UNIVERSITI PUTRA MALAYSIA

PHYSIOLOGICAL CHANGES AND HEAT RELATED ILLNESS AMONG TRAFFIC POLICEMEN UNDER HEAT STRESS CONDITIONS IN KUALA LUMPUR

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BY

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Thesis submitted in fulfilment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

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ABSTRAK

PERUBAHAN FISIOLOGI DAN PENYAKIT BERKAITAN HABA DALAM KALANGAN POLIS TRAFIK DI BAWAH TEKANAN HABA DI KUALA LUMPUR

NOR AMALINA BINTI MUHAMMAD SABRI

Pengenalan: Polis trafik terlibat dalam pekerjaan dengan keadaan suhu persekitaran yang tinggi semasa mereka bekerja.Walau bagaimanapun,kajian kurang dilakukan ke atas pendedahan tekanan haba dalam kalangan polis trafik yang menggunakan motorsikal sebagai pengangkutan mereka semasa proses kerja.**Objektif:**Tujuan kajian ini adalah untuk menentukan perubahan fisiologi dan penyakit berkaitan haba di bawah tekanan haba dalam kalangan polis trafik di Kuala Lumpur.**Metodologi:**Kajian keratan rentas telah dijalankan dalam kalangan polis trafik di Kuala Lumpur.Polis trafik (n = 55) telah ditemuramah menggunakan borang soal selidik yang dirangka sendiri.Temuramah berdasarkan pada borang soal selidik telah digunakan untuk menentukan latar belakang sosioekonomi responden,sejarah perubatan dan huraian kerja.Penilaian tekanan haba bagi kelembapan dan suhu telah diukur menggunakan EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD.Alat ini telah dipakai oleh polis trafik di Kuala Lumpur secara peribadi selama 4 jam. Sementara itu,Termometer suhu telinga,Omron MC-510 Gentle (mengukur teras suhu badan),kadar denyutan nadi POLAR FT60 (mengukur kadar denyutan nadi) dan pemantau tekanan darah automatic OMRON T3 (mengukur tekanan darah) telah digunakan dalam pengukuran fisiologi responden.Semua parameter ini telah diambil dalam tiga sesi iaitu sebelum shift,selepas dua jam bekerja dan selepas 8 jam bekerja.**Keputusan dan Perbincanagan:** Keputusan membuktikan bahawa semua polis trafik di Kuala Lumpur telah tidak melebihi Nilai Had Ambang (TLV) (< 28°C).Dehidrasi (89.1%) adalah prevalens paling tinggi penyakit berkaitan haba dilaporkan,diikuti oleh keletihan haba (80.0%),kekejangan haba (29.1%),pengsan haba (25.5%),ruam panas (18.2%) dan strok haba (12.7%).Nilai WBGTout mempunyai korelasi dengan bacaan kelembapan ($r = 0.76$, $p < 0.001$).Terdapat perbezaan yang signifikan dalam parameter fisiologi (teras suhu badan,,$F (1.93, 104.05) = 33.19$, $p<0.001$; kadar denyutan nadi, $F (1.28, 106.30) = 3.71$, $p< .001$; tekanan darah sistolik ($F (1.90, 129.539) = 1.912$, $p<0.001$; and tekanan darah diastolik $F(1.92, 103.71) = 3.094$, $p<0.001$) antara tiga sesi.**Kesimpulan:** Polis trafik di Kuala Lumpur terdedah kepada tekanan haba yang rendah kerana ia dipengaruhi oleh persekitaran.Prevalens yang tinggi dalam penyakit berkaitan haba dalam kalangan polis trafik adalah dehidrasi.Terdapat perbezaan yang signifikan dalam parameter fisiologi antara tiga sesi berbeza dimana ia menunjukkan pada dua jam pertama,pekerja terdedah kepada tekanan haba yang tinggi sebelum proses penyesuaian haba di dalam badan berlaku.

Kata kunci: Tekanan haba,penyakit berkaitan haba,polis trafik,parameter fisiologi

TABLE OF CONTENTS

CHATER 2: LITERATURE REVIEW

CHAPTER 3: METHDOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

%	Percentage
ACGIH	American Conference Governmental Industrial Hygiene
BMI	Body Mass Index
BP	Blood Pressure
bpm	Beats per minute
HSE	Health and Safety Executive
ILO	International Labor Organization
mmHG	milimeter of mercury
NIOSH	National Institute for Occupational Safety and Health
NWS	National Weather Service
°C	Degree Celsius
°F	Degree Fahrenheit
OSHA	Occupational Safety and Health Administration
PDRM	Polis Diraja Malaysia
Ta	Dry Bulb Temperature
TLV	Threshold Limit Value

WBGTout	Wet Bulb Globe Temperature outdoor
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Exposure to extreme heat is one of occupational hazards that present in the workplaces. Heat in the occupational environment is a common hazard and identified to become a greater occupational health and safety risk in the future as a result of increment in industrialization and climate change due to global warming (Farshad et al., 2014)

Previous studies have identified that workers in variety of industries has been subjected to work in heat stress condition (Wahid et al., 2007). Employees who are working in extreme temperature need optimum body temperature (37°C) for his body to work effectively. In order to maintain a stable temperature, the body should release the heat to the surrounding environment at the same rate as heat is produced (Andrew, 2011).However, heat stress can happen when air temperature, radiation, humidity, and climate change interact to produce rising a tendency for body temperature (Azlis et al., 2007; Zulmilman et al., 2007; Khalid et al., 2007).

Exposure to high heat stress level can overcome the body's coping mechanisms leading to a serious condition such as heat stroke and fatality (Azlis ,2007).High temperature can cause the clinical syndromes such as heat stroke, heat exhaustion, heat syncope, and heat cramps (National Institute for Occupational Safety and Health,2013).Heat stress results from a combination of internal (body) heat production from doing work and external heat exposure from the environment (Minnesota Department of Labor and Industry Occupational Safety and Health Division, 2012).

Working in heat environment produced a phenomenon called acclimatization (Dresser, 1969).It is a process that occurs over 5-14 days with daily exercise in hot ambient condition of sufficient duration and of exertion to raise body temperature. Although a worker can be acclimatized, excessive exposure to hot environment can bring about a variety a heat-induced disorders such as heat stroke, heat exhaustion, heat cramps, heat rash and heat fatigue (Centers for Disease Control and Prevention, 2013).

Heat stress also has been recognized as a widely prevalence health hazard in many public services such as postmen, fire fighter, traffic policemen, army and paramedic services (Balakrishnan et al., 2010).Previous study also stated that traffic policemen has been exposed to heat stress in duties of a prolonged traffic or incident control (Centre, 2012)

1.2 Problem Statement

In Malaysia, the traffic policemen use variety of vehicles in their working process. Among this vehicles, motorcycle are considered as one of the important transport for them especially for the traffic policemen. They are working in hot environmental condition with high temperature during their working hour. The most common hazards that they encountered are such as biological hazard, physical hazard, chemical hazard and psychosocial hazard (Figure 1.1). The usage of motorcycle are more exposed to the external hazards (physical hazard such as heat stress).Majority in traffic policemen internationally highly exposed to heat stress such as in India, China and Pakistan (Carillo et al., 2000).

