Risk of Post-Traumatic Stress Disorder and Changing of
Cardiovascular Biomarkers among Bangkok Firefighters

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ความเสี่ยงต่อการเกิดภาวะความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและการเปลี่ยนแปลงสารบ่งชี้ทางชีวภาพของระบบหัวใจและหลอดเลือดในพนักงานดับเพลิงของกรุงเทพมหานคร

นางจินต์จุฑา ขำทอง

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      พนักงานดับเพลิงในเขตเมืองมีความเสี่ยงต่อการเกิดความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัย เนื่องจากต้องเผชิญ
เหตุการณ์ร้ายแรงจากการปฏิบัติงาน ภาวะเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยเป็นที่ยอมรับกันว่าเป็นปัญหา
สาธารณสุข เนื่องจากเชื่อมโยงกับผลกระทบด้านสุขภาพมากมายรวมถึงโรคหัวใจและหลอดเลือด การศึกษานี้แบ่งการศึกษาออกเป็น 2
ระยะ สำหรับระยะที่ 1 เป็นการศึกษาเชิงพรรณนาแบบภาคตัดขวาง เพื่อศึกษาความชุกของความเครียดจากการทำงานภายหลังเหตุการณ์
อัคคีภัยในพนักงานดับเพลิงของกรุงเทพมหานครและศึกษาปัจจัยที่มีความสัมพันธ์ การศึกษาระยะที่ 2 เป็นการศึกษาวิจัยระยะยาว เพื่อ
ศึกษาถึงความสัมพันธ์ระหว่างความเสี่ยงต่อการเกิดความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและการเปลี่ยนแปลงสารบ่งชี้ทาง
ชีวภาพของโรคหัวใจและหลอดเลือด (Brain Natriuretic Peptide (BNP), Troponin T (TnT), and high-
sensitive C-reactive protein (hs-CRP)) หลังจากการติดตามเป็นระยะเวลา 6 เดือน ในระยะแรกของ
การศึกษา คัดเลือกพนักงานดับเพลิงในกรุงเทพมหานครด้วยแบบสอบถาม พบว่า 302 คนจาก 1215 คน (24.90%) ของพนักงาน
ดับเพลิง มีผลคะแนนในระดับที่เท่ากับจุดตัดที่แนะนำ(คะแนน PCL-C $\geq$ 30) ปัญหาสุขภาพ, การสูบบุหรี่, การดื่มเครื่องดื่ม
แอลกอฮอล์, การออกกำลังกาย, คุณภาพการนอนหลับ, ประสบการณ์การทำงาน, ประสบการณ์เผชิญเหตุอัคคีภัย มีความสัมพันธ์กับความ
เสี่ยงต่อการเกิดความเครียดจากการทำงานภายหลังเหตุการณ์ (p-value<0.05) ในระยะที่ 2 พนักงานดับเพลิงทุกคนใน 2 สถานี
ดับเพลิงที่ผ่านการคัดเลือกเข้าร่วมการศึกษา การตรวจเลือดดำเนินการในเดือนสิงหาคม 2560 และเดือนกุมภาพันธ์ 2561 พนักงาน
ดับเพลิง 19 คนมีความเสี่ยงต่อการเกิดความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและ 35 คนไม่พบความเสี่ยง Brain-
derived neurotrophic factor (BDNF) เป็นสารที่เซลล์ใช้ในการสื่อสารระหว่างกันสะท้อนถึงความทรงจำในระยะยาว และ
ยังเป็นสารบ่งชี้ทางชีวภาพของความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัย การศึกษาระยะที่ 2 ในขั้นต้นพบว่าระดับ BDNF
มีความแตกต่างอย่างมีนัยสำคัญในพนักงานดับเพลิงที่มีและไม่มีความเสี่ยงต่อการเกิดความเครียดจากการทำงานภายหลังเหตุการณ์
อัคคีภัย สารบ่งชี้ทางชีวภาพของโรคหัวใจและหลอดเลือด 2 ชนิด (hs-CRP and BNP) มีความสัมพันธ์กับความเครียดจาก
การทำงานภายหลังเหตุการณ์อัคคีภัย ภายหลังการติดตาม 6 เดือน 27.8% ของพนักงานดับเพลิงหายไปจากการศึกษาและพนักงานดับเพลิง
อีก 14 คนถูกคัดออกจากการศึกษา เนื่องจากผลการตรวจเลือดไม่สมบูรณ์ พบว่าพนักงานดับเพลิง 12 คนมีความเสี่ยงต่อการเกิด
ความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและอีก 13 คนไม่พบความเสี่ยง ข้อมูลส่วนบุคคลยังคงไม่มีความแตกต่างจาก
การศึกษาในขั้นต้น (p-value>0.05) ผลการศึกษาพบว่ามีเพียง BNP เท่านั้นที่มีความสัมพันธ์กับความเสี่ยงต่อการเกิด
ความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัย (adjusted OR=31.22) กล่าวโดยสรุปคือ พนักงานดับเพลิงที่มีความเสี่ยงต่อ
การเกิดความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัย จะมีโอกาสเพิ่มความเสี่ยงต่อการเปลี่ยนแปลงสารบ่งชี้ทางชีวภาพของ
โรคหัวใจและหลอดเลือด โครงการและนโยบายที่เกี่ยวข้องกับการจัดการกับปัญหาสุขภาพจิตในพนักงานดับเพลิงควรได้รับการ
ส่งเสริม เพื่อช่วยลดความเสี่ยงต่อการเกิดโรคหัวใจและหลอดเลือด

5879152053 : DOCTOR OF PHILOSOPHY
Firefighters, Post-traumatic stress disorder (PTSD), Cardiovascular diseases (CVDs)

Chinchuta Khumtong : Risk of Post-Traumatic Stress Disorder and Changing of Cardiovascular Biomarkers among Bangkok Firefighters. ADVISOR: Asst. Prof. Nutta Taneepanichskul, Ph.D., Pairoj Chattranukulchai, M.D.

Urban firefighters are at risk of posttraumatic stress disorder (PTSD) because of their occupational exposure to trauma event. PTSD has been recognized as public health problem because it links to many health consequences including cardiovascular disease. This study was conducted in 2 phases. The first phase; a cross-sectional study, was aimed to determine a prevalence of risk of PTSD among all Bangkok firefighters and to access its associated factors. The second phase; a longitudinal study, aimed to access an association between risk of PTSD and changes of cardiovascular biomarker (Brain Natriuretic Peptide (BNP), Troponin T (TnT), and high-sensitive C-reactive protein (hs-CRP)) after 6-months follow-up. In the first phase of the study, all Bangkok firefighters were recruited for self-reported questionnaire. 302 of 1215 firefighters (24.90%) were met the suggested PCL cut-point criteria for civilian (PCL Scores $\geq$ 30). Health problems, smoking status, alcohol consumption, physical activity, sleep quality, duration of work, and past exposure to major fire in Thailand were associated with risk of PTSD (p-value<0.05). In phase 2, all firefighters from 2 purposively selected firefighter stations were recruited to participate. Blood check-up was performed in August, 2017 and February, 2018. 19 risk of PTSD and 35 non-risk of PTSD firefighters were participated. Brain-derived neurotrophic factor (BDNF), which is a member of the neurotrophin family of growth factors reflected for long-term memory, was investigated as a biomarker of PTSD. At baseline of study, the results showed a significant different BDNF concentration between risk of PTSD and non-risk of PTSD firefighters. Two cardiovascular biomarkers (hs-CRP and BNP) were associated with PTSD. After 6 month follow-up, 27.8% of firefighters were loss to follow-up and 14 of them were excluded because of blood samples. 12 risk of PTSD and 13 non-risk of PTSD firefighters were completed follow-up. General characteristic of remained firefighters was not different from baseline (p-value>0.05). The results showed that only BNP was associated with risk of PTSD (adjusted OR=31.22). In conclusion, firefighter at risk of PTSD was increased risk of cardiovascular biomarker change. Further intervention and policy related to coping mental health among firefighter should be introduced for reducing the risk of cardiovascular disease.

Department:	Common Course	Student's Signature ....
Field of Study:	Public Health	Advisor's Signature ....
Academic Year:	2018	Co-advisor's Signature ....

ACKNOWLEDGEMENTS

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INTRODUCTION

1.1 Background and rationale

Firefighters are one of the most challenging and dangerous professions. When a building or structure is on fire, firefighters are often the first responders to the scene. Leading to a possibility to expose with several health hazards in the fire scene such as physical accident (Szubert & Sobala, 2000), heat stress (Smith, Petruzzello, Chludzinski, Reed, & Woods, 2001), noise exposure (Neitzel, Hong, Quinlan, & Hulea, 2013), numerous chemical in fire smoke (Reh & Weber, 2004) and mental stress (Pelham, 2016). The roles of the firefighters are recognized as extremely dangerous and hazardous working environments which can causes not only physical injuries but also trauma and mental or emotional impact among firefighters. Especially, post-traumatic stress disorder (PTSD), is mental disorders that developed in people after exposure with traumatic events, life threatening, threatened death, threatened sexual violence or serious injuries. The potential biomarker for determine severity and the onset of PTSD is the brain-derived neurotrophic factor (BDNF), which is the protein that stimulates the production of new brain cells and strengthens existing ones. When the firefighters face with fire or stressful situation is effect to the lower level of BDNF. An estimated 3.6% of the world's population has suffered from PTSD according to World Health Organization's study in 21 countries and causes of PTSD among the study population were witnessing violence or experiencing interpersonal violence, accidents, exposure to war or trauma (World Health Organization, 2013). Meanwhile, the estimated prevalence of PTSD among

firefighters was varied from 57% to 9.7% (Alghamd, Hunt, & Thomas, 2013), (Saijo, Ueno, & Hashimoto, 2012). Moreover, post-traumatic stress disorder (PTSD) is linked to many health symptoms or diseases including sleep apnea (Colvonen et al., 2015), fibromyalgia (Usui et al., 2013), suicide (Krysinska & Lester, 2010) and cardiovascular disease (Burg & Soufer, 2016).

The U.S. National Fire Protection Association stated that job-related exposure have in chronic illnesses such as cancer, heart disease and in behavioral health issues that may end in suicide among the firefighters, moreover, the U.S. National Institute for Occupational Safety and Health reported on the risk to firefighters of cardiovascular conditions. According to U.S. firefighter fatalities report in 2017 revealed that Sudden cardiac death accounted for nearly half of all U.S. firefighters fatalities (29 deaths from 60 deaths) (Rita F. Fahy, Paul R. LeBlance, & Molis, 2018).

Firefighter Deaths by Nature of Injury -- 2017
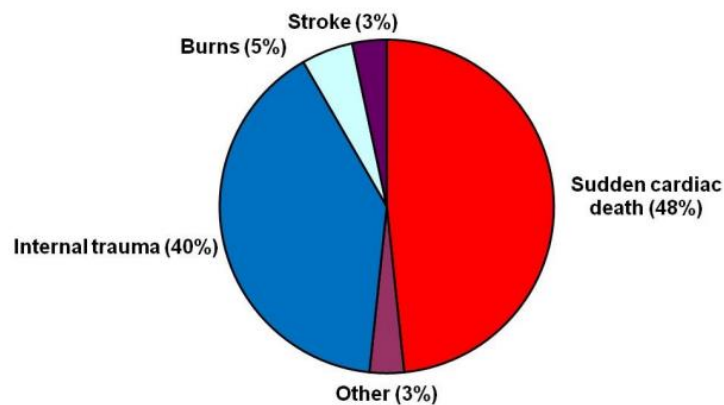
Figure 1.1 The 2017 U.S. firefighter fatalities
(Rita F. Fahy et al., 2018)

Cardiovascular disease is one of the leading cause of death among on-duty firefighters (Soteriades, Smith, Tsismenakis, Baur, & Kales, 2011) and caused by a combination of personal and workplace factors. For the personal risk factors are

increasing age, gender, tobacco used, alcohol, unhealthy diet, high cholesterol, high blood pressure, obesity or overweight, diabetes mellitus and physical inactivity (World Health Organization, 2017). High-sensitivity C-reactive protein (hs-CRP), Troponin T (TnT) and Brain natriuretic peptide (BNP) are the biomarkers to determine severity of cardiovascular disease, moreover these three biomarkers have been shown to be independent prognostic indicators of total and cardiac death during short- and long-term follow-up (Nilsen et al., 2015). For High-sensitivity C-reactive protein (hs-CRP), is a protein that increase in blood response to the inflammation in the body. The hs-CRP is used to predict the risk of developing heart disease and its complications, such as heart attacks, strokes, peripheral arterial disease, and sudden cardiac death. Troponin T (TnT), is cardiac regulatory protein that control the calcium mediated interaction between actin and myosin and release in blood response to the damages in the heart after a heart attack, and Brain natriuretic peptide (BNP) or B-type natriuretic peptide is the hormone secreted by cardiomyocytes in response to stretching caused by increased pressure load in the heart.

In addition, work-related factors of cardiovascular diseases among firefighters are fire smoke (complex mixture of heated gases, vapors, and particulate matter), increased of heart rates and heavy physical exertion, heat stress, shift work and overtime (National Institute for Occupational Safety and Health, 2007). Moreover, other factor contributed to risk of cardiovascular disease is stress (American Heart Association, 2014), especially, post-traumatic stress disorder (PTSD) leads to cardiovascular disease according to the summary of the clinical evidence and epidemiologic studies were revealed that persons who suffered from PTSD may have increased risk of coronary heart disease (Coughlin, 2011).

Post-traumatic stress disorder (PTSD) is link to cardiovascular diseases (CVDs), the mechanism between PTSD and CVDs is that PTSD leads to overactive of nerve activity, inflammatory consequences of PTSD, dysfunctional of the immune response and the activation of hormone system that controls blood pressure, result of these changes can ultimately increase risk of cardiovascular diseases (Brudey et al., 2015). Many studies indicated that the prevalence of PTSD among firefighters had more than in general population (Lee, Ahn, Jeong, Chae, & Choi, 2014). Therefore, firefighters might have higher chance of developed cardiovascular diseases than general population. However, the follow-up study of association between post-traumatic stress disorder (PTSD) and changing cardiovascular biomarkers among firefighters in a short time period is still limited.

In Thailand, the report of Department of Disaster Prevention and Mitigation, Ministry of Interior was revealed approximately 1,536 major fires per year (between 2006 to 2015) (Social and Quality of Life Database System, 2017). Moreover, most of the fire situations were occur in Bangkok Metropolitan (Department of Disaster Prevention and Mitigation, 2013). However, a concern and an evidence of firefighters' health risk and health status including post-traumatic stress disorder (PTSD) in Thailand are still limited. Therefore, this longitudical study aims to determine the association between risk of post-traumatic stress disorder (PTSD) and changes of cardiovascular biomarkers among Bangkok firefighters after 6-month follow-up.

1.2 Research questions

1.2.1 Does the risk of post-traumatic stress disorder (PTSD) associate with changes of cardiovascular biomarkers among firefighters after 6-month follow-up.

Phase I (Baseline: Overall firefighters in BKK)

1.2.2 What is the prevalence of risk of post-traumatic stress disorder (PTSD) among firefighters in Bangkok?

1.2.3 What are associated factors of risk of post-traumatic stress disorder (PTSD) among firefighters in Bangkok?

Phase II (Follow-up: Selected firefighters in BKK)

1.2.4 Does risk of post-traumatic stress disorder (PTSD) associate with cardiovascular biomarkers* at baseline?

1.2.5 Does risk of post-traumatic stress disorder (PTSD) associate with brain derived neurotrophic factor (BDNF) at baseline?

1.2.6 Are cardiovascular biomarkers* different between baseline and 6-month follow-up among PTSD and non PTSD-firefighters?

*Cardiovascular biomarkers include Hs-CRP, Troponin T, BNP

1.3 Research objective

1.3.1 General objective

1.3.1.1 To determine the association between risk of post-traumatic stress disorder (PTSD) and changes of cardiovascular biomarkers among firefighters after 6-month follow-up.

1.3.2 Specific objectives

Phase I (Baseline: Overall firefighters in BKK)

1.3.2.1 To determine the prevalence of risk of post-traumatic stress disorder (PTSD) among firefighters in Bangkok, Thailand.

1.3.2.2 To determine the associated factors of risk of post-traumatic stress disorder (PTSD) among Bangkok firefighters.

Phase II (Follow-up: Selected firefighters in BKK)

1.3.2.3 To access an association between risk of post-traumatic stress disorder (PTSD) and cardiovascular biomarkers* at baseline.

1.3.2.4 To access an association between risk of post-traumatic stress disorder (PTSD) and brain derived neurotrophic factor (BDNF) at baseline.

1.2.3.5 To compare the cardiovascular biomarkers* from baseline to 6-month follow-up among PTSD and non PTSD-firefighters.

*Cardiovascular biomarkers include Hs-CRP, Troponin T, BNP

1.4 Hypothesis

1.4.1 Post-traumatic stress disorder checklist-civilian version (PCL-C Thai version) scores was associate with risk of post-traumatic stress disorder (PTSD).

1.4.2 Demographic information and working characteristics were associate with risk of post-traumatic stress disorder (PTSD).

1.4.3 Risk of post-traumatic stress disorder (PTSD) was associate with brain derived neurotrophic factor (BDNF) at baseline.

1.4.4 Risk of post-traumatic stress disorder (PTSD) was associate with high-sensitivity C-reactive protein (hs-CRP) at baseline and 6 month follow-up.

1.4.5 Risk of post-traumatic stress disorder (PTSD) was associate with troponin T (TnT) at baseline and 6 month follow-up.

1.4.6 Risk of post-traumatic stress disorder (PTSD) was associate with brain natriuretic peptide (BNP) at baseline and 6 month follow-up.

1.4.7 Risk of post-traumatic stress disorder (PTSD) was associate with change of high-sensitivity C-reactive protein (hs-CRP) from baseline and 6 month follow-up.

1.4.8 Risk of post-traumatic stress disorder (PTSD) was associate with change of troponin T (TnT) from baseline and 6 month follow-up.

1.4.9 Risk of post-traumatic stress disorder (PTSD) was associate with change of brain natriuretic peptide (BNP) from baseline and 6 month follow-up.

*Cardiovascular biomarkers include Hs-CRP, Troponin T, BNP

1.5 Conceptual Framework

Independent Variable

Demographic Information
- Age
- Body mass index (BMI)
- Health status
- Alcohol consumption
- Smoking status
- Secondhand smoking exposure
- Physical activity
- Sleep quality

Working Characteristics
- Duration of work
- Past exposure to a major fire
- Fire training course
- Mental training course

Post-traumatic stress disorder (PTSD)
- PTSD Scores
- Brain-derived neurotrophic factor (BDNF) Level

Covariate Factors of CVD
- Cholesterol
- LDL, HDL
- Blood pressure
- Heart rate

Dependent Variable

Cardiovascular biomarkers
- Blood biomarker associate with CVD
  - Hs-CRP
  - Troponin T
  - BNP

1.6 Operational Definitions

    1.6.1 Post-traumatic stress disorder (PTSD) is psychiatric disorder that developed in people after experienced shocking, scary, dangerous event or extremely traumatic events.

(American Psychiatric Association, 2018)

    In this study, post-traumatic stress disorder checklist-civilian version (PCL-C) Thai version to determine firefighters with PTSD and without PTSD according to DSM-IV was utilized. The cut-off point of 30 was applied to classify firefighters with PTSD (PCL-C scores $\geq$ 30) and firefighters without PTSD (PCL-C scores < 30).

    1.6.2 Brain-derived neurotrophic factor (BDNF) is a neurotrophin that serves as survival factor for induce the development, function of central nervous system (CNS) neurons and plays a role in the limbic system by regulating synaptic plasticity, memory processes and behavior (Angelucci et al., 2014). BDNF protein was effect in response to stress, person with stressful was report lower level of BDNF. In this study, BDNF was quantified as nanogram per milliliter (ng/mL).

    1.6.3 Cardiovascular biomarkers are the biological parameters to identify or diagnose the risk of cardiovascular diseases. In this study there are 3 biomarkers to be used for determine cardiovascular disease including High-sensitivity C-reactive protein (hs-CRP), Troponin T (TnT) and Brain natriuretic peptide (BNP).

    High-sensitivity C-reactive protein (hs-CRP) is the protein that increasing in

blood after inflammation and/or infection include the following symptoms are surgery, heart attack, trauma. The high-sensitivity CRP test measures low levels of CRP in the blood to identify low levels of inflammation that are associated with risk of developing cardiovascular disease. Hs-CRP is increase in person with acute stage of myocardial infraction and indicate the higher level in person with risk of cardiovascular disease.

Troponin T (TnT) is proteins found in heart muscle and are released into the blood when there are damages to the heart, after a heart attack or after the angina (chest pain related to heart trouble) worsens. Troponin T is release in acute stage of person with myocardial infraction and higher in person with risk of cardiovascular disease.

Brain natriuretic peptide (BNP) is primarily used to help detect, diagnose, and evaluate the severity of heart failure. BNP is a substance that are produced in the heart and released when the heart is stretched and working hard to pump blood. Person with risk of cardiovascular disease have the higher level of BNP.

(American Association for Clinical Chemistry, 2015c).

1.6.4 Covariate factors of cardiovascular disease are the factors that associated with cardiovascular disease. The covariate factors of cardiovascular disease in this study were blood pressure, heart rate, cholesterol, high-density lipoproteins (HDL), low-density lipoproteins (LDL).

1.6.5 Follow-up month refer to study period to follow the change of

cardiovascular biomarkers among Bangkok firefighters. In this study, the follow-up

period were 6 months.

1.6.6 Mental training course refer to the training course that provides the

personal development in coping with stress.

1.6.7 Sleep quality is explained as the satisfaction of the sleep experience,

sleep quantity, and refreshment upon awakening.

In this study, sleep quality was used the Pittsburgh sleep quality index (PSQI)

questionnaires to determine the sleep quality of firefighters

1.6.8   Major fire in Thailand is classified based on fire danger period and

consequences of fire and including the potential for property, environment damage /

endangering safety of personnel of the fire incident. In this study, major fire is the

serious fires that harm people or cause damage to the property more than 50 million

baht and/or the major cause of environment damage.

1.6.9 Physical activity is defined as any bodily movement produced by

skeletal muscles that requires energy expenditure. Recommended levels of physical

activity for adults aged 18 - 64 years should do at least 150 minutes of moderate-

intensity aerobic physical activity throughout the week.

In this study, physical activity refers to continuous body movement at least

twenty minutes per time (average from WHO recommendation, 150 minutes per

week).

(World Health Organization, 2010)

CHAPTER II
LITERATURE REVIEW

Post-traumatic stress disorder (PTSD) is the mental illness that developed in person after experiencing with traumatic events. Previous studies indicated that PTSD is associated with many health effects and diseases, especially Cardiovascular diseases (CVDs). In general population can be developed PTSD by directly experience with traumatic events, witnessing the trauma, learning that a relative or close friend was exposed to trauma. Meanwhile, firefighters can be developed PTSD in the same way as in general population, however role of the firefighters have to repeated directly exposure with traumatic events and/or indirect exposure to aversive details of trauma. Therefore, firefighters might have higher chance to developed PTSD and CVDs than in general population.

2.1 Post-traumatic stress disorder (PTSD)

Post-traumatic stress disorder or PTSD is the mental problem that develop in people who have experienced a shocking, scary, or dangerous event, and after that trauma people may have upsetting memories, feel on edge, or have trouble sleeping, these symptoms might be effect to daily living activities. There are many cause of PTSD such as combat experience, sexual or physical assault, accident, physical abuse, terrorist attacks, natural disasters, and fire events (National Center for PTSD, 2018).

According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) was include the post-traumatic stress disorder (PTSD) in trauma and stressor-related disorders category which focus on the disorder that relating to

exposure with a stressful event as a precondition, however, not all stressful events are involve in trauma for the DSM-5 definition. For diagnose PTSD were required the following criteria:

Criterion A;   The person who exposed to trauma such as death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence.

Criterion B;   Persistently re-experienced about that trauma.

Criterion C;   Avoidance of trauma-related stimuli after the trauma.

Criterion D;   Negative thoughts after the trauma.

Criterion E;   Trauma-related arousal and reactivity that began after the trauma.

Criterion F;   Symptoms last for more than 1 month.

Criterion G;   Symptoms create distress or functional impairment.

Criterion H;   Not include the symptoms that due to medication, substance use, or other illness.

(American Psychiatric Association, 2013).

Furthermore, PTSD Checklist (PCL) is another way to screening individuals for PTSD, aiding in diagnostic assessment of PTSD and monitoring change in PTSD symptoms. There are three versions of the PCL according to DSM-IV including

- The PCL-M (military version) asks about symptoms in response to "stressful military experiences."

- The PCL-C (civilian version) asks about symptoms in relation to generic "stressful experiences" and can be used with any population.

- The PCL-S (specific) asks about symptoms in relation to an identified "stressful experience."

Moreover, the PCL-5 is the newest version of PTSD Checklist according to DSM-V, PCL-5 is most similar to the PCL-S (specific) version.

(National Center for PTSD, 2012)

The World Health Organization World Mental Health (WHO WMH) surveys were reveal that trauma exposures are common throughout the world and risk of post-traumatic stress disorder (PTSD) was differed by the trauma type and 3.6% of the population around the world has suffered from PTSD (Kessler et al., 2017). The lifetime prevalence of post-traumatic stress disorder (PTSD) was varied by region, in general population have ranged from 2.3 to 8.8. For instance, in European countries were 8.8% in Northern Ireland (Ferry et al., 2014), France was 3.9% (Husky, Lépine, Gasquet, & Kovess-Masfety, 2015), 6.8% among adult Americans (Kessler et al., 2005) and South African was 2.3% (Atwoli et al., 2013). Moreover, the review article related to prevalence of PTSD among military and veteran population revealed that an estimated current PTSD ranging from 12.9% to 33.0% among the veterans of Iraq and Afghanistan War (Gates et al., 2012).

In addition, PTSD was linked to several health hazards or disease, for instance, poor sleep quality (Westermeyer et al., 2010) , obstructive sleep apnea (OSA) (Colvonen et al., 2015), low quality of life (Giacco, Matanov, & Priebe, 2013), depression and suicide (Cougle, Resnick, & Kilpatrick, 2009), fibromyalgia syndrome (Usui et al., 2013) and cardiovascular disease (Coughlin, 2011).

National Center for Post-traumatic stress disorder was indicated the risk factor of PTSD including trauma characteristics, for example natural disasters, violence, war or combat-related trauma and individual risk factors interacting. For the demographic factors that associated with risk of trauma exposures including gender, age, ethnicity and socioeconomic status (The National Center for Post-Traumatic Stress Disorder, 2000).

