affect an individual's self-esteem, their body image dissatisfaction, and a decreased quality of life (Sarwer & Polonsky, 2016).

Childhood obesity is also associated with psychological problems such as anxiety and depression, low self-esteem and lower quality of life (CDC, 2022). Obese children and adolescents are more involved in bullying, they suffer from both physical and verbal victimization, and have been excluded from group activities (Bacchini et al., 2015).

2.1.4.3 Aging Process

Obesity increases the risk of disabilities and age-related diseases such as cardiovascular disease, diabetes, osteoarthritis and cancer. Moreover, it was implied that obesity decreases life span and affects the cellular process of aging. According to previous studies, obesity is negatively associated with telomere length, which may be due to oxidative stress and inflammation (Salvestrini et al., 2019).

2.2 High Sensitivity C-Reactive Protein (Hs-CRP)

C-reactive protein (CRP) is an acute phase protein synthesized mainly by the liver, in response to proinflammatory cytokines, particularly interleukin-6 (Polyakova & Mikhaylov, 2020). Their levels can be elevated in acute infections, inflammatory conditions and trauma, which rise rapidly generally beyond 10 mg/L. Due to its stable structure, their levels don’t have much variation during the day, so high-sensitivity methods for measurement have been done. These include radioimmunoassay, immunonephelometry, immunoturbidimetry, and ELISA, which can detect CRP with a sensitivity range of 0.01 to 10 mg/L (Kamath et al., 2015). This helps identify low grade systemic inflammation, which plays an important role in atherosclerosis, so it is used as an atherosclerotic risk marker (Roberts, 2004).

Hs-crp is also widely used as a biomarker for cardiovascular disease risk prediction. The American Heart Association and U.S. Centers for Disease Control (AHA/CDC) Working Group on markers of inflammation in CVD has classified serum Hs-CRP levels less than 1 mg/L as low risk groups, 1–3 mg/L as intermediate risk groups, and more than 3 mg/L as high risk groups for global CVD (Kamath et al., 2015).

2.2.1 Role of Hs-CRP in Atherosclerosis

Hs-CRP takes place in the atherosclerotic process by increasing the recruitment of monocytes to atheromatous plaque, leading to a suppression of nitric oxide release from vascular endothelium cells, resulting in endothelial dysfunction. It can increase the expression of plasminogen activator inhibitor-1 (PAI-1) and other adhesion molecules. Also, it increased low-density lipoprotein-cholesterol (LDL-C) uptake by macrophages (Kamath et al., 2015; Banait et al., 2022).

2.2.2 Prognostic Role of Hs-CRP in Non-communicable Diseases

People with elevated levels of baseline hs-CRP have an increased risk of cardiovascular disease, type 2 diabetes mellitus and hypertension. Also, elevated hs-

CRP can increase the area of ischemic infarction by complement activation, leading to severe diseases like myocardial ischemia and stroke. Hs-CRP less than 1.0 mg/L is considered normal, while more than 2.0 mg/L is associated with poorer prognosis, higher complication rates and death from cardiovascular diseases (Banait et al., 2022).

In acute myocardial infarction, hs-CRP levels can sharply rise and reach peak value within 48 to 72 hours and gradually decrease overtime to less than 10 mg/L. Hs-CRP rises in response to inflammation from myocardial ischemia, before the marked elevation of cardiac troponin I. In patients with acute myocardial infarction, hs-CRP level is associated with lesion size, risk of recurrence, new onset cardiac arrhythmia, heart failure and mortality rate. (Polyakova & Mikhaylov, 2020; Zhang et al., 2021)

Examples of other diseases associated with elevated levels of hs-CRP are obstructive sleep apnea (OSA), age-related macular degeneration (AMD), cancer with chronic inflammation like lung cancer, and degenerative disorders like Alzheimer’s disease and Parkinson’s disease (Banait et al., 2022)

2.2.3 Factors Affecting HS-CRP

Previous research suggested that the quantity of fat intake and type of dietary fat can affect the level of CRP. High fat intake, especially saturated and trans fatty acids, was associated with an increase in CRP levels. Also, anti-inflammatory supplementations like alpha-linolenic acid (ALA) and oleic acid can also decrease CRP levels. High refined carbohydrate intake can also affect CRP levels by increasing postprandial hyperglycemia which may lead to the increased circulating levels of free radicals and pro-inflammatory cytokines (Shen & Ordovas, 2009).

Several studies have reported that healthy dietary habits, including higher intake of fruits, vegetables, lean meat, and omega-3-rich foods, were inversely correlated with cardiometabolic risk factors and inflammatory biomarkers, including hs-CRP (Vahid et al., 2022; Rostgaard-Hansen et at., 2023).

According to a study in African Americans about the association between movement behaviors and CRP concentration, an increase in physical activity relative to sedentary behavior and sleep was associated with reductions in hs-CRP levels (Booker et al., 2022).

Smoking can also affect hs-CRP levels. It was found that smokers had significantly higher hs-CRP compared to non-smokers and will remain higher after quitting up to 20 years after cessation. In smokers, white blood cells are increased and recruited to inflamed tissues. IL-β and IL-6, which are increased in response to lung inflammation, are related to the induction of CRP synthesis (Tonstad & Cowan, 2009).

2.3 Association Between Obesity and Hs-CRP

Obesity is associated with low grade systemic inflammation, while hs-crp is one of the markers to detect the inflammatory state (Dayal et al., 2014). Monocyte-derived macrophages in adipose tissue can produce proinflammatory cytokines, including C-reactive protein (CRP), interleukin-6 (IL-6) and tumor necrosis factor alpha (TNF-α). Increased adipose tissue in obesity can lead to an overproduction of them (Shih et al., 2022). Previous studies show that overweight and obese children had significantly higher hs-CRP levels compared to normal weight children, indicating a low grade systemic inflammation (Dayal et al., 2014; Kitsios et al., 2013). In adults, elevated hs-crp is also strongly correlated with obesity (Blaha et al., 2011).

2.4 Sedentary Lifestyle and Physical Inactivity

Being sedentary is when you have any behavior with an energy expenditure of 1.5 metabolic equivalent task (MET) or less, such as sitting, leaning, or lying down. This includes watching television, playing games, using a computer, and sitting at school or work (Park et al., 2020). MET values are used to estimate the energy used in each individual's physical activity. Physical activity is characterized by the Compendium of Physical Activities into sedentary behavior (i.e., 1.0-1.5 METs), light-intensity (1.6-2.9 METs), moderate-intensity (3-5.9 METs), and vigorous-intensity (≥6 METs) activities (Ainsworth et al., 2011).

According to WHO recommendations on physical activity for health, throughout a week, adults should do at least:

1. 150 minutes of moderate-intensity physical activity OR

2. 75 minutes of vigorous-intensity physical activity OR

3. Achieving total physical activity at least 600 MET-minutes/week

Insufficient physical activity compared to the recommended level of regular physical activity is considered physical inactivity.

2.4.1 Prevalence

From a study in Chiang Mai, Thailand, about a quarter (26%) of the population were physically inactive (Thanamee et al., 2017). Moreover, a study revealed that the Thai population is having a shift to a more sedentary lifestyle, with a significant amount of physical activity replaced by sedentary behavior overtime (Liangruenrom et al., 2023).