In Malaysia, they spent most of time approximately 63% riding motorcycle in outdoor. So, they are exposed to high temperature that can caused the clinical syndromes such as heat stroke, heat exhaustion, heat syncope, and heat cramps (ACGIH, 1992). However, there is no data found in Malaysia regarding heat stress among traffic policemen.

Most of the previous research on heat stress among workers in different workplace show that, there is significant between high environmental temperature and negative impact on workers' performance, attitude and satisfaction level (Parson, 2003). Frequent exposure to the workplace induces heat related illness such as heat stroke, heat exhaustion, heat cramps, heat syncope, and heat rash.

In Kuala Lumpur, most of the traffic policemen has also involved with high temperature and humidity during working process. Traffic policemen may develop health problems as a result of spending much time riding motorcycle on outdoors, including under the sun or in bad weather. It can lead to have a direct impact on production by causing poor task performance and it increases accident possibility morbidity and injuries when one's ability to respond to heat stress is exceeded (Carillo et al., 2000)

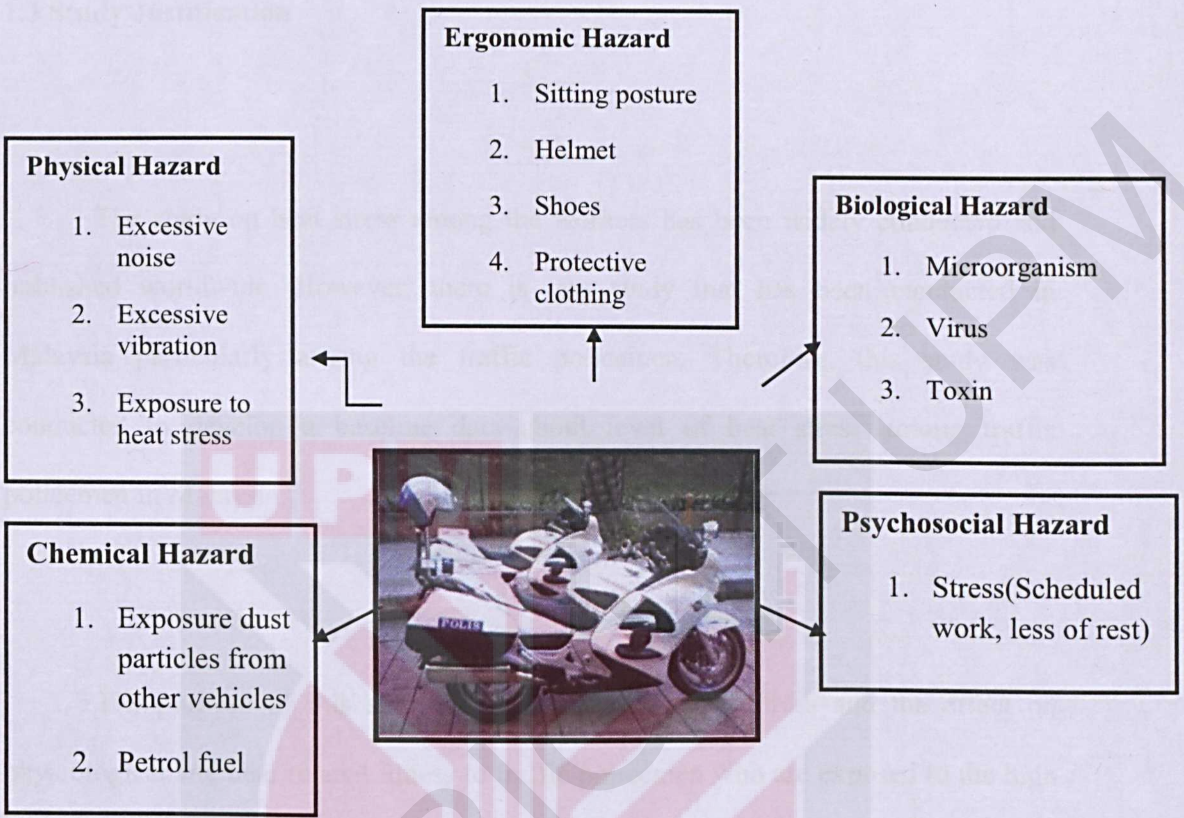

Figure 1.1: Types of hazard on motorcycle based traffic policemen

1.3 Study Justification

The study on heat stress among the workers has been widely conducted and published worldwide. However, there is less study that has been conducted in Malaysia particularly among the traffic policemen. Therefore, this study was conducted to develop a baseline data about level of heat stress among traffic policemen in Malaysia.

The purpose of this study is to measure the heat stress and the effect on physiological and heat related illness to traffic policemen who are exposed to the high environment temperature. Previous studied reported that the high temperature can reduce the quality of work, mental and physical ability (Victor,2003).Thus, by conducting this study, the level of extreme temperature can be identified either it is increase or decrease by time exposure as well as level of heat related illness also can be determined.

The information gained from this study can be used by the employers in providing the necessary control measure to reduce the effect of heat exposure i.e. administrative and engineering controls. The administrative control include limiting or modifying the duration of exposure time, reducing metabolic heat load, exchanging tolerance to heat and health safety training so that all employees understands the reason for changing old work practices. Ventilation and air cooling fans are the major types of engineering controls that can be used to reduce heat stress in the environment.

This study is also to give the knowledge to the traffic policemen specifically to the effects of the ultimate temperature to the heart rate and body core temperature and encourage the individual to be aware of their physiological changes, which they experience while working, regardless if those changes are negative or positive. Equipped of this knowledge and sense of awareness, traffic policemen can then identify hazards and risks they face during working hour.

1.4 Objectives

1.4.1 General Objectives

To determine the physiological changes and heat related illness among traffic policemen under heat stress condition.

1.4.2 Specific Objectives

1. To determine the socio demographic characteristics of respondents
2. To measure the heat stress index ($WBGT_{out}$), relative humidity and temperature among traffic policemen.
3. To determine the correlation between heat stress index ($WBGT_{out}$) and relative humidity among traffic policemen.
4. To determine the prevalence of heat related illness among traffic policemen when exposed to heat.
5. To determine physiological parameters between before shift, after 2 hours working and after 8 hours working among respondents.
6. To compare the differences of blood pressure before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.
7. To compare the differences of heart rate before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.
8. To compare the differences of core body temperature before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.

1.5 Study Hypotheses

The alternative hypothesis are:

i. There is a significant association between heat stress index (WBGT out), and relative humidity among traffic policemen who exposed to heat.

ii. There is a significant difference between blood pressure before shift, after 2 hours working, and after 8 hours working among exposed to heat.

iii. There is a significant difference between heart rate before shift, after 2 hours working, and after 8 hours working among exposed to heat.

iv. There is a significant difference between core body temperature before shift, after 2 hours working, and after 8 hours working among exposed to heat.

1.6 Definition

1.6.1 Heat Stress

1.6.1.1 Conceptual Definition

Heat stress is the cumulative of environmental and physical work factors that constitute the total heat load imposed on the body (Alpaugh, 2001).

1.6.1.2 Operational Definition

Heat stress level is determined by using data logger to measure outdoor environmental temperature in degree Celsius.