2.2 Post-traumatic stress disorder in firefighters

Firefighters are one of the most dangerous and stressful professions. In their working conditions can cause various adverse health effects not only the physical traumas but also psychological traumas. Mental health problem of firefighters as the result of experience with traumatic events as part of firefighters' job. Several health effects from their job related to stress, especially post-traumatic stress disorder (PTSD). Previous studies indicate factors that might be influence firefighters at risk for develop PTSD are including start work as a firefighter at a younger age, previously in treatment for another disorder, working as the supervisor in the fire service, proximity to death during a traumatic event, feeling fear and horror during traumatic event, but on the other hand the factors might be protect the firefighters in developing PTSD are social support and having effective coping strategies available may lessen the impact of experiencing multiple events (Matthew Tull, 2018).

The longitudinal study among firefighters exposed to World Trade Center Disaster on September 11, 2001 was revealed the prevalence of firefighter probable to develop PTSD was 15.5% (Berninger et al., 2010) and among the retired male firefighters who worked at ground zero in 9/11 disaster were diagnosed the

firefighters with PTSD by using PTSD check list (PCL), the prevalence of elevated PTSD risk relative according to DSM-IV criteria varied from 16.0 to 22.0% (Chiu et al., 2011). Furthermore, prevalence rate of PTSD symptoms in State of Rheinland-Pfalz' s professional firefighters in Germany was 18.2% (Wagner, Heinrichs, & Ehlert, 1998). Meanwhile, among Japanese firefighters who were exposed with the Great East Japan Earthquake (GEJE) and tsunami on March 11, 2011 and affected the explosion of the Fukushima nuclear power plants, the prevalence of probable post-traumatic stress disorder fourteen months after the GEJE was 1.6% (Sakuma et al., 2015) and among urban firefighters in Japan who work for the local government was 9.7% (Saijo et al., 2012).

Currently, in Thailand have no data reported in the epidemiological focusing on estimated prevalence of lifetime PTSD in general population and no prevalence of PTSD in Thai firefighters. However, after the tsunami disaster in on December 26, 2004 affected areas in southern of Thailand. The study was found the prevalence of PTSD and PTSD symptoms in Thai survivors varied from 6.3% to 13% (Udomratn, 2009).

2.3 Brain-derived neurotrophic factor (BDNF)

Firefighters are the profession at high risk of the trauma exposure. Therefore, the bio -marker of susceptibility is necessary to prevent or early detection the risk of post-traumatic stress disorder (PTSD) among the firefighters. Brain-derived neurotrophic factor (BDNF), which regulates neuronal survival, growth differentiation, and synapse formation, is known to be a potential biomarker for PTSD risk and its possible roles in the onset of PTSD (Zhang, Li, & Hu, 2016). In many

studies have shown that stress associated with reduction of BDNF, moreover, BDNF levels were significantly lower among PTSD patients compared with healthy subjects (Dell'Osso et al., 2009) and among healthy subjects who had current psychological stress was found the negative correlation with serum BDNF (Mitoma et al., 2008). However, several study were found that among in patients with severe injured from motor vehicle accidents (MVAs) with PTSD have higher BDNF level than patients with severe injured in no PTSD group (Matsuoka, Nishi, Noguchi, Kim, & Hashimoto, 2013). However, the previous study was indicated that BDNF level were higher right after exposure with the traumatic event and after that decrease over time (Hauck et al., 2010).

Furthermore, BDNF levels can increase in human serum by physical activity (Pilc, 2010). The previous studies were indicated that BDNF was release from brain at rest and during exercised BDNF can increased 2 to 3 fold. Moreover, from both at rest and during exercised brain can contribute more than 70% to 80% of BDNF circulation, however the contribution decreased following one hours of recovery (Rasmussen et al., 2009). Higher level of BDNF was the important protective factors for prevention of traumatized subjects from developing PTSD (Su et al., 2015).

2.4 Cardiovascular diseases (CVDs)

The number one cause of death among population around the world annually is Cardiovascular disease (CVD). CVDs are a group of diseases of the heart, diseases of blood vessels and vascular diseases of the brain include:

- Coronary heart disease – disease of the blood vessels supplying the heart muscle

- Cerebrovascular disease – disease of the blood vessels supplying the brain

- Peripheral arterial disease – disease of blood vessels supplying the arms and legs

- Rheumatic heart disease – damage to the heart muscle and heart valves from rheumatic fever, caused by streptococcal bacteria

- Congenital heart disease – malformations of heart structure existing at birth

- Deep vein thrombosis and pulmonary embolism – blood clots in the leg veins, which can dislodge and move to the heart and lungs

(World Health Organization, 2017)

Risk factors associated with CVDs are behavioral risk factors (tobacco used, physical inactivity, unhealthy diet, alcohol used), metabolic risk factors (hypertension, diabetes, high blood lipids, overweight and obesity) and other risk factors including poverty and low educational status, age, gender, genetic disposition and psychological factors such as stress and depression (Mendis, Puska, Norrving, & Organization, 2011).

The Global Burden of Cardiovascular Diseases in 2015 was indicated an estimated 422.7 million cases of CVDs and 17.92 million CVDs deaths, while ischemic heart disease was the leading cause of CVDs death around the world and following by stroke. Prevalence of CVDs according to age-standardized was varied significant by country, the countries lowest age-standardized prevalence in 2015, all with less than 5,000 cases per 100,000 persons, while the countries with the highest age-standardized prevalence are all with more than 9,000 cases per 100,000 persons. Meanwhile, in Thailand the age-standardized prevalence were 6,601 to 7,500 cases per 100,000 persons (Figure 2.1) (Roth et al., 2017).
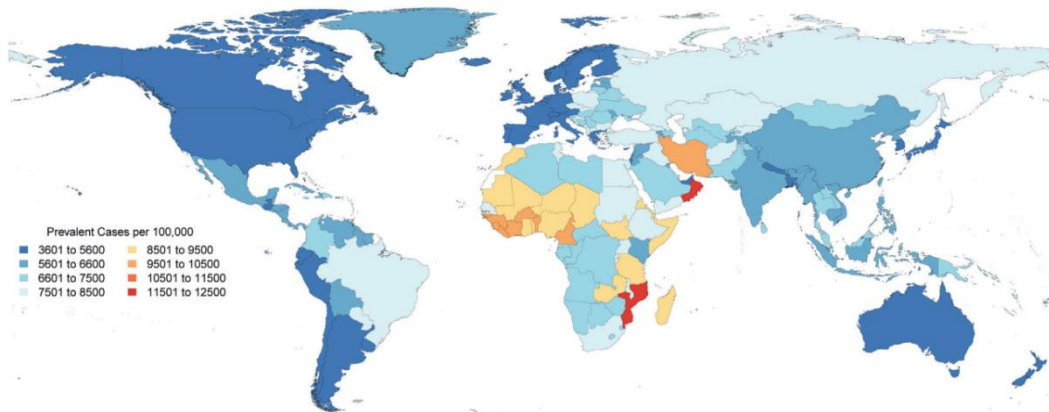
Figure 2.1 Global map, Age-Standardized Prevalence of Cardiovascular
diseases in 2015
(Roth et al., 2017).

In 2016, Word Health Organization was reported the 10 leading causes of
death in the world (Figure 2.2). CVDs were ranked first and second of global leading
causes of death, and around 17.86 million people died from CVDs, representing
31.40% of all global deaths.
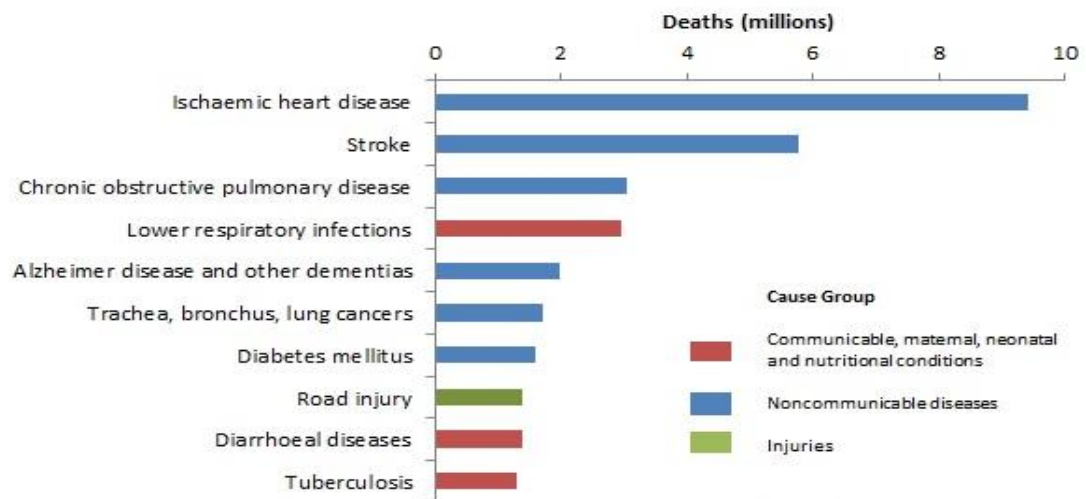
Figure 2.2 Global causes of deaths 2016
(World Health Organization, 2018)

Moreover, World Health Organization was predicted in the year 2030 almost 23.6 million people around the world will die from cardiovascular diseases (CVDs) and especially from heart disease and stroke (World Health Organization, 2017)

2.5 Cardiovascular disease in Thailand

In 2014, Non-Communicable diseases (NCDs) was account for 71% of total cause of deaths among population in Thailand and 29% of proportional mortality was cardiovascular diseases from total deaths 501,000 (Figure 2.3).
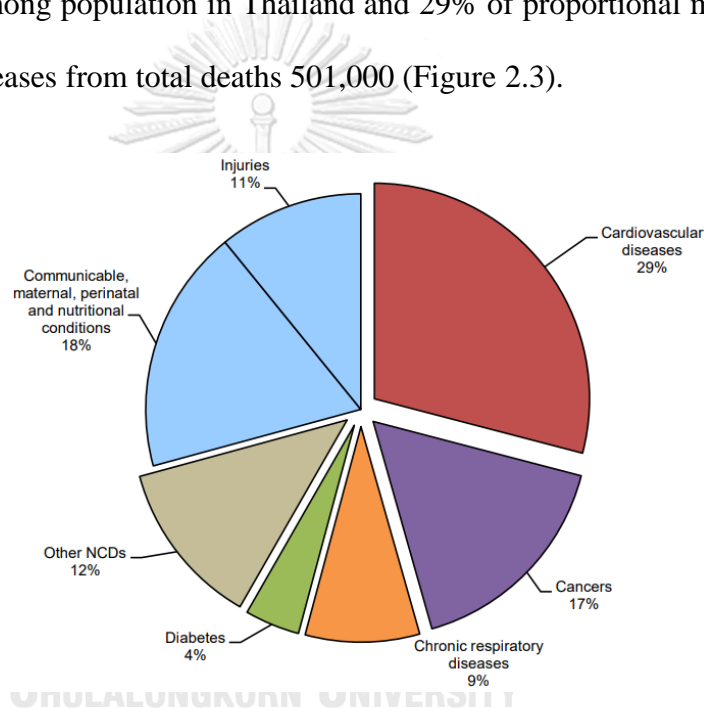
Figure 2.3 Total cause of deaths in Thailand; 2014
(World Health Organization, 2014)

The Thai cohort study at the start of study in 1985 (17-year follow-up) among participants aged between 35 and 54 years was revealed 96 cases of ischaemic heart disease, 69 cases of strokes occurred, for each 1 millimoles per liter (mmol/l) in total cholesterol was associated with 5 fold increased risk of ischaemic heart disease among people aged 30 – 44 years old and increased 10 mmHg of systolic blood

pressure was associated with the relative risks for ischaemic heart disease of 1.31 and 1.40 of stroke among people aged 45 – 59 years old (Khonputsa et al., 2010).

2.6 Cardiovascular Diseases in Firefighters

Firefighters are recognized as the challenging and stressful occupation. They have to exposed with unpredictable working environment that possibly effect to their physical and mental health. Many studied investigated that fire-suppression activities markedly increase the risk of CVD events (Kales & Smith, 2017). A Systematic Review on Cardiovascular Disease in U.S. Firefighters was revealed that 45% of on-duty fatalities cause by CVDs (Soteriades et al., 2011), as the same with the study about on-duty U.S. firefighters sudden cardiac death (SCDs) between 1996 and 2012, 42% of these deaths cause by SCDs, moreover on these deaths were age at death ≤ 45 years (Farioli et al., 2014). Among Australian volunteer firefighters was revealed predicted coronary heart disease (CHD) risk for male firefighter was 19.2% (Wolkow et al., 2014).

2.7 Cardiovascular biomarkers

Cardiac biomarkers are substances that measurable and quantifiable biological parameters to assessing the risk for cardiovascular disease. There are numerous cardiovascular biomarkers. However, The prospective follow-up study was indicated that Troponin-T (TnT), high-sensitive C-reactive protein (hs-CRP), and Brain Natriuretic Peptide (BNP) have been shown to be independent prognostic indicators of total and cardiac death during short- and long-term follow-up (Nilsen et al., 2015).

High-sensitivity C-reactive protein (hs-CRP) is the classical acute phase reactants protein of the inflammation and infection response such as heart attack or trauma. The high-sensitivity CRP test measures low levels of CRP in the blood to identify low levels of inflammation that are associated with risk of developing cardiovascular diseases (CVDs) and there is the potential adjunct for Global risk assessment in the primary prevention of cardiovascular disease. Detectable of hs-CRP is reveal individual at high risk of plaque rupture, the inflammation plays a major role in atherothrombosis. Several large-scale prospective epidemiological studies demonstrate that hs-CRP is a strong independent predictor of future myocardial infarction and stroke peripheral arterial disease, and vascular death among individuals without known cardiovascular disease (Ridker, 2001).

Troponin T (TnT) is the protein which found in cardiac muscle fibers that produce muscular contraction and TnT released into blood stream when heart damage. However, there are three types of troponin including troponin C, troponin I and troponin T, for Troponin C initiates contraction by binding calcium and moves troponin I so that the two proteins that pull the muscle fiber shorter can interact. Troponin T anchors the troponin complex to the muscle fiber structure. High concentration of cardiac troponin T was associated with damage in heart muscle and used for the diagnosis of acute myocardial infraction (AMI) (American Association for Clinical Chemistry, 2015c).

Brain Natriuretic Peptides (BNP)or **B-type natriuretic peptides** are known as the predictors to evaluate the severity of heart failure. BNP is released in blood when heart stretched and working hard to pump blood (American Association for Clinical Chemistry, 2015a). High BNP concentration in patient who presents to an

emergency room is associated with greater probability of a diagnosis of heart failure. Moreover, higher BNP concentration on admission to the hospital is also associated with greater in-hospital mortality (Fonarow et al., 2007). The previous studies were revealed that BNP rises with age over the course of a lifetime but generally stays under 20 pg/ml in the absence of left ventricular dysfunction or structural heart disease. B-type natriuretic peptide 100 pg/ml is the cutoff for diagnosing congestive heart failure in symptomatic patients as show in Figure 2.4.
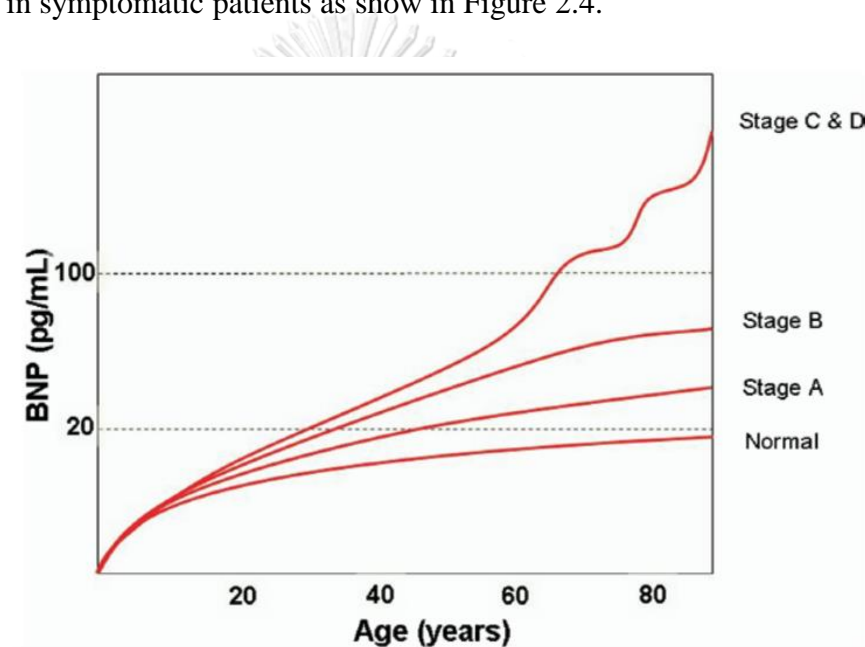
Figure 2.4 BNP Levels by ACC/AHA Heart Failure Stages
(Daniels & Maisel, 2007)

Moreover, Troponin T (TnT) and brain Natriuretic Peptides (BNP) have been shown to be associated with outcome in several clinical conditions. The study among patients with low flow low gradient aortic stenosis (LGLG AS) demonstrate the usefulness of combined measures of BNP and hsTNT to enhance risk stratification in patients with LFLG AS. Patients having activation of both BNP and hsTNT have a 4-

fold increase risk of mortality (Dahou, Clavel, Capoulade, Dumesnil, & Pibarot, 2015).

2.8 Post-traumatic stress disorder and Cardiovascular diseases

Firefighters have a wide range of job descriptions such as fire suppression, emergency medical treatment and rescue operations, these duties can cause extreme stressors and effect to developing of post-traumatic stress disorder (PTSD) among firefighters, potentially contribute to increased stress levels, leading to elevated heart rate and blood pressure, metabolic syndrome and poor sleep (De Lange et al., 2009), as confirmed by (Burg & Soufer, 2016), indicated that developing of post-traumatic stress disorder (PTSD) is function of many factors, the most important being exposure to traumatic events that independently increases risk for early incident cardiovascular disease (CVD) and cardiovascular (CV) mortality by over 50% and incident hypertension risk by over 30%. Many studies have found evidence of elevated inflammation biomarkers in patients with PTSD and in PTSD-related increased risk for cardiovascular, autoimmune, and neurodegenerative diseases (O'Donovan, 2016). Likewise, The IAFF report stated that firefighters experience increased and various psychological stressors at work, for example, high occupational demands low decisional latitude, presumably leading to changes in the nervous system and hormonal homeostasis with subsequent elevated blood pressure, elevated heart rate, dyslipidemia and sleep disturbances. Susceptible fire fighters who are exposed to extreme stressors may develop post-traumatic stress disorder, which is also associated with adverse effects on blood pressure, heart rate and the metabolic syndrome (International Association of Fire Fighters, 2013).

The potential mechanism between post-traumatic stress disorder (PTSD) and risk of cardiovascular diseases (CVDs) illustrates that PTSD was related to cardiac dysfunction, neuroendocrine, immune, nervous, and metabolic pathways with associated biomarkers that may potentiate CVD (Figure 2.5).
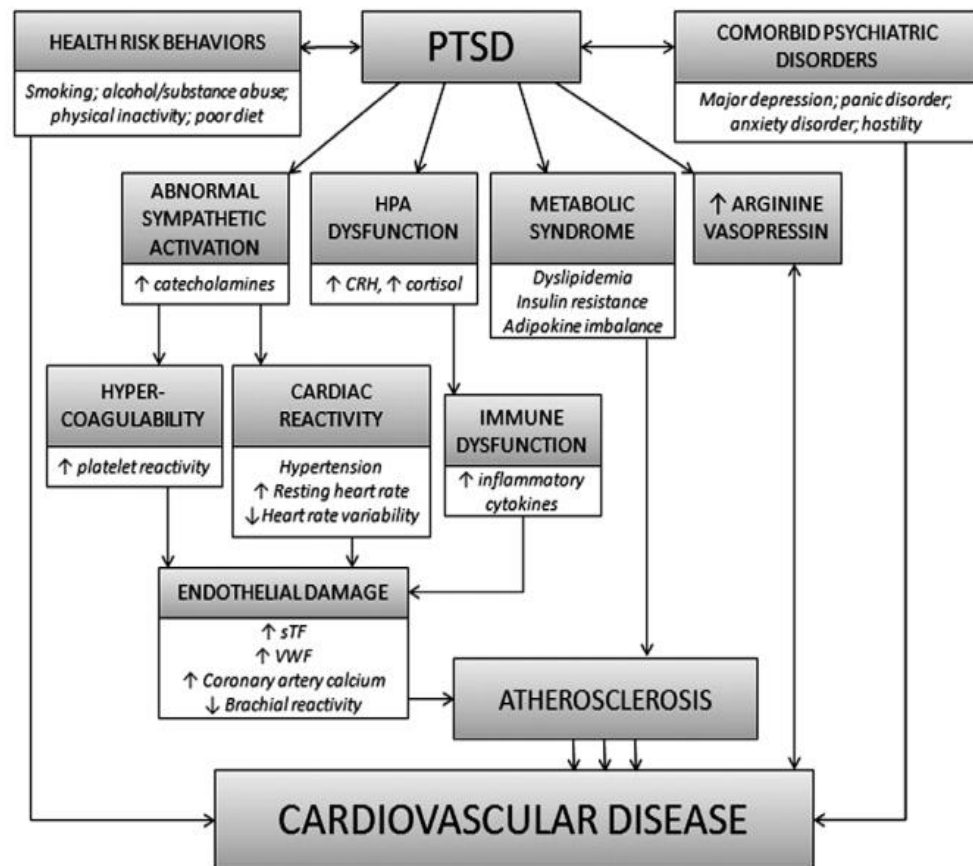
Figure 2.5 Potential paths way to cardiovascular disease in PTSD
(Wentworth et al., 2013).

Current knowledge about the association between post-traumatic stress disorder (PTSD) and cardiovascular diseases (CVDs) was persons with PTSD may influent an activity of Hypothalamic-pituitary-adrenal axis (HPA Axis) and increase sympathetic nervous system (SNS) activity that may contribute increased risk of hypertension, hyperlipidemia, obesity and these were associated with risk of cardiovascular diseases (Coughlin, 2011).

2.9 Post-traumatic stress disorder and Cardiovascular Biomarkers

Hs-CRP

The prospective cohort study of post-traumatic stress disorder effect on health outcomes among Veterans Affairs patients was found that individuals with current PTSD had significantly higher hs-CRP and WBC than patients with no history of PTSD (O'Donovan et al., 2017)

TnT

The Whitehall II epidemiological cohort study, evaluated mental stress with salivary cortisol response and cardiac troponin T plasma was found strong association between cortisol response and detectable hs-cTnT (Lazzarino, Hamer, Gaze, Collinson, & Steptoe, 2013).

BNP

The study among military veterans with PTSD was found patients with PTSD had a trend toward worse survival (on Kaplan-Meier analysis P=0.057) and among patients with elevated BNP (>60 pg/ml), those with PTSD had significant increased mortality than patients without PTSD (Xue et al., 2012).

In addition, the prospective cohort study 2-year follow-up among chest-pain patients for investigated the prognostic value of hs-CRP, TnT and BNP the result was demonstrated that BNP was a strong prognostic indicator of 2-year total and cardiac mortality, however TnT and hs-CRP did not render prognostic information (Nilsen et al., 2015).

Moreover, several studies were found evidence of elevated inflammation biomarkers in patients with PTSD (O'Donovan, 2016), meanwhile inflammation and inflammatory cell infiltration are the hallmarks of myocardial infarction (MI) (Liu,

Wang, & Li, 2016). The study of biomarkers in acute myocardial infarction reveals that hs-CRP, TnT and BNP were the acute myocardial infraction biomarkers (Figure 2.6).
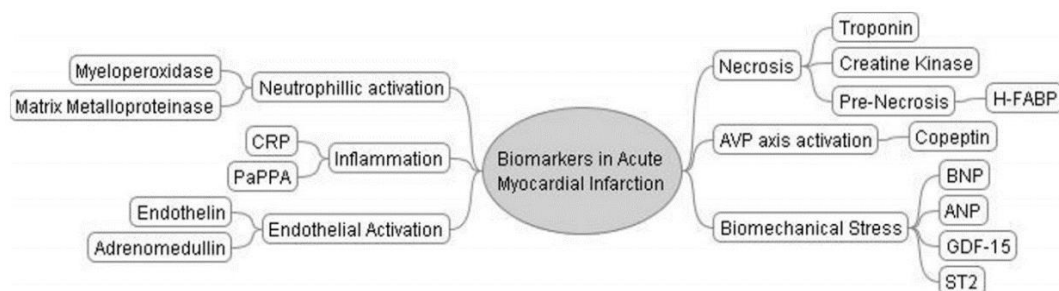
Figure 2.6 Biomarkers associated with acute myocardial infraction
(Chan & Ng, 2010)
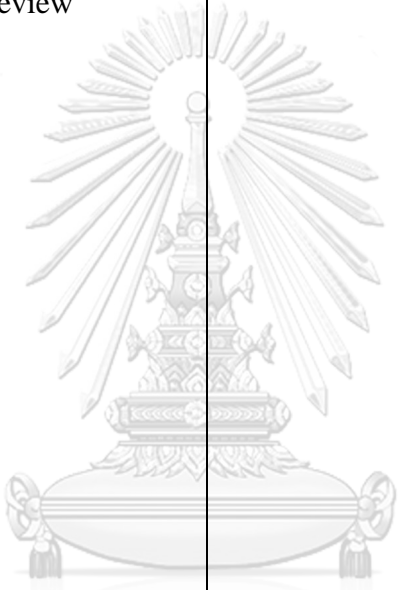
2.10 Related-Article

References	Study Design	Study Population	Results
Risk of Post-traumatic stress disorder (PTSD)			
(Wichian Sripootorn et.al, 2015)	Retrospective study	665 Royal Thai Navy personnel	- Prevalence of PTSD among the Royal Thai Navy personnel deployed for the peace building process in southernmost provinces of Thailand was 10.3% classified by PTSD Checklist-Military Version (PCL-M).
(Saijo et al., 2012)	Cross-sectional study	1,667 Japanese firefighters	- 9.7% of subjects identified as PTSD-positive.
(Chiu et al., 2011)	Cross-sectional study	1,915 retired firefighters	- PTSD prevalence of male firefighters who worked at the World Trade Center attacks on 2001 was 22%.