2.4.2 Consequences

A sedentary lifestyle increases the risk of non-communicable diseases, including cardiovascular diseases, obesity, diabetes, hypertension and cancer (Park et al., 2020). An increase in screen time is associated with higher overweight and obesity risk (Nagata et al., 2023). High levels of sedentary behavior are also associated with health outcomes of poor cognitive function, depression, function and disability, and decreased quality of life in adults. Reducing or stopping sedentary behavior may help improve body composition and markers of cardiometabolic risk (Saunders et al., 2020).

Physical activity decreases the risk of cognitive decline and age-related diseases, leading to successful aging with good physical function and mental health (Szychowska & Drygas, 2022).

2.5 Association Between Physical Activity and Hs-CRP

Physical activity is inversely associated with quantitative CRP, independent of body adiposity. The association was mild but significant due to a large population but small variation of CRP levels. A recent study showed that people with high physical activity were associated with lower hs-CRP compared to people with low physical activity, but this may be due to more overweight and obese participants in the low physical activity group (Aljaloud et al., 2022).

Another study done in children indicated that higher levels of sedentary time and lower levels of physical activity were associated with higher levels of biomarkers for inflammation, including hs-CRP. However, the result was found in children with higher body fat percentage, but not in children with lower body fat percentage. This suggested that the associations may possibly be mediated by the level of adiposity (Haapala et al., 2022).

A study about the association between sedentary behaviors and cardio-metabolic biomarkers revealed that longer television screen time was significantly associated with higher C-reactive protein, while computer and reading time had no association with C-reactive protein (Nang et al., 2013).

According to previous studies, hs-CRP is positively correlated with obesity and negatively correlated with physical activity. However, it was suggested that the results of elevated hs-CRP in the low physical activity group might be mediated by obesity. Meanwhile, the association between screen time and hs-CRP was still unclear. Therefore, this study was conducted to study the association between physical activity, screen time and hs-CRP in normal weight, overweight and obese adults in Thailand.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Study Design

A cross-sectional clinical study design

3.2 Study Population

Healthy Thai males and females, aged between 20 and 40 years old, with BMI equal to or more than 18.5 kg/m^2

3.3 Study Location

Mae Fah Luang University Hospital, Bangkok, Thailand

3.4 Sample Size Determination

Due to lack of information about physical activity and hs-CRP from previous researches, sample size was calculated by using the reference data from a similar article, Disparate Habitual Physical Activity and Dietary Intake Profiles of Elderly Men with Low and Elevated Systemic Inflammation by Dimitrios Draganidis (Draganidis et al., 2018).

$$Z_F = \frac{1}{2} ln\left(\frac{1+|r|}{1-|r|}\right)$$

$$Z_F = \frac{1}{2} ln\left(\frac{1+|-0.37|}{1-|-0.37|}\right)$$

$$Z_F = 0.388$$

Where;

r = the expected correlation coefficient between hs-CRP and total physical activity (-0.37)

Z_F = Fisher's transformation of the correlation coefficient

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

$$n = \frac{(1.645 + 0.84)^2}{0.388} + 3$$

$$n = 18.92$$

$$n \approx 19$$

Where;

n = Sample size

Z_α = Z-score at confidence interval of 95% (1.645)

Z_β = Z-score for the desired power of 80% (0.84)

The expected dropout rate was 10% (~ 2).

Total sample size $19 + 2 = 21$

In this study, 21 subjects were enrolled.

3.5 Inclusion Criteria

3.5.1 Male and female participants aged between 20 and 40 years old

3.5.2 BMI equal to or more than 18.5 kg/m^2

3.5.3 Non-smokers or quitted smoking for more than 20 years

3.5.4 Participants are healthy and not on any supplements or medication

3.5.5 Willingness to sign the informed consent and follow the instructions given

3.5.6 Participants accepted to examine blood samples

3.6 Exclusion Criteria

3.6.1 Pregnant and breastfeeding women

3.6.2 Participants with other inflammatory conditions, such as autoimmune diseases, inflammatory bowel disease, inflammatory joint diseases, cancer

3.6.3 Participants with recent infections (within 2 weeks)

3.6.4 Participants with recent traumas (within 2 weeks)

3.7 Discontinuation Criteria

3.7.1 Participants who want to drop out of the study

3.7.2 Participants who cannot comply with the instructions.

3.7.3 Participants who suffer from serious illness during the study

3.7.4 Participants with hs-CRP more than 10 mg/L

3.8 Variables of the Study

3.8.1 Independent Variables

3.8.1.1 Total Physical Activity (MET-minutes/week)

3.8.1.2 Screen time (Hour)

3.8.2 Dependent Variables

Hs-CRP (mg/L)

3.9 Research Materials

3.9.1 The information sheet

3.9.2 The informed consent

3.9.3 The participant record form

3.9.4 Global Physical Activity Questionnaire (GPAQ)

Physical Activity

Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person.
Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. *[Insert other examples if needed].* In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.

Question	Response	Code
Work		
Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like *[carrying or lifting heavy loads, digging or construction work]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 4*	P1
In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days └─┘	P2
How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P3 (a-b)
Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 7*	P4
In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days └─┘	P5
How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P6 (a-b)
Travel to and from places		
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. *[Insert other examples if needed]*		
Do you walk or use a bicycle *(pedal cycle)* for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to P 10*	P7
In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days └─┘	P8
How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P9 (a-b)

Continued on next page

Note Fair to moderate validity by Wanner et al., good to very good reliability by Keating et al.

Source Wanner et al. (2017) and Keating et al. (2019)

Figure 3.1 GPAQ Questionnaire

Physical Activity, Continued		
Question	**Response**	**Code**
Recreational activities		
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure), *[Insert relevant terms]*.		
Do you do any vigorous-intensity sports, fitness or recreational *(leisure)* activities that cause large increases in breathing or heart rate like *[running or football]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 13*	P10
In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational *(leisure)* activities?	Number of days └─┘	P11
How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P12 (a-b)
Do you do any moderate-intensity sports, fitness or recreational *(leisure)* activities that cause a small increase in breathing or heart rate such as brisk walking, *[cycling, swimming, volleyball]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P16*	P13
In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational *(leisure)* activities?	Number of days └─┘	P14
How much time do you spend doing moderate-intensity sports, fitness or recreational *(leisure)* activities on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P15 (a-b)
Sedentary behaviour		
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, train, reading, playing cards or watching television, but do not include time spent sleeping. *[INSERT EXAMPLES] (USE SHOWCARD)*		
How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ hrs mins	P16 (a-b)

Figure 3.1 (continued)

3.9.5 Screen time Questionnaire

Screen-time Questionnaire

For the following set of questions, ***primary activity*** is defined as the main activity you are engaged in rather than using a television/other screen in the background while performing another activity such as cooking or exercising.

Screen use on an average weekday
Thinking of an average weekday (from when you wake up until you go to sleep), how much time do you spend using each of the following types of screen as the primary activity?
You must answer both hours and minutes. **If zero please type "0" in the box.**

	Hours	Minutes
Television		
TV-connected devices (e.g. streaming devices, video game consoles)		
Laptop/computer		
Smartphone		
Tablet		

Screen use on an average weeknight
Now, thinking of an average weeknight (from when you return from work until you go to sleep), how much time do you spend using each of the following types of screen as the primary activity?
You must answer both hours and minutes. **If zero please type "0" in the box.**

	Hours	Minutes
Television		
TV-connected devices (e.g. streaming devices, video game consoles)		
Laptop/computer		
Smartphone		
Tablet		

Screen use on an average weekend day
Now, thinking of an average weekend day (Saturday or Sunday), how many hours over the course of the whole day (from when you wake up until you go to sleep) do you spend using each of the following types of screen as the primary activity?
You must answer both hours and minutes. **If zero please type "0" in the box**.