1.6.2 Humidity

1.6.2.1 Conceptual Definition

Humidity is the amount of water vapour within a given space and measured as relative humidity (Berry et al., 2010)

1.6.2.2 Operational Definition

EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD which calculates the value of relative humidity (RH) .This instrument is place on mobile traffic policemen for four hours.

1.6.3 Dew point temperature

1.6.3.1 Conceptual Definition

Dew point temperature is indicates amount of moisture in air and it will not ease the evaporation of sweat to release heat from the body (Berry et al., 2010; Bowen et al., 2010;& Kjellstrom et al.,2010)

1.6.3.2 Operational definition

EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD which calculates the value of dew point. This instrument is place on mobile traffic policemen for four hours.

1.6.4 Blood Pressure

1.6.4.1 Conceptual Definition

A single blood pressure reading consists of two separate figures that represent the pressure of blood during two different times. During heartbeats blood pressure oscillates between maximum which is systolic while minimum is diastolic (Lacetera et al., 2006).

1.6.4.2 Operational Definition

Omron T3 Automatic Blood pressure Monitor was used to measure blood pressure. The cut was fastened onto the left arm and it was ensured the respondents were remained seated while the measurement was taken. Reading was taken before work, 2 hours working and 8 hours of work. Three measurement were taken per session.

1.6.5 Core Body Temperature

1.6.5.1 Conceptual Definition

The primary variable of interest in assessing heat strain is core body temperature. Measurements of body temperature orally, in the axilla, or on the tympanic membrane, whilst easily accessible and practical measurements locations, can be influenced by external factors and does not offer the highest degree of accuracy to reflect the temperature of the deep body regions at rest or during exercise heat stress (Hosokawa, Adams, Stearns, & Casa, 2014).

1.6.5.2 Operational Definition

Body core temperature was measured in degree Celsius (°C) by using Omron MC-510 Gentle Temperature Ear Thermometer. This instrument measure the temperature by inserting the sensor into the right ear.

1.6.6 Heart Rate

1.6.6.1 Conceptual Definition

Heart rate is one of the indicators in heat strain which it will determined by several factors at any given time. The thermal rise in heart rate is closely related to the increase in core body temperature, with a 33 bpm increase in heart rate corresponding to a 1˚C increase in body temperature (Pyke et al., 2015; Costello et al., 2015; Stewart et al., 2015)

1.6.6.2 Operational Definition

Heart rate was measured by using Omron T3 Automatic Blood pressure Monitor. The cut was fastened onto the left arm and it was ensured the respondents were remained seated while the measurement was taken. Three measurements were taken per session and respondents were asked not to eat and drink at least 15 minutes before the measurement.

1.6.7 Heat Related Illness

1.6.7.1 Conceptual Definition

Heat-related illness is an individual with symptoms including headache, fatigue and nausea after occupational exposure to the heat (MedicineNet.com, 2013).

1.6.7.2 Operational Definition

Heat related illness will be measured by using self-constructed questionnaires. In this questionnaire, it covers all symptoms related with heat effect stress exposure to high level of temperature.

1.7 Conceptual Framework

In occupational setting, workers are commonly exposed to five types of hazard. In this study of traffic policemen in Malaysia, one of the main hazards is heat stress. Heat stress can cause when there are combination of environmental factor and individual activity. In this conceptual framework, among the concerned variables are environmental factors including climate change, humidity, radiant heat and air temperature.

Traffic policemen that are exposed to the high level of temperature during work will tend to get heat stress symptoms and the worst case, they will involve with heat related illness. However, for the heat related illness it involved heat cramps, heat stroke, heat rashes, heat syncope, dehydration and heat exhaustion (Figure 1.1).

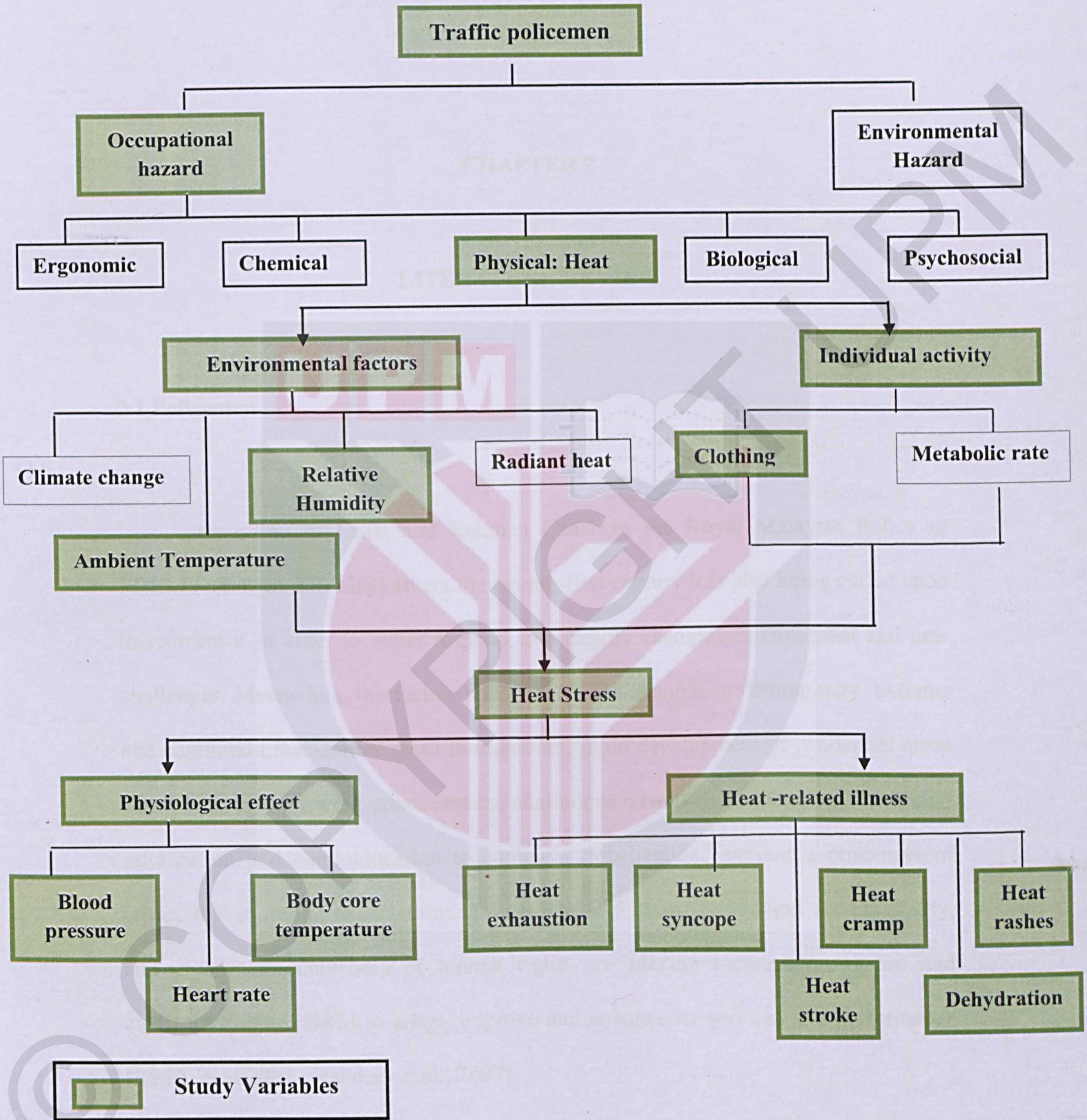

Figure 1.2 Conceptual Frameworks

CHAPTER 2

LITERATURE REVIEW

2.1 Policemen

According to Latiff and Rahman (2007),as the Royal Malaysia Police or PDRM (acronym in Malay) enters the twenty-first century it is also being called upon to reinvent it in order to better respond to a rapidly changing environment and new challenges. Meanwhile, the factors such as affected changes in demography, extreme and continual urbanization, great immigration, rapid development of residential areas adjacent to ever growing urban centers, continuous advances in technology especially information and communication technology, globalization, increasing crudeness of crime, rise in public expectations and demands for transparency and accountability, and greater consciousness of human rights are placing increasing pressure and challenges upon PDRM to adapt, improve and enhance its services and performance (Latiff et al 2007 ; Rahman et al., 2007).