Factor associate with risk of Post-traumatic stress disorder (PTSD)			
(Müller, Ganeshamoorthy, & Myers, 2017)	Cohort study	5,826 US veterans	- Drug abuse, current smoking, alcohol abuse, history of chest pain and higher exercise capacity were strong independent risk factors for PTSD in a univariate model. - In the final multivariate model, current smoking, history of chest pain, and younger age were significantly associated to PTSD.
(Iversen et al., 2008)	Retrospective cohort study	4,762 UK Armed Forces personnel who have been deployed in Iraq since 2003	- Post-traumatic stress symptoms were associated with lower rank, being unmarried, having low educational attainment and a history of childhood adversity. - Exposure to potentially

			traumatizing events, in particular being deployed to a 'forward' area in close contact with the enemy, was associated with post-traumatic stress symptoms. - Low morale and poor social support within the unit and non-receipt of a home-coming brief (psycho-education) were associated with greater risk of post-traumatic stress symptoms.
Risk of post-traumatic stress disorder and Brain derived neurotrophic factor			
(Su et al., 2015)	Cross-sectional study	65 subjects experienced road traffic accidents	- Subject without PTSD who experience road traffic accidents revealed higher BDNF levels than PTSD-subject
(Dell'Osso et al.,	Cross-sectional	36 patients with	- PTSD patients were

2009)	study	and without PTSD	significantly lower BDNF levels, as compared with those of healthy subjects
Risk of Post-traumatic stress disorder and Cardiovascular diseases			
(Beristianos, Yaffe, Cohen, & Byers, 2016)	Retrospective cohort study	138,341 veterans, 55 years and older.	- 4,041 veterans had PTSD at baseline. - 45% of veterans with PTSD increased risk for incident CVD, and 49% increased risk for incident myocardial infarction.
(Xue et al., 2012)	The longitudinal study	891 patients at Medical Center	- Among patients with high level of B-type natriuretic peptide (>60 pg/ml), with PTSD had significant increased mortality (p = 0.024).
(Coughlin, 2011)	Review of epidemiologic studies		- Persons with (PTSD) may have an increased risk of

			coronary heart disease and possibly thromboembolic stroke.
Risk of Post-traumatic stress disorder and Cardiovascular diseases change			
(Kibler, Tursich, Ma, Malcolm, & Greenbarg, 2014)	The systematic review		- PTSD is positively associated with metabolic syndrome. - There appears to be considerable metabolic, autonomic and immune involvement in the elevated CVD risk among individuals with PTSD.

CHAPTER III
METHODOLOGY

3.1 Study Design

This longitudinal research study aims to determine the association between risk of post-traumatic stress disorder (PTSD) and changes of cardiovascular biomarkers among firefighters in Bangkok, Thailand after 6-month follow-up.

This study was divided into two phases. Phase I or baseline phase was the cross-sectional study to determine the prevalence and factors that associated with post-traumatic stress disorder among all firefighters in Bangkok, Thailand. In Phase II was the longitudinal study to determine the association between risk of post-traumatic stress disorder and changes of cardiovascular biomarker after 6-month follow-up among selected firefighters in Bangkok, Thailand. Data were collected during June 2017 to February 2018.

3.2 Study Area

The study area is Bangkok, the capital city of Thailand, subdivided into 50 districts and occupies 1,568.7 square kilometers (Figure 3.1). In 2015, population of Bangkok is approximately 5.69 million people. Population density in Bangkok 3,631 persons per square kilometer (Bangkok Metropolitan Administration Data Center, 2015).
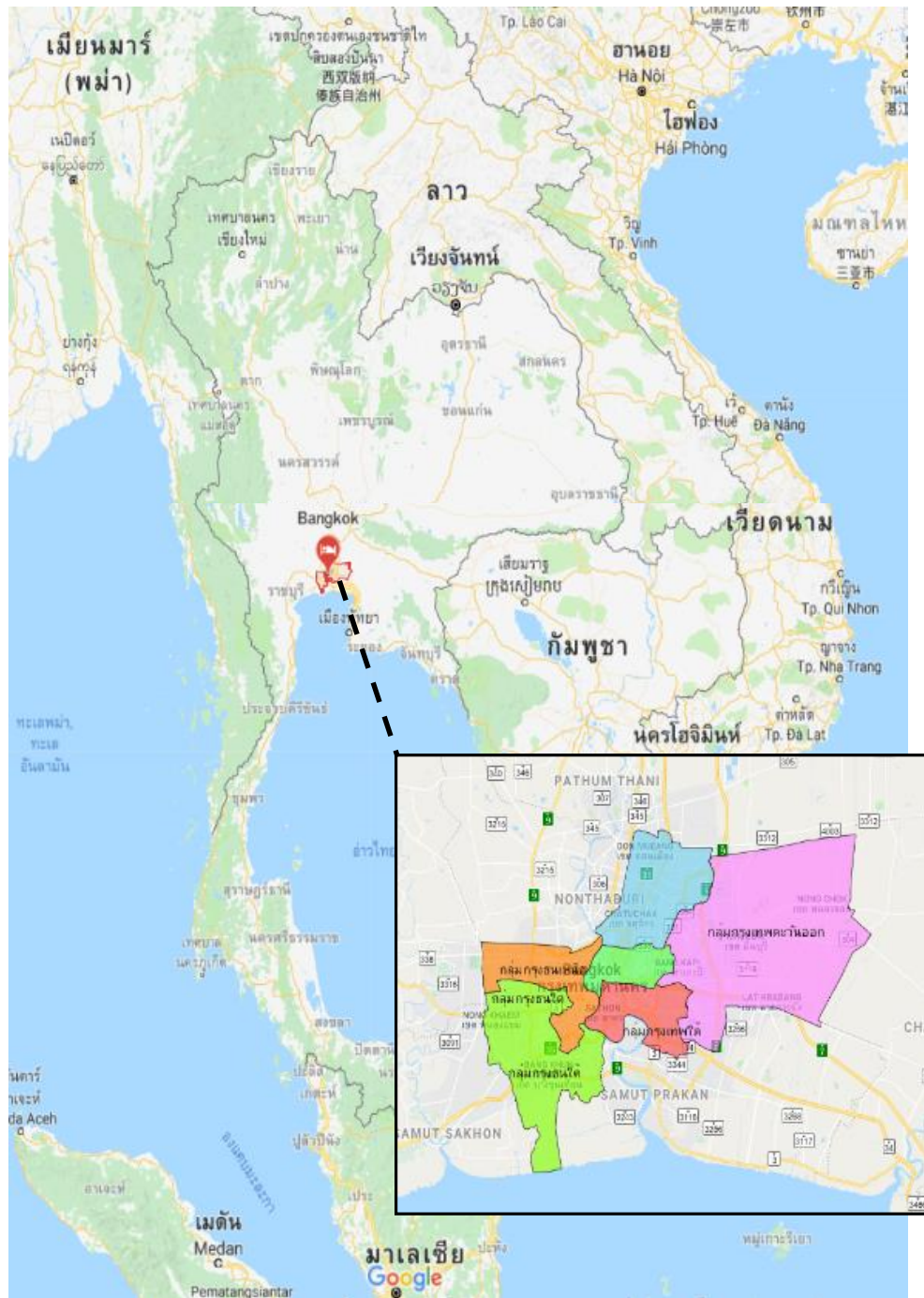
Figure 3.1 Bangkok map

3.3 Study Population

The population in this study are the firefighters under the Fire Brigade Division (No.1-4) in the Bangkok fire and rescue department under the Bangkok Metropolitan Administration (BMA) (Figure 3.2).
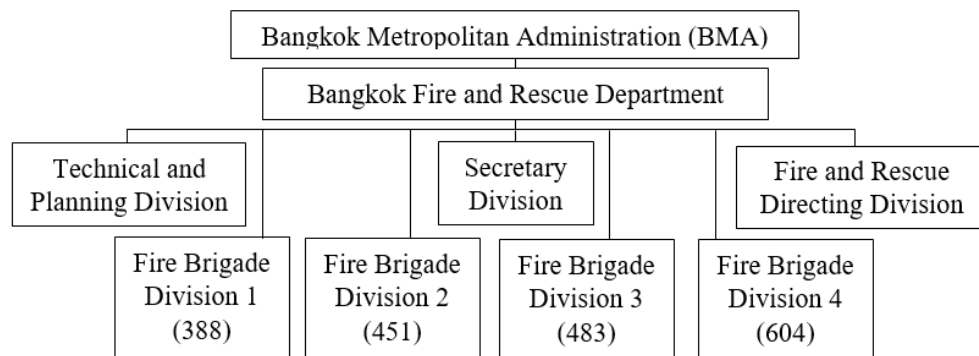
Figure 3.2 Bangkok fire and rescue department organization structure
(Bangkok Fire and Rescue Department, 2016)

The Fire Brigade Division 1 (7 fire and rescue stations) include Phu Khao Thong, Suan Mali, Bang Rak, Yannawa, Thanon Chan, Tung Maha Mek and Banthat Thong.

The Fire Brigade Division 2 (8 fire and rescue stations) include Bang kapi, Huai Khwang, Bang Chan, Lat Krabang, Hua Mak, Phrakhanong, Khlong Toei and Bonkai.

The Fire Brigade Division 3 (9 fire and rescue stations) include Bang Po, Samsen, Lat Yao, Bang son, Bang Khen, Ladprao, Dusit, Phayathai and Sutthisan.

The Fire Brigade Division 4 (11 fire and rescue stations) include Talat Phlu, Thungkhru, Bang O, Dao Khanong, Bangkae, Bang Khun Non, Pak Khlong San, Taling Chan, Thon Buri, Bang Khun Thian, and Borwornmongkol.

3.4 Study Participants

In this study, all firefighters from 35 fire and rescue stations under the Fire Brigade Division in the Bangkok Fire and Rescue Department under the Bangkok Metropolitan Administration (BMA) were invited to participate. The total number of firefighters in Bangkok Metropolitan Administration (BMA) around 1,926 firefighters (Bangkok Fire and Rescue Department, 2016)

3.5 Sample and sample size

Phase I: Baseline

All firefighters under the Fire Brigade Division in the Bangkok Fire and Rescue Department under the Bangkok Metropolitan Administration (BMA) were invited to participate.

Phase I: Inclusion and Exclusion criteria

Inclusion criteria	Exclusion criteria
- Firefighters who were on duty at least 1 year - Male firefighters	- Family history of cardiovascular disease - Have some symptoms that related to cardiovascular disease (Angina chest pain, Shortness of breath, Fainting) - Have kidney disease

Phase II: Follow-up 6 months (Purposive selected firefighters)

The expected number of cases (firefighters with risk of post-traumatic stress) is estimate by the prevalence of post-traumatic stress disorder (PTSD) which is approximately 9%–22% among Japanese firefighters (Saijo et al., 2012). Therefore, the expected number of firefighters with risk of post-traumatic stress are 173 – 424 cases for Bangkok firefighters. (The total number of firefighters in Bangkok are 1,926 firefighters)

An estimated sample size for phase II is performed by using STATA version 14.1 program in a function of "Estimated sample sizes for two-sample comparison of survivor functions" (command: power exponential, hratio(x) effect(hratio))

Calculation is used parameter as following;

Alpha =   0.05

Power =   0.80

Delta =   1.69 (Hazard ratio of BNP for mortality at the endpoint of Military Veterans)

Ratio =   1 (proportion between PTSD firefighters and non-PTSD firefighters)

An estimated hazard ratio was predicted by hazard ratio of brain natriuretic peptide (BNP) for mortality at the endpoint of Military Veterans with post-traumatic stress disorder comparing to those without post-traumatic stress disorder, the previous study found that brain natriuretic peptide was a predictor of mortality among Military Veterans with hazard ratio 1.69 and 95% Confidence Interval 1.24 - 2.31 (Xue et al., 2012).

Total estimated sample size is 122 separated into 61 firefighters per group. 10% of sample size was added up to avoid loss-to-follow up. Therefore, sample size in each group was 68 firefighters.

If firefighter with risk of post-traumatic stress is limited or is lower than estimated sample size, all of firefighter with risk of post-traumatic stress were invited to participate in this study and selected firefighters without PTSD from the same station (buddy) with the firefighter with risk of post-traumatic stress.

If firefighter with risk of post-traumatic stress are more than 68, the researcher will be purposive selection firefighters from fire and rescue stations that have more event.

Phase II: Inclusion and Exclusion criteria

Inclusion criteria	Exclusion criteria
Firefighters with risk of PTSD	
- No history of cardiovascular disease	- Change position to office
	- Resignation during study
- Have the risk of post-traumatic stress disorder (PCL-C scores $\geq$ 30)	
- Willing to participate in this study with written and signed consent	
Firefighters without risk of PTSD	- Change position to office
- No history of cardiovascular disease	- Resignation during study
- No risk of post-traumatic stress disorder (PCL-C scores < 30)	
- Working in the same fire and rescue stations as PTSD firefighters (to adjusted traumatic events exposure during follow-up period)	
- Willing to participate in this study with written and signed consent	

3.6 Measurement Tools

3.6.1   Screening form

The screening form was used for recruitment the participants into Phase I, the criteria including male firefighters, no family history of cardiovascular disease, no kidney disease, no history of angina chest pain and no history of cardiovascular disease hospitalization.

3.6.2   Questionnaire consist of 5 parts

3.6.2.1 Demographic information 15 items

The validity of questionnaire in this part was proved by three experts and the professionals in fire and rescue field. The validity test in demographic information part was using Index of item Objective Congruence (IOC) methods. The IOC scores was 0.94.

3.6.2.2 Working characteristics 16 items

The validity of working characteristics part was proved by three experts and the professionals in fire and rescue field. The validity test in this part was using Index of item Objective Congruence (IOC) methods. The IOC scores was 0.90.

3.6.2.3 Pittsburgh Sleep Quality Index (PSQI) Thai version 29 items

This questionnaire is an effective instrument for assess the quality and sleep patterns of Bangkok firefighters over the previous month. Previous study was revealed that the Pittsburgh sleep quality index (Thai version) had excellent internal consistency (Cronbach's alpha = 0.84), meanwhile, the test-retest reliability (intraclass correlation coefficient = 0.89) (Sitasuwan, Bussaratid, Ruttanaumpawan, & Chotinaiwattarakul, 2014). Moreover, in this study, the PSQI questionnaire (Thai version) also had excellent internal consistency (Cronbach's alpha = 0.73).

Pittsburgh sleep quality index consists of 19 self-rated items are combined to form seven "component" scores. The seven component scores are then added to yield one "global" score, with a range of 0 – 21 points, "0" indicating no difficulty and "21" indicating severe difficulties in all areas. In this study using the cut-off point 5 to determine sleep quality (Jirapramukpitak & Tanchaiswad, 1997). There were contains self - rated and questions rated by the bed partner or roommate. Only self-rated questions are included in the scoring.

- Firefighters with good sleep, global PSQI score equal to or less than 5.
- Firefighters with poor sleep, global PSQI score greater than 5.

3.6.2.4 Patient Health Questionnaire (PHQ-9) Thai version 9 items

The instrument for measuring the severity of depression over the last 2 weeks. There had satisfactory internal consistency (Cronbach's alpha = 0.79), The scores in each item of this questionnaire ranging from 0 – 3, "0" indicating not at all, "1" indicating several days, "2" indicating more than half of the days, "3" indicating nearly every day and the summed scores ranging from 0 to 27. For the diagnosis of major depression using the cut-off point $\geq$ 10, revealed a sensitivity of 0.74, specificity of 0.85 (Lotrakul, Sumrithe, & Saipanish, 2008). In this study, the PHQ-9 questionnaire (Thai version) had excellent internal consistency (Cronbach's alpha = 0.81). The interpretation of total scores of PHQ-9 are as follows (Kroenke, Spitzer, & Williams, 2001).

Interpretation of Total Score

Total Score	Depression Severity
0 - 4	Minimal depression
5 - 9	Mild depression
10 - 14	Moderate depression
15 - 19	Moderately severe depression
20 - 27	Severe depression

3.6.2.5 Post-traumatic stress disorder checklist – civilians version (PCL-C) Thai version 17 items

The self-report questionnaire consists of 17 items of problems that general population response to stressful experiences from any traumatic events over the last month. The PCL-C Thai version had satisfactory internal consistency (Cronbach's alpha = 0.96) and content validity 0.77 (Chawanakrasaesin, Rukskul, & Ratanawilai, 2011). In each item of this questionnaire ranging from $1 - 5$, "1" indicating not at all to "5" indicating extremely and the minimum to maximum scores were $17 - 85$. For diagnosis the risk of post-traumatic stress disorder using the cut-off point ≥ 30 (National Center for PTSD, 2012) revealed a sensitivity of 0.85, specificity of 0.73 (Terhakopian, Sinaii, Engel, Schnurr, & Hoge, 2008). Moreover, in this study the PCL-C questionnaire had excellent internal consistency (Cronbach's alpha = 0.84).

- Firefighters with risk of post - traumatic stress disorder, PCL-C scores $\geq$ 30.

- Firefighters without risk of post - traumatic stress disorder, PCL-C scores < 30.

3.6.3 Blood sample collection

The venous blood samples were collected between 8 a.m. to 9 a.m. at the fire and rescue stations to determine the level of biomarkers that associated with post-traumatic stress disorder and cardiovascular disease as follows:

3.6.3.1 Brain-derived neurotrophic factor (BDNF)

Serum BDNF was quantified by Human BDNF Speed Elisa Kit (RayBio® technique). The SpeedELISA employs a biotinylated capture and a HRP-conjugated detection antibody which immunocaptures the sample analyte in solution. The microplate in the kit is precoated with streptavidin. The biotinylated capture antibody/protein/HRP-conjugated detection antibody mixture is pipetted into the wells and the biotinylated target protein present in a sample is bound to the wells by the immobilized streptavidin. After incubation, the wells are washed to remove unbound material. The Stop Solution changes the color from blue to yellow, and the intensity of the color is measured at 450 nm with the microplate readers. Plot the standard curve on log-log graph paper or using MasterPlex software, with standard concentration on the x-axis and absorbance on the y-axis. Draw the best-fit straight line through the standard points.

Several studies were found the association between traumatic events and post-traumatic stress disorder associated with lower brain-derived neurotrophic factor and plasma level. There was no reference range of normal level BDNF, however the meta-analysis from 15 papers on depression revealed that mean (± SD) BDNF concentration levels in healthy subjects ranging from 12.2 (± 2.4) to 64.1 ± 13.1 ng/mL (Bocchio-Chiavetto et al., 2010).

3.6.3.2 Cardiovascular disease biomarkers

There are three blood biomarkers used for determine risk of cardiovascular disease. The cardiovascular biomarkers used in this study are High-sensitivity C-reactive protein (hs-CRP), Troponin T (TnT) and Brain natriuretic peptide (BNP).

High-sensitivity C-reactive protein (Hs-CRP)

The normal range of hs-CRP refer to The American Heart Association recommendation (American Association for Clinical Chemistry, 2015b).

Reference Range

< 1.0	mg/L	refer to	Low risk
1.0 – 3.0	mg/L	refer to	Average risk
> 3.0	mg/L	refer to	High risk

Troponin T (TnT)

The reference value of cardiac troponin is 0.0 – 100.0 ng/L

Brain natriuretic peptide (BNP)

The reference value of cardiac troponin is 0.0 – 100.0 pg/mL

3.6.3.3 Covariate factors of cardiovascular disease

In this study, covariate factors including blood pressure, heart rate and blood biomarkers as follows Cholesterol, High-density lipoprotein (HDL), Low-density lipoprotein (LDL) are blood biomarkers for determine covariate factors of cardiovascular disease.

Blood pressure

The American Heart Association recommendation blood pressure category are as follows (American Heart Association, 2018b).

Blood Pressure Category	Systolic mmHg (upper number)		Diastolic mmHg (lower number)
Normal	Less than 120	and	Less than 80
Elevated	120 - 129	and	Less than 80
High blood pressure (Hypertension) Stage 1	130 - 139	or	80 - 89
High blood pressure (Hypertension) Stage 2	140 or Higher	or	90 or Higher
Hypertensive Crisis	Higher than 180	and/or	Higher than 120

Heart rate

The American Heart Association identified resting heart rate are as follows (American Heart Association, 2018a).

≤ 59	beats per min	refer to	Not necessarily signal a medical problem
60 – 100	beats per min	refer to	Normal heart rate
≥ 101	beats per min	refer to	Tachycardia

Cholesterol

< 200	mg/dL	refer to	Normal level
200 - 239	mg/dL	refer to	Consider borderline high
≥ 240	mg/dL	refer to	High blood cholesterol

High-density lipoprotein (HDL)

< 50	mg/dL	refer to	Low HDL (Major risk of CVD)
50 - 59	mg/dL	refer to	Normal range
≥ 60	mg/dL	refer to	High HDL (Protective against CVD)

Low-density lipoprotein (LDL)

< 100	mg/dL	refer to	Optimal
100 - 129	mg/dL	refer to	Normal range
≥ 130	mg/dL	refer to	High LDL (Major risk of CVD)

3.7 Data Collection

In Phase I, questionnaire data collection process was done by researcher and the general service officer at the fire and rescue stations. For Phase II, questionnaire data collection was done by researcher and blood collection was done by registered nurses.

Phase I: Questionnaire data collection

The data collection processes, was request permission from the Bangkok Metropolitan Administration (BMA). Used the screening form (Appendix A) including male firefighters, duration of work at least 1 year, family history of cardiovascular disease, symptoms related with cardiovascular disease and kidney disease to recruited the participants into Phase I by general service officers in each the fire and rescue station and researcher. The eligible participants were enrolled in June 2017.

The researcher was request permission to conduct a research study to the head of fire and rescue stations and sent the baseline questionnaire. Moreover, the researcher pleased to answer any additional questions the participants may have. All firefighters who were invited to participate in this phase received the baseline questionnaire from general service officer at the fire and rescue station. This questionnaire no limit of time to complete and participants can fill out the questionnaire at home, after completed the baseline questionnaire the firefighters were sent back to general service officer by sealing envelopes individually and general service officer were collected the questionnaires and sent back to the researcher by the messenger.

To determine risk of post-traumatic stress disorder by post-traumatic stress disorder checklist – civilian's version (PCL-C) in Thai, the maximum scores were 85 in this study used the cut-off point 30 to determine risk of post-traumatic stress disorder.

- Firefighters with risk of post - traumatic stress disorder, PCL-C scores ≥ 30.
- Firefighters without risk of post - traumatic stress disorder, PCL-C scores < 30.

Phase II: Questionnaire data collection and Blood collection

To recruit the firefighters into Phase II, used the post-traumatic stress disorder scores from phase I to determine the firefighters with/without risk of post-traumatic stress disorder. According to the sample size calculation in Phase II were 136 including 68 firefighters with risk of post-traumatic stress disorder and 68 firefighters without risk of post-traumatic stress disorder.

The researcher was request permission to the head of fire and rescue stations. All firefighters who willing to participate in this study with written and signed consent. The firefighters who were invited to participate in this phase complete the questionnaire and the researcher pleased to answer any additional questions the participants may have. After questionnaire was complete the researcher collect the questionnaire.

Moreover, blood samples were collected on site at the fire and rescue station between 8 a.m. to 9 a.m. by registered nurses in August 2017, 10 ml per time by registered nurses to determine level of LDL, HDL, Cholesterol, Hs-CRP, Troponin T, BNP and BDNF. Blood was contain in blood collection tubes with lithium heparin and send to the National Healthcare Systems Company Limited (N Health) Clinical Laboratory services within 2 hours (Laboratory accreditation ISO 15189 and 15190). Techniques of blood analysis, LDL and HDL were analyzed by Homogeneous enzymatic method, Cholesterol was analyzed by Enzymatic colorimetric method, Hs-CRP was analyzed by Particle enhanced immunoturbidimetry, Troponin T and BNP was analyzed by Electrochemiluminescence Immunoassay (ECLIA). For BDNF was used Human BDNF Speed Elisa Kit has been used to determine the level of BDNF in blood analyzed by the researcher. To perform the assay, samples or standards are added to the wells, followed by the antibody mix. After incubation, the wells are washed to remove unbound material. TMB substrate is added and during incubation is catalyzed by HRP, generating blue coloration. This reaction is then stopped by addition of Stop Solution completing any color change from blue to yellow. Signal is generated proportionally to the amount of bound analytic and the intensity is measured at 450 nm.

Registered nurses were collected blood pressure and pulse rate were measured on site at the fire and rescue station by Automatic blood pressure and pulse monitor that passed calibrate before used. The participants were received the blood test results letter from general service officer at the fire station by sealing envelopes individually 2 months after the end of Phase II at baseline (October 2017). After 6-month follow-up, questionnaire and blood samples were collected to determine change of cardiovascular biomarkers (same method as in the Phase II at baseline). Two months after the end of phase 2 (April 2018), the participants were receive the blood test results letter from general service officer at the fire station by sealing envelopes individually. The results including summary result from Post-traumatic stress disorder checklist – civilians version (Thai version PCL-C), the global Pittsburgh Sleep Quality Index (PSQI) scores, Patient health questionnaire depression scale with explanation and interpretation, Heart rate, Blood pressure and the blood samples results (LDL, HDL, Cholesterol, Hs-CRP, Troponin T, BNP and BDNF) with explanation and interpretation. The researcher was provided phone numbers and e-mail address of the physician and researcher (in footnotes of results letter) to participants if they have any question, worry about the results or did not understand any information in the results.
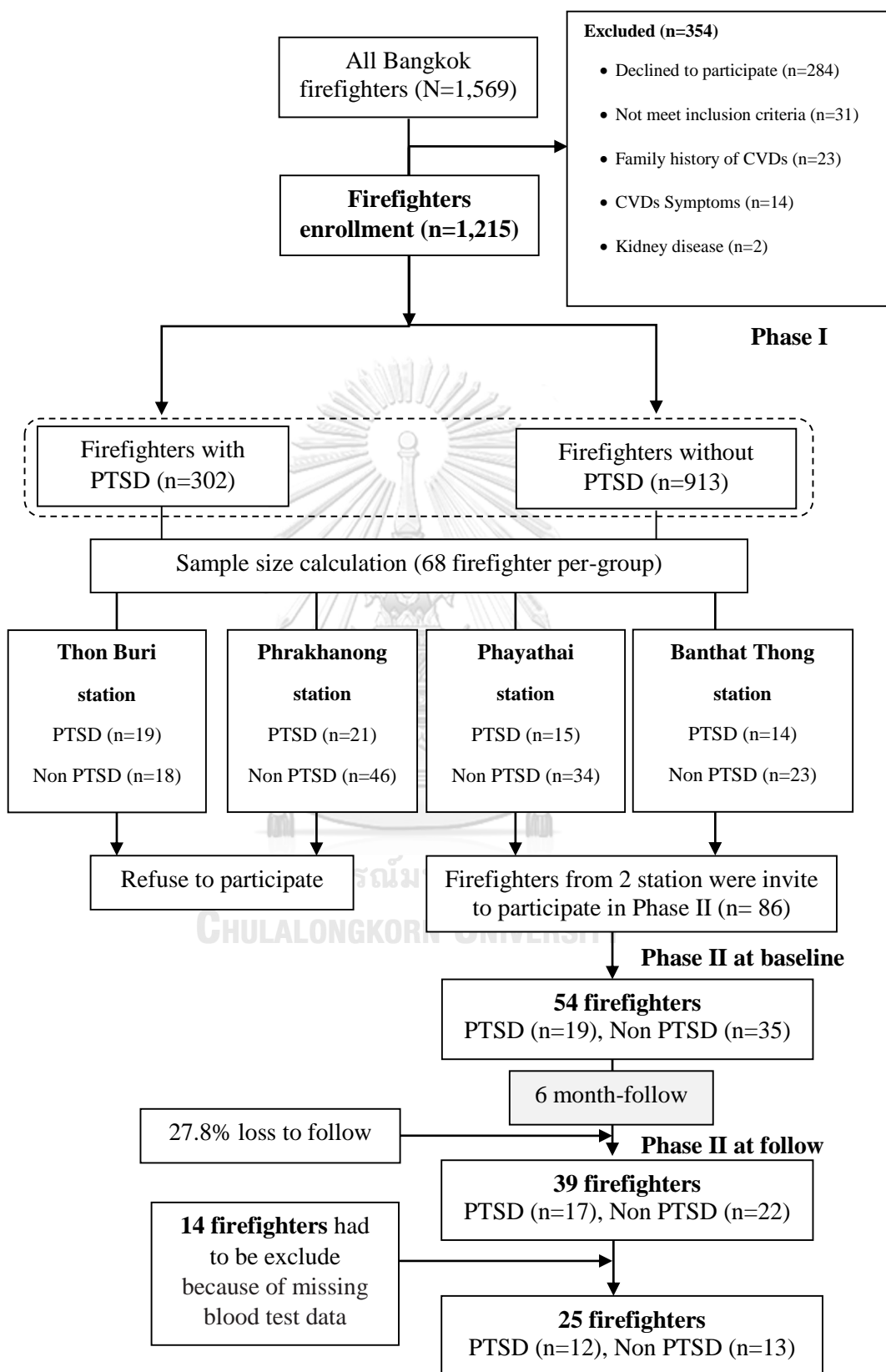
Figure 3.3 Chart of data collection

3.8 Data Analysis

The data analysis was carried out using SPSS version 22 (Chulalongkorn university licensed). Statistical approach used in this analysis were Prevalence rate, Chi-square test, Fisher's exact test, Mann-Whitney U-test, Independent T test, Multiple logistic regression. Normality tests were used to determine the distribution of data. Statistical significance was considered at p-value ≤ 0.05.