	Hours	Minutes
Television		
TV-connected devices (e.g. streaming devices, video game consoles)		
Laptop/computer		
Smartphone		
Tablet		

Note Fair to excellent relative reliability, except for the item inquiring about the use of smartphone during an average weekend day by Vizcaino et al.

Source Vizcaino et al. (2019)

Figure 3.2 Screen Time Questionnaire

For the following set of questions, **background screen** is defined as the use of a television or another screen near you while performing other activities such as exercising, cooking, and interacting with family/friends.

Thinking about a regular weekday (Monday through Friday), on average, how many hours **over the course of the whole day** (from when you wake up until you go to sleep) are you exposed to background screen use?

Example: If you exercise in the morning for one hour while watching the TV news, you use your smartphone for one hour while eating lunch and an additional 30 minutes while eating dinner, you would estimate that you are exposed to 2 hours and 30 minutes of background screen use per day.

	Hours	Minutes
Background screen use on a regular weekday		

Now we want to ask about background screen use **during the evening specifically**. On average, how many hours per evening (Monday through Friday) are you exposed to background screen use from when you return from work until you go to sleep?

Example: If you regularly prepare dinner with the television on for one hour, and you keep the television on for an additional hour while using your smartphone for social media use, you can estimate that you are exposed to 2 hours of background screen use every evening.

	Hours	Minutes
Background screen use on a regular weeknight		

Now we want to ask about background screen use **during the weekend**. Thinking about a regular weekend day (Saturday or Sunday), on average, how many hours over the course of the whole day (from when you wake up until you go to sleep) are you exposed to background screen use?

Example: If you have the television on while you do some online shopping for two hours, and you keep the television on when friends come over to visit for an additional two hours, you can estimate that you are exposed to 4 hours of background screen use every evening.

	Hours	Minutes
Background screen use on a regular weekend day		

Figure 3.2 (continued)

3.9.6 Anthropometric measurements: Weight scale and Stadiometer for height

Figure 3.3 Weight Scale and Stadiometer

3.9.7 Digital sphygmomanometer

Figure 3.4 Digital Sphygmomanometer

3.9.8 A skilled nurse and equipment for drawing blood

3.9.9 Laboratory measurement for hs-CRP by N Health Laboratory

3.10 Research Procedure

3.10.1 Enroll volunteers according to the inclusion and exclusion criteria.

3.10.2 Inform volunteers about the study's objective and procedure.

3.10.3 Subjects sign the informed consent.

3.10.4 History taking is done and the researcher will fill in the case record form, including underlying disease, current medication and general information for the study.

3.10.5 Subjects are appointed for interview, physical examination, and blood drawing with overnight fasting.

3.10.6 At the date of appointment, subjects' body weight, height and vital signs are measured.

3.10.7 5 ml of venous blood is drawn at Mae Fah Luang University Hospital by a skilled nurse, stored at 2-8°C, and sent to N Health Laboratory for hs-CRP measurement.

3.10.8 Subjects are interviewed for the GPAQ questionnaire and questionnaire on screen time.

3.10.9 Data is collected, analyzed, discussed, and concluded.

3.11 Data Collection, Outcome Measurement and Cut-offs

3.11.1 Questionnaires

3.11.1.1 General data such as age, sex, occupation, underlying disease, and current medication.

3.11.1.2 GPAQ (Global Physical Activity Questionnaire)

1. 16 Questions, 3 Domains (Activity at work, Travel to and from places, Recreational activities)

2. Total Physical Activity (TPA) calculated by the equation:

TPA (MET-minutes/week) = summation of the total MET-minutes of activity computed for each domain (days of activity per week * amount of time * intensity of activity) (* = multiplication)

Table 3.1 MET Value Used for the Calculation of a Person's Overall Energy Expenditure Using GPAQ Data

Domain	**MET Value**
Work	Moderate MET value = 4.0 Vigorous MET value = 8.0
Transport	Cycling and walking MET value = 4.0
Recreation	Moderate MET value = 4.0 Vigorous MET value = 8.0

3. Physical Activity cut-off value: Score of less than 600 MET-minutes per week do not meet WHO recommendations on physical activity for health

3.11.1.3 Screen time: the amount of time spent on devices such as mobile phones, tablets, computer and television on an average day

Screen time is calculated by the equation:

Screen Time (hr) = [5 * (summation of the time used on each device on an average weekday) + 2 * (summation of the time used on each device on an average weekend)] / 7 (* = multiplication, / = division)

3.11.1.4 Background screen time: the amount of time when the screens are near you while you are performing other activities, such as eating lunch, cooking, having an exercise

3.11.1.5 Total Screen Time (hr) = Screen Time + Background Screen Time

3.11.2 Physical Examination

3.11.2.1 Weight was measured by digital scale, done in light clothing and without shoes.

3.11.2.2 Height was measured by the stadiometer without shoes.

3.11.2.3 Body mass index (BMI) was calculated by dividing weight in kilograms (kg) by height in centimeters (cm) squared.

Table 3.2 Obesity Classification by WPRO Criteria

Classification	BMI (kg/m²)
Underweight	< 18.5
Normal	18.5 - 22.9
Overweight	23.0 - 24.9
Obesity Class I	25.0 - 29.9
Obesity Class II	≥ 30

3.11.2.4 Blood pressure and heart rate were measured by a digital sphygmomanometer.

3.11.3 Biochemical Measurements

Hs-crp was obtained from venous blood samples, with a volume of 5 ml drawn by a skilled nurse at Mae Fah Luang University, stored at 2-8°C, and sent to N Health Laboratory for analysis by immunoturbidimetry method.

AHA/CDC had classified serum hs-CRP levels into 3 groups for cardiovascular risk.

Table 3.3 Hs-CRP Classification for Cardiovascular Risk

Risk Group	Serum Hs-CRP (mg/L)
Low Risk	< 1
Intermediate Risk	1 - 3
High Risk	> 3

3.12 Statistical Analysis

Documentation of the medical records and the outcome in this study are recorded and analyzed by Microsoft Excel and SPSS software version 29.0 (IBM Corp in 2023).

3.12.1 Descriptive Statistics

3.12.1.1 Qualitative data, such as sex and occupation, were analyzed and the results are presented as numeric data and percentage.

3.12.1.2 Quantitative data, such as weight, height, BMI and hs-CRP, are analyzed and the results were presented as the mean, median, standard deviation, interquartile range.

3.12.2 Inferential Statistics

3.12.2.1 Pearson correlation coefficient was used to find the correlation between physical activity, screen time, and body mass index with hs-CPR level.

3.12.2.2 Chi-square test was used to assess the association between body mass index classification and total physical activity adequacy, calculating the odds ratio (OR) and 95% confidence intervals (CI).

3.12.2.3 A two-sided P-value less than 0.05 is considered statistically significant.

3.13 Ethical Consideration

This study was strictly conducted under Good Clinical Practice (GCP) guidelines. This guideline includes protection of human rights as a subject in clinical trials, assurance of safety and wellbeing of the subjects, standards on how clinical trials should be conducted.

For general understanding, the considerations were as follows.

3.13.1 Volunteers completely understand the objective, methodology, and possible adverse effects of the study.

3.13.2 Volunteers are willing to attend the study and sign the informed consent before conducting the study. They can leave anytime without prohibitions.