The Royal Commission Report in 2004 have highlighted few important issue about the traffic policemen in Malaysia such as:-

i. Checking of parking meters for violations

ii. Routine round in a designated area

iii. Initial investigation and traffic regulation

iv. Investigation duties in a designated area

v. Required to assist other workforces of the police department in conducting examinations

vi. Escorting females and juveniles to and from designated points.

Traffic policemen or traffic officers often referred to as traffic cops. They are police officers who direct traffic or serve in a traffic or roads policing unit enforcing rules of the road. Traffic police include officers who duty major roads and also police who address traffic violations on other roads. The Traffic Division was first established in 1976 but officially under their Malaysian Government since 1967. It currently consists of 4,882 personnel. In accordance to Section 3 (3) of the Police Act 1967, the Traffic Branch's functions include the enforcement of traffic laws, management of traffic, investigating accidents, and escorting WIPs. The focus of the Traffic Branch is in the major urban areas and main cities (Latiff & Rahman, 2007)

2.2 Police Motorcycle

Traffic policemen used cars and motorcycles for performing the work task. Commonly, vehicle like motorcycle is used by Polis Di Raja Malaysia (PDRM), the Traffic Unit in Malaysia. Model motorcycle such as Honda VRF 800 and Kawasaki Ninja 300 are the model of motorcycle that used by PDRM Traffic Division since 1967 until today.

According to PDRM Trafic Divisions (2000), Honda VRF 800 has been used for traffic, round, pursuit and escort (Figure 2.1).The Honda VFR800 is also known in some markets as the Interceptor which a motorcycle sold by Honda since 1998 is introducing a V-4 engine configuration shared with the Honda VF and VFR family of motorcycles. The VFR features heavier structure and a more straight riding position than a pure sport bike, nevertheless lower than a cruiser. The motorcycle also has 4 safety guards (2 on each side), a meter-stop option (to record top speed), loud speakers, and no fuel device.

Figure 2.1 Honda VRF 800

Currently, new model known as Kawasaki Ninja (Figure 2.2) also has been used by the traffic policemen. Its upgraded and installed racing spec parts, that makes this super bike could go faster than usual. Generally, the traffic policemen used to patrolling but this super bike is a special detection unit. In addition, Polis Diraja Malaysia are committed to keep Malaysian people safe. So they won't fall behind like the other country. The traffic policemen in Malaysian Police Force has high standard as Indonesia, Singapore and others country around Asia. Their skill are good on handling patrol car like Kawasaki Ninja 300.

Figure 2.2 Kawasaki Ninja 300

The International Labour Organization (ILO) in 2004 have identified few important facts about the hazard that exposed to traffic policemen in Malaysia such as:-

A. Accident hazard

   i. Traffic policemen may involve in car or motorcycle accidents while chasing escaping vehicles, or while fast driving in response to emergency calls

B. Physical hazard

i. Traffic policemen may be exposed to ambient environmental factors like a low or high air temperatures, rain, and wind, sun which is resulting in acute which is common cold, heat stroke, dehydration, and others.

ii. Traffic policemen also may be exposed to high noise levels from the emergency siren or on the firing range.

C. Chemical hazard

i. Traffic policemen also may be exposed to excessive levels of carbon monoxide while directing traffic.

D. Biological hazard

i. Traffic policemen will be injured that caused by insects or rodents while entering polluted or abandoned places for the purpose of inspection, search and observation.

E. Ergonomic Hazard

i. Traffic policemen also may be affected the ergonomic disease such as cumulative trauma disorders of lower extremities as a result of long-time, extensive foot patrolling jobs and also long periods of time spent riding motorcycle may in the course of time result in musculoskeletal disorders such as low-back pains.

F. Psychosocial hazard

i. Traffic policemen also may be exposed to psychosocial hazard which is family problems caused by shiftwork, irregular work hours include at night, constant state of alertness include when off duty, relations with peers.

2.3 Heat Stress

Heat stress can be defined in term of external demands of environment and limit placed to an individual. In other word, it is described as the situation where the human body experience problem in adapting to the over exposure of heat to the environment (World Health Organization, 1969).This situation happened when the worker is exposed to the low humidity and high temperature for a long period of time. The external environmental factors that contribute to the heat stress among workers in hot working area are temperature, humidity, radiant heat and climate change (Pyke et al., 2015)

Heat stress is cause by the interaction of a number of environmental factors and metabolic heat production. Where, the environmental factors of heat stress include air temperature and movement, water vapour pressure and radiant heat. Physical work contributes total heat stress by producing metabolic heat. Clothing will also alter the amount of heat stress by working (Carter, 1996) According to workplace Health and Safety Queensland, the resulting strain from the combined combination of job, environmental factor and worker factor.

In addition, the main important role in determining the heat load on the body is physical work. The workers who are at risk, can increased core body temperature which is above 38°C when levels of physical work is increased in hot working environment and it will lead to reducing in physical work capacity (Berry, Bowen, & Kjellstrom, 2010), mental task ability (Ramsey, 1995), increased accident risk (Ramsey 1983) and eventually heat stroke and deaths (Hale et al., 1987). The factor which is individual reaction to the heat is influence on personal characteristics such as age, weight, lifestyle, medical condition and level of acclimatization (Belding & Hatch, 1995). The research that done on heat stress is in the firefighting industry (Brahmapurkar et al., 2012).This is due to distinctive job task, work physicality and also high exposure to heat fire as well as high pressure situation (Firefighter Life Safety Research Center, 2008)

In 1992, the American Conference Governmental Industrial Hygiene (ACGIH) declared that workers should not be permitted to work when their deep body temperature exceeds 38°C (100.4°F).Although, the World Health Organization (WHO) also recommends that deep body temperature should not, under circumstances of prolonged daily work and heat be permitted to exceed 38°C (100.4°F) rectally or 37.5 °C (99.5°F) orally.

2.4 Heat Exchange

Heat exchange between the body and the environment is influenced by air temperature, and humidity, skin temperature, air velocity, evaporation of sweat, radiant temperature and clothing worn (Dresser, 1969).The human body is equipped to maintain an appropriate balance between the metabolic heat that it produces and the environment heat to which it is exposed.