Phase I

Prevalence rate was used to determine the prevalence of risk of post-traumatic stress disorder (PTSD) among firefighters in Bangkok.

The descriptive analysis including frequency, minimum, maximum, mean (± standard deviation), median (Interquartile range) and percentage were used to analyze general information including Age, Weight, Height, Body mass index, Health problems, Smoking status, Family member smoke, Alcohol consumption, Alcohol consumption per week, Physical activity, Working position, Duration of work, Past exposure to major fire in Thailand, Occupational injury, Fire extinguisher training course, Mental training course, Sleep quality, PHQ-9 scores. Chi-square test, Fisher's exact test, Mann-Whitney U-test were used to determine the associated factors of risk of post-traumatic stress disorder (PTSD) among Bangkok firefighters.

Phase II

Prevalence rate was used to determine the prevalence of risk of post-traumatic stress disorder (PTSD) among firefighters in Bangkok among participants in Phase II at baseline.

The descriptive analysis including frequency, minimum, maximum, mean (± standard deviation), median (Interquartile range) and percentage were used to analyze

general information and working characteristics. Chi-square test, Fisher's exact test, Mann-Whitney U-test, Independent T test were used to determine the associated factors of risk of post-traumatic stress disorder (PTSD) among Bangkok firefighters in Phase II at baseline.

For blood test results of covariate factors of cardiovascular disease were analyzed by frequency, minimum, maximum, mean (± standard deviation), median (Interquartile range) and percentage. Chi-square test, Fisher's exact test, Mann-Whitney U-test, Independent T test were used to determine the association between risk of post-traumatic stress disorder (PTSD) and covariate factors of cardiovascular biomarker.

Blood test results of BDNF levels and cardiovascular biomarkers were analyzed by frequency, minimum, maximum, mean (± standard deviation), median (Interquartile range) and percentage. Mann-Whitney U-test, Independent T test were used to determine the association between risk of post-traumatic stress disorder (PTSD) and BDNF levels, cardiovascular biomarker levels.

Multiple logistic regression was used to determine the association between risk of post-traumatic stress disorder and cardiovascular biomarker levels.

Paired T test and Wilcoxon signed-rank test were used to compare the cardiovascular biomarkers from baseline to 6-month follow-up among PTSD and non PTSD-firefighters.

3.9 Ethical Consideration

The study was approved by the Ethic Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University with certified code no.047.1/60 (Date of approval: 31 May 2017). All participants who willing to participate in this study had signed consent form. Results of blood test were sent to all participant with explanation and interpretation. The researcher was provided phone numbers and e-mail address of the physician and researcher (in footnotes of results letter) to participants if they have any question, worry about the results or did not understand any information in the results.
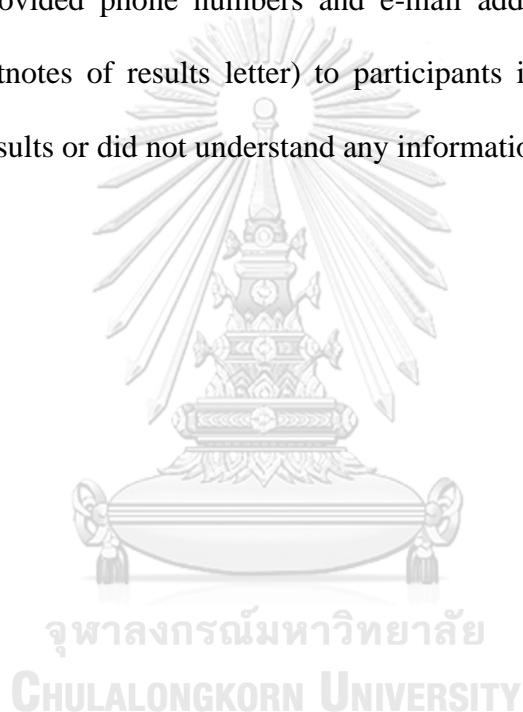
CHAPTER IV
RESULTS

This study was divided into two phases between June 2017 to February 2018. In phase I, all firefighters under the Fire Brigade Division in the Bangkok Fire and Rescue Department were invited to participate in this phase to determine the prevalence of risk of post-traumatic stress disorder and factors that associated with risk of post-traumatic stress disorder. Phase I data collected during June to July 2017.

Phase II was 6-month follow-up during August 2017 to February 2018. The main objective was to access an association between risk of post-traumatic stress disorder and change of cardiovascular biomarkers. The Firefighters with and without risk of post-traumatic stress disorder in 2 stations (Phayathai and Banthat Thong) were invited to participate in this phase. Risk of post-traumatic stress disorder, brain derived neurotrophic factor (BDNF); as a biomarker of PTSD, and cardiovascular biomarkers were accessed.

Phase I

4.1 General Information in Phase I

4.1.1   Data Collection

One thousand five hundred and sixty-nine questionnaires were sent out to all active firefighters from 35 fire and rescue station under the Bangkok Metropolitan Administration (BMA) and 1,215 questionnaires were returned, return rate was 77.44% (Table 4.1).

Table 4.1 Questionnaires return rate classified by fire and rescue station

No.	Fire and rescue station	Questionnaire sent out	Return questionnaire	Return rate questionnaire	Firefighters with risk of PTSD
Fire Brigade Division 1 (7 fire and rescue stations)					
1	Phu Khao Thong	40	21	52.50	7
2	Suan Mali	43	31	72.09	7
3	Bang Rak	57	24	42.11	5
4	Yannawa	40	36	90.00	11
5	Thanon Chan	46	44	95.65	11
6	Tung Maha Mek	35	31	88.57	4
7	Banthat Thong	40	37	92.50	14
Fire Brigade Division 2 (8 fire and rescue stations)					
8	Bang kapi	40	24	60.00	5
9	Huai Khwang	40	27	67.50	6
10	Bang Chan	50	44	88.00	12
11	Lat Krabang	52	37	71.15	5
12	Hua Mak	40	34	85.00	10
13	Phrakhanong	80	67	83.75	21
14	Khlong Toei	30	26	86.67	8
15	Bonkai	40	30	75.00	9
Fire Brigade Division 3 (9 fire and rescue stations)					
16	Bang Po	42	32	76.19	9
17	Samsen	44	39	88.64	8
18	Lat Yao	42	36	85.71	8
19	Bang son	40	36	90.00	10

No.	Fire and rescue station	Questionnaire sent out	Return questionnaire	Return rate questionnaire	Firefighters with risk of PTSD
20	Bang Khen	45	39	86.67	11
21	Ladprao	40	23	57.50	3
22	Dusit	38	34	89.47	10
23	Phayathai	49	49	100.00	15
24	Sutthisan	55	45	81.82	4
Fire Brigade Division 4 (11 fire and rescue stations)					
25	Talat Phlu	42	25	59.52	5
26	Thungkhru	45	29	64.44	5
27	Bang O	51	24	47.06	6
28	Dao Khanong	60	48	80.00	5
29	Bangkae	60	34	56.67	11
30	Bang Khun Non	38	30	78.95	3
31	Pak Khlong San	40	37	92.50	9
32	Taling Chan	45	37	82.22	9
33	Thon Buri	40	37	92.50	19
34	Bang Khun Thian	40	33	82.50	9
35	Borwornmongkol	40	35	87.50	8
	Total	**1,569**	**1,215**	**77.44**	**302**

4.2 Prevalence of risk of post-traumatic stress disorder

Prevalence of risk of post-traumatic stress disorder among Bangkok firefighters was 24.86%. The 302 firefighters were met the suggested PTSD check list cut-point criteria for civilian (PCL Scores $\geq$ 30). The median score of risk of PTSD (IQR) in Bangkok firefighters were 22.00 (18.00 - 29. 00) with range of 17. 00 -75.00. Among risk of PTSD-firefighters were report PCL median scores 34.00 and ranging from 30.00 to 75.00, while firefighters without risk of PTSD were report PCL median scores 20.00 and ranging from 17.00 to 29.00 (Table 4.2).

Table 4.2 Prevalence of risk of post-traumatic stress disorder (n=1,215)

Risk of post-traumatic stress disorder PCL-C	n	%
Risk of PTSD (PCL-C scores $\geq$ 30)	302	24.86
Median		34.00
(IQR)		(32.00 – 40.00)
Range (min-max)		30.00 – 75.00
Without risk of PTSD (PCL-C scores < 30)	913	75.14
Median		20.00
(IQR)		(17.00 – 24.00)
Range (min-max)		17.00 – 29.00

4.3 Demographic Information in Phase I

4.3.1   General Characteristic of Bangkok firefighters

The 1,215 firefighters from 35 fire and rescue stations were willing to participate with written and signed consent in phase I. The majority of the firefighters age group was ranked between 31 to 40 years old (54.98%), the median age (IQR) was 39 (36.00 – 44.00) years old and ranging from 22 to 58 years old. Median weight (IQR) 70.0 (65.00 – 78.00) kilograms and median height (IQR) 174.00 (157.00 – 186.00) centimeters. Body mass index (BMI) was revealed median (IQR) 23.74 (21.88 – 25.90) kilograms per square meter and most of the firefighters BMI were overweight (61.15%). 33.17% of the firefighters were reported having health problems such as hypertension, hyperlipidemias, diabetes, gout, allergic rhinitis. The firefighters report currently smoke status were 28.31%. 28.97% of them were report secondhand smoking exposure by the members in their family. 911 firefighters (74.98%) were consumed alcohol. Among the firefighters who consumed alcohol, 486 (53.35%) were consumed alcohol only on special occasions. The 948 firefighters (78.02%) exercised for at least 150 minutes per week.

Firefighters with risk of PTSD

The majority of PTSD firefighters were age between 31 to 40 years old and the median age were 39.00 years old. The median weight (IQR) were 70.00 (65.00– 78.00) kilograms and median height (IQR) were 174.00 (169.00–178.00) centimeters. Most of them were reported BMI as overweight (≥ 23.00 kg/m^2). The 40.73% of them were report some medical problems such as hypertension, hyperlipidemias, diabetes. More than half of them (62.25%) were not currently smoke, however 32.45% of them

reported secondhand smoking exposure. Eighty percent of them drinking alcohol and they mostly drank on the special occasions. Most of the firefighters with risk of PTSD did an exercised weekly.

Firefighters without risk of PTSD

Most of firefighters without risk of PTSD were reported age group between 31 to 40 years old and the median age were 39.00 years old as the same of firefighters with risk of PTSD. Moreover, the median weight and height of firefighters with risk of PTSD and non-risk of PTSD were the same. More than half of them were reported BMI over weight. For 30.67% of them have health problems such as hyperlipidemias, diabetes, gout. The 74.81% of them were not currently smoke, while 27.82% of them exposure with smoke by the members in their family and 73.49% of them drinking alcohol. They mostly work out at least 150 minutes each week.

Moreover, when compared the demographic information of firefighters with risk of PTSD and without risk of PTSD with statistical approach were found health problems, smoking status, alcohol consumption, alcohol consumption frequency and physical activity were associated with risk of post-traumatic stress disorder with statistically significant (Table 4.3).

Table 4.3 General characteristics of study population (n=1,215)

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes	No	
		n (%)	n (%)	
		302 (24.9)	913 (75.1)	
Age (years)				0.753 [a]
≤ 30	49 (4.0)	14 (4.6)	35 (3.8)	
31 - 40	668 (55.0)	170 (56.3)	498 (54.5)	
41-50	391 (32.2)	95 (31.5)	296 (32.4)	
51-60	107 (8.8)	23 (7.6)	84 (9.2)	
				0.868 [c]
Median (IQR)	39.0	39.0	39.0	
	(36.0 – 44.0)	(36.0 – 44.0)	(36.0 – 44.0)	
Range (min-max)	22.0 – 58.0	23.0 – 58.0	22.0 – 58.0	
Weight (kg)				0.951 [c]
Median (IQR)	70.0	70.0	70.0	
	(65.0–78.0)	(65.0–78.0)	(65.0–78.0)	
Range (min-max)	44.0 – 131.0	46.0 – 122.0	44.0 – 131.0	
Height (cm)				0.689 [c]
Median (IQR)	174.0	174.0	174.0	
	(169.0–178.0)	(169.0–178.0)	(169.0–178.0)	
Range (min-max)	157.0 – 186.0	159.0 – 184.0	157.0 – 186.0	
Body mass index (kg/m^2)				0.957 [a]
< 18.5 (Underweight)	31 (2.6)	7 (2.3)	24 (2.6)	
18.5 – 22.9 (Normal range)	441 (36.3)	110 (36.4)	331 (36.3)	
≥ 23.0 (Overweight)	743 (61.2)	185 (61.3)	558 (61.1)	

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 (75.1)	
Health problem				0.001 [a*]
Yes	403 (33.2)	123 (40.7)	280 (30.7)	
No	812 (66.8)	179 (59.3)	633 (69.3)	
Smoking status				< 0.001 [a*]
Currently smoke	344 (28.3)	114 (37.7)	230 (25.2)	
Ever smoke	311 (25.6)	102 (33.8)	209 (22.9)	
Never smoke	560 (46.1)	86 (28.5)	474 (51.9)	
Family member smokes				0.124 [a]
Yes	352 (29.0)	98 (32.5)	254 (27.8)	
No	863 (71.0)	204 (67.5)	659 (72.2)	
Alcohol consumption				0.038 [a*]
Yes	911 (75.0)	240 (79.5)	671 (73.5)	
No	304 (25.0)	62 (20.5)	242 (26.5)	
Alcohol consumption per week (n=911)				0.003 [a*]
< 3 times per week	227 (24.9)	54 (22.5)	173 (25.8)	
≥ 3 times per week	198 (21.7)	71 (29.6)	127 (18.9)	
Only on special occasions	486 (53.3)	115 (47.9)	371 (55.3)	
Physical activity				< 0.001 [a*]
Yes	948 (78.0)	204 (67.5)	744 (81.5)	
No	267 (22.0)	98 (32.5)	169 (18.5)	

* Significant at $p < 0.05$

[a] Chi-square, [c] Mann-Whitney U test

4.3.2   Working Characteristic of Bangkok firefighters

The firefighters from 35 fire and rescue stations were willing to participated in this study. There were composed of 33 Head of fire and rescue stations, 163 Chief firefighters and 1,019 firefighters. One out of four participants (24.86%) were suffered risk of post-traumatic stress disorder. The median (IQR) duration of work were 10.00 (8.00 – 13.00) years and ranging from 2 to 42 years. The 68.73% of them past exposure to major fire in Thailand such as Praksa landfill fire, Santika club fire, Central World fire during political demonstration. The 476 (39.18%) of them were injured at work. Almost all of them (95.39%) completed fire extinguishers training course and 83.37% of them were completed mental training course. Moreover, duration of work and past exposure to major fire were associate with risk of post-traumatic stress disorder with statistically significant (Table 4.4).

Firefighters with risk of PTSD

The working position and proportion of firefighters with risk of PTSD and without risk of PTSD were the same. However, median duration of work (IQR) among PTSD-firefighters were 13.00 (9.00 -13.00) years and almost three out of four of risk of PTSD-firefighters (73.84%) were past exposure to major fire in Thailand. The 43.71% of them suffered with occupational injury. Almost all of them completed extinguishers training course and 85.76% of risk of PTSD-firefighters passed mental training course.

Firefighters without risk of PTSD

The median duration of work (IQR) among firefighters without risk of PTSD were 10.00 (8.00 -10.00) years and 67.03% of firefighters without risk of PTSD were past exposure to major fire. The 37.68% of them suffered with occupational injury. The 95.62% of them passed extinguishers training course and 82.58% completed mental training course.

Table 4.4 Working characteristics of study population (n=1,215)

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 (75.1)	
Working position				0.993 [a]
Head of fire and rescue station	33 (2.7)	8 (2.6)	25 (2.7)	
Chief firefighter	163 (13.4)	41 (13.6)	122 (13.4)	
Firefighter	1019 (83.9)	253 (83.8)	766 (83.9)	
Duration of work				< 0.001 [c*]
Median (IQR)	10.0 (8.0 – 13.0)	13.0 (9.0 – 13.0)	10.0 (8.0 – 10.0)	
Range (min-max)	2.0 – 42.0	2.0 – 40.0	2.0 – 42.0	
Past exposure to major fire in Thailand				0.027 [a*]
Yes	835 (68.7)	223 (73.8)	612 (67.0)	
No	380 (31.3)	79 (26.2)	301 (33.0)	
Occupational injury				0.063 [a]
Yes	476 (39.2)	132 (43.7)	344 (37.7)	
No	739 (60.8)	170 (56.3)	569 (62.3)	

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 (75.1)	
Fire extinguisher training course				0.510 [a]
Yes	1159 (95.4)	286 (94.7)	873 (95.6)	
No	56 (4.6)	16 (5.3)	40 (4.4)	
Mental training course				0.199 [a]
Yes	1013 (83.4)	259 (85.8)	754 (82.6)	
No	202 (16.6)	43 (14.2)	159 (17.4)	

* Significant at p < 0.05

[a] Chi-square, [c] Mann-Whitney U test

4.3.3 Sleep quality

Almost half (49.05%) of 1,215 firefighters reported the global Pittsburgh Sleep Quality Index (PSQI) scores more than five, defined as poor sleep quality and in each component and the PSQI median scores were 5.00 (4.00 – 8.00) ranging from 0.00 – 18.00. In term of subjective sleep quality, 72.10% of them reported fairly good to very bad sleep while only 27.90% of them feeling very good sleep. The 46.99% taking longer than 30 minutes to fall asleep. The majority of firefighters (83.46%) were short sleep duration, which less than 7 hours (≤ 7 hrs.) and, likewise, more than half of the firefighters were report lower sleep efficiency (the ratio of total sleep time and number of hours spent in bed) 703 (57.86%). In term of sleep disturbances, 1134 (93.33%) reported at least once a week with conforms to daytime dysfunction due to sleep was 799 (65.76%) reported at least once or twice in the past one month. The one

hundred and eight (8.89%) of the firefighters ever used of sleep medication, and overall poor sleep quality (classified by PSQI scores > 5), 77.48% (234/302) of risk of PTSD-firefighters, while 39.65% (362/913) among firefighters without risk of PTSD report poor sleep quality and poorer sleep quality with statistically significant (p-value < 0.001) when comparing with firefighters without risk of PTSD (Table 4.5).

Firefighters with risk of PTSD and without risk of PTSD

Firefighters with risk of PTSD reported poorer sleep quality in all 7 components of the global Pittsburgh Sleep Quality Index scores with statistically significant (p-value < 0.001) when compare with firefighters without PTSD. For Component 1 Subjective sleep quality; 83.11% (251/302) of risk of PTSD firefighters and 68.46% (625/913) of firefighters with non-risk of PTSD reported poor sleep quality, Component 2 Sleep latency; 68.21% of risk of PTSD-firefighters and 39.98% of firefighters with non-risk of PTSD spending more than 30 minutes to fall asleep, Component 3 Sleep duration; risk of PTSD-firefighters 90.07% (272/302) and firefighters with non-risk of PTSD 81.27% (742/913) were short sleep duration (≤ 7 hours), Component 4 Sleep efficiency; 78.15% of risk of PTSD firefighters and 51.15% of firefighters with non-risk of PTSD were report low sleep efficiency, Component 5 Sleep disturbances; 97.68% (295/302) risk of PTSD-firefighters and 91.89% (839/913) were at least once a week with conforms to daytime dysfunction due to sleep (Component 7) among risk of PTSD-firefighters and firefighters with non-risk of PTSD were 84.44% (255/302) and 59.58% (544/913) respectively. Moreover, 21.85% of risk of PTSD-firefighters and 4.60% of firefighters with non-risk of PTSD ever used of sleep medication (Component 6). In addition, the PSQI

median scores were 8.00 (6.00 – 9.00) and 5.00 (3.00 – 7.00) among risk of PTSD-firefighters and firefighters with non-risk of PTSD.

Table 4.5 The comparison of Pittsburgh Sleep Quality index between the firefighters with and without risk of PTSD (n=1,215)

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 (75.1)	
Component 1 : Subjective sleep quality				<0.001 [a*]
Very good	339 (27.9)	51 (16.9)	288 (31.5)	
Fairly good	688 (56.6)	169 (56.0)	519 (56.8)	
Fairly bad	164 (13.5)	70 (23.1)	94 (10.4)	
Very bad	24 (2.0)	12 (4.0)	12 (1.3)	
Component 2 : Sleep latency (mins)				<0.001 [a]
≤ 15	396 (32.6)	30 (9.9)	366 (40.1)	
16 - 30	248 (20.4)	66 (21.9)	182 (19.9)	
31 - 60	561 (46.2)	203 (67.2)	358 (39.2)	
> 60	10 (0.8)	3 (1.0)	7 (0.8)	
Component 3 : Sleep duration (hrs.)				<0.001 [a*]
≤ 5	392 (32.3)	125 (41.4)	267 (29.2)	
5.1 – 6.0	364 (30.0)	96 (31.8)	268 (29.4)	
6.1 – 7.0	258 (21.2)	51 (16.9)	207 (22.7)	
Component 4 : Sleep efficiency				<0.001 [a*]
< 65%	215 (17.7)	70 (23.2)	145 (15.9)	
65% – 74%	173 (14.2)	53 (17.5)	120 (13.1)	
75% – 85%	315 (25.9)	113 (37.4)	202 (22.2)	
> 85%	512 (42.1)	66 (21.9)	446 (48.8)	

General Information	Total n=1,215	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 (75.1)	
Component 5 : Sleep disturbances				<0.001 [a~]
Not during the past month	81 (6.7)	7 (2.3)	74 (8.1)	
Less than once a week	789 (64.9)	148 (49.0)	641 (70.2)	
More than once a week	345 (28.4)	147 (48.7)	198 (21.7)	
Component 6 : Use of sleep medication				<0.001 [a*]
Never	1107 (91.1)	236 (78.1)	871 (95.4)	
Ever	108 (8.9)	66 (21.9)	42 (4.6)	
Component 7 : Daytime dysfunction due to sleep				<0.001 [b*]
Never	416 (34.2)	47 (15.6)	369 (40.4)	
$\leq$ 2 times a week	711 (58.5)	208 (68.9)	503 (55.1)	
> 2 times a week	88 (7.2)	47 (15.5)	41 (4.5)	
Overall sleep quality (Global PSQI Scores)				<0.001 [a*]
Good Sleep PSQI $\leq$ 5	619 (50.9)	68 (22.5)	551 (60.4)	
Poor sleep PSQI > 5	596 (49.1)	234 (77.5)	362 (39.6)	
				<0.001 [c*]
Median (IQR)	5.0 (4.0 – 8.0)	8.0 (6.0 – 9.0)	5.0 (3.0 – 7.0)	
Range (min-max)	0.0 – 18.0	1.0 – 18.0	0.0 – 15.0	

* Significant at p < 0.05

[a] Chi-square, [b] Fisher's Exact, [c] Mann-Whitney U test

4.4 Factors related to risk of post-traumatic stress disorder

In phase I, all eligible firefighters were invited to participate the study in this phase. When compared demographic information of firefighters with risk of PTSD and without risk of PTSD with statistical approach, results indicated that health problems, smoking status, alcohol consumption, alcohol consumption frequency, physical activity, sleep quality (Table 4.5) and severity of depression (Appendix E) were associated with risk of post-traumatic stress disorder with statistically significant (Table 4.3). Comparing working characteristic factors of firefighters with risk of PTSD and without risk of PTSD with statistical approach were found duration of work and past exposure to major fire in Thailand associated with risk of post-traumatic stress disorder with statistically significant (Table 4.4).

4.5 Participants in phase 1 and phase 2

4.5.1   Participants flow

The flow chart was showed sampling technique and drop out from Phase I to Phase II at baseline and follow up. Of 1,215 Bangkok firefighters were eligible and willing to participate in Phase I, among firefighters in Phase I including 302 firefighters with risk of PTSD and 913 firefighters without risk of PTSD. The firefighters from four fire and rescue stations (selected from each Fire Brigade Division) that reveals highest number of firefighters with risk of post-traumatic stress disorder and high return rate questionnaire in Phase I (more than 80%) were invite to participate in Phase II at baseline, however two fire and rescue stations willing to participate in this phase. Of 54 firefighters from two fire and rescue stations willing to participate in Phase II at baseline after that follow up 6 months. Phase II at follow up, 39 firefighters willing to participate, however 14 subjects including 2 firefighters in

risk of PTSD group and 9 firefighters in without risk of PTSD group had to be exclude because of missing blood test data. Therefore, 25 participants (including 12 risk of PTSD-firefighters and 13 without risk of PTSD-firefighters) were included in the Phase II follow up data analysis.

4.5.2 Comparison of participants' characteristic in phase 1 and phase 2

Regarding to the number of firefighters who willing to participate in Phase II at follow up and complete blood test data, Table 4.6 showed the participants in Phase II at baseline and follow up were not significant different in term of demographic information and working characteristic.