3.13.3 This research is free of charge. There is no interest between the researcher and the subjects.

3.13.4 In any case, if any problem occurs, the researcher will help as much as possible.

3.13.5 All volunteers' information is confidential.

This study was conducted after receiving approval from Mae Fah Luang University Ethics Committee on Human Research No.EC 23166-20.

CHAPTER 4

RESULTS

4.1 Demographic Data, Total Physical Activity, Screen Time Score and Hs-CRP Levels

This research was conducted to study the association between hs-CRP and total physical activity and screen time in overweight and obese adults. It was conducted on 21 healthy volunteers aged between 20-40 with BMI more than 18.5 kg/m^2 and no underlying diseases and concurrent use of any medication or supplements. General characteristics, total physical activity and screen time were collected by a questionnaire, and the participants' body weight, height and serum hs-CRP was measured. The results were shown as follows:

Table 4.1 Baseline Characteristics

Demographic data	**n = 21**
Sex, n (%)	
Male	6 (28.6)
Female	15 (71.4)
Age, n (%)	
21-30	5 (23.8)
31-40	16 (76.2)
Age (years), mean±SD (min-max)	34.90±5.34 (25-40)
Height, n (%)	
150-159	8 (38.1)
160-169	10 (47.6)

Table 4.1 (continued)

Demographic data	n = 21
170-179	2 (9.5)
180-189	1 (4.8)
Height (cm), mean±SD (min-max)	162.43±7.86 (150-183)
Weight, n (%)	
40-49	4 (19.0)
50-59	7 (33.3)
60-69	5 (23.8)
70-79	4 (19.0)
80-89	1 (4.8)
Weight (kg), mean±SD (min-max)	60.41±11.51 (45-83)
Body mass index classification, n (%)	
Normal weight (18.5 - 22.9 kg/m^2)	10 (47.6)
Overweight (23.0 - 24.9 kg/m^2)	5 (23.8)
Obese (more than 25.0 kg/m^2)	6 (28.6)
Body mass index (kg/m^2), mean±SD (min-max)	22.77±3.20 (18.73-27.48)
Occupation, n (%)	
Office worker	16 (76.2)
Medical personnel	4 (19.0)
Housekeeper	1 (4.8)
Total physical activity (MET-minutes/week), median (IQR)	1,120 (200, 1,615)
Total physical activity level, n (%)	
Adequate physical activity	14 (66.7)
Inadequate physical activity	7 (33.3)
Screen time score, n (%)	
0-5.0	0 (0)
5.1-10.0	5 (23.8)
10.1-15.0	14 (66.7)

Table 4.1 (continued)

Demographic data	n = 21
15.1-20.0	2 (9.5)
Screen time score, mean±SD (min-max)	11.42±2.50 (6.57-15.57)
Hs-CRP (mg/L), median (IQR)	0.92 (0.41, 1.86)
Cardiovascular Risk, n (%)	
Low (hs-CRP < 1 mg/L)	13 (61.9)
Intermediate (hs-CRP 1-3 mg/L)	7 (33.3)
High (hs-CRP > 3 mg/L)	1 (4.8)

Table 4.1 shows the baseline characteristics of the 21 participants. It was found that 15 were female and 6 were male. The mean age was 34.90±5.34 years old, the mean height was 162.43±7.86 cm, and the mean weight was 60.41±11.51 kg. The mean body mass index (BMI) was 22.77±3.20 kg/m². 10 subjects were normal weight, followed by 6 subjects who were obese, and 5 subjects who were overweight. Most of the participants were office workers (16 subjects), followed by medical personnel (4 subjects) and one housekeeper. Total physical activity had a median value of 1,120 (IQR 200, 1,615) MET-minutes/week. 14 subjects, which was 66.7%, had adequate physical activity. The mean screen time score was 11.42 ± 2.50. The median hs-CRP level was 0.92 (IQR 0.41, 1.86) mg/L. The majority had a low risk of cardiovascular disease (13 subjects), followed by intermediate risk (7 subjects), and high risk (1 subject).

4.2 Correlation between Physical Activity, Screen Time, and BMI with Hs-CRP

Table 4.2 Correlation between Physical Activity, Screen Time, and BMI with Hs-CRP

	Hs-CRP level	**Total physical activity**	**Screen time score**	**Body mass index**
Hs-CRP level	1.000			
Total physical activity	-0.352 (P=0.118)	1.000		
Screen time score	-0.005 (P=0.984)	-0.019 (P=0.935)	1.000	
Body mass index	0.462 (P=0.035*)	-0.171 (P=0.459)	0.050 (P=0.830)	1.000

Note Data were analyzed with Pearson correlation

Table 4.2 presents the correlation analysis between total physical activity, screen time, and body mass index with hs-CRP. It was found that body mass index had a significant, moderate positive correlation with hs-CRP (r=0.462, P=0.035). This means that an increase in body mass index leads to an increase hs-CRP, whereas a decrease in body mass index leads to a decrease in hs-CRP levels. However, the total physical activity and screen time score had no significant correlation with hs-CRP (P>0.05).

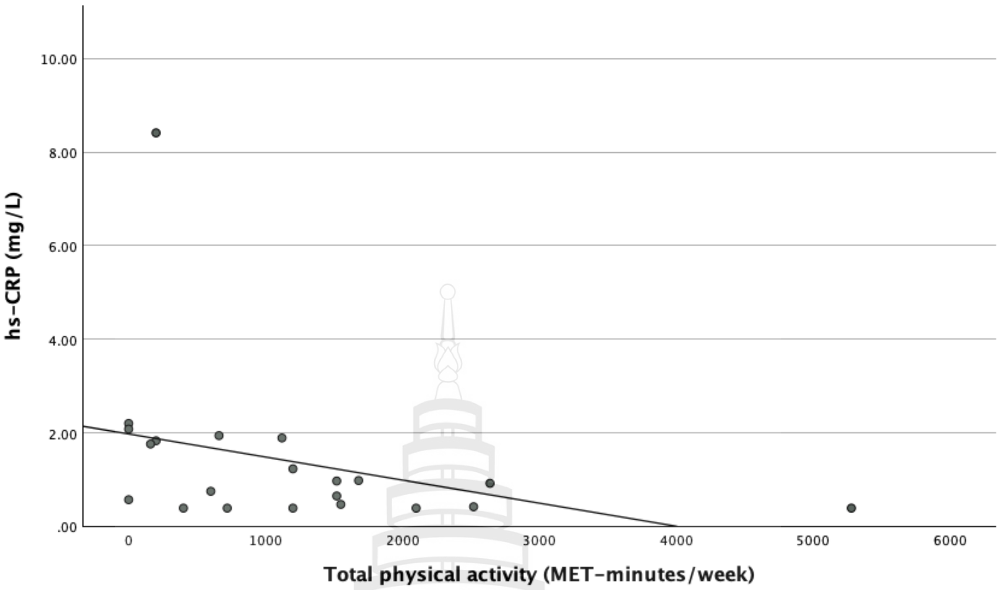

Figure 4.1 Scatter Plot Illustrating the Correlation Between Total Physical Activity and Hs-CRP