According to Dresser (1969), body heat balance is described by the following heat balance equation.

$H = M \pm R \pm C - H$ ——————— Formula 1

Whereas:

H = Body heat

M = Internal heat gain

C = Convection heat gain

E = Evaporation

The heat balance equation incorporates the major modes of heat exchange or loss by the body. As long as heat gained from radiation, convection and metabolic processes does not exceed that loss through the evaporation (Dresser et al., 1969).According to Howe and Boden (2007) heat loss is mainly through the evaporation of perspiration from the skin.

2.5 Mechanisms of heat exchange

2.5.1 Heat Exchange rate by Radiation

Radiant heat is defined as a net heat flow of the solid bodies in different temperature from the hotter to the cooler surface in the infrared wavelength by radiation (Barbara et al., 2002; Patricia et al., 2002). Howe and Boden (2007) has stated the exchange rate of heat gradient by certain environmental condition can enhance appropriate thermoregulation. By radiation, electromagnetic heat waves are propagated from a warm surface (the skin) to a nearby cool surface that is not in direct contact with the individual. At rest, the majority of heat is lost through radiation. Transfer of heat energy through space. According to OSHA (2008), the worker whose body temperature is greater than the temperature of the surrounding surfaces radiates heat to these surfaces. Hot surfaces and infrared light sources radiate heat that can increase the body's heat load.

2.5.2 Heat Exchange rate by Conduction

Conduction is the flow of heat through solids and liquids by vibration and collision of molecules and free electrons (John et al., 2011).Through conduction, the air surrounding the individual is warmed to equilibrate with skin temperature. This creates a zone of insulation where further heat loss by conduction is impaired (Taylor et al., 2010).According to Nahle (2010) stated that the molecules in a segment of a system at high temperature vibrate faster than the molecules in other region of the same or another's systems which are at lower temperatures. The molecules with higher motions strike the less energized molecules and transfer some of their energy to the molecules at the colder regions of the system.

2.5.3 Heat Exchange rate by Convection

Convection is the transference of heat by air movement or body motion. It transfer of heat in moving fluid. Air flowing part the body can cool the body if the temperature is low. Besides, air that exceeds 35°C can increase the heat on the body. The faster the air moves, the faster the rate of convection. A person loses about 15 percent of body heat into the air by this method of heat transfer. In order for heat loss to continue the air in the zone of insulation must be replaced with cool air. Convection facilitates body heat loss by replacing the warm air close to the body with cool air (OSHA, 2002)

2.6 Wet Globe Bulb Temperature Index (Outdoor)

According to Reviewed and Anne (2012), the Wet Globe Bulb Temperature (WBGT) is the most index commonly used to mix the relevant environmental heat condition reading include air temperature, T_a and relative humidity, RH which come out with one value. The WBGT for outdoor thermal stress is recommended measurement by governmental agencies in Australia, Australia Bureau of Meteorology. The WBGT was calculated under condition of direct sunlight (outdoors), WBGTout as the following equation:

$$WBGT_{out} = 0.567 \times T_a + 0.393 \times e + 3.94 \quad \text{—— Formula 2}$$

T_a = Dry Bulb Temperature in Celsius (˚C)

e = Water vapour Pressure in hPa

While, the vapour pressure, e can be calculated from the temperature and relative humidity using the equation:

$$e = RH/100 \times 6.105 \times exp\,[17.27 \times T_a / (237.7 + T_a)]$$

RH = Relative Humidity in Percentage (%)

T_a = Dry Bulb Temperature in Celsius (˚C)

The formula used by the Australian Bureau of Meteorology does not described the intensity of solar radiation or wind speed (Kjellstrom et al., 2011). Dry bulb temperature (Ta) is function to measure air temperature directly from the environment.

2.7 Climate Change

Climate change is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (United Nations Framework Convention on Climate Change,2014).The first report on this issue in the context of global climate change likened the heat effect on work output to the caused by diseases, and concluded that this effect may contribute to disability in a population to a greater degree than most diseases (Kjellstrom et al., 2000). The temperature of the country is fairly consistent round the year with the annual temperature variation below 3°C. The temperature during the day is usually hot ranging from 27°C to 32°C in most places, and the night temperature is typically between 21°C to 24°C. The daily variation is in the range of 5°C and up to 12°C .Nevertheless, some places with different topographical attributes especially at the mountainous areas experience different temperature gamut. For example, places such as Cameron Highlands and Fraser's Hill in Pahang have relatively colder ambient temperature whereas the Northern part of the Malaysian Peninsular is hotter. The lowest temperature ever recorded was 7.8°C in Cameron Highlands in 1978 (Malaysian Meteorological Department, 2008).high temperature may cause fatigue and deteriorate driving performance. Therefore, riding a motorcycle during hot day can also be dangerous since the intense sunlight and extreme temperature effects may materialize concurrently.

2.8 Physiological Changes

2.8.1 Blood Pressure

According to Green (1996),blood pressure is the force that caused by pushing up of blood against the walls of the blood vessels.While,systolic blood pressure is the highest pressure attained in arteries during systolic and diastolic blood pressure is the lowest arterial pressure during diastole (Wheeler et al.,2003).

The increase of blood pressure is closely related with the increase of heart rate. This is because the heart must to work harder to pump the blood to all the body parts so that the body temperature can be reduced (Carter, 1996)

2.8.2 Heart Rate

Heart rate is the rate of heartbeat. According to Lu and Zhu (2007), heart rate is a general indicator of stress in the body. The WHO recommended that an average heart rate over the duration of working shift should not exceed 100 beats per minute (Bates and Schneider, 2008).

In case of heat stress, our circulating blood volume need to transport oxygen and also to serve as a cooling fluid. Therefore, it transport heat from the interior of the body to the skin where it is dissipated to the surrounding environment by conduction, convection, radiation or sweat evaporation. This requires an increase in speed of the blood circulating by increasing the heart rate (Rodahl, 2003).

2.8.3 Core Body Temperature

Tortora and Grabowski (2003) stated that core temperature is the temperature in body structures deep to the skin and subcutaneous layer. The deep body temperature should maintain within a limit of ± 1°C around the acceptable resting body core temperature of 37°C to ensure the body can function normally (Epstein and Moran, 2006).

The body core temperature is one of the most obvious responses when the body exposed to heat (Bernard et al, .2000).Metabolic factors where the heat generated by the workload and environmental factor including air temperature, radiant temperature, air speed and humidity are the two main factors that can affect the body temperature when working in heat (Shanks and Papworth, 2001).

According to Tortora and Grabowski (2003), when the body core temperature rises above normal, thermoreceptors will be stimulated. These thermoreceptors will send nerve impulses to the preoptic area, which in turn, stimulate the heat-losing center and inhibit the heat-promoting center. Nerve impulses from heat-losing center cause dilation of blood vessels in the skin. The skin becomes warm, and the excess heat is lost to the environment as an increased volume of blood flows from the warmer core of the body into the cooler skin. The high temperature of the blood stimulates sweat glands of the skin. The skin is cooled as the water from perspiration evaporates from the surfaces of the skin.