Table 4.6 Comparison of participants in Phase II at baseline and follow up

| Variables | Participants in Phase II | | |
	Baseline n (%)	Follow-up n (%)	p-value*
	54	25	
Demographic Information			
Age (years)			0.546[b]
≤ 30	3 (5.6)	1 (4.0)	
31 - 40	33 (61.1)	17 (68.0)	
41-50	13 (24.1)	7 (28.0)	
51-60	5 (9.2)	0 (0.0)	
			0.528[d]
Mean (± SD)	39.4 (± 6.4)	38.5 (± 5.1)	
Range (min-max)	26.0 – 54.0	29.0 – 42.0	
Weight (kg)			0.617[d]
Mean (± SD)	75.1 (± 10.0)	76.4 (± 11.8)	
Range (min-max)	55.0 – 110.0	60.0 – 110.0	
Height (cm)			0.463[d]
Mean (± SD)	170.5 (± 4.5)	171.3 (± 4.8)	
Range (min-max)	160.0–180.0	162.0 – 180.0	

Variables	Participants in Phase II		p-value*
	Baseline n (%)	Follow-up n (%)	
	54	25	
Body mass index (kg/m^2)			1.000 [b]
18.5 – 22.9 (Normal range)	10 (18.5)	5 (20.0)	
≥ 23.0 (Overweight)	44 (81.5)	20 (80.0)	
Health problem			0.527 [a]
Yes	19 (35.2)	7 (28.0)	
No	35 (64.8)	18 (72.0)	
Smoking status			0.833 [a]
Currently smoke	20 (37.0)	9 (36.0)	
Ever smoke	9 (16.7)	3 (12.0)	
Never smoke	25 (46.3)	13 (52.0)	
Family member smokes			0.925 [a]
Yes	21 (38.9)	10 (40.0)	
No	33 (61.1)	15 (60.0)	

Variables	Participants in Phase II		p-value*
	Baseline n (%)	Follow-up n (%)	
	54	25	
Alcohol consumption			1.000 [b]
Yes	49 (90.7)	23 (92.0)	
No	5 (9.3)	2 (8.0)	
Alcohol consumption per week (n=911)			0.749 [a]
< 3 times per week	10 (20.4)	3 (13.0)	
≥ 3 times per week	12 (24.5)	6 (26.1)	
Only on special occasions	27 (55.1)	14 (60.9)	
Physical activity			0.701 [a]
Yes	39 (72.2)	17 (68.0)	
No	15 (27.8)	8 (32.0)	
Working Characteristic			
Working position			1.000 [b]
Head of fire and rescue station	2 (3.7)	1 (4.0)	
Chief firefighter	6 (11.1)	2 (8.0)	
Firefighter	46 (85.2)	22 (88.0)	
Duration of work			0.340 [d]
Mean (± SD)	10.3 (± 7.1)	8.8 (± 4.7)	
Range (min-max)	2.0-30.0	2.0-21.0	

Variables	Participants in Phase II		p-value*
	Baseline n (%)	Follow-up n (%)	
	54	25	
Past exposure to major fire in Thailand			0.806 [a]
Yes	33 (61.1)	16 (64.0)	
No	21 (38.9)	9 (36.0)	
Occupational injury			0.499 [a]
Yes	28 (51.9)	15 (60.0)	
No	26 (48.1)	10 (40.0)	
Mental training course			0.659 [b]
Yes	49 (90.7)	24 (96.0)	
No	5 (9.3)	1 (4.0)	
Risk of PTSD			0.278 [a]
PTSD	19 (35.2)	12 (48.0)	
Non PTSD	35 (64.8)	13 (52.0)	

* Significant at $p < 0.05$

[a] Chi-square, [b] Fisher's Exact, [c] Mann-Whitney U test, [d] Independent T test

Phase II

4.6 General Information in Phase II

In phase II, all firefighters from four fire and rescue stations including Thon Buri, Phrakhanong, Phayathai, and Banthat Thong fire and rescue stations were invited to participate, however, only two fire and rescue stations willing to participate in this phase composed of Phayathai fire and rescue stations and Banthat Thong fire and rescue stations.

Eighty-six firefighters from Phayathai and Banthat Thong fire and rescue stations were invited to participate in Phase II. However, fifty-four firefighters from two fire and rescue stations willing to participate in this study.

4.7 Prevalence of risk of post-traumatic stress disorder in Phase II (at Baseline)

Fifty-four firefighters from Phayathai and Banthat Thong fire and rescue stations were willing to participate with written and signed consent in phase II (at Baseline). Prevalence of risk of post-traumatic stress disorder was 35.19%, 19 firefighters were met the suggested PTSD check list cut-point criteria for civilian (PCL Scores $\geq$ 30). An average ($\pm$ SD) score of risk of PTSD in Bangkok firefighters was 25.96 ($\pm$ 6.29). Firefighters with risk of PTSD have average ($\pm$ SD) score of risk of PTSD was 33.00 ($\pm$ 2.27), while, firefighters without risk of PTSD was 21.94 ($\pm$ 3.42) (Table 4.7).

Table 4.7 Prevalence of post-traumatic stress disorder in Phase II (n=54)

Risk of post-traumatic stress disorder PCL-C	n	%
Without risk of PTSD (PCL-C scores < 30)	35	64.8
Mean (± SD)	21.94 (± 3.42)	
Range (min-max)	17.0 – 28.0	
Risk of PTSD (PCL-C scores ≥ 30)	19	35.2
Mean (± SD)	33.0 (± 2.27)	
Range (min-max)	30.0 – 39.0	

4.8 Demographic Information in Phase II at Baseline

4.8.1   General Characteristic of Bangkok firefighters

Most of 54 firefighters in Phase II age group between 31 to 40 years old (61.01%), the average (± SD) age was 39.41 (± 6.42) years old and ranging from 26.00 to 54.00 years old. An average (± SD) weight was 75.14 (± 9.99) kilograms and average (± SD) height was 170.50 (± 4.51) centimeters. Most of firefighters were revealed BMI overweight (81.48%). The 35.19% of the firefighters were reported medical problems for example hypertension, hyperlipidemias, diabetes, and gout. The 37.04% were never smoke, however 38.89% of them were report secondhand smoking exposure by the members in their family. The 49 firefighters (90.74%) were consumed alcohol and among the firefighters who were consumed alcohol, half of them (50.01%) were reported that consumed alcohol only on special occasions. The 39 (72.22%) of firefighters have an exercised at least 150 minutes each week. In

addition, physical activity was associated with risk of post-traumatic stress disorder with statistically significant (Table 4.8).

Firefighters with risk of PTSD

Among 19 risk of PTSD-firefighters, most of them were reported age group between 31 to 40 years old and the average ($\pm$ SD) age was 38.10 ($\pm$ 6.50) years old. Average ($\pm$ SD) weight and height ($\pm$ SD) were 74.84 ($\pm$ 13.30) kilograms and 170.63 ($\pm$ 5.90) centimeters respectively. The 78.94% of risk of PTSD-firefighters revealed BMI overweight. Almost half of them (47.37%) were reported some medical problems. The 47.37% were currently smoke, while 31.58% of them were secondhand smoke. The 84.21% of risk of PTSD-firefighters consume alcohol, and 50.00% of them drinking alcohol only on special occasions. Moreover, 52.63% of them have an exercise.

Firefighters without risk of PTSD

The 35 firefighters without risk of PTSD, majority of them were reported age group between 31 to 40 years old and the average ($\pm$ SD) age was 40.1 ($\pm$ 6.4) years old. Moreover, an average ($\pm$ SD) weight 75.31 ($\pm$ 7.87) kilograms, while height ($\pm$ SD) was 170.43 ($\pm$ 3.63) centimeters. In term of BMI, 82.86% of them were overweight. 28.57% of them were reported some medical problems. The 31.43% of them reported currently smoking, while 42.86% of them were report secondhand smoking exposure by the members in their family. The 94.29% of firefighters without risk of PTSD were consume alcohol, and 57.58% of them drinking alcohol only on special occasions, and 82.86% of them have an exercise.

Table 4.8 General information of firefighters in Phase II at Baseline (n=54)

General Information	Total n=54	Risk of PTSD		p-value*
		Yes	No	
		n (%)	n (%)	
		19 (35.2)	35 (64.8)	
Age (years)				0.697[b]
≤ 30	3 (5.6)	0 (0.0)	3 (8.6)	
31 - 40	33 (61.0)	13 (68.4)	20 (57.1)	
41-50	13 (24.1)	4 (21.1)	9 (25.7)	
51-60	5 (9.3)	2 (10.5)	3 (8.6)	
				0.852[d]
Mean (± SD)	39.4 (± 6.4)	38.1 (± 6.5)	40.1 (± 6.4)	
Range (min-max)	26.0 – 54.0	26.0 – 53.0	29.0 – 54.0	
Weight (kg)				0.872[d]
Mean (± SD)	75.1 (± 10.0)	74.8 (± 13.3)	75.3 (± 7.9)	
Range (min-max)	55.0 – 110.0	55.0 – 110.0	63.0 – 92.0	
Height (cm)				0.876[d]
Mean (± SD)	170.5 (± 4.5)	170.6 (± 5.9)	170.4 (± 3.6)	
Range (min-max)	160.0 – 180.0	160.0 – 180.0	165.0 – 176.0	
Body mass index (kg/m²)				0.728[b]
18.5 – 22.9 (Normal range)	10 (18.5)	4 (21.1)	6 (17.1)	
≥ 23.0 (Overweight)	44 (81.5)	15 (78.9)	29 (82.9)	
Health problem				0.167[a]
Yes	19 (35.2)	9 (47.4)	10 (28.6)	
No	35 (64.8)	10 (52.6)	25 (71.4)	

General Information	Total n=54	Risk of PTSD		p-value*
		Yes	No	
		n (%)	n (%)	
		19 (35.2)	35 (64.8)	
Smoking status				0.445 [a]
Currently smoke	20 (37.0)	9 (47.4)	11 (31.4)	
Ever smoke	9 (16.7)	2 (10.5)	7 (20.0)	
Never smoke	25 (46.3)	8 (42.1)	17 (48.6)	
Family member smokes				0.417 [a]
Yes	21 (38.9)	6 (31.6)	15 (42.9)	
No	33 (61.1)	13 (68.4)	20 (57.1)	
Alcohol consumption				0.332 [b]
Yes	49 (90.7)	16 (84.2)	33 (94.3)	
No	5 (9.3)	3 (15.8)	2 (5.7)	
Alcohol consumption per week (n=49)				0.783 [b]
< 3 times per week	10 (20.4)	3 (18.8)	7 (21.2)	
≥ 3 times per week	12 (24.5)	5 (31.2)	7 (21.2)	
Only on special occasions	27 (55.1)	8 (50.0)	19 (57.6)	
Physical activity				0.018 [a]*
Yes	39 (72.2)	10 (52.6)	29 (82.9)	
No	15 (27.8)	9 (47.4)	6 (17.1)	

* Significant at $p < 0.05$

[a] Chi-square, [b] Fisher's Exact, [d] Independent T test

4.8.2 Working Characteristic

The 54 firefighters from two fire and rescue stations were willing to participate in this phase. There were composed of 2 Head of fire and rescue stations, 6 Chief firefighters and 46 firefighters. Among 54 firefighters who willing to participate in this phase report the-median (IQR) duration of work were 9.50 (4.75 – 13.00) years and ranging from 2 to 30 years. The 66.67% of them past exposure to major fire in Thailand such as Praksa landfill fire, Santika club fire, Central World fire during political demonstration. The 28 (51.85%) of them were injured at work. Normally, Fire and rescue department; BMA provided the firefighting training course to all firefighters, thus almost all of them (98.14%) completed fire extinguishers training course and 90.74% of them were completed mental training course (Table 4.9).

Firefighters with risk of PTSD

Working position of risk of PTSD-firefighters and non-risk of PTSD firefighters were the same in term of the proportion of chief firefighters and firefighters, however, among non-risk PTSD firefighters including two head of fire and rescue station. The median (IQR) duration of work among risk of PTSD-firefighters were 12.00 (4.00 -13.00) years. 73.68% of them were past exposure to major fire in Thailand and 42.11% suffered with occupational injury. All risk of PTSD-firefighters completed extinguishers training course and almost all of them (94.74%) passed mental training course.

Firefighters without risk of PTSD

The median (IQR) duration of work among non-risk of PTSD firefighters were 9.00 (5.00 -13.00) and ranging from 2 to 30 years. More than half of them (62.86%)

were past exposure to major fire in Thailand and 57.14% of them suffered with occupational injury. The 97.14% of them passed extinguishers training course and 88.57% completed mental training course.

Table 4.9 Working Characteristic of firefighters in Phase II at Baseline (n=54)

General Information	Total n=54	Risk of PTSD		p-value*
		Yes	No	
		n (%)	n (%)	
		19 (35.2)	35 (64.8)	
Working position				0.560 [b]
Head of fire and rescue station	2 (3.7)	0 (0.0)	2 (5.7)	
Chief firefighter	6 (11.1)	2 (10.5)	4 (11.4)	
Firefighter	46 (85.2)	17 (89.5)	29 (82.9)	
Duration of work				0.482 [c]
Median (IQR)	9.5	12.0	9.0	
	(4.8 – 13.0)	(4.0-13.0)	(5.0-13.0)	
Range (min-max)	2.0 – 30.0	3.0-30.0	2.0-30.0	
Past exposure to major fire in Thailand				0.420 [a]
Yes	36 (66.7)	14 (73.7)	22 (62.9)	
No	18 (33.3)	5 (26.3)	13 (37.1)	
Occupational injury				0.291 [a]
Yes	28 (51.9)	8 (42.1)	20 (57.1)	
No	26 (48.1)	11 (57.9)	15 (42.9)	
Fire extinguisher training course				0.457 [b]
Yes	53 (98.1)	19 (100.0)	34 (97.1)	
No	1 (1.9)	0 (0.0)	1 (2.9)	

| General Information | Total n=54 | Risk of PTSD | | p-value* |
		Yes n (%)	No n (%)	
		19 (35.2)	35 (64.8)	
Mental training course				0.455 [b]
Yes	49 (90.7)	18 (94.7)	31 (88.6)	
No	5 (9.3)	1 (5.3)	4 (11.4)	

* Significant at $p < 0.05$

[a] Chi-square, [b] Fisher's Exact, [c] Mann-Whitney U test

4.8.3 Cardiovascular Biomarkers Phase II at baseline

Blood samples were collected to determine the association between cardiovascular biomarkers including High-sensitive C-reactive protein (hs-CRP), Troponin T (TnT), Brain Natriuretic Peptide (BNP) and risk of post-traumatic stress disorder. The 54 firefighters from two fire and rescue stations were invited to participate in this phase, blood samples were collected in August 2017 (Table 4.10).

High-sensitive C-reactive protein (hs-CRP)

The statistical analysis was revealed that the mean serum level of hs-CRP among the firefighters in Phase II at baseline was 2.03 (± 1.67) (range of 0.35 − 7.40) milligram per liter (mg/L). The 33.33% of participants revealed mean serum levels of hs-CRP more than 2.03 mg/L and 66.67% of them showed mean serum levels of hs-CRP less than or equal to 2.03 mg/L.

Troponin T (TnT)

The 54 firefighters were revealed the mean serum level of TnT 4.78 (± 2.53) nanograms per liter (ng/L) and ranging from <3.00 to 12.80 ng/L. The 46.30 % of them revealed mean TnT serum level more than 4.78 ng/L, while 53.70% of them revealed mean TnT serum level less than or equal to their mean serum level of TnT.

Brain Natriuretic Peptide (BNP)

The median BNP serum level of the firefighter in Phase II at baseline was <10.00 (range of <10.00 – 51.50) picograms per milliliter (pg/mL). The 42.59% of firefighters in phase II at baseline showed median BNP serum level more than 10.00 pg/mL and 57.41% of them revealed median BNP less than or equal to their median serum level of BNP.

Table 4.10 Level of Cardiovascular biomarkers among firefighters in Phase II at Baseline (n=54)

Cardiovascular Biomarkers	Mean ± SD/ Median (IQR)	Range	High level[††]		Low level[†]	
			n	%	n	%
hs-CRP (mg/L)	2.03 (± 1.67)	0.35 – 7.40	18	33.33	36	66.67
TnT (ng/L)	4.78 (± 2.53)	<3.00 – 12.80	25	46.3	29	53.7
BNP (pg/mL)	<10.00 (<10.00 – 12.52)	<10.00 – 51.50	23	42.59	31	57.41

[††] High level was considered if the value was > Mean of hs-CRP, TnT and Median of BNP

[†] Low level was considered if the value was ≤ Mean of hs-CRP, TnT and Median of BNP

Statistically significant difference was observed between the mean or median of cardiovascular biomarker serum levels between risk of PTSD-firefighters and non-risk of PTSD firefighters. The mean (± SD) hs-CRP of risk of PTSD-firefighter was 2.66 (± 1.99) (ranging from 0.41 to 7.40 mg/L, while the mean hs-CRP of non PTSD-firefighter was 1.69 (± 1.38) (range of 0.35 − 7.04) mg/L. The comparison of hs-CRP serum levels among risk of PTSD and non-risk of PTSD firefighter was statistically significant difference (P=0.039).

In term of, troponin T showed mean (± SD) serum level of risk of PTSD-firefighter was 4.88 (± 2.45) (range of <3.00 -10.20) ng/L, while the mean serum level of TnT among non-risk of PTSD firefighter was 4.72 (± 2.60) ranging from <3.00 to 12.80 ng/L. However, there was no significant difference between the mean TnT of risk of PTSD-firefighter and non-risk of PTSD firefighter.

In addition, the risk of PTSD-firefighter revealed median (IQR) serum level of BNP 12.40 (<10.00 − 15.70) and ranging from <10.00 − 45.60 pg/mL, while among non-risk of PTSD firefighter was <10.00 (<10.00 − 11.20) (range of <10.00 − 51.50) pg/mL. There was statistically significant difference between the median BNP of risk of PTSD-firefighter and non-risk of PTSD firefighter (P=0.006) (Table 4.11).

Table 4.11 Level of Cardiovascular biomarker of firefighters with/without PTSD in Phase II at Baseline (n=54)

Cardiovascular biomarkers	Risk of PTSD				p-value*
	Yes		No		
	n	%	n	%	
	19	35.2	35	64.8	
High-sensitive C-reactive protein (hs-CRP) (mg/L)					**0.039 [d]***
Mean (± SD)	2.66 (± 1.99)		1.69 (± 1.38)		
		2.03 (± 1.67)			
Range (min-max)	0.41 – 7.40		0.35 – 7.04		
		0.35 – 7.40			
Troponin T (TnT) (ng/L)					0.825 [d]
Mean (± SD)	4.88 (± 2.45)		4.72 (± 2.60)		
		4.78 (± 2.53)			
Range (min-max)	<3.00 – 10.20		<3.00 – 12.80		
		<3.00 – 12.80			
Brain Natriuretic Peptide (BNP) (pg/mL)					**0.006 [c]***
Median (IQR)	12.40		<10.00		
	(<10.00 – 15.70)		(<10.00 – 11.20)		
		< 10.00 (<10.00 – 12.52)			
Range (min-max)	<10.00 – 45.60		<10.00 – 51.50		
		<10.00 – 51.50			

* Significant at p < 0.05

[c]Mann-Whitney U test, [d]Independent T test

Multiple logistic regression was performed to access an association between risk of post-traumatic stress disorder (PTSD) and cardiovascular biomarkers among Bangkok firefighters in Phase II at baseline. Unadjusted, age adjusted, and multivariable adjusted logistic regression models for age, BMI, smoking status, systolic blood pressure, heart rate were fit to estimate odds ratio and 95 confidence intervals (95% CI) (Table 4.12).

For high-sensitive C-reactive protein (hs-CRP), the firefighters with risk of PTSD were 3.75 times (95%CI 1.133 – 12.416) more likely to have serum level of hs-CRP higher than mean (> 2.03 mg/L) than non-risk of PTSD-firefighters, 3.76 times (95%CI 1.128 – 12.526) for age-adjusted and 6.14 times (95%CI 1.242 – 30.350) after adjusted for age, BMI, smoke, systolic blood pressure, heart rate. Brain natriuretic peptide (BNP) among risk of PTSD-firefighters more likely to have serum level of BNP higher than non-risk of PTSD firefighters (OR = 3.74, 95% CI 1.156 – 12.099) and after age adjusted firefighters with risk of PTSD remained have median serum level of BNP higher than firefighters without risk of PTSD (AOR = 3.76, 95% CI 1.152 – 12.248). However, after multivariate adjusted for age, BMI, smoke, systolic blood pressure, heart rate there was no significant difference between risk of PTSD and non-risk of PTSD firefighters.

In addition, mean serum level of troponin T (TnT) was no significant difference between risk of PTSD and non-risk of PTSD firefighters.

Table 4.12 Odds Ratios (OR) and 95% Confidence Interval (CI) of Cardiovascular biomarkers and Risk of Post-traumatic stress disorder Phase II at Baseline (n=54)

Cardiovascular Biomarkers	Unadjusted		p-value	Age adjusted	p-value	Multivariable adjusted**	p-value
	OR	(95% CI)		AOR (95% CI)		AOR (95% CI)	
High-sensitive C-reactive protein (hs-CRP)							
≤ 2.03 mg/L	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 2.03 mg/L	**3.750**		**0.030***	**3.759**	**0.031***	**6.139**	**0.026***
	(1.133 – 12.416)			**(1.128 – 12.526)**		**(1.242 – 30.350)**	
Troponin T (TnT)							
≤ 4.78 ng/L	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 4.78 ng/L	2.062		0.211	2.055	0.215	1.903	0.342
	(0.663 – 6.413)			(0.658 – 6.422)		(0.504 – 7.177)	
Brain Natriuretic Peptide (BNP)							
≤ 10.00 pg/mL	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 10.00 pg/mL	**3.740**		**0.028***	**3.757**	**0.028***	3.235	0.093
	(1.156 – 12.099)			**(1.152 – 12.248)**		(0.822 – 12.733)	

* Significant at p < 0.05

** Multivariable adjusted for age, BMI, smoke, systolic blood pressure, heart rate

4.8.4 Covariate factors of cardiovascular disease

Cardiovascular covariate factors were collected to fit an estimate odds ratio and 95% confidence intervals (95% CI) for the association between risk of post-traumatic stress disorder (PTSD) and cardiovascular biomarkers. For blood pressure, most of the firefighters in Phase II at baseline (61.11%) have high blood pressure with hypertension stage 2; Systolic 140 mmHg or higher (or) Diastolic 90 mmHg or higher and revealed the mean (± SD) systolic 137.69 ± 12.49 mmHg, mean (± SD) diastolic 88.31 ± 10.55 mmHg, while the 92.59% of them reported heart rate in normal range

(60 to 100 beats per minute). The mean level of total cholesterol was 218.93 ± 34.17 mg/dL, HDL was 52.91 ± 12.16 mg/dL, while mean level of LDL was 149.37 ± 35.17 mg/dL. However, covariates factors of cardiovascular disease including blood pressure, heart rate, cholesterol, HDL, LDL were not show a significant relationship with risk of post-traumatic stress disorder (Table 4.13).

The 63.16% of risk of PTSD-firefighters reported hypertension stage 2 and revealed the mean (± SD) systolic 140.36 ± 13.33 mmHg, mean (± SD) diastolic 89.74 ± 11.06 mmHg, while the 84.21% of them reported heart rate in normal range. The 63.16% of them reported total cholesterol ≥ 200 mg/dL. In term of HDL, 47.37% of them have low level of HDL and 78.94% reported high level of LDL.

Most of the non-risk of PTSD firefighters (60.00%) reported high blood pressure with hypertension stage 2 which revealed the mean (± SD) systolic 136.29 ± 11.97 mmHg, mean (± SD) diastolic 87.54 ± 10.35 mmHg. Majority of them (97.14%) have heart rate in normal range. In term of total cholesterol, 71.43% of them reported total cholesterol ≥ 200 mg/dL. Non-risk of PTSD firefighters 34.39% have low level of HDL, while 68.57% of them reported high level of LDL.

Table 4.13 Covariate factors of cardiovascular disease among firefighters in Phase II

at Baseline (n=54)

Covariate factors of cardiovascular disease	Total n=54	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		19 (35.2)	35 (64.8)	
Blood pressure (mmHg)				0.869 [b]
Normal	5 (9.3)	1 (5.3)	4 (11.4)	
Elevated	2 (3.7)	1 (2.9)	1 (5.3)	
Hypertension stage 1	14 (25.9)	5 (26.3)	9 (25.7)	
Hypertension stage 2	33 (61.1)	12 (63.2)	21 (60.0)	
Hypertensive crisis	0 (0.0)	0 (0.0)	0 (0.0)	
Systolic (mmHg)				0.268 [d]
Mean (± SD)	137.7 ± 12.5	140.4 ± 13.3	136.3 ± 12.0	
Range (min-max)	110.0 - 160.0	116.0 - 158.0	110.0 - 160.0	
Diastolic (mmHg)				0.471 [d]
Mean (± SD)	88.3 ± 10.6	89.7 ± 11.1	87.5 ± 10.4	
Range (min-max)	71.0 - 111.0	75.0 - 111.0	71.0 - 108.0	
Heart rate (Beats per minute)				0.119 [b]
≤ 59	3 (5.6)	2 (10.5)	1 (2.9)	
60 to 100	50 (92.6)	16 (84.2)	34 (97.1)	
≥ 101	1 (1.8)	1 (5.3)	0 (0.0)	
Cholesterol (mg/dL)				0.764 [a]
Normal level (< 200 mg/dL)	17 (31.5)	7 (36.8)	10 (28.6)	
Consider borderline high (200 to 239 mg/dL)	23 (42.6)	8 (42.1)	15 (42.8)	
High blood cholesterol (240 mg/dL and above)	14 (25.9)	4 (21.1)	10 (28.6)	

Covariate factors of cardiovascular disease	Total n=54	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		19 (35.2)	35 (64.8)	
				0.111 [d]
Mean (± SD)	218.9 ± 34.2	208.8 ± 37.4	224.4 ± 31.5	
Range (min-max)	141.0 - 288.0	159.0 - 270.0	141.0 - 288.0	
HDL (mg/dL)				0.641 [a]
Low HDL (Major risk of CVD) (< 50 mg/dL)	21 (38.9)	9 (47.4)	12 (34.4)	
Normal range (50 to 59 mg/dL)	20 (37.0)	6 (31.6)	14 (40.0)	
High HDL (Protective against CVD) (≥ 60 mg/dL)	13 (24.1)	4 (21.0)	9 (25.6)	
				0.339 [d]
Mean (± SD)	52.9 ± 12.2	50.7 ± 13.6	54.1 ± 11.3	
Range (min-max)	22.0 - 83.0	22.0 - 80.0	32.0 - 83.0	
LDL (mg/dL)				0.115 [b]
Optimal (< 100 mg/dL)	5 (9.3)	3 (15.8)	2 (5.7)	
Normal range (100 to 129 mg/dL)	10 (18.5)	1 (5.3)	9 (25.7)	
High LDL (≥ 130 mg/dL)	39 (72.2)	15 (78.9)	24 (68.6)	
				0.160 [d]
Mean (± SD)	149.4 ± 35.2	154.3 ± 32.9	140.2 ± 38.1	
Range (min-max)	56.0 - 205.0	89.0 - 205.0	56.0 - 204.0	

* Significant at $p < 0.05$

[a] Chi-square, [b] Fisher's Exact, [c] Mann-Whitney U test, [d] Independent T test

4.8.5   Brain derived neurotrophic factor (BDNF)

The Bangkok firefighters who were willing to participate in this phase revealed mean (± SD) of brain derived neurotrophic factor 20.140 (± 5.450) and ranging from 9.120 – 29.512 nanogram per milliliter (ng/mL). In term of, risk of PTSD-firefighter showed mean (± SD) of BDNF was 17.970 (± 6.597) ng/mL, while among non-risk of PTSD-firefighters mean (± SD) of BDNF was 21.317 (± 4.382) ng/mL. Moreover, there was significant difference between the mean BDNF level of risk of PTSD-firefighter and non-risk of PTSD firefighter (Table 4.14).