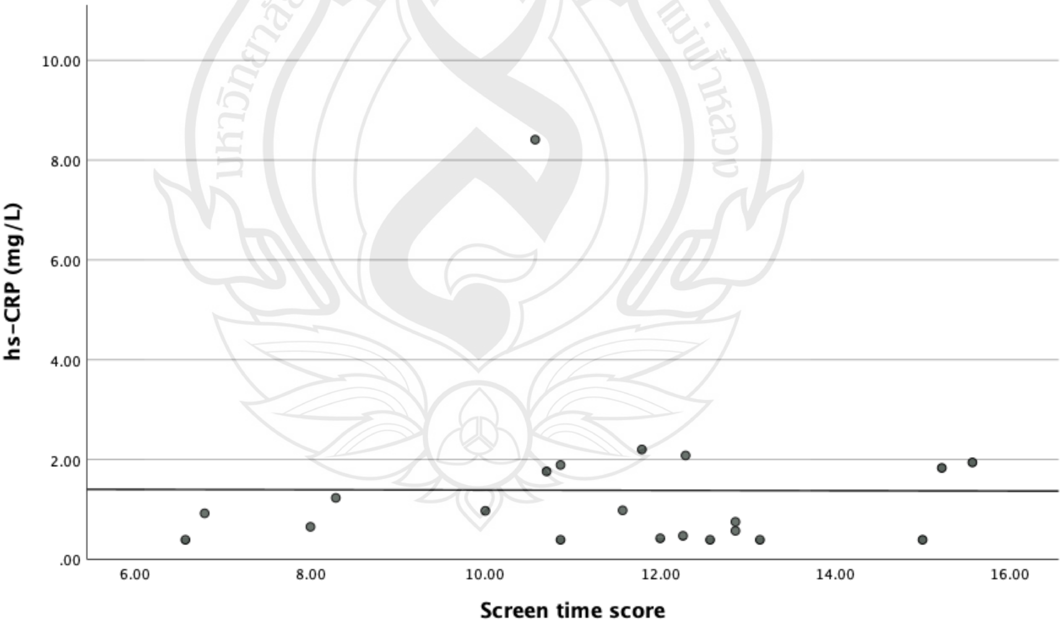

Figure 4.2 Scatter Plot Illustrating the Correlation Between Screen Time Score and Hs-CRP

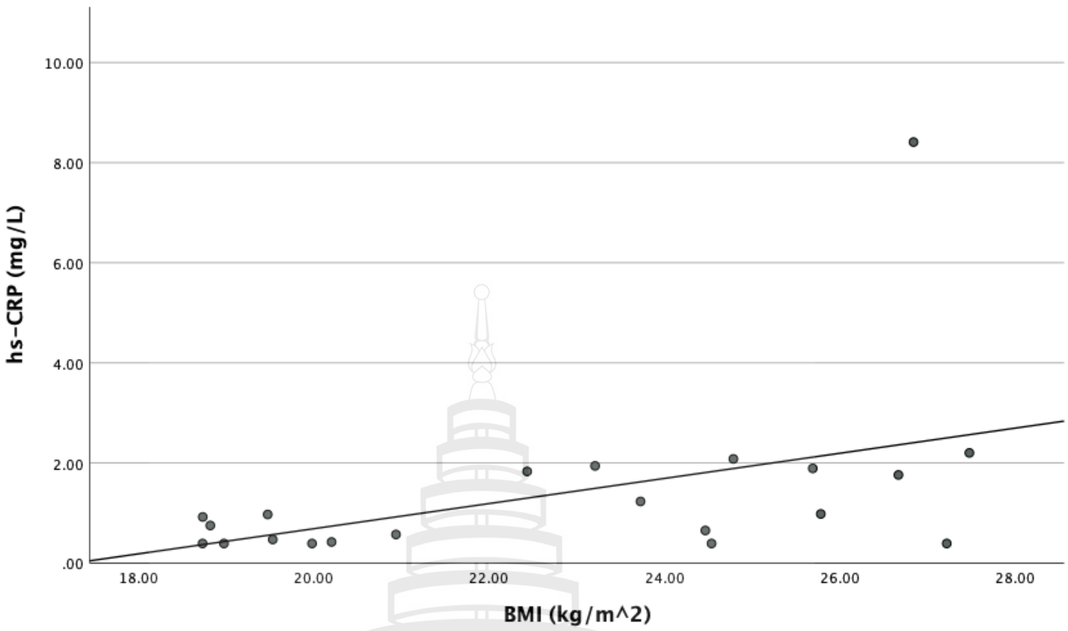

Figure 4.3 Scatter Plot Illustrating the Correlation Between Body Mass Index and Hs-CRP

4.3 The Association Between BMI and Total Physical Activity

Table 4.3 The Association Between BMI and Total Physical Activity Adequacy

BMI classification	Total Physical Activity Adequacy		Odds ratio (95%CI)	P-value
	Adequate (n=14)	Inadequate (n=7)		
Normal	7 (70.0)	3 (30.0)	Reference	
Overweight/ Obese I	7 (63.6)	4 (36.4)	0.75 (0.12, 4.66)	0.757

Note Data were analyzed with Chi-square test.

Table 4.3 shows the relationship between BMI and physical activity adequacy. It was found that 70% of the participants with normal weight had adequate physical activity and 30% had inadequate physical activity, while 63.6% of those who were overweight or obese had adequate physical activity and 36.4% had inadequate physical activity. The relationship between BMI classification and total physical activity adequacy was not statistically significant (P=0.758). However, considering the odds ratio value of 0.75 (95% CI 0.12, 4.66), it can be said that the odds of overweight or obese participants who had adequate physical activity are 0.75 times lower than normal weight participants.

CHAPTER 5

DISCUSSION, SUGGESTIONS AND CONCLUSION

5.1 Discussion

This research was aimed to study the association between hs-CRP and total physical activity and screen time in overweight and obese adults. The hypothesis was that total physical activity was negatively correlated with hs-CRP while screen time was positively correlated with hs-CRP in overweight and obese adults. The research was done in 21 healthy participants aged between 20 and 40 years old with BMI equal to or more than 18.5 kg/m^2. Total physical activity and screen time were collected by questionnaires and serum hs-CRP was collected for analysis.

Low physical activity and high screen time usage represents sedentary lifestyle, which could lead to higher risk of non-communicable diseases, including obesity and cardiovascular diseases (Park et al., 2020). So hs-CRP, one of the cardiovascular markers, was studied in this research. The benefits of this study are to identify the increased risk of developing cardiovascular disease in overweight and obese adults and to use as reference data for future studies.

From the statistical analysis, BMI had a significant moderate negative correlation with hs-CRP, whereas total physical activity and screen time had no significant correlation with hs-CRP. The findings were as follows:

Table 4.2 showed the correlation between total physical activity, screen time, and body mass index with hs-CRP levels by using Pearson correlation. According to the results, BMI was moderately positively correlated with hs-CRP, which was consistent with previous studies in children and adults (Blaha et al., 2011; Dayal et al., 2014; Kitsios et al., 2013).

However, total physical activity had no significant correlation with hs-CRP, which was different from the previous study with a result of significant but weak inverse correlation between physical activity and quantitative CRP, with an average total physical activity of 623 MET-minutes/day (Esteghamati et at., 2012) The median total physical activity of this research is 1,120 MET-minutes/week (IQR 200,1615), which is a lot less. The different results may be due to our research sample's low physical activity, which was too little to affect hs-CRP.

Moreover, screen time had no significant correlation with hs-CRP. This was inconsistent with a previous study about the association between sedentary behaviors and cardio-metabolic biomarkers which showed that longer television screen time was significantly associated with higher C-reactive protein (Nang et al., 2013).