2.9 Heat Related Illness

Heat related illness is a condition where it results from the accumulative effects of heat in the body and inability of the body to maintain normal body temperature because of excess heat production and less heat transfer to environment (Hoa *et al*., 2013). Heat-related illnesses can manifest in occupations that demand a high amount of physical work in high ambient temperatures. Heat-related illnesses include heat edema, cramps, syncope, heat exhaustion, and heat stroke (Cuddy *et al.*, 2011; Rudy *et al.,* 2011).

These symptoms are basically caused by the effect of dehydration, an extreme rise in body temperature or both (Backer *et al*., 1999; Andrew *et al*., 2011).Acute heat related illness may occur when the body temperature above 39°C.The disease like hyperpyrexia or thermal injury might be occur when the core body temperature is 40.6°C (Leithead *et al.,* 1964; & Lind *et al.,* 1964).The major problem in heat related illness is a heat stroke. At 20% of those who have suffered heat stroke, they will also suffer damage in vital organ such as heart, liver, kidneys or nervous system (Abdelhamid et al., 2009)

2.9.1 Heat Exhaustion

Heat exhaustion is defined as depletion of water or salt when the body subjected exposed to the more heat that it can handle. Normally, it is happened in high environment temperatures followed by high humidity (Bruchim et al., 2009).Heat exhaustion is a moderate heat illness which it occurs when blood pressure and sustain adequate cardiac output are unable to maintain. This results from strenuous physical activity, high temperature of environment, acute dehydration and energy depletion. The sign and symptoms of heat exhaustion include dizziness, weakness, headache, nausea and high core body temperature (American Academy of Pediatrics, 2011)

2.9.2 Heat Rashes

Heat rashes is caused by profuse sweating that saturates the skin and clogs the sweat ducts (Allyson *et al*.,2007).Heat rashes or also be known as miliara rubra is a milder form of heat illness. It is commonly occurred in area which covered by clothing likely at waist, trunk and groin. In occupational settings, heat rashes had been reported (Donoghue& Sinclair, 2000) and have significant implications for health and performance. It also reported that body temperature and body heat storage were elevated in the affected subject and this condition can bring to the high risk of heat illness where the workers can collapse if returning to the work before the renewal of the sweat ducts is complete (Pandolf *et al*., 1980).

2.9.3 Dehydration

Dehydration is defined as the removal of water from a molecule under the influence of heat, usually in the presence of a catalyst, or through activity of dehydrating agent .Dehydration occurs when body use or lose more fluid than take in, and the body does not have enough water and other fluids to carry out its normal functions (Kuras et al., 2015).In occupational settings, sweat level of range is estimated in between 0.5-2.0 litre per hour which rate of sweat is become higher during wearing protective clothing that limits the heat loss by evaporation and its similar values been estimated in variety of sport settings (Ely et al., 2013)

2.9.4 Heat Cramps

Dannenbaum et al (2012) defines heat cramps as sporadic, often severe muscle spasms, which most commonly occur in the voluntary muscles of the extremities and abdomen. They arise abruptly after vigorous exertional stress. While, Schwellnus (2004) stated that it happened commonly athletes and in occupational settings which involve prolonged activity when exposed to the heat stress where spasm or cramps muscle are painful and involuntary contraction of skeletal muscle.

2.9.5 Heat Syncope

Macknigt and Mistry (2005) stated heat syncope occurred as a sudden, transient loss of consciousness and postural tone with spontaneous recovery, most often caused by generalized cerebral hypo perfusion. Heat syncope is fainting secondary to insufficient cerebral perfusion during and after exertion in the heat (Dannenbaum, 2012).Heat syncope can affect quality-of-life, to cause physical injuries, be challenging to manage and can be a harbinger of sudden death (S. Rosanio *et al.*, 2013).Besides, during sports may be secondary to no sustained ventricular arrhythmias and thus a precursor of sudden cardiac death; however, not all syncope is life threatening (Bader *et al.*, 2013).

2.9.6 Heat Stroke

Heat stroke is defined by central nervous system abnormalities and failure of proper maintenance of thermoregulation as a result of high core body temperature ensuing from exposure to high environmental temperatures or strenuous exercise. Common complications include acute respiratory distress syndrome, disseminated intravascular coagulation, acute renal injury, hepatic injury, and rhabdomyolysis. Heat stroke may occur when internal core temperatures rise above a critical level, leading to a cascade of cellular and systemic responses (Bruchim et al., 2009). Under unusual environmental conditions, healthy individual may experience severe heat stroke with multi organ dysfunction including liver failure.

2.10 Personal factor

Personal risk factors are those elements that may reduce an individual's tolerance for heat stress (ACGIH, 2001).

2.10.1 Age

According to ACGIH (2001), age itself may not be the most important criterion. Physical condition commonly associated with age are more significant. Some physical disabilities associated with aging seriously weaken response to heat stress. Similarly, chronic illnesses that weaken cardiac output or reduce circulating blood volume reduce safety in heat stress.

2.10.2 Gender

Heat strain can differ between men and women exposed to the same level of heat stress. Women tend to have a lower aerobic capacity compared to men, as well as a higher body fat content, lower total body mass, and lower surface area (Havenith et al., 1995).In terms of the capacity of the sweating response to heat stress, women appear to have greater density of active glands. However, there is a smaller output per sweat gland than compared to men. The majority of research into physiological response to heat stress primarily focuses on males. This is because the hormonal state of males is constant compared to women, which varies with the menstrual cycles (Inoue et al., 2005).

2.10.3 Clothing

Clothing, by its very nature interferences with our ability to lose heat to the environment. Wearing too much clothing or personal protective equipment (PPE) may be a primary cause of heat stress even if the environment is not considered warm or hot. Clothing is both a potential cause of thermal discomfort as well as a control for it as we adapt to the climate in which is to live and play (HSE, 2007).Clothing creates a barrier between the skin surfaces and the surrounding environment and can therefore impede heat transfer. Heat loss by conduction, convection and radiation can be limited by the insulation properties of the clothing, commonly related to the thickness of the fabric (Havenith,1999).Also, the type of fabric used and any protective coatings applied to them can dramatically affect their capacity of vapour transfer, impairing evaporative heat loss (Philip et al., 2014).

2.10.4 Alcohol

Alcohol in high doses induces many physiological and perceptual disorders. Not only is it a central nervous system depressant, but alcohol also produces peripheral vasodilation and dieresis. Aside from affecting perception and judgment, demonstrating that low doses of alcohol seriously reduce thermoregulatory response, including vasomotor and sweating reflexes or that it may serve as a diuretic is difficult. Alcohol use will adversely affect cardiovascular regulator of blood pressure, leaving some people more susceptible to a fall in arterial pressure during heat stress (ACGIH, 2001).

2.10.5 Smoking

According to Tortora and Grobowski (2003), smoke from cigarette reduces immune system function, influences the response to other agents and increases the risk of heart disease. Tobacco in cigarettes contains nicotine which constricts the walls of the blood vessels. Constriction means the vessel is narrower, requiring the heart to pump harder to push the blood through the narrower vessel, throughout the body and back to heart.