Table 4.14 Level of Brain derived neurotrophic factor of firefighters with/without PTSD in Phase II at Baseline (n=54)

Variable	Risk of PTSD				p-value*
	Yes		No		
	n	%	n	%	
	19	35.2	35	64.8	
Brain derived neurotrophic factor level (ng/mL)					**0.030 d***
Mean (± SD)	17.970 (± 6.597)		21.317 (± 4.382)		
	20.140 (± 5.450)				
Range (min-max)	9.120 – 29.512		9.550 – 27.542		
	9.120 – 29.512				

* Significant at p < 0.05

dIndependent T test

To determine the association between risk of post-traumatic stress disorder (PTSD) and brain derived neurotrophic factor among Bangkok firefighters Phase II at baseline. Multiple logistic regression was performed to access an association, Unadjusted, age adjusted, and multivariable adjusted logistic regression models for age, BMI, smoking status, alcohol consumption and exercise were fit to estimate odds ratio and 95 confidence intervals (95% CI). However, brain derived neurotrophic factor was not show a significant associate with risk of post-traumatic stress disorder (Table 4.15). It could be concluded that because of in each fire and rescue station have the exercise machines for the firefighters so the benefit of exercised can increase expression of BDNF levels. Therefore, risk of PTSD and non-risk of PTSD firefighters can increase their BDNF levels by exercised.

Table 4.15 Odds Ratios (OR) and 95% Confidence Interval (CI) of Brain derived neurotrophic factor and Risk of Post-traumatic stress disorder Phase II at Baseline (n=54)

Risk of PTSD Biomarker	Unadjusted	p-value	Age adjusted	p-value	Multivariable adjusted**	p-value
	OR (95% CI)		AOR (95% CI)		AOR (95% CI)	
Brain derived neurotrophic factor level (ng/mL)						
≤ 20.140	1.00 (Reference)		1.00 (Reference)		1.00 (Reference)	
> 20.140	0.333	0.063	0.332	0.062	0.413	0.201
	(0.105 – 1.060)		(0.104 – 1.058)		(0.107 – 1.600)	

* Significant at p < 0.05

**Multivariable adjusted for age, BMI, smoking status, alcohol consumption and exercise

4.9 Demographic Information in Phase II (6-month follow-up)

    4.9.1   General Characteristic

    Twenty-five firefighters willing to participate in Phase II after 6-month follow-up. Most of them age group between 31 to 40 years old (68.00%), the average (± SD) age was 38.48 (± 5.11) years old and ranging from 29.00 to 49.00 years old. The average (± SD) weight of them was 77.60 (± 11.79) kilograms, while the average (± SD) height was 171.40 (± 4.84) centimeters. The 88.00% of them reported BMI overweight. The 24.00% of the firefighters were reported medical problems for example hypertension, hyperlipidemias, diabetes, and gout. The 28.00% of them were currently smoke and 52.00% of them were report secondhand smoking exposure by the members in their family. The 19 firefighters (76.00%) were consume alcohol, among the firefighters who consume alcohol more than half of them (57.89%) were reported that consume alcohol only on special occasions. The 14 (56.00%) of firefighters have an exercised at least 150 minutes each week. However, there were no significant difference in term of demographic information and risk of post-traumatic stress disorder among firefighters in Phase II after 6-month follow-up (Table 4.16).

Firefighters with risk of PTSD

    Twelve risk of PTSD-firefighters were reported age group between 31 to 40 years old and the average (± SD) age was 37.92 (± 4.40) years old. Average (± SD) weight and height were 79.00 (± 14.33) kilograms and 171.50 (± 6.13) centimeters respectively. The 83.33% of risk of PTSD-firefighters revealed BMI overweight. One out of four of them (25.00%) were reported some medical problems. The 41.67% of risk of PTSD-firefighters were reported currently smoke, similarly to 41.67% of them

were secondhand smoke. The 75.00% of risk of PTSD-firefighters consume alcohol, and 44.45% of them drinking alcohol only on special occasions. Half of them (50.00%) have an exercise.

Firefighters without risk of PTSD

Among 13 firefighters without risk of PTSD, majority of them were reported age group between 31 to 40 years old and the average age (± SD) was 39.00 (± 5.82) years old. An average weight (± SD) 76.31 (± 9.27) kilograms, while height (± SD) was 171.31 (± 3.52) centimeters and 92.31% of them were overweight. The 23.08% of them were reported some medical problems. More than half of them (53.84%) of them never smoke, while 61.54% of them were report secondhand smoking exposure by the members in their family. In term of alcohol consumption, 76.92% consume alcohol and 70.00% of them drinking alcohol only on special occasions, and 61.54% of them have an exercise each week.

Table 4.16 General information of firefighters in Phase II at follow up (n=25)

General Information	Total n=25	Risk of PTSD Yes n (%)	No n (%)	p-value*
		12 (48.0)	13 (52.0)	
Age (years)				1.000[b]
≤ 30	1 (4.0)	0 (0.0)	1 (7.7)	
31 - 40	17 (68.0)	9 (75.0)	8 (61.5)	
41-50	7 (28.0)	3 (25.0)	4 (30.8)	
				0.607[d]
Mean (± SD)	38.5 (± 5.1)	37.9 (± 4.4)	39.0 (± 5.8)	
Range (min-max)	29.0 – 49.0	32.0 – 47.0	29.0 – 49.0	
Weight (kg)				0.579[d]
Mean (± SD)	77.6 (± 11.8)	79.0 (± 14.3)	76.3 (± 9.3)	
Range (min-max)	65.0 – 110.0	65.0 – 110.0	65.0 – 95.0	
Height (cm)				0.923[d]
Mean (± SD)	171.4 (± 4.8)	171.5 (± 6.1)	171.3 (± 3.5)	
Range (min-max)	162.0 – 180.0	162.0 – 180.0	165.0 – 176.0	
Body mass index (kg/m^2)				0.593[b]
18.5 – 22.9 (Normal range)	3 (12.0)	2 (16.7)	1 (7.7)	
≥ 23.0 (Overweight)	22 (88.0)	10 (83.3)	12 (92.3)	
Health problem				1.000[b]
Yes	6 (24.0)	3 (25.0)	3 (23.1)	
No	19 (76.0)	9 (75.0)	10 (76.9)	

General Information	Total n=25	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		12 (48.0)	13 (52.0)	
Smoking status				0.280 [b]
Currently smoke	7 (28.0)	5 (41.7)	2 (15.4)	
Ever smoke	8 (32.0)	4 (33.3)	4 (30.8)	
Never smoke	10 (40.0)	3 (25.0)	7 (53.8)	
Family member smokes				0.320 [a]
Yes	13 (52.0)	5 (41.7)	8 (61.5)	
No	12 (48.0)	7 (58.3)	5 (38.5)	
Alcohol consumption				1.000 [b]
Yes	19 (76.0)	9 (75.0)	10 (76.9)	
No	6 (24.0)	3 (25.0)	3 (23.1)	
Alcohol consumption per week (n=19)				0.211 [b]
< 3 times per week	3 (15.8)	3 (33.3)	0 (0.0)	
≥ 3 times per week	5 (26.3)	2 (22.2)	3 (30.0)	
Only on special occasions	11 (57.9)	4 (44.5)	7 (70.0)	
Physical activity				0.561 [a]
Yes	14 (56.0)	6 (50.0)	8 (61.5)	
No	11 (44.0)	6 (50.0)	5 (38.5)	

* Significant at p < 0.05

[a] Chi-square, [b] Fisher's Exact, [d] Independent T test

4.9.2 Working Characteristic

Of 25 firefighters willing to participate in Phase II at follow up. There were composed of 1 Head of fire and rescue stations, 3 Chief firefighters and 21 firefighters. There were report the mean (± SD) duration of work was 8.76 (± 4.69) years and ranging from 2 to 21 years. The 52.00% of them past exposure to major fire in Thailand such as Praksa landfill fire, Santika club fire, Central World fire during political demonstration. The 13 (52.00%) of them were injured at work. All of participants in this phase completed fire extinguishers training course and 96.00% of them were completed mental training course (Table 4.17).

Firefighters with risk of PTSD

None of risk of PTSD-firefighters were the head of fire and rescue stations, however there were composed of 1 Chief firefighters and 11 firefighters. An average (± SD) duration of work of them was 9.00 (± 4.82) years. Moreover, 66.67% of risk of PTSD-firefighters were past exposure to major fire in Thailand. Half of them suffered with occupational injury. All of them completed extinguishers training course and passed mental training course.

Firefighters without risk of PTSD

Working position of non-risk of PTSD firefighters including one head of fire and rescue station, two chief firefighters and ten firefighters. The average (± SD) duration of work was 8.62 (± 4.82) years. The 38.46% of them were past exposure to major fire in Thailand and 53.84% suffered with occupational injury. All of non-risk of PTSD firefighters completed extinguishers training course. Likewise, almost all of them (92.31%) passed mental training course.

Table 4.17 Working Characteristic of firefighters in Phase II at Follow up (n=25)

Working Characteristic	Total n=25	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		12 (48.0)	13 (52.0)	
Working position				1.000 [b]
Head of fire and rescue station	1 (4.0)	0 (0.0)	1 (7.7)	
Chief firefighter	3 (12.0)	1 (8.3)	2 (15.4)	
Firefighter	21 (84.0)	11 (91.7)	10 (76.9)	
Duration of work				0.879 [d]
Mean (± SD)	8.8 (± 4.7)	9.0 (± 4.9)	8.6 (± 4.8)	
Range (min-max)	2.0-21.0	2.0-13.0	2.0-21.0	
Past exposure to major fire in Thailand				0.158 [a]
Yes	13 (52.0)	8 (66.7)	5 (38.5)	
No	12 (48.0)	4 (33.3)	8 (61.5)	
Occupational injury				0.848 [a]
Yes	13 (52.0)	6 (50.0)	7 (53.8)	
No	12 (48.0)	6 (50.0)	6 (46.2)	
Mental training course				1.000 [b]
Yes	24 (96.0)	12 (100.0)	12 (92.3)	
No	1 (4.0)	0 (0.0)	1 (7.7)	

* Significant at p < 0.05

[a] Chi-square, [b] Fisher's Exact, [d] Independent T test

4.9.3   Cardiovascular Biomarkers Phase II at follow up

After 6-month follow-up, blood samples were collected to determine cardiovascular biomarkers including High-sensitive C-reactive protein (hs-CRP), Troponin T (TnT), Brain Natriuretic Peptide (BNP). The 25 firefighters who willing to participate in phase II at follow-up complete blood test in February 2018 (Table 4.18).

High-sensitive C-reactive protein (hs-CRP)

The statistical analysis was revealed the mean serum level of hs-CRP among the firefighters in Phase II at follow-up was 5.07 ($\pm$ 4.97) and ranging from of 0.25 to 15.03 milligram per liter (mg/L). Their mean serum level was used as a cut-off point to classified the level of hs-CRP into high level and low level. The 40.00% of firefighters mean serum levels of hs-CRP more than 5.07 mg/L and 60.00% of them showed mean serum levels of hs-CRP less than or equal to 5.07 mg/L.

Troponin T (TnT)

The mean serum level of TnT was 5.40 ($\pm$ 2.76) nanograms per liter (ng/L) and ranging from <3.00 to 12.40 ng/L. The 32.00 % of them revealed mean TnT serum level more than 5.40 ng/L, while 68.00% of them revealed mean TnT serum level less than or equal to their mean serum level of TnT.

Brain Natriuretic Peptide (BNP)

The median BNP serum level of the firefighter in Phase II at follow-up was 12.70 and ranging from <10.00 – 48.70 picograms per milliliter (pg/mL). The 48.00%

of firefighters showed median BNP serum level more than 12.70 pg/mL and 52.00% of them revealed median BNP less than or equal to their median serum level of BNP.

Table 4.18 Level of Cardiovascular biomarkers among firefighters in Phase II at follow up (n=25)

Cardiovascular Biomarkers	Mean ± SD/ Median (IQR)	Range	High level[††]		Low level[†]	
			n	%	n	%
hs-CRP (mg/L)	5.07 (± 4.97)	0.25 – 15.03	10	40.0	15	60.0
TnT (ng/L)	5.40 (± 2.76)	<3.00 – 12.40	8	32.0	17	68.0
BNP (pg/mL)	12.70 (<10.00-14.69)	<10.00 – 48.70	12	48.0	13	52.0

[††] High level was considered if the value was > Mean of hs-CRP, TnT and Median of BNP

[†] Low level was considered if the value was ≤ Mean of hs-CRP, TnT and Median of BNP

Statistical analysis was performed to observe the association of the mean or median of cardiovascular biomarker serum levels (High-sensitive C-reactive protein; hs-CRP, Troponin T; TnT, Brain Natriuretic Peptide; BNP) between risk of PTSD-firefighters and non-risk of PTSD firefighters. For mean (± SD) serum level of hs-CRP among risk of PTSD-firefighter was 6.48 (± 5.30) and ranging from 0.25 to 15.03 mg/L, while the mean hs-CRP of non-risk of PTSD firefighter was 3.77 (± 4.44) and ranging from 0.48 to 12.52 mg/L. However, the comparison of hs-CRP serum levels among risk of PTSD and non-risk of PTSD firefighter was not statistically significant difference (P=0.178).

Meanwhile, mean (± SD) serum level of troponin T (TnT) was 5.71 (± 2.88) and ranging from <3.00 to 11.70 ng/L, while the mean (± SD) serum level of TnT among non-risk of PTSD firefighter was 5.11 (± 2.73) and ranging from <3.00 to 12.40 ng/L. Furthermore, there was no significant difference between the mean (± SD) TnT of risk of PTSD-firefighter and non-risk of PTSD firefighter (P=0.602).

In addition, the median (IQR) serum level of BNP among risk of PTSD-firefighters was 14.69 (12.93 − 21.53), ranging from <10.00 − 48.70 pg/mL, while median (IQR) serum level of BNP among non-risk of PTSD firefighter was <10.00 (<10.00 − 12.67) and ranging from <10.00 to 14.23) pg/mL. Moreover, there was statistically significant difference between the median BNP of risk of PTSD-firefighter and non-risk of PTSD firefighter (P=0.001) (Table 4.19).

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Table 4.19 Level of Cardiovascular biomarker of firefighters with/without PTSD in

Phase II at follow up (n=25)

Cardiovascular biomarkers	PTSD				p-value*
	Yes		No		
	n	%	n	%	
	12	48.0	13	52.0	
High-sensitive C-reactive protein (hs-CRP) (mg/L)					0.178 [d]
Mean (± SD)	6.48 (± 5.30)		3.77 (± 4.44)		
	5.07 (± 4.97)				
Range (min-max)	0.25 – 15.03		0.48 – 12.52		
	0.25 – 15.03				
Troponin T (TnT) (ng/L)					0.602 [d]
Mean (± SD)	5.71 (± 2.88)		5.11 (± 2.73)		
	5.40 (± 2.76)				
Range (min-max)	<3.00 -11.70		<3.00 – 12.40		
	<3.00 – 12.40				
Brain Natriuretic Peptide (BNP) (pg/mL)					0.001 [c]*
Median (IQR)	14.69 (12.93 – 21.53)		<10.00 (<10.00 – 12.67)		
	12.70 (<10.00 - 14.69)				
Range (min-max)	<10.00 – 48.70		<10.00 – 14.23		
	<10 – 48.70				

* Significant at p < 0.05

[c]Mann-Whitney U test, [d]Independent T test

Multiple logistic regression was performed to access an association between risk of post-traumatic stress disorder (PTSD) and cardiovascular biomarkers among Bangkok firefighters in Phase II after 6-month follow-up. Unadjusted, age adjusted, and multivariable adjusted logistic regression models for age, BMI, smoking status, systolic blood pressure, heart rate were fit to estimate odds ratio and 95 confidence intervals (95% CI) (Table 4.20).

In term of, brain natriuretic peptide (BNP) risk of PTSD-firefighters were 10.00 times (95%CI 1.594 – 62.732) more likely to have median serum level of BNP > 12.70 pg/mL than non-risk of PTSD firefighters, 10.72 times (95% CI 1.623 – 70.783) for age-adjusted and 17.32 times (95%CI 1.590 – 188.570) after adjusted for age, BMI, smoke, systolic blood pressure, heart rate and there was significant difference between firefighters with risk of PTSD and without risk of PTSD.

However, high-sensitive C-reactive protein (hs-CRP) and troponin T (TnT) mean serum level were no significant difference between firefighter with risk of PTSD and without risk of PTSD.

Table 4.20 Odds Ratios (OR) and 95% Confidence Interval (CI) of Cardiovascular

biomarkers and Risk of Post-traumatic stress disorder Phase II at Follow up (n=25)

Cardiovascular Biomarkers	Unadjusted		p-value	Age adjusted		p-value	Multivariable adjusted**		p-value
	OR	(95% CI)		AOR	(95% CI)		AOR	(95% CI)	
High-sensitive C-reactive protein (hs-CRP)									
≤ 5.07 mg/L	1.00	(Reference)		1.00 (Reference)			1.00	(Reference)	
> 5.07 mg/L	2.250		0.330	2.179		0.383	2.616		0.363
		(0.439 – 11.522)		(0.379 – 12.512)			(0.330 – 20.729)		
Troponin T (TnT)									
≤ 5.40 ng/L	1.00	(Reference)		1.00 (Reference)			1.00	(Reference)	
> 5.40 ng/L	2.381		0.325	2.297		0.348	4.761		0.202
		(0.423 – 13.387)		(0.404 – 13.059)			(0.433 – 52.313)		
Brain Natriuretic Peptide (BNP)									
≤ 12.70 pg/mL	1.00	(Reference)		1.00 (Reference)			1.00	(Reference)	
> 12.70 pg/mL	**10.000**		**0.014***	**10.719**		**0.014***	**17.315**		**0.019***
		(1.594 – 62.732)		**(1.623 – 70.783)**			**(1.590 – 188.570)**		

* Significant at p < 0.05

** Multivariable adjusted for age, BMI, smoke, systolic blood pressure, heart rate

4.9.4   Covariate factors of cardiovascular disease

Covariate factors of cardiovascular disease were collected to fit an estimate odds ratio and 95% confidence intervals (95% CI) for the association between risk of post-traumatic stress disorder (PTSD) and cardiovascular biomarkers. For blood pressure, most of the firefighters in Phase II at 6-month follow-up (60.00%) reported hypertension stage 2; Systolic 140 mmHg or higher (or) Diastolic 90 mmHg or higher and showed mean (± SD) systolic 134.34 ± 17.59 mmHg, mean (± SD) diastolic 86.94 ± 12.46 mmHg. The 80.00% of firefighters who willing to participate in Phase II at 6-month follow-up reported heart rate in normal range (60 to 100 beats per minute). For, the mean (± SD) level of total cholesterol was 220.00 ± 40.09 mg/dL, mean (± SD) of HDL was 49.24 ± 15.22 mg/dL, while mean (± SD) level of LDL was 139.76 ± 29.94 mg/dL. However, covariates factors of cardiovascular disease were not show a significant relationship with risk of post-traumatic stress disorder (Table 4.21).

Most of the risk of PTSD-firefighters (58.35%) reported high level of blood pressure with hypertension stage 2, the mean (± SD) systolic 136.67 ± 20.18 mmHg, mean (± SD) diastolic 89.67 ± 10.56 mmHg. Majority of them (66.67%) have heart rate in normal range.   In term of total cholesterol, 75.00% of them reported total cholesterol ≥ 200 mg/dL. Risk of PTSD-firefighters 58.33% have low level of HDL, while 66.67% of them reported high level of LDL.

The 61.54% of risk of PTSD-firefighters reported hypertension stage 2 and revealed the mean (± SD) systolic 131.62 ± 15.24 mmHg, mean (± SD) diastolic 84.46 ± 13.94 mmHg, while the 92.31% of them reported heart rate in normal range.

The 69.23% of them reported total cholesterol ≥ 200 mg/dL. In term of HDL, 46.15%

of them have low level of HDL and 69.23% reported high level of LDL.

Table 4.21 Covariate factors of cardiovascular disease among firefighters in Phase II
at Follow up (n=25)

Covariate factors of cardiovascular disease	Total n=25	Risk of PTSD		p-value*
		Yes	No	
		n (%)	n (%)	
		12 (48.0)	13 (52.0)	
Blood pressure (mmHg)				0.621 [b]
Normal	2 (8.0)	0 (0.0)	2 (15.4)	
Elevated	1 (4.0)	1 (8.3)	0 (0.0)	
Hypertension stage 1	7 (28.0)	4 (33.3)	3 (23.1)	
Hypertension stage 2	15 (60.0)	7 (58.4)	8 (61.5)	
Hypertensive crisis	0 (0.0)	0 (0.0)	0 (0.0)	
Systolic (mmHg)				0.485 [d]
Mean (± SD)	134.3 ± 17.6	136.7 ± 20.2	131.6 ± 15.2	
Range (min-max)	107.0 - 178.0	113.0 - 178.0	107.0 - 159.0	
Diastolic (mmHg)				0.307 [d]
Mean (± SD)	86.9 ± 12.5	89.7 ± 10.6	84.5 ± 13.9	
Range (min-max)	63.0 - 110.0	75.0 - 108.0	63.0 - 110.0	
Heart rate (Beats per minute)				0.155 [b]
≤ 59	2 (8.0)	1 (8.3)	1 (7.7)	
60 to 100	20 (80.0)	8 (66.7)	12 (92.3)	
≥ 101	3 (12.0)	3 (25.0)	0 (0.0)	

Covariate factors of cardiovascular disease	Total n=25	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		12 (48.0)	13 (52.0)	
Cholesterol (mg/dL)				1.000 [a]
Normal level (< 200 mg/dL)	7 (28.0)	3 (25.0)	4 (30.8)	
Consider borderline high (200 to 239 mg/dL)	12 (48.0)	6 (50.0)	6 (46.2)	
High blood cholesterol (240 mg/dL and above)	6 (24.0)	3 (25.0)	3 (23.0)	
				0.742 [d]
Mean (± SD)	220.0 ± 40.1	222.8 ± 38.3	217.4 ± 43.1	
Range (min-max)	130.0 - 289.0	175.0 - 289.0	130.0 - 289.0	
HDL (mg/dL)				0.868 [b]
Low HDL (Major risk of CVD) (< 50 mg/dL)	13 (52.0)	7 (58.3)	6 (46.2)	
Normal range (50 to 59 mg/dL)	6 (24.0)	3 (25.0)	3 (23.0)	
High HDL (Protective against CVD)	6 (24.0)	2 (16.7)	4 (30.8)	
				0.428 [d]
Mean (± SD)	49.2 ± 15.2	46.7 ± 17.1	51.6 ± 13.6	
Range (min-max)	22.0 - 77.0	22.0 - 77.0	33.0 - 75.0	

Covariate factors of cardiovascular disease	Total n=25	Risk of PTSD		p-value*
		Yes n (%)	No n (%)	
		12 (48.0)	13 (52.0)	
LDL (mg/dL)				1.000 [b]
Optimal (< 100 mg/dL)	2 (8.0)	1 (8.3)	1 (7.7)	
Normal range (100 to 129 mg/dL)	6 (24.0)	3 (25.0)	3 (23.1)	
High LDL (≥ 130 mg/dL)	17 (68.0)	8 (66.7)	9 (69.2)	
				0.216 [d]
Mean (± SD)	139.8 ± 29.9	131.9 ± 19.9	147.0 ± 36.3	
Range (min-max)	76.0 - 210.0	96.0 - 162.0	76.0 - 210.0	

* Significant at $p < 0.05$

[a] Chi-square, [b] Fisher's Exact, [d] Independent T test

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4.10 Cardiovascular biomarker change during 6-month-follow up

After 6-month follow-up, statistical analysis was performed to determine mean and median difference of cardiovascular biomarkers level between baseline and follow-up. An average baseline serum level of hs-CRP and TnT were lower than after 6-month follow-up. Likewise, median serum level of BNP was lower at follow-up. Furthermore, mean serum level of hs-CRP and median serum level of BNP were significantly higher between baseline and follow-up (P=0.004 and P=0.041 respectively) (Table 4.22).

Table 4.22 Comparison of participants in Phase II at baseline and follow up (n=25)

Cardiovascular biomarkers	Total		P-value
	Baseline	Follow-up	
	Mean (±SD) / Median (IQR)	Mean (±SD)/ Median (IQR)	
hs-CRP	1.94 (±1.27)	5.07 (±4.97)	0.004[e]*
TnT	4.86 (±2.37)	5.40 (±2.76)	0.130[e]
BNP	<10 (<10.00-12.89)	12.7 (<10.00-14.69)	0.041[f]*

* Significant at p < 0.05
[e]Paired T test, [f]Wilcoxon signed Rank test

In addition, when considered in risk of Post-traumatic stress disorder, firefighters with risk of PTSD and without risk of PTSD were revealed an average and median serum level of cardiovascular biomarkers at follow-up higher than at baseline. Moreover, an average and median serum level of hs-CRP and BNP were significantly

higher among firefighters in risk of PTSD group (P=0.019 and P=0.023 respectively) (Table 4.23).

Table 4.23 Comparison of Cardiovascular biomarkers in Phase II at baseline and follow up according to post-traumatic stress disorder

Cardiovascular biomarkers	Risk of PTSD (n=12)			Non-risk of PTSD (n=13)		
	Baseline Mean(±SD)/ Median(IQR)	Follow-up Mean(±SD)/ Median(IQR)	P-value	Baseline Mean(±SD)/ Median(IQR)	Follow-up Mean(±SD)/ Median(IQR)	P-value
Hs-CRP	2.24 (±1.49)	3.11 (±5.30)	0.019[e]*	1.65 (±1.01)	3.77 (±4.44)	0.107[e]
TnT	4.84 (±2.42)	5.71 (±2.88)	0.066[e]	4.88 (±2.42)	5.11 (±2.73)	0.667[e]
BNP	<10 (<10-13.65)	14.69 (12.93-21.53)	0.023[f]*	<10 (<10-12.12)	<10 (<10-12.67)	0.683[f]

* Significant at p < 0.05

[e]Paired T test, [f]Wilcoxon signed Rank test

When considered in the number of the firefighters with increased of cardiovascular biomarkers, there were significantly different in the number of firefighters with increased BNP serum level after 6-month follow-up between the firefighters in risk of PTSD group and non-risk of PTSD group (P=0.041). However, there were no significantly different in the number of firefighters with increased of hs-CRP and TnT (Table 4.24).