A recent study showed that people with high physical activity had lower hs-CRP compared to people with low physical activity, but the results may be due to more overweight and obese participants in the low physical activity group (Aljaloud et al., 2022). So, in this research, we studied the association between BMI (normal weight and overweight/obese group) and total physical activity adequacy (adequate and inadequate), of which more than 600 MET-minutes/week was considered adequate. The results were not significant, which means that the number of normal weight participants who had adequate total physical activity were not significantly different from the overweight and obese group. However, according to the odds ratio, the odds of overweight or obese participants who had adequate physical activity are 0.75 times lower than normal weight participants.

The limitation of this study was the data collection method. Questionnaires were used to record total physical activity and screen time usage. Therefore, the participants need to recall their memory of their daily physical activity and the amount of time they spent in front of a screen throughout the week, which could possibly lead to inaccurate answers and results. The confounding factor between physical activity and hs-CRP level is obesity, since people with obesity tend to have lower physical activity and higher level of hs-CRP.

The results do not support the research conceptual framework. It was shown that physical inactivity and screen time, which are the measures of sedentary behaviors, had no significant effect on hs-CRP in overweight and obese adults. However, BMI does significantly affect hs-CRP, therefore, weight reduction could help reduce hs-CRP. In the field of anti-aging medicine, the findings contribute to the idea of encouraging people to lose weight, aiming to decrease the risk of cardiovascular diseases and other age-related diseases.

5.2 Suggestions

5.2.1 Further Studies on the Association Between Sedentary Behaviors and Hs-CRP

According to this research, there is no significant association between physical activity, screen time and hs-CRP. However, there are still some other sedentary behaviors that could be studied, for example, time spent sitting or lying down.

5.2.2 Considering Other Markers for Inflammation and Cardiovascular Diseases

Apart from hs-CRP, there are other markers related to inflammation and cardiovascular diseases that could be studied, for example, arterial stiffness, and inflammatory markers like erythrocyte sedimentation rate (ESR), fibrinogen, and interleukin-6 (IL-6).

5.2.3 1 Further Studies on the Association Between Physical Activity Intensity and Hs-CRP

There is no significant association between physical activity and hs-CRP in this study, while a previous study with a higher level of average physical activity compared to this study had a significant association. Therefore, the amount and intensity of physical activity might have an influence on hs-CRP, while too little physical activity could not affect hs-CRP.

5.3 Conclusion

According to our study, total physical activity and screen time had no significant correlation with hs-CRP in overweight and obese adults. However, BMI had a significant moderate negative correlation with hs-CRP.

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APPENDICES

APPENDIX A

ETHICAL APPROVAL

The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel: (053) 917-170 to 71, (053) 916-551 Fax: (053) 917-170 E-mail: rec.human@mfu.ac.th

CERTIFICATE OF APPROVAL

COA: 223/2023 Protocol No: EC 23166-20

Title:	THE ASSOCIATION BETWEEN TOTAL PHYSICAL ACTIVITY, SCREEN TIME AND HS-CRP IN OVERWEIGHT AND OBESE ADULTS
Principal investigator:	Suchanart Tangchitnob, M.D.
School:	Anti Aging and Regenerative Medicine
Funding support:	Personal Budget

Approval:

1) Research protocol	Version 2 Date October 29, 2023
2) Information sheet and informed consent documents	Version 2 Date October 29, 2023
3) Questionnaires	Version 2 Date October 29, 2023
4) Record forms	Version 2 Date October 29, 2023
5) Research participant recruitment information	Version 2 Date October 29, 2023

6) Principal investigator and Co-investigators
- Suchanart Tangchitnob, M.D. - Vitoon Jularattanaporn, M.D., Ph.D.

The aforementioned documents have been reviewed and approved by the Mae Fah Luang University Ethics Committee on Human Research in compliance with international guidelines such as Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use - Good Clinical Practice (ICH GCP)

Date of Approval:	November 18, 2023
Date of Expiration:	November 17, 2024
Frequency of Continuing Review:	1 year

(Assoc. Prof., Maj. Gen. Sangkae Chamnanvanakij, M.D.)
Chairperson of the Mae Fah Luang Ethics Committee on Human Research

AL 02_1/2022 Certificate of Approval หน้า 3 จาก 4

The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel: (053) 917-170 to 71, (053) 916-551 Fax: (053) 917-170 E-mail: rec.human@mfu.ac.th

หนังสือรับรองด้านจริยธรรมการวิจัย

COA: 223/2023 **รหัสโครงการวิจัย: EC 23166-20**

ชื่อโครงการวิจัย : การศึกษาความสัมพันธ์ระหว่างกิจกรรมทางกาย การใช้เวลาหน้าจอ กับค่าซี-รีแอคทีฟโปรตีนความไวสูงในอาสาสมัครที่มีภาวะน้ำหนักเกินและภาวะอ้วน

ชื่อผู้วิจัยหลัก: แพทย์หญิง สุชานาถ ตั้งจิตนบ

สำนักวิชา: เวชศาสตร์ชะลอวัยและฟื้นฟูสุขภาพ

ผู้สนับสนุนทุนวิจัย: ทุนส่วนตัว

การรับรอง :

(1) โครงร่างการวิจัย ฉบับที่ 2 วันที่ 29 ตุลาคม 2566
(2) เอกสารข้อมูลและขอความยินยอมเข้าร่วมการวิจัย ฉบับที่ 2 วันที่ 29 ตุลาคม 2566
(3) แบบสอบถาม ฉบับที่ 2 วันที่ 29 ตุลาคม 2566
(4) แบบบันทึกข้อมูล ฉบับที่ 2 วันที่ 29 ตุลาคม 2566
(5) ข้อมูลประชาสัมพันธ์รับสมัครผู้เข้าร่วมวิจัย ฉบับที่ 2 วันที่ 29 ตุลาคม 2566
(6) ผู้วิจัย และผู้วิจัยร่วม
- แพทย์หญิง สุชานาถ ตั้งจิตนบ - อาจารย์ ดร. นพ. วิทูร จุลรัตนาภรณ์

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณารับรองจากคณะกรรมการ จริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง ว่าสอดคล้องกับแนวทางจริยธรรมสากล ได้แก่ ปฏิญญาเฮลซิงกิ (Declaration of Helsinki) รายงานเบลมองต์ (Belmont Report) แนวทางจริยธรรมสากลสำหรับการวิจัยในมนุษย์ของสภาองค์การสากลด้านวิทยาศาสตร์การแพทย์ (CIOMS) และแนวทางการปฏิบัติการวิจัยที่ดี (ICH GCP)

วันที่รับรองด้านจริยธรรมของโครงร่างการวิจัย: 18 พฤศจิกายน 2566
วันสิ้นสุดการรับรอง: 17 พฤศจิกายน 2567
ความถี่ของการส่งรายงานความก้าวหน้าของการวิจัย: 1 ปี

ลงนาม ....
(รองศาสตราจารย์ พลตรีหญิง แพทย์หญิง แสงแข ชำนาญวนกิจ)
ประธานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง

APPENDIX B

INFORMED CONSENT FORM

Version 2 Date 29 ตุลาคม 2566 AP 03_1/2022

หนังสือแสดงความยินยอมเข้าร่วมการวิจัย

ข้าพเจ้า ______________________________ ตัดสินใจเข้าร่วมการวิจัยเรื่อง การศึกษาความสัมพันธ์ระหว่างกิจกรรมทางกาย การใช้เวลาหน้าจอ กับค่าซี-รีแอคทีฟโปรตีนความไวสูงในอาสาสมัครที่มีภาวะน้ำหนักเกินและภาวะอ้วน ซึ่งข้าพเจ้าได้รับข้อมูลและคำอธิบายเกี่ยวกับการวิจัยนี้แล้ว และได้มีโอกาสซักถามและได้รับคำตอบเป็นที่พอใจแล้ว ข้าพเจ้ามีเวลาเพียงพอในการอ่านและทำความเข้าใจข้อมูลในเอกสารให้ข้อมูลสำหรับผู้เข้าร่วมการวิจัยอย่างถี่ถ้วน และได้รับเวลาเพียงพอในการตัดสินใจว่าจะเข้าร่วมการวิจัยนี้

ข้าพเจ้ารับทราบว่าข้าพเจ้าสามารถปฏิเสธการเข้าร่วมการวิจัยนี้ได้โดยอิสระ และระหว่างการเข้าร่วมการวิจัย ข้าพเจ้ายังสามารถถอนตัวออกจากการวิจัยได้ทุกเมื่อ โดยไม่ส่งผลกระทบต่อการดูแลรักษา หรือสิทธิที่ข้าพเจ้าพึงมี

โดยการลงนามนี้ ข้าพเจ้าไม่ได้สละสิทธิใด ๆ ที่ข้าพเจ้าพึงมีตามกฎหมาย และหลังจากลงนามแล้ว ข้าพเจ้าจะได้รับเอกสารข้อมูลและขอความยินยอมไว้จำนวน 1 ชุด

ลายมือชื่อผู้เข้าร่วมการวิจัย ____________________ วัน-เดือน-ปี __________

(____________________)

.... (กรณีที่ผู้เข้าร่วมการวิจัยอ่านหนังสือไม่ออกแต่ฟังเข้าใจ) ....

ข้าพเจ้าไม่สามารถอ่านหนังสือได้ แต่ผู้วิจัยได้อ่านข้อความในเอกสารข้อมูลและขอความยินยอมนี้ให้แก่ข้าพเจ้าฟังจนเข้าใจดีแล้ว ข้าพเจ้าจึงลงนามหรือพิมพ์ลายนิ้วมือของข้าพเจ้าในหนังสือนี้ด้วยความสมัครใจ

ลงนาม/พิมพ์ลายนิ้วมือผู้เข้าร่วมการวิจัย ____________________ วัน-เดือน-ปี __________

(____________________)

ลายมือชื่อผู้ขอความยินยอม ____________________ วัน-เดือน-ปี __________

(____________________)

THE MAE FAH LUANG UNIVERSITY
ETHICS COMMITTEE ON HUMAN RESEARCH
1 8 NOV 2023
APPROVED

Version 2 Date 29 ตุลาคม 2566 AP 03_1/2022

คำรับรองของพยานผู้ไม่มีส่วนได้เสียกับการวิจัย (กรณีที่ผู้เข้าร่วมการวิจัยอ่านหนังสือไม่ออกแต่ฟังเข้าใจ)

ข้าพเจ้าได้อยู่ร่วมในกระบวนการขอความยินยอมและยืนยันว่า ผู้ขอความยินยอมได้อ่าน/อธิบายเอกสารข้อมูลให้แก่ ______________________ ซึ่งผู้มีชื่อข้างต้นมีโอกาสซักถามข้อสงสัยต่าง ๆ และได้ให้ความยินยอมเข้าร่วมการวิจัยโดยอิสระ หลังจากรับทราบข้อมูลที่มีอยู่ตรงตามที่ปรากฏในเอกสารนี้แล้ว

ลายมือชื่อพยาน ______________________ วัน-เดือน-ปี __________

(______________________)

กรณี อาสาสมัครที่เป็นเด็ก อายุน้อยกว่า 18 ปี หรือเป็นบุคคลที่มีปัญหาทางจิตหรือสติปัญญา ต้องได้รับการปกป้องคุ้มครองเป็นพิเศษ

ข้าพเจ้าในฐานะ ______________________ กับผู้เข้าร่วมการวิจัย ได้อ่านข้อความข้างต้นและมีความเข้าใจดีทุกประการแล้ว ยินยอมให้ ด.ช./ด.ญ./นาย/นาง/นางสาว __________________ เข้าร่วมการวิจัยด้วยความสมัครใจ จึงได้ลงนามในเอกสารใบยินยอมนี้

ลายมือชื่อผู้แทนโดยชอบธรรม/ผู้ปกครอง______________________ วัน-เดือน-ปี __________

(______________________)

THE MAE FAH LUANG UNIVERSITY
ETHICS COMMITTEE ON HUMAN RESEARCH
18 NOV 2023
APPROVED

APPENDIX C

CASE RECORD FORM

Code: ____

Case Record Form

เพศ ____________ อาชีพ ______________________ เบอร์ติดต่อ _______________

วัน/เดือน/ปีเกิด ______________________ อายุ__________

น้ำหนัก (kg) _____________ ☐ Underweight (<18.5 kg/ m²)

ส่วนสูง (cm) ___________ ☐ Normal weight (18.5-22.9 kg/ m²)

BMI (kg/m²) ___________________ ☐ Overweight (23.0-24.9 kg/ m²)

☐ Obese Class I (25.0-29.9 kg/ m²)

☐ Obese Class I (≥30 kg/ m²)

บุหรี่ ☐ ไม่สูบ ☐ สูบ ☐ เคยสูบ เลิกมานาน ___________

สุรา ☐ ไม่ดื่ม ☐ ดื่ม ปริมาณ ____________________

แพ้ยา/อาหาร/สารเคมี ☐ ไม่แพ้ ☐ แพ้ ____________________

ได้รับการผ่าตัด/อุบัติเหตุ/การติดเชื้อภายในระยะเวลา 2 สัปดาห์หรือไม่ ☐ ไม่ใช่ ☐ ใช่

โรคประจำตัว ☐ ไม่มี ☐ มี ได้แก่ ____________________

ยา/อาหารเสริม ☐ ไม่มี ☐ มี ได้แก่ ____________________

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Code: ____

GPAQ Questionnaire

- Activity at work
  - Vigorous Intensity Exercise: 8 * _______ day * _______ min = __________
  - Moderate Intensity Exercise: 4 * _______ day * _______ min = __________
- Travel to and from places: 4 * _______ day * _______ min = __________
- Recreational activities
  - Vigorous Intensity Exercise: 8 * _______ day * _______ min = __________
  - Moderate Intensity Exercise: 4 * _______ day * _______ min = __________
- TPA (MET-minutes/week) = ______________________

☐ Inadequate (<600 MET-minutes/week) ☐ Adequate (≥600 MET-minutes/week)

Screen Time Questionnaire

- Screen use: Average weekday _______ hr _______ min

  Average weekend _______ hr _______ min

  Screen time (hr) = (5 * _______ + 2 * _______) / 7 = ____________
- Background Screen use: Average weekday _______ hr _______ min

  Average weekend _______ hr _______ min

  Background Screen time (hr) = (5 * _______ + 2 * _______) / 7 = ____________
- Total Screen Time (hr) = ______________________

Hs-CRP Level

Hs-CRP (md/L) ______________________

☐ Low Risk (<1 mg/L)

☐ Intermediate Risk (1-3 mg/L)

☐ High Risk (>3 mg/L)