2.10.6 Drug

According to Eric et al. (2013), drugs is the one of the factors that can contribute to the interfering processes of thermoregulatory in the individual's body. It is including antidepressants and bronchodilators which can alter the reading of heart rate and decrease the sweat rate. Drugs for heart blood pressure such as beta blockers can reduce the flow of blood to the skin and directly reducing convective cooling.Anti-histamines can both reduce the level of blood flow and increase body temperature as well as diuretic medications which will change the balance of fluid in the body (Platt, 2010).

2.10.7 Obesity

Obesity is a liability when working in the heat because the specific heat of fat is much greater than that of muscle tissue, excess fat increases the insulator properties of the body surfaces and retards conduction of heat to the periphery (Mack et al., 2013).

2.10.8 Acclimatization

Acclimatization is the gradual process where your body is made used to higher work and heat levels. Through acclimatization, our body benefit from smaller increase in body temperature and heart rate, and increased sweat production, while working in heat.it takes about 7 days, working in a warm or hot environment for at least 100 minutes a day, to approach full acclimatization to the environment about 2 weeks. Full-time workers usually become naturally acclimatized as weather warms, and do not need a formal acclimatization period unless there is a sudden increase in workload, temperature and humidity that restricts body cooling (HSE, 2007)

CHAPTER 3

METHODOLOGY

3.1 Study Design

This is a cross sectional study where the exposure and the health effects of heat stress was measured and observed at the specific point of time.

3.2 Study Location

This study was conducted among of Point Duty Unit of traffic policemen in Kuala Lumpur.

3.3 Study Population

The study populations involve the Point Duty Unit of traffic policemen in Kuala Lumpur who were exposed to the extreme level of outdoor environment temperature.

3.4 Sampling

3.4.1 Sampling Frame

The sampling frame was taken from the name list of all traffic policemen who are working at the Balai Polis Trafik Kuala Lumpur. The name lists will be obtained from the Human Resources Department of Balai Polis Trafik Kuala Lumpur.

3.4.2 Sampling Unit

The respondent will be selected using purposive sampling who fulfilled the following inclusion criteria and exclusion criteria:

Inclusion criteria:

a) Male traffic policemen

b) Traffic policemen employed not less than 3 months (ACGIH, 2011)

c) Traffic policemen who are exposed to high temperature (≥28°C) during working task.

d) Has not been diagnosed with hypertension, diabetes and heart disease

Exclusive Criteria:

1) Traffic policemen who were on leave for more than 4 days. This is because loss to heat acclimatization begins when the activity under those heat stress condition is discontinued, and a noticeable loss occur after 4 days.(ACGIH 2001)
2) Traffic policemen who have been diagnosed with diabetes mellitus, hypertension, asthma, and any heart disease. This is because workers who consume medications such as diuretic drug,anti-hypertension,anti-histamine drugs due to the mentioned medical condition will contribute to the increase in body temperature due to effects on the body fluid balance, vasoconstrictor/dilator activity and on cardiac function (Havenith,1995)

3.4.3 Sampling Size

The sampling size for this study was based on Kirkwood & Sterne (1988).

$$N = (P\beta + P\alpha)^2 (SD1^2 + SD2^2) / (X1 - X2)^2$$

$$= (0.84 + 1.96)^2 [(14.08)^2 + (12.67)^2] / (124.98 - 117.51)^2$$

$$= 50 + 10\%$$

$$= 55$$

Where:

$P\beta$ = z-value at beta of 0.2

$P\alpha$ = z-value at alpha of 0.05

SD1 & SD2 = Standard deviation of systolic BP before working (1)* & after working (2)*

X1 & X2 = mean of systolic BP before working (1)* & after working (2)

*Value taken from (Muznita, 2004)

Based on calculation above, Beta value will be set at 0.2 and Alpha value will be set at 0.05 level of significant in statistical analysis. Hence, the minimum sample size of this study should be around 50. 10% was added from the sample size to overcome this withdrawal of respondent and error during collecting data. Therefore 55 sample was collected in this study.

3.5 Instrumentation

3.5.1 Questionnaire

A self-constructed questionnaire adapted from previous study (Nur Athirah et al., 2014) is used in this study which consists of four (4) parts:

a) Part A: Socio demographic

b) Part B: Occupational information

c) Part C: Health Information

d) Part D: Heat Related Illness complaints

These questionnaires are distributed to the respondents and require them to fill the information as mentioned above.

3.5.2 Data Logger

The environmental temperature is measured by using EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD which calculates the value of relative humidity (RH) and temperature. This instrument is wear by traffic policemen of shift working in Kuala Lumpur personally. This instrument is place on mobile traffic policemen for four hours.

Figure 3.1 EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD

Figure 3.2 Traffic policeman is wearing the EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD

3.5.3 Personal Body Core Meter

Omron MC-510 Gentle Temperature was used to measure respondent body core temperature (Figure3.2).Measurement of body core temperature was taken before, during and after working hour where the sensor was inserted into the respondent's ear when taking a temperature reading.

Figure 3.3 Omron MC-510 Gentle Temperature

3.5.4 Blood Pressure Monitor

OMRON T3 Automatic Blood Pressure Monitor is used to measure blood pressure and heart rate of respondents (Figure 3.4).The cuff is fastened onto the left arm when taking the blood pressure measurements. The respondents are asking not to eat and drink for at least 15 minutes before the measurements.

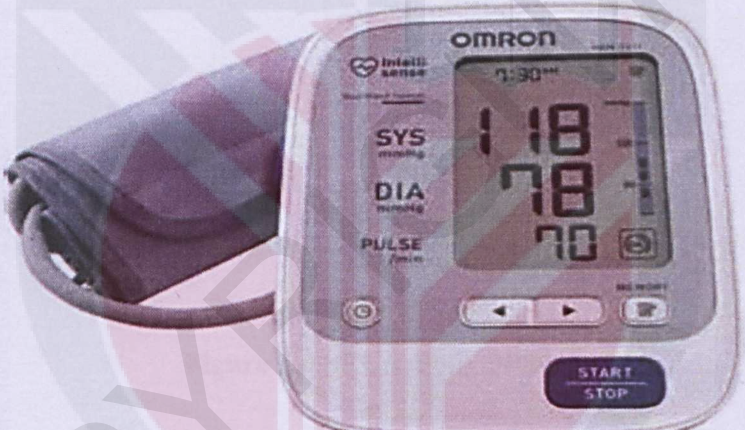

Figure 3.4 OMRON T3 Automatic Blood Pressure Monitor

3.5.6 Weighing Scale and Height Meter

The SECA Body Meter was used to measure the height, while SECA Body Weighting was used to measure the weight of respondent (Figure 3.5 and Figure 3.6).Both of this data then will be used to calculate the Body Mass Index (BMI) of the respondents.