The previous studies stated that risk of Post-traumatic stress disorder was link to atherosclerosis and the atherosclerosis was one of the cause of myocardial infraction. In this study was found the hs-CRP and BNP were significant higher among risk of PTSD-firefighters. It could be concluded that because of risk of PTSD-firefighter have higher change to developed atherosclerosis so the hs-CRP and BNP levels among this group of firefighters were released in response to myocardial infraction.

Table 4.24 Number of firefighters increased Cardiovascular biomarkers after 6-month follow up (n=25)

| Cardiovascular biomarkers | 6 month-follow up | | p-value* |
	Risk of PTSD group (n=12)	Non-risk of PTSD group (n=13)	
Hs-CRP	9 (75.00%)	8 (61.54%)	0.673[a]
TnT	7 (58.33%)	7 (53.85%)	0.821[a]
BNP	10 (83.33%)	5 (38.46%)	**0.041[b]***

* Significant at p < 0.05

[a]Chi-square , [b]Fisher's Exact

Considering the level of increase of cardiovascular biomarkers with 75th percentile change, firefighters in risk of PTSD group were increased cardiovascular biomarkers levels at 75th percentile more than firefighters in non-risk of PTSD group after 6-month follow-up. The levels of increased at 75th percentile of cardiovascular biomarkers were as follows: hs-CRP was 7.31 mg/L, TnT was 1.50 ng/L and BNP was 4.39 pg/mL.

Moreover, the number of firefighters with increased of BNP serum level was significantly different between risk of PTSD-firefighters and non-risk of PTSD firefighters after 6-month (P=0.030). However, there were no significant different in the number of firefighters with increase of hs-CRP and TnT with 75th percentile change after follow-up (Table 4.25).

Table 4.25 Number of firefighters increased at 75th percentile of Cardiovascular biomarkers after 6-month follow up (n=25)

| Cardiovascular biomarkers | 6 month-follow up | | p-value* |
	Risk of PTSD group (n=12)	Non-risk of PTSD group (n=13)	
hs-CRP	4 (33.33%)	2 (15.39%)	0.378[b]
TnT	3 (25.00%)	2 (15.39%)	0.645[b]
BNP	6 (50.00%)	1 (7.69%)	**0.030[b]***

* Significant at p < 0.05

[b]Fisher's Exact

Multiple logistic regression was performed to determine the association between risk of post-traumatic stress disorder (PTSD) and change of cardiovascular biomarkers among Bangkok firefighters after 6-month follow-up. Unadjusted, age adjusted, and multivariable adjusted logistic regression models for age, BMI, smoking status, systolic blood pressure, heart rate were fit to estimate odds ratio and 95 confidence intervals (95% CI) (Table 4.26).

For brain natriuretic peptide (BNP), the firefighters with risk of PTSD were 12.00 times (95%CI 1.164 – 123.684) more likely to reported serum level increased > 4.39 pg/mL than non-risk of PTSD-firefighters, 13.72 times (95%CI 1.203 – 156.621) for age-adjusted and 31.22 times (95% CI 1.108 – 879.717) after adjusted for age, BMI, smoke, systolic blood pressure, heart rate and there was significant difference between firefighter with risk of PTSD and without risk of PTSD. However, high-sensitive C-reactive protein serum level increased and troponin T serum levels

increased at 75th percentile were no significant difference between risk of PTSD and non-risk of PTSD-firefighters.

Table 4.26 Odds Ratios (OR) and 95% Confidence Interval (CI) of Increased of Cardiovascular biomarkers at 75th Percentile and Risk of Post-traumatic stress disorder after 6-month- follow up (n=25)

Cardiovascular Biomarkers	Unadjusted		p-value	Age adjusted	p-value	Multivariable adjusted**	p-value
	OR (95% CI)			AOR (95% CI)		AOR (95% CI)	
High-sensitive C-reactive protein (hs-CRP)							
≤ 7.31 mg/L	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 7.31 mg/L	2.750		0.303	2.643	0.327	3.822	0.278
	(0.401 – 18.876)			(0.378 – 18.464)		(0.339 – 43.041)	
Troponin T (TnT)							
≤ 1.50 ng/L	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 1.50 ng/L	1.833		0.551	1.744	0.591	2.335	0.589
	(0.250 – 13.470)			(0.229 – 13.281)		(0.108 – 50.670)	
Brain Natriuretic Peptide (BNP)							
≤ 4.39 pg/mL	1.00 (Reference)			1.00 (Reference)		1.00 (Reference)	
> 4.39 pg/mL	**12.000**		**0.037***	**13.724**	**0.035***	**31.222**	**0.043***
	(1.164 – 123.684)			**(1.203 – 156.621)**		**(1.108 – 879.717)**	

* Significant at p < 0.05

** Multivariable adjusted for age, BMI, smoke, systolic blood pressure, heart rate

CHAPTER V
DISSCUSSION

5.1 Prevalence of risk of post-traumatic stress disorder

In phase I, the prevalence of risk of post-traumatic stress disorder among Bangkok firefighters was 24.86% and in phase II was 35.19%. Comparing to male retired firefighters who worked at ground zero on 911 disaster in September 2001 revealed prevalence was 22% (Chiu et al., 2011) and among Saudi firefighters was 57% (Alghamd et al., 2013), however prevalence of risk of PTSD among urban firefighters in Thailand was higher than German professional firefighters and urban firefighters in Japan (Wagner et al., 1998); (Saijo et al., 2012). Bangkok firefighters' risk of PTSD prevalence was higher than urban firefighters in other countries by reason of the other countries in this study were using another criteria and/or determine the prevalence of PTSD by psychiatrist.

5.2 Demographic Information

5.2.1 General Characteristic of Bangkok firefighters

The associated risk factors of risk of post-traumatic stress disorder among Bangkok professional firefighters in this study at phase I were health problems, smoking status, alcohol consumption, frequency of alcohol consumption per week and physical activity. However, among firefighters in phase II only physical activity factor associated with risk of post-traumatic stress disorder.

Of 1,215 firefighters, the majority of participants in present study was ranked between 31 - 40 years old inconsistent with among urban Japan firefighters with risk of post-traumatic stress disorder, most of them were aged 50 and over (Saijo et al., 2012). Over sixty percent of them reported BMI overweight ($\geq$ 23.0 kg/m^2 refer to overweight classified by World Health Organization Body Mass Index recommendation for Asian population), however BMI was not associated with risk of PTSD inconsistent with the study among patient suffer from post-traumatic stress disorder (Kubzansky et al., 2014)., however there was study among women patient. Nevertheless, in this study was found the association between risk of PTSD and physical activity instead of body mass index, among non PTSD and PTSD-firefighters have regular physical activity 82% and 68% respectively. Health problems that participants were reported such as hypertension, hyperlipidemias, diabetes, gout, allergic rhinitis, moreover health problems of the firefighters were associated with risk of post-traumatic stress disorder, as the same with study among U.S older adults with lifetime PTSD were more likely to report many physical health conditions, such as hypertension, angina pectoris, other heart disease, stomach ulcer, gastritis, and arthritis (Pietrzak, Goldstein, Southwick, & Grant, 2012).

Thirty-eight percent of PTSD-firefighters were reported currently smokers and 34% of them reported as ever smokers greater than among non PTSD-firefighters, moreover current study revealed the relationship between smoking status and risk of post-traumatic stress disorder as the same with a systematic review from 45 studies found that smoking rates were high among clinical sample with PTSD (Fu et al., 2007). In term of alcohol consumption, 80% of firefighters with PTSD and 74% of firefighters without PTSD were reported drinking alcohol. Alcohol consumption and

drinking frequency were associated with risk post-traumatic stress disorder with statistically significant in accordance with the study in municipal firefighters showed that post-traumatic stress symptoms was related to at-risk drinking and alcohol-related problems (Tomaka, Magoc, Morales-Monks, & Reyes, 2017). Moreover, smoking status and alcohol consumption associated with risk of PTSD reveal in current study, consistent with (VanderVeen et al., 2012) was found that drinking pattern and smoking relapse associate with occupational stress and exposure to potentially traumatic events among the firefighters in North America.

5.2.2 Working characteristic related to risk of post-traumatic stress disorder

Current study was determined characteristic of firefighters' job and risk of post-traumatic stress disorder. In phase I, there were two variables significant including duration of work and past exposure to major fire. However, in phase II there was no significant associate factor between working characteristic and risk of post-traumatic stress disorder. These results were consistent with study among male Korea firefighters showed mean job duration were higher in firefighter with PTSD-positive (Chung, Lee, Jung, & Nam, 2015) and impact of exposure to traumatic events was associated with development of PTSD in firefighters (Lee et al., 2014). When considering in the occupational injuries factor, the results revealed that the occupational injury was not associated with risk of PTSD, inconsistent with (Katsavouni & Bebetsos, 2016) was found the association between work-related injuries (WRIs) and PTSD among Greece firefighters.

5.2.3 Sleep quality related to risk of post-traumatic stress disorder

Prevalence of urban Thai firefighters with poor sleep was 49.05% as the same with the prevalence of sleep disorders among South Korea male firefighters was 48.7% (Lim, Baek, Chung, & Lee, 2014),while Tehran fire and rescue service in Iran was report poor sleep (69. 9%) (Mehrdad, Haghighi, & Esfahani, 2013). The prevalence abovementioned indicated similar as the results in this study that firefighters have sleep problems in many countries. Nevertheless, the results of this study revealed that risk of post-traumatic stress disorder associated with all components of the Pittsburgh Sleep Quality Index (PSQI). The results was revealed the association between PTSD among urban Thai firefighters and sleep disturbance, consistent with (Khazaie, Ghadami, & Masoudi, 2016) study in veterans with chronic war-induced PTSD and among patients with PTSD also found the effect of PTSD symptoms to sleep disturbance (Leskin, Woodward, Young, & Sheikh, 2002).

5.2.4 Severity of depression

The results revealed that risk of post-traumatic stress disorder was associate with severity of depression with statistically significant. However, in this study was determine the risk of post-traumatic stress disorder and severity of depression at the same time thus cannot be concluded PTSD or depression came first. Meanwhile, several studies revealed that people with Post-Traumatic Stress Disorder (PTSD) also suffer from Major Depressive Disorder (MDD) (Flory & Yehuda, 2015). The study among Ohio National Guard soldiers indicated that both PTSD's dysphoria and hyperarousal factors were more related to depression's somatic than non-somatic factor (Biehn et al., 2013).

5.3 Brain derived neurotrophic factor (BDNF)

The current study was revealed BDNF mean serum level of firefighters with risk of post-traumatic stress disorder was significant lower than non PTSD-firefighters, as confirmed by the study among depression patients showed significantly lower serum BNDF level compare with the control group (Ristevska-Dimitrovska et al., 2013). Moreover, the results in this study also consistent with the study among PTSD and non PTSD subject who experience road traffic accidents was that subjects without PTSD showed higher BDNF levels than PTSD-subject, however there were no significant different between PTSD and non PTSD-subjects (Su et al., 2015). Furthermore, the previous study was found the benefit of exercised and increase expression of BDNF levels (Sleiman et al., 2016). Therefore, exercise could be associate with higher production of BDNF among Bangkok firefighters because of non PTSD-firefighters showed high physical activity levels than PTSD-firefighters.

On the contrary, some studies have found that PTSD patients who were survivors from motor vehicle accident had significant higher BDNF levels than non PTSD group at baseline and 6 months (Matsuoka et al., 2013). Comparing to the results of current study, BDNF levels were different because of Matsuoka et.al.'s study participants were accident survivors and measured BDNF levels shortly after the accident (at baseline) therefore levels of BDNF were high, while the current study was measured BDNF levels among Bangkok firefighters as the regular BDNF levels (not immediately after exposure with traumatic events). According to the study of Hauck et.al. indicated that BDNF levels were higher right after exposure the traumatic events and after that decreasing over time (Hauck et al., 2010).

5.4 Cardiovascular Biomarkers in Phase II

There were three cardiovascular biomarkers including High-sensitive C-reactive protein (hs-CRP), Troponin T (TnT), Brain Natriuretic Peptide (BNP) collected in phase II at baseline. After 6-month follow-up, most of the firefighters revealed higher levels of all three cardiovascular than in Phase II at baseline, however only BNP serum level among PTSD-firefighters was significant higher than non PTSD-firefighters.

As the results of current study in Phase II at baseline most of Bangkok firefighters were revealed the cardiovascular biomarkers levels not reach the standard level or the cut-off value, thus in this study was classified the level of cardiovascular by mean and/or median. The statistical analysis was indicated that mean and/or median serum level of hs-CRP and BNP of PTSD-firefighters were significant higher than non PTSD-firefighters in Phase II at baseline.

High-sensitive C-reactive protein

Hs-CRP serves as a sensitive but nonspecific inflammation. The large population study (3,049 adults living in the community) was found participants with PTSD positive had significantly higher odds for elevated CRP values than those without PTSD (OR=2.27; 95% CI: 1.32-3.93) (Spitzer et al., 2010). Moreover, the study in Veterans Affairs was found patients with current PTSD had significantly higher hs-CRP than patients with no history of PTSD (O'Donovan et al., 2017), consistent with results in this study in Phase II at baseline that the firefighters with PTSD had four times more likely to reported hs-CRP serum level more than mean

compare with non PTSD-firefighters and mean serum level of hs-CRP among PTSD-firefighters was significant higher than non PTSD-firefighters.

Troponin T

This study was revealed that mean serum level of TnT was no significant difference between firefighter with PTSD and without PTSD, inconsistent with the study about cortisol response to mental stress and hs-cTnT among healthy adults found that older male with high stress were more likely to have detectable hs-cTnT than participants with low stress (Lazzarino et al., 2013).

Brain Natriuretic Peptide

Brain natriuretic peptide (BNP) is synthesized as an inactive pro-hormone primarily from the cardiac ventricles as a result of myocardial wall stress, it splits into an active BNP and inactive but stable NT-proBNP. They serve as biomarkers for diagnosis and prognosis cardiovascular disease and heart failure. Previous studies indicated BNP rises with age, normally stay under 20 pg/ml (Daniels & Maisel, 2007), meanwhile median level of BNP among Bangkok firefighters was less than 10 and ranging from <10.00 to 51.50 pg/mL, moreover median serum level of BNP among PTSD-firefighters was significant higher than non PTSD-firefighters. Inconsistent with the study among military veterans was found that BNP serum level among veterans without PTSD seem higher than veterans with PTSD, however PTSD-veteran with BNP > 60 pg/mL had significant increased mortality compare to veteran without PTSD (Xue et al., 2012). Meanwhile, PTSD-firefighters had four times more likely to reported BNP serum level more than median compare with non PTSD-firefighters

5.5 Covariate factors of cardiovascular disease in Phase II at Baseline

Heart rate and Blood pressure

Most of firefighters in this study report normal heart rate, while the majority of them reported high blood pressure with hypertension stage 2; Systolic 140 mmHg or higher (or) Diastolic 90 mmHg or higher, however did not significant different between PTSD and non PTSD-firefighters. Conversely with the study in PTSD patients have increased resting heart rates and increased 1–5 mm Hg in diastolic blood pressure (Kales, Tsismenakis, Zhang, & Soteriades, 2009) and revealed increased startle reaction, and increased heart rate and blood pressure reactivity when exposed to traumatic stimuli firefighters (Guthrie & Bryant, 2005)

Cholesterol

The firefighters in Phase II at baseline and 6-month follow-up were reported cholesterol levels ≥ 200 mg/dL, however did not significant with risk of PTSD. Inconsistent with the Review of the Evidence is the PTSD patients had significant higher cholesterol than control subjects (Dedert, Calhoun, Watkins, Sherwood, & Beckham, 2010).

HDL and LDL

In Phase II at baseline, most of the firefighters reported HDL ≥ 50 mg/dL, while at 6-month follow-up most of them have low level of HDL (high risk of CVD), for LDL both baseline and follow-up Bangkok firefighters reported high levels of LDL (major risk of CVD). Confirm by the study among Croatian war veterans with PTSD had higher levels of cholesterol and LDL cholesterol and lower HDL

cholesterol levels as compared with the patients with major depression (Karlović, Buljan, Martinac, & Marčinko, 2004).

5.6 Change of cardiovascular biomarker after 6-month follow-up

In this study, determine change of cardiovascular biomarkers as increased of cardiovascular biomarker after 6-month follow-up at 75th percentile change. BNP was only one cardiovascular biomarkers that change after 6-month follow-up, however hs-CRP and troponin t were not change at 75th. Moreover, BNP change was associate with risk of PTSD. These results were consistent with the literature review on PTSD and cardiovascular/metabolic disease and biomarkers that PTSD was associate with cardiovascular biomarkers (Eric A. Dedert, 2010). The fire situation during follow-up 6-month might related to cardiovascular biomarkers. For hs-CRP and troponin t were increase in acute stage of cardiovascular disease, while BNP was the chronic stage. In this study was 6-moth follow-up so hs-CRP and troponin t were not change. BNP can reduce by quit smoking and stop consume alcohol, lose weight, exercise regularly, have a good sleep quality and relieve stress.

CHAPTER VI
CONCLUSIONS

6.1 Conclusions

One out of four (24.86%) of Bangkok firefighters were have risk of post-traumatic stress disorder. The factors associated with risk of post-traumatic stress disorder were health problems, smoking status, alcohol consumption, alcohol consumption frequency, physical activity, sleep quality and severity of depression, in term of working characteristic factors were found duration of work and past exposure to major fire in Thailand associated with risk of post-traumatic stress disorder with statistically significant.

In addition, brain-derived neurotrophic factor (BDNF) which is the potential biomarker for post-traumatic stress disorder risk not show a significant associate with risk of post-traumatic stress disorder, however there was significant difference between the mean BDNF level of PTSD-firefighter and non PTSD-firefighter.

In term of cardiovascular biomarkers, there were two cardiovascular biomarkers associated with risk of post-traumatic stress disorder including high-sensitive C-reactive protein (hs-CRP) and brain Natriuretic Peptide (BNP) with statistically significant, while troponin T (TnT) was not associated with risk of post-traumatic stress disorder. For hs-CRP was associated with risk of post-traumatic stress disorder even age adjusted and multivariate adjusted for age, BMI, smoke, systolic blood pressure, heart rate, while BNP was associated with risk of post-traumatic stress disorder in unadjusted and age adjusted, however in multivariate adjusted was not significant.

The comparison of cardiovascular biomarkers from baseline to 6-month follow-up among PTSD and non PTSD-firefighters were found that an average and median serum level of hs-CRP and BNP significantly higher among firefighters in PTSD group, while among firefighters without risk of PTSD was not significant different.

After 6-month follow-up, considering in change of cardiovascular biomarkers, there was only change of brain Natriuretic Peptide (BNP) associated with risk of post-traumatic stress disorder statistically significant, while change of high-sensitive C-reactive protein (hs-CRP) and troponin T (TnT) were not associated with risk of post-traumatic stress disorder (Figure 6.1)
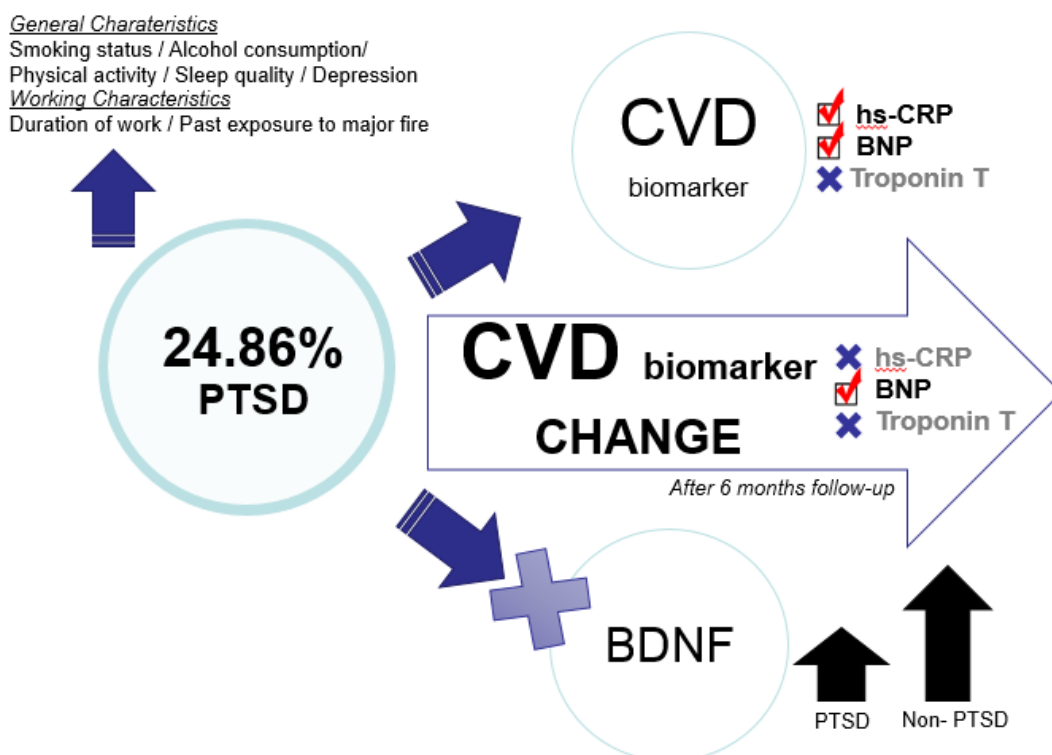
Figure 6.1 Summary of the study diagram

6.2 Benefit from this study

1.   The results of this study were provide the information about occupational hazard of the firefighters, which will be essential for prevention program.

2.   Study results can be benefit to policy recommendation for firefighters' health related to mental stress and cardiovascular disease. For annul health check-up of firefighters, sensitive cardiovascular biomarker may possible to concern.

6.3 Limitation of this study

1.   Health problems in this study were not excluded underlying diseases such as hypertension, diabetes, hyperlipidemias which may influence study results.

2.   PCL-C never been used in Thai firefighters before.

3.   Physical activity in this study is the self-report, so it might be over or under report.

4.   Covariate factors of cardiovascular disease in this study not include all covariate factors of cardiovascular disease, for example the triglyceride, eating behaviors.

5.   Loss to follow-up, the 28% of participants lost to follow-up at Phase II follow-up. Moreover, fourteen firefighters who willing to participated in Phase II at follow-up had to be exclude because of missing blood test data, however the statistical analysis was revealed that number of firefighters in Phase II at baseline and follow-up was not significant difference.

6.   Firefighters in Thailand perform tasks not only fire extinguish but also

rescue, preventing, disaster mitigating which difference from firefighting jobs in other countries. Therefore, the results in this study might not be compare to firefighting situation in other countries directly.

6.4 Recommendation for further study

1. Further study should be used the PTSD checklist according to the diagnostic and statistical manual of mental disorders, fifth edition (DSM-5) is that PCL-5.

2. Cardiovascular diseases among the participants in this study cannot be justified by using only biomarkers. Further diagnosis by physician is required.

3. Risk of PTSD was associated sleep quality among Bangkok firefighters. Therefore, the program or intervention to promote quality of sleep among person at risk of PTSD might be reduce the chances of developing PTSD.

4. Mental training course & fire extinguish course were not associated with risk of PTSD, especially mental training course that provide by Bangkok fire and rescue department might be not effective to coping stress in the firefighters. Therefore, the mental training course should be need to make an adjustments.

5. Brain natriuretic peptide (BNP) was associate with risk of PTSD after 6-month follow-up. Therefore, reduce risk of developing PTSD may reduce cardiovascular risk too.

6. The further intervention and policy related mental health problem among firefighters may need to be considered.

7. Psychological support should be considered for people suffering from PTSD.

8.   The social support can help to reduce occupational stressors among PTSD firefighters.

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APPENDIX
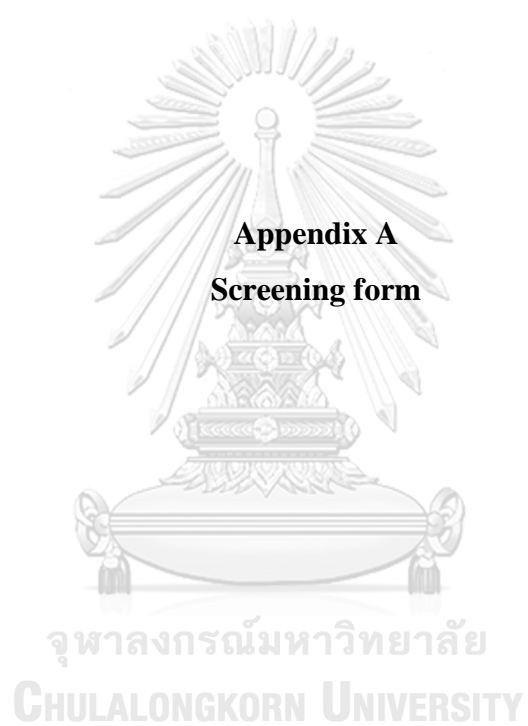
Appendix A
Screening form

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

แบบคัดกรองผู้เข้าร่วมโครงการวิจัย

เรื่อง ความเสี่ยงต่อภาวะความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและการเปลี่ยนแปลง สารบ่งชี้ทางชีวภาพของระบบหัวใจและหลอดเลือดในพนักงานดับเพลิงของกรุงเทพมหานคร

คำชี้แจง

       แบบคัดกรองผู้เข้าร่วมโครงการวิจัย เพื่อคัดกรองว่าท่านมีคุณสมบัติที่เหมาะสมที่จะเข้าร่วมในการวิจัยครั้งนี้หรือไม่ หากท่านมีคุณสมบัติตามเกณฑ์การคัดเลือกกลุ่มตัวอย่างเพื่อเข้าร่วมโครงการวิจัย ระยะที่ 1 ท่านจะได้รับการเชิญให้เข้าร่วมโครงการวิจัย เรื่อง ความเสี่ยงต่อภาวะความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและความเสี่ยงต่อการเกิดผลกระทบต่อระบบหัวใจและหลอดเลือดในพนักงานดับเพลิงของกรุงเทพมหานครต่อไป

       ประเด็นการพิจารณาตามเกณฑ์คัดเข้าในการวิจัย

เพศ ☐ ชาย   ☐ หญิง

ท่านปฏิบัติงานในตำแหน่งพนักงานดับเพลิงมาแล้วกี่ปี .... ปี

       ประเด็นการพิจารณาตามเกณฑ์คัดออกในการวิจัย

ท่านมีประวัติบุคคลในครอบครัวเป็นโรคหัวใจและหลอดเลือดหรือไม่   ☐ มี   ☐ ไม่มี

ท่านมีประวัติบุคคลในครอบครัว**เสียชีวิตกะทันหัน**ด้วยโรคหัวใจและหลอดเลือดหรือไม่

(เพศชายก่อน 45 ปี, เพศหญิง 55 ปี)   ☐ มี   ☐ ไม่มี

หมายเหตุ : บุคคลในครอบครัว หมายถึง บุคคลที่อยู่ร่วมบ้านในปัจจุบัน หรือพ่อแม่พี่น้อง ญาติสายตรง

ท่านมีอาการดังกล่าวเหล่านี้หรือไม่ (เจ็บหน้าอกแบบเจ็บแน่น ตื้อ บริเวณกลางอก, หายใจหอบเหนื่อย, วูบ)

   ☐ มี

   ☐ ไม่มี

ท่านเคยเข้าโรงพยาบาลด้วยอาการเกี่ยวกับโรคหัวใจหรือไม่   ☐ เคย   ☐ ไม่เคย

ท่านมีอาการหรือความผิดปกติเกี่ยวกับโรคไตหรือไม่   ☐ มี   ☐ ไม่มี

              ลงชื่อ ....