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APPENDIX D

GPAQ QUESTIONNAIRE

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แบบสอบถามเรื่องกิจกรรมทางกาย (Global Physical Activity Questionnaire)		
แบบสอบถามนี้จะถามเกี่ยวกับระยะเวลาที่ท่านใช้ในการทำกิจกรรมทางกายต่างๆใน 1 สัปดาห์ กำหนดให้กิจกรรมระดับหนัก (vigorous-intensity activity) หมายถึงการใช้แรงแบบหนัก อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นมาก ส่วนกิจกรรมระดับหนักพอควร (moderate-intensity activity) หมายถึงการใช้แรงแบบพอสมควร อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นเล็กน้อย		
คำถาม		**คำตอบ**
กิจกรรมขณะทำงาน		
คำถามต่อไปนี้จะถามเกี่ยวกับกิจกรรมที่ท่านทำขณะทำงาน เช่น ทำงานออฟฟิศ ทำงานยกของ แม่บ้าน		
1	งานที่ท่านทำมีกิจกรรมระดับหนัก ซึ่งทำให้อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นมาก นานติดต่อกันอย่างน้อย 10 นาทีหรือไม่ เช่น	☐ ใช่ ☐ ไม่ใช่ (ข้ามไปข้อที่ 4)
2	ท่านทำงานที่มีกิจกรรมระดับหนักกี่วันต่อสัปดาห์	จำนวน .... วัน
3	ท่านใช้เวลาในการทำกิจกรรมระดับหนักกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที
4	งานที่ท่านทำมีกิจกรรมระดับหนักพอควร ซึ่งทำให้อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นเล็กน้อย นานติดต่อกันอย่างน้อย 10 นาทีหรือไม่ เช่น	☐ ใช่ ☐ ไม่ใช่ (ข้ามไปข้อที่ 7)
5	ท่านทำงานที่มีกิจกรรมระดับหนักพอควรกี่วันต่อสัปดาห์	จำนวน .... วัน
6	ท่านใช้เวลาในการทำกิจกรรมระดับหนักพอควรกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที
การเดินทางไปสถานที่ต่างๆ		
คำถามต่อไปนี้จะถามเกี่ยวกับวิธีเดินทางที่ท่านใช้เพื่อไปสถานที่ต่างๆ เช่น ไปที่ทำงาน ไปชอปปิ้ง ไปตลาด เป็นต้น		
7	ท่านเดินหรือปั่นจักรยานนานติดต่อกันอย่างน้อย 10 นาที เพื่อเดินทางหรือไม่	☐ ใช่ ☐ ไม่ใช่ (ข้ามไปข้อที่ 10)
8	ท่านเดินหรือปั่นจักรยานนานติดต่อกันอย่างน้อย 10 นาที กี่วันต่อสัปดาห์	จำนวน .... วัน
9	ท่านใช้เวลาในการเดินหรือปั่นจักรยานกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที

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กิจกรรมนันทนาการ หรือ กิจกรรมยามว่าง		
คำถามต่อไปนี้จะถามเกี่ยวกับกิจกรรมนันทนาการ หรือกิจกรรมที่ท่านทำยามว่าง เช่น การเล่นกีฬา เข้าฟิตเนส		
10	ท่านทำกิจกรรมหรือเล่นกีฬาระดับหนัก ซึ่งทำให้อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นมาก นานติดต่อกันอย่างน้อย 10 นาทีหรือไม่ เช่น การวิ่ง เล่นฟุตบอล	☐ ใช่ ☐ ไม่ใช่ (ข้ามไปข้อที่ 13)
11	ท่านทำกิจกรรมหรือเล่นกีฬาระดับหนักกี่วันต่อสัปดาห์	จำนวน .... วัน
12	ท่านใช้เวลาในการทำกิจกรรมระดับหนักกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที
13	ท่านทำกิจกรรมหรือเล่นกีฬาระดับหนักพอควร ซึ่งทำให้อัตราการหายใจและอัตราการเต้นของหัวใจเพิ่มขึ้นเล็กน้อย นานติดต่อกันอย่างน้อย 10 นาทีหรือไม่ เช่น การเดิน ปั่นจักรยาน เล่นโยคะ	☐ ใช่ ☐ ไม่ใช่ (ข้ามไปข้อที่ 16)
14	ท่านทำกิจกรรมหรือเล่นกีฬาระดับหนักพอควรกี่วันต่อสัปดาห์	จำนวน .... วัน
15	ท่านใช้เวลาในการทำกิจกรรมระดับหนักพอควรกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที
พฤติกรรมเนือยนิ่ง (Sedentary Behavior)		
พฤติกรรมเนือยนิ่ง คือพฤติกรรมการนั่งหรือนอนในกิจกรรมต่างๆ เช่น การนั่งทำงาน การเดินทางโดยรถยนต์ การอ่านหนังสือ การดูโทรทัศน์ เป็นต้น (ไม่รวมเวลานอนหลับ)		
16	ท่านใช้เวลาในการนั่งหรือนอนเอนตัวกี่ชั่วโมง/นาทีต่อวัน	ระยะเวลา .... ชม. .... นาที

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APPENDIX E

SCREEN TIME QUESTIONNAIRE

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แบบสอบถามเรื่องการใช้เวลาหน้าจอ (Screen Time Questionnaire)		
สำหรับคำถามต่อไปนี้ กิจกรรมหลัก (primary activity) **หมายถึง** กิจกรรมที่ท่านตั้งใจทำเป็นหลัก ไม่ใช่การเปิดหน้าจอไว้ขณะทำกิจกรรมอย่างอื่น เช่น การเล่นกีฬา หรือทำอาหาร		
การใช้หน้าจอในวันจันทร์-ศุกร์		
ในวันจันทร์-ศุกร์ ปกติแล้วท่านใช้อุปกรณ์ต่อไปนี้เป็นกิจกรรมหลักกี่ชั่วโมง/นาทีต่อวัน		
	ชั่วโมง	**นาที**
โทรทัศน์		
อุปกรณ์ที่เชื่อมต่อโทรทัศน์ เช่น การสตรีมมิ่ง การเล่นวีดีโอเกม		
คอมพิวเตอร์/แล็ปท็อป		
มือถือ		
แท็บเล็ต		
การใช้หน้าจอในวันเสาร์-อาทิตย์		
ในวันเสาร์-อาทิตย์ ปกติแล้วท่านใช้อุปกรณ์ต่อไปนี้เป็นกิจกรรมหลักกี่ชั่วโมง/นาทีต่อวัน		
	ชั่วโมง	**นาที**
โทรทัศน์		
อุปกรณ์ที่เชื่อมต่อโทรทัศน์ เช่น การสตรีมมิ่ง การเล่นวีดีโอเกม		
คอมพิวเตอร์/แล็ปท็อป		
มือถือ		
แท็บเล็ต		
การใช้หน้าจอขณะทำกิจกรรมอื่น (Background Screen Use)		
สำหรับคำถามต่อไปนี้ การใช้หน้าจอขณะทำกิจกรรมอื่น หมายถึง การเปิดหน้าจอไว้ขณะทำกิจกรรมอย่างอื่นเป็นหลัก เช่น การเปิดโทรทัศน์ขณะออกกำลังกายหรือรับประทานอาหาร		
	ชั่วโมง	**นาที**
การใช้หน้าจอขณะทำกิจกรรมอื่นในวันจันทร์-ศุกร์		
การใช้หน้าจอขณะทำกิจกรรมอื่นในวันเสาร์-อาทิตย์		

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CURRICULUM VITAE

NAME	Suchanart Tangchitnob

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