                (   )

          ตำแหน่ง ....

       ผู้ดำเนินการคัดกรองผู้เข้าร่วมโครงการวิจัย

Appendix B
Questionnaire

แบบสอบถาม

**เรื่อง ความเสี่ยงต่อภาวะความเครียดจากการทำงานภายหลังเหตุการณ์อัคคีภัยและการเปลี่ยนแปลงสารบ่งชี้
ทางชีวภาพของระบบหัวใจและหลอดเลือดในพนักงานดับเพลิงของกรุงเทพมหานคร**

        แบบสอบถามนี้ มีวัตถุประสงค์เพื่อสอบถามเกี่ยวกับปัจจัยเสี่ยงต่อการเกิดความเครียดจากการทำงาน
ภายหลังเหตุการณ์อัคคีภัย และการเกิดผลแทรกซ้อนทางระบบหัวใจและหลอดเลือดจากการปฏิบัติงานของ
พนักงานดับเพลิงในเขตกรุงเทพมหานคร

คำชี้แจง

    1.   แบบสอบถามแบ่งออกเป็น 5 ส่วน ดังนี้

ส่วนที่ 1   คุณลักษณะทั่วไปของผู้ตอบแบบสอบถาม

ส่วนที่ 2   ข้อมูลเกี่ยวกับการทำงาน

ส่วนที่ 3   แบบประเมินคุณภาพการนอนหลับ (PSQI)

ส่วนที่ 4   แบบประเมินอารมณ์ความรู้สึก (PHQ-9)

ส่วนที่ 5   แบบคัดกรองความเสี่ยงต่อการเกิดความเครียดภายหลังเหตุการณ์อัคคีภัย

    2.   โปรดอ่านคำชี้แจงในการตอบแบบสอบถามแต่ละส่วนให้ครบถ้วน

    3.   ผู้วิจัยขอเรียนว่า ข้อมูลที่ได้จะไม่มีผลกระทบต่อท่านแต่อย่างใด โดยผู้วิจัยจะนำไป
วิเคราะห์ในภาพรวมตามระเบียบวิธีการวิจัย เพื่อตอบวัตถุประสงค์ของการวิจัย จึงใคร่
ขอความกรุณาท่านตอบแบบสอบถามให้ครบถ้วนทุกข้อตามความเป็นจริง
ผู้วิจัยหวังเป็นอย่างยิ่งว่า จะได้รับความอนุเคราะห์จากท่านเป็นอย่างดี จึง
ขอขอบพระคุณใน

ความร่วมมือตอบแบบสอบถามมา ณ โอกาสนี้

นางจินต์จุฑา ขำทอง

นิสิตหลักสูตรปรัชญาดุษฎีบัณฑิต แขนงอนามัยสิ่งแวดล้อมและอาชีวอนามัย

วิทยาลัยวิทยาศาสตร์และสาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

	รหัสผู้ตอบแบบสอบถาม ☐☐☐☐

ส่วนที่ 1 คุณลักษณะทั่วไปของผู้ตอบแบบสอบถาม

Q1001   อายุ ....ปี

Q1002   น้ำหนัก .... กิโลกรัม

Q1003   ส่วนสูง .... เซนติเมตร

Q1004   ท่านมีปัญหาสุขภาพด้านใดหรือไม่ (ตอบได้มากกว่า 1 ข้อ)

    ☐   1. ไม่มี   ☐   2. ความดันโลหิตสูง   ☐   3. เบาหวาน

    ☐   4. โรคหัวใจ   ☐   5. โรคไต   ☐   6. อื่นๆ...........................

Q1005   ท่านมีอาการดังกล่าวเหล่านี้หรือไม่ (ตอบได้มากกว่า 1 ข้อ)

    ☐   1. เจ็บหน้าอก(แบบเจ็บ   ☐   2. หายใจหอบเหนื่อย   ☐   3. วูบ
แน่น ตื้อ บริเวณตรงกลางอก)

Q1006   ท่านเคยเข้าโรงพยาบาลด้วยอาการเกี่ยวกับโรคหัวใจหรือไม่

    ☐   1. เคย   ☐   2. ไม่เคย

Q1007   ปัจจุบันท่านสูบบุหรี่หรือไม่

    ☐   1. สูบ   โดยเฉลี่ยสูบบุหรี่วันละกี่มวน .... มวนต่อวัน

                                      สูบบุหรี่มาเป็นระยะเวลานานเท่าไร .... ปี

    ☐   2. เคยสูบ   เลิกสูบบุหรี่มานานเท่าไร .... ปี

                                      สูบบุหรี่มาเป็นระยะเวลานานเท่าไร .... ปี

    ☐   3. ไม่สูบ

Q1008   มีสมาชิกในครอบครัวสูบบุหรี่หรือไม่

    ☐   1. มี   ☐   2. ไม่มี

Q1009   ท่านดื่มเครื่องดื่มแอลกอฮอล์หรือไม่

☐ 1. ดื่ม   ☐ 2. ไม่ดื่ม (ข้ามไปข้อ Q1012)

Q1010   ท่านดื่มเครื่องดื่มแอลกอฮอล์บ่อยเพียงใด

☐ 1. 1 - 2 วันต่อสัปดาห์   ☐ 2. 3 - 4 วันต่อสัปดาห์

☐ 3. 5 - 7 วันต่อสัปดาห์   ☐ 4. เฉพาะโอกาสสำคัญหรืองานรื่นเริง

Q1011   โดยส่วนใหญ่ท่านดื่มเครื่องดื่มแอลกอฮอล์ประเภทใด (ตอบได้มากกว่า 1 ข้อ)

หมายเหตุ : 1 แก้วเท่ากับ 250 มิลลิลิตร (อ้างอิง : Thai Drinking Survey Guide)

☐ 1. สุรา (ปริมาณแอลกอฮอล์ 28 – 40%)

ลักษณะของการดื่ม   ☐ ผสม โดยเฉลี่ยท่านดื่มปริมาณกี่แก้วต่อครั้ง.............แก้วต่อครั้ง

☐ ไม่ผสม โดยเฉลี่ยท่านดื่มปริมาณกี่แก้วต่อครั้ง.............แก้วต่อครั้ง

☐ 2. เบียร์ (ปริมาณแอลกอฮอล์ 5 – 7%)

โดยเฉลี่ยท่านดื่มปริมาณกี่แก้วต่อครั้ง.............แก้วต่อครั้ง

☐ 3. เครื่องดื่มแอลกอฮอล์ประเภทอื่นๆ (ปริมาณแอลกอฮอล์ 6 – 12%)

โดยเฉลี่ยท่านดื่มปริมาณกี่แก้วต่อครั้ง.............แก้วต่อครั้ง

Q1012   ท่านออกกำลังกายเป็นประจำหรือไม่ (ออกกำลังกาย หมายถึงการเคลื่อนไหวและขยับร่างกาย อย่างต่อเนื่อง ติดต่อกันอย่างน้อย 20 นาทีต่อครั้ง หรือ 150 นาทีต่อสัปดาห์)

☐ 1. ใช่   ☐ 2. ไม่ใช่ (ข้ามไปข้อ Q1014)

Q1013   โดยเฉลี่ยท่านออกกำลังกายกี่ครั้งต่อสัปดาห์ .... ครั้งต่อสัปดาห์

Q1014   ท่านมีประวัติบุคคลในครอบครัวเป็นโรคหัวใจและหลอดเลือดหรือไม่

*หมายเหตุ : บุคคลในครอบครัวหมายถึงพ่อแม่ พี่ น้อง และญาติสายตรง

☐ 1. มี   ☐ 2. ไม่มี

Q1015   ท่านมีประวัติบุคคลในครอบครัว**เสียชีวิตกะทันหัน**ด้วยโรคหัวใจและหลอดเลือดหรือไม่ (เพศ ชายก่อน 45 ปี, เพศหญิง 55 ปี) *หมายเหตุ : บุคคลในครอบครัวหมายถึงพ่อแม่ พี่ น้อง และญาติสายตรง

☐　1. มี　　　　　　　☐　2. ไม่มี

ส่วนที่ 2 ข้อมูลเกี่ยวกับการทำงาน
Q2001   ปัจจุบันท่านต้องออกปฏิบัติงานบรรเทาเหตุสาธารณภัย นอกสถานที่หรือไม่   ☐ 1. ใช่ ☐ 2. ไม่ใช่
Q2002   ตำแหน่งงานปัจจุบัน   ☐ 1. หัวหน้าชุด ☐ 2. ผู้ปฏิบัติการดับเพลิง ☐ 3. อื่นๆโปรดระบุ   ....
Q2003   ท่านปฏิบัติงานป้องกันและบรรเทาสาธารณภัยมาแล้วกี่ปี .... ปี
Q2004   ท่านเริ่มปฏิบัติงานดับเพลิงครั้งแรกเมื่อปี พ.ศ.ใด ....
Q2005   ระยะเวลาในการผจญเพลิงโดยเฉลี่ย .... ชั่วโมงต่อสัปดาห์
Q2006   โดยทั่วไปท่านต้องเข้าปฏิบัติงานในช่วงเวลาใด .... (โปรดระบุ เป็นช่วงเวลา)
Q2007   ท่านเคยมีประสบการณ์การบาดเจ็บจากการทำงานหรือไม่   ☐ 1. เคย โปรดระบุรายละเอียด ลักษณะการบาดเจ็บ/การดูแล/แก้ไขปัญหาจากการบาดเจ็บ   ....   ☐ 2. ไม่เคย
Q2008   ท่านเคยผ่านการปฏิบัติงานในเหตุอัคคีภัยครั้งใหญ่ในประเทศหรือไม่   ☐ 1. เคย (ตอบได้มากกว่า 1 ข้อ)   ☐ เพลิงไหม้โรงงานเคเดอร์ ☐ เพลิงไหม้ท่าเรือคลองเตย ☐ รถแก๊สระเบิดที่ถนนเพชรบุรี   ☐ เพลิงไหม้โรงแรมโรยัล ☐ เพลิงไหม้ผับซานติก้า ☐ เพลิงไหม้บ่อขยะแพรกษา   จอมเทียน พัทยา สมุทรปราการ   ☐ อื่นๆ โปรดระบุ ....   ☐ 2. ไม่เคย (ข้ามไปข้อ Q2011)
Q2009   ท่านปฏิบัติหน้าที่ใด ในเหตุการณ์ครั้งนั้น

....

Q2010	ท่านปฏิบัติงานในเหตุการณ์ดังกล่าว นานเพียงใด (โปรดระบุเป็น ....วัน ....ชั่วโมง ....นาที)
Q2011	เพลิงไหม้ลักษณะใด ที่ท่านต้องเข้าปฏิบัติหน้าที่ระงับเหตุเป็นประจำ ☐ เพลิงไหม้อาคาร/สิ่งของ ☐ เพลิงไหม้ยานพาหนะ ☐ เพลิงสงบก่อนรถดับเพลิงถึง ภายในอาคาร ที่เกิดเหตุ ☐ ไฟฟ้าลัดวงจร ☐ เพลิงไหม้หญ้าและขยะ ☐ อื่นๆโปรดระบุ....................
Q2012	ท่านเคยได้รับการอบรมแนวทางการดับเพลิงจากสำนักป้องกันและบรรเทาสาธารณภัยหรือไม่ ☐ 1. เคย ☐ 2. ไม่เคย (ข้ามไปข้อ Q2014)
Q2013	ท่านได้รับการอบรมแนวทางการดับเพลิงครั้งล่าสุดเมื่อใด วันที่........เดือน .... ปี พ.ศ. ....
Q2014	ท่านเคยได้รับการฝึกอบรมด้านการจัดการความเครียด หรือแนวทางการดูแลสุขภาพจิตหรือไม่ ☐ 1. เคย ☐ 2. ไม่เคย (ข้ามไป ส่วนที่ 3)
Q2015	ท่านได้รับการอบรมด้านการจัดการความเครียด หรือแนวทางการดูแลสุขภาพจิต ครั้งล่าสุด เมื่อใด วันที่................เดือน .... ปี พ.ศ. ....
Q2016	หัวข้อในการอบรมด้านการจัดการความเครียด หรือแนวทางการดูแลสุขภาพจิต ประกอบด้วย อะไรบ้าง ....
ส่วนที่ 3 แบบประเมินคุณภาพการนอนหลับ	
โปรดทำเครื่องหมาย ✔ หรือเติมคำในช่องว่างแต่ละข้อที่ตรงกับการนอนส่วนใหญ่ของท่านในระยะ 1 เดือนที่ผ่านมา	

Q3001 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ส่วนใหญ่ท่านมักเข้านอนเวลากี่โมง เวลาเข้านอน				
Q3002 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ส่วนใหญ่ท่านต้องใช้เวลานานเท่าไหร่ (นาที) จึงจะนอนหลับ จำนวนนาที				
Q3003 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ส่วนใหญ่ท่านตื่นนอนตอนเช้าเวลากี่โมง เวลาตื่นนอนตอนเช้า				

	ไม่เคยเลยในช่วงระยะเวลา 1 เดือนที่ผ่านมา	น้อยกว่า 1 ครั้งต่อสัปดาห์	1 หรือ 2 ครั้งต่อสัปดาห์	3 ครั้งต่อสัปดาห์ขึ้นไป
Q3004 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ท่านนอนหลับได้จริงเป็นเวลากี่ชั่วโมงต่อคืน (คำตอบอาจแตกต่างจากระยะเวลารวมทั้งหมดตั้งแต่เริ่มเข้านอนจนถึงตื่นนอน) จำนวนชั่วโมงที่หลับได้จริงต่อคืน				
โปรดทำเครื่องหมาย "✓" ในช่องที่ตรงกับสิ่งที่เกิดขึ้นเพียง 1 คำตอบ **ในช่วง 1 เดือนที่ผ่านมาท่านมีปัญหาการนอนหลับ เนื่องจากเหตุผลต่อไปนี้บ่อยเพียงใด**				
Q3005 นอนไม่หลับหลังจากเข้านอนไปแล้วนานกว่า 30 นาที				
Q3006 รู้สึกตัวตื่นขึ้นระหว่างนอนหลับกลางดึกหรือตื่นเช้ากว่าเวลาที่ตั้งใจไว้				
Q3007 ตื่นเพื่อไปเข้าห้องน้ำ				
Q3008 หายใจไม่สะดวก				
Q3009 ไอ หรือ กรน เสียงดัง				
Q3010 รู้สึกหนาวเกินไป				
Q3011 รู้สึกร้อนเกินไป				
Q3012 ฝันร้าย				
Q3013 รู้สึกปวด				

Q3014 สาเหตุอื่นๆ ถ้ามีกรุณาระบุ				
Q3015 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ท่านใช้ยาเพื่อช่วยในการนอนหลับบ่อยเพียงใด (ไม่ว่าตามใบแพทย์สั่งหรือซื้อมาเอง)				

Q3016 ในช่วง 1 เดือนที่ผ่านมา ท่านมีปัญหา ง่วงนอนหรือเผลอหลับ ขณะขี่ยานพาหนะ, ขณะ รับประทานอาหารหรือขณะร่วมกิจกรรมทางสังคม ต่างๆ บ่อยเพียงใด				
Q3017 กรนเสียงดัง				
Q3018 มีช่วงหยุดหายใจเป็นระยะเวลานาน ขณะหลับ			■	■
	ดีมาก	ค่อนข้างดี	ค่อนข้างแย่	แย่มาก
Q3019 ในช่วง 1 เดือนที่ผ่านมา ท่านคิดว่า คุณภาพการนอนหลับโดยรวมของท่านเป็นอย่างไร				
Q3020 ในช่วงระยะเวลา 1 เดือนที่ผ่านมา ท่านมีปัญหาเกี่ยวกับความกระตือรือร้นในการทำงานให้ สำเร็จมากน้อยเพียงใด .... ไม่มีปัญหาเลยแม้แต่น้อย .... ไม่มีปัญหาเพียงเล็กน้อย .... ค่อนข้างที่จะเป็นปัญหา .... เป็นปัญหาอย่างมาก				
Q3021 ท่านมีคู่นอน, เพื่อนร่วมห้องหรือผู้อาศัยอยู่ในบ้านหลังเดียวกันหรือไม่ .... ไม่มีเลย .... มี แต่นอนคนละห้อง .... มี และนอนในห้องเดียวกัน แต่คนละเตียง .... มี และนอนเตียงเดียวกัน				

โปรดทำเครื่องหมาย "✔" ในแต่ละสถานการณ์ ความน่าจะเป็นของท่านในการที่จะเกิดการหลับขึ้น (ไม่ว่าท่านจะตั้งใจหรือไม่ก็ตาม)				
สถานการณ์.............	ไม่แน่นอน	มีแนวโน้มบ้าง	มีแนวโน้มปานกลาง	มีแนวโน้มมาก
Q3022 กำลังนั่งอ่านหนังสือ				
Q3023 กำลังชมรายการจากโทรทัศน์				
Q3024 นั่งอยู่เฉยๆ ในที่สาธารณะ เช่น ในโรงภาพยนตร์				
Q3025 นั่งอยู่ในรถโดยสารติดต่อกันหนึ่งชั่วโมง				
Q3026 เอนหลังนอนพักในตอนบ่าย ถ้าสถานการณ์เอื้ออำนวย				
Q3027 กำลังนั่งและพูดคุยอยู่กับคนบางคน				
Q3028 นั่งเฉยๆ เงียบๆ หลังอาหารมื้อเที่ยง โดยไม่ได้ดื่มเครื่องดื่มที่มีแอลกอฮอล์				
Q3029 ในรถ ขณะรถกำลังติดอยู่ได้ 2-3 นาที				
ส่วนที่ 4 แบบประเมินภาวะความซึมเศร้า (PHQ-9)				
ในช่วงระยะเวลา 2 อาทิตย์ที่ผ่านมา ท่านประสบกับปัญหาเหล่านี้บ่อยเพียงใด				
	ไม่มีเลย	เป็นบางวัน (น้อยกว่า 7 วัน)	เป็นบ่อย (มากกว่า 7 วัน)	เป็นทุกวัน
Q4001 เบื่อ ไม่สนใจอยากทำอะไร				
Q4002 ไม่สบายใจ ซึมเศร้า ท้อแท้				
Q4003 หลับยาก หรือหลับๆ ตื่นๆ หรือหลับมากไป				
Q4004 เหนื่อยง่าย หรือ ไม่ค่อยมีแรง				
Q4005 เบื่ออาหาร หรือ กินมากเกินไป				

|	ไม่ส่งผลเลย	ส่งผลเล็กน้อย	ส่งผลมาก	ส่งผลมาก ที่สุด
Q4006 รู้สึกไม่ดีกับตัวเอง คิดว่า ตัวเองล้มเหลว หรือ ทำให้ตนเองหรือครอบครัวผิดหวัง				
Q4007 สมาธิไม่ดีเวลาทำอะไร เช่น ดูโทรทัศน์ ฟัง วิทยุ หรือทำงานที่ต้องใช้ความตั้งใจ				
Q4008 พูดช้าทำอะไรช้าลงจนคนอื่นสังเกตเห็นได้ หรือกระสับกระส่ายไม่สามารถอยู่นิ่งได้เหมือนที่เคย เป็น				
Q4009 คิดทำร้ายตนเอง หรือคิดว่าถ้าตายไปคงจะ ดี				
Q4010 ถ้าท่านต้องเผชิญกับปัญหาเหล่านี้ ปัญหาที่ เกิดขึ้นจะส่งผลต่อการทำงาน การดูแลบ้าน การดูแล ตัวเอง และการเข้าสังคมนานเพียงใด				

คำชี้แจง : รายการด้านล่างนี้ คือแบบสอบถามถึงความคิด ความรู้สึก พฤติกรรมที่เกิดขึ้นกับผู้ปฏิบัติงานป้องกันและ
ระงับอัคคีภัย โปรดทำเครื่องหมาย "✓" ในช่องที่ตรงกับสิ่งที่เกิดขึ้น**ในช่วง 1 เดือนที่ผ่านมา**

ข้อ	รายการการตอบสนอง	ไม่อย่าง สิ้นเชิง (1)	เล็กน้อย (2)	ปานกลาง (3)	ค่อนข้าง (4)	อย่างมาก (5)
1	มีสิ่งต่างๆ ที่เกี่ยวกับเหตุการณ์ที่ทำให้ทุกข์ทรมานผุด ขึ้นมาอยู่ซ้ำๆ ซึ่งประกอบด้วยมโนภาพ ความคิด หรือการ รับรู้					
2	มีความฝันที่ทำให้ทุกข์ทรมานอยู่ซ้ำๆ เกี่ยวกับเหตุการณ์					
3	มีการกระทำหรือความรู้สึก เหมือนหนึ่งเหตุการณ์ที่ กระทบกระเทือนจิตใจเกิดขึ้นมาอีก					
4	มีความทุกข์ทรมานใจอย่างมาก เมื่อเผชิญกับสิ่งที่มาให้ ระลึกถึง					
5	มีปฏิกิริยาตอบสนองทางร่างกาย เช่น ใจสั่น, หายใจไม่อิ่ม , เหงื่อแตก เมื่อเผชิญกับสิ่งที่ทำให้เราระลึกถึง					
6	พยายามเลี่ยงความคิด ความรู้สึก หรือการสนทนาที่ เกี่ยวข้องกับเหตุการณ์นั้น					
7	พยายามเลี่ยงกิจกรรม สถานที่ หรือบุคคลที่กระตุ้นให้ ระลึกถึงเหตุการณ์นั้น					
8	ไม่สามารถระลึกถึงส่วนที่สำคัญของเหตุการณ์นั้น					
9	ความสนใจหรือการเข้าร่วมในกิจกรรมที่สำคัญต่างๆ ลดลงอย่างมาก					
10	รู้สึกแปลกแยก หรือเหินห่างไม่สนิทสนมกับผู้อื่น					
11	ขอบเขตของอารมณ์ลดลงไม่สามารถมีความรู้สึก รับผิดชอบใครได้					
12	*ท่านมองอนาคตไม่ยาวไกล เช่น หากยังไม่มีงานทำ ท่าน* *ไม่คิดหวังจะมีงานทำ, หากยังไม่แต่งงาน ท่านไม่คิดหวัง* *จะแต่งงาน, หากยังไม่มีลูก ท่านไม่คิดหวังที่จะมีลูก หรือ* *ท่านไม่คิดหวังว่าจะมีอายุยืนยาวตามปกติวิสัย*					
13	นอนหลับยากหรือหลับๆ ตื่นๆ					
14	หงุดหงิดหรือแสดงความโกรธออกมาอย่างรุนแรง					
15	ตั้งสมาธิลำบาก					

16	มีความระวังระไวมากขึ้น					
17	สะดุ้งตกใจมากกว่าปกติ					

(ผดุงเกียรติ เชาวนกระแสสินธุ์ และคณะ, 2554)

18. โปรดระบุถึงเหตุการณ์ที่ทำให้ท่านเกิดภาวะเครียดภายหลังเหตุการณ์อัคคีภัย

เหตุการณ์ใด ที่ทำให้ท่านเกิดภาวะเครียดภายหลังเหตุการณ์อัคคีภัย (ตอบได้มากกว่า 1 ข้อ)

☐ 1. เหตุจากการปฏิบัติงานดับเพลิง ☐ 2. อุบัติเหตุ ☐ 3. การถูกล่วงละเมิด

☐ 4. การถูกทำร้ายร่างกาย/กระทำความรุนแรง ☐ 5. ภัยพิบัติทางธรรมชาติ ☐ 6. การเจ็บป่วย

☐ 7. การสูญเสียคนรัก/บุคคลในครอบครัว ☐ 8. เหตุก่อการร้าย/สงคราม

Appendix C
Severity of Depression
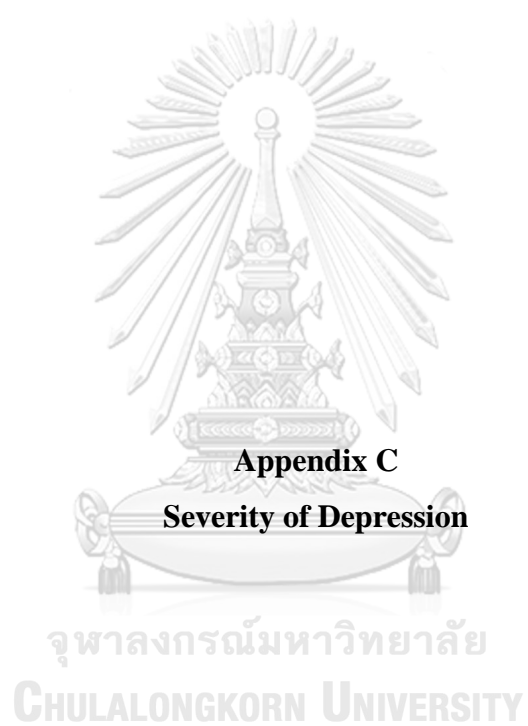
จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

Severity of Depression

The severity of depression over the last two months was defined by Patient health questionnaire depression scale (PHQ-9 scores). Bangkok firefighters revealed the median score of PHQ-9 were 2.00 (0.00 - 6.00) Range (0.00 - 23.00). Among PTSD-firefighters were report PHQ-9 median (IQR) scores 7.00 (4.00 – 9.00), while firefighters without PTSD were 1.00 (0.00 – 4.00). In addition, severity of depression was associated with risk of post-traumatic stress disorder with statistically significant (p-value < 0.001) (Table 4.6).

The comparison of the severity of depression (PHQ-9 scores) between the firefighters with and without PTSD (n=1,215)

Severity of depression	Total n=1,215	PTSD		p-value*
		Yes n (%)	No n (%)	
		302 (24.9)	913 75.1)	
PHQ-9				<0.001 [a]*
Low risk of major depression (PHQ-9 scores < 10)	1,144 (94.2)	251 (83.1)	893 (97.8)	
High risk of major depression (PHQ-9 scores ≥ 10)	71 (5.8)	51 (16.9)	20 (2.2)	
Median (IQR)		7.0 (4.0 – 9.0)	1.0 (0.0 – 4.0)	
Range (min-max)		0.0 – 23.0	0.0 – 16.0	

* Significant at p < 0.05

[a] Chi-square

VITA

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