Figure 3.5 SECA Body Meter

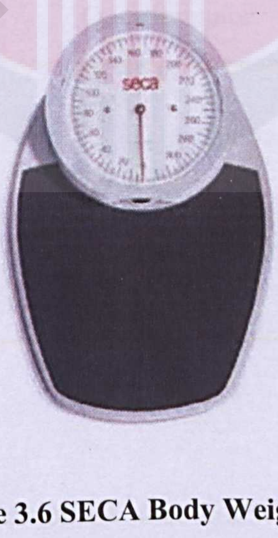

Figure 3.6 SECA Body Weighting

3.6 Data Collection Workflow

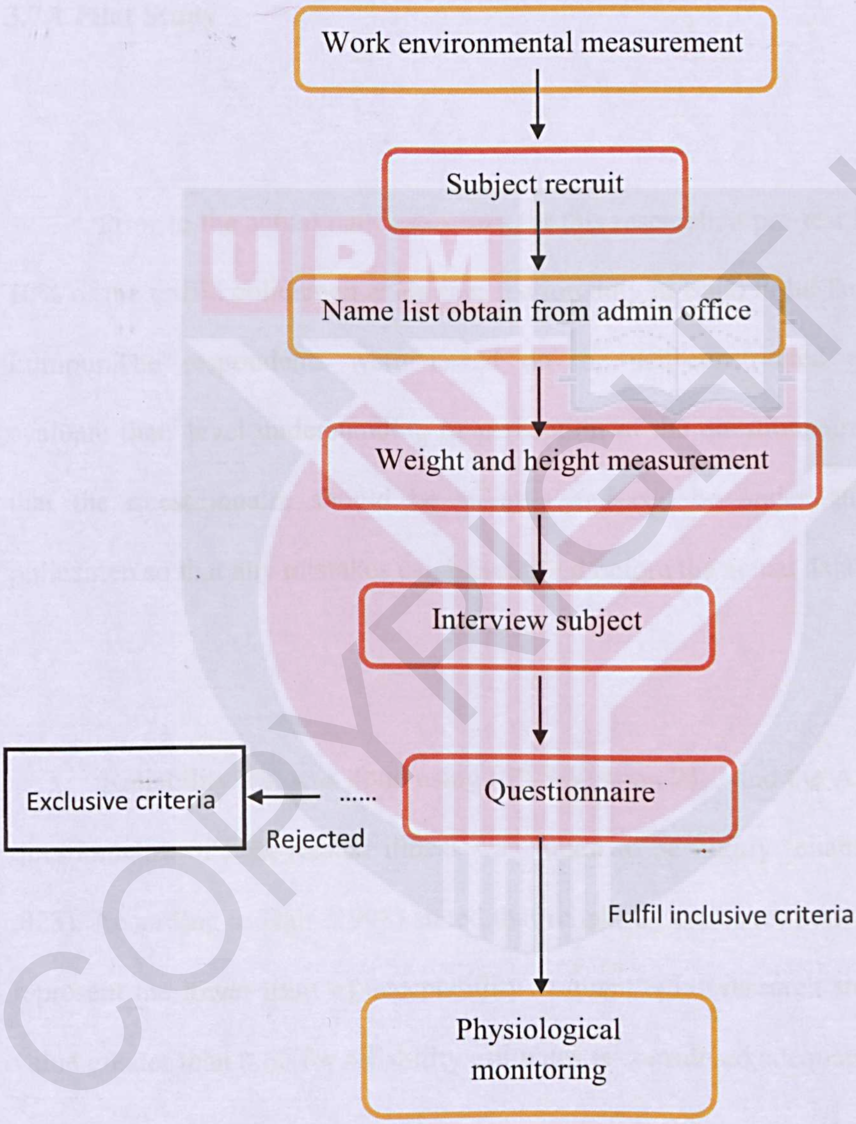

Figure 3.7 Data Collection Workflow

3.7 Quality Control

3.7.1 Pilot Study

Prior to the actual data collection for this research, a pre-test has conducted on 10% of the traffic policemen at another section duty in Balai Polis Tun H.S Lee, Kuala Lumpur.The respondents were tested on the self-constructed questionnaires to evaluate their level understanding or perception of the questionnaires. It is to ensure that the questionnaire should be suitable and can be understand by the traffic policemen so that any mistakes can be rectified before the actual data collection.

Reliability test was done using SPSS Version 21.0 and the Alpha value for the questionnaire of heat related illness was found to be highly reliable (21 items; α = .823). According to Hair (1998) stated that reliability estimates between 0.60 and 0.70 represent the lower limit of acceptability in quantitative research studies. Thus alpha value greater than 0.60 for reliability estimates is considered adequate.

3.7.2 Standard Operating Procedure (SOP) for Data Logger

An important aspects of a quality system is to work according to proper Standard Operating Procedures (SOPs).A Standard Operating Procedures is a document which describe the regularly recurring operations correctly and always in the same manner. This instruments used in this study was followed the SOPs providing by manufacturer.

The Standard Operating Procedures (SOPs) of data logger as below:

1. Firstly, install the battery of EL-USB-2-LCD Humidity, Temperature and Dew Point Data Logger with LCD (data logger).
2. Then, install the software and USB Driver of data logger in PC desktop. An "EasyLog USB" icon will be placed on the desktop.
3. Next, insert the data logger into an available USB port on PC.
4. For the setting of data logger, name the logger and select the sample rate (Figure 3.8)

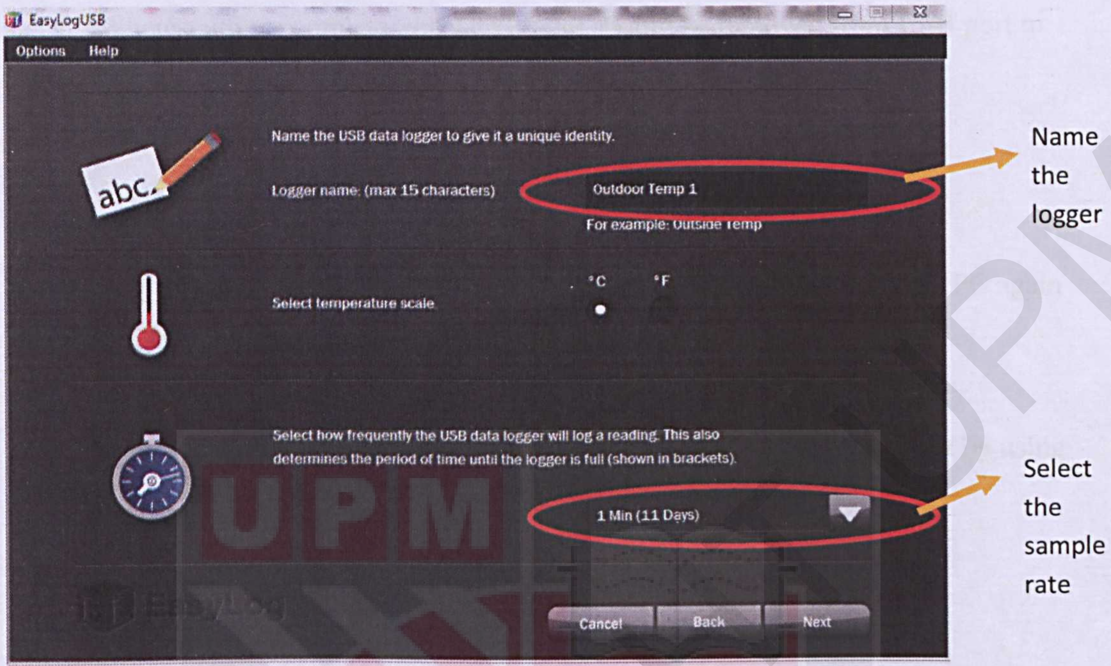

Figure 3.8 Setup the name of logger and sample rate of data logger

5. Before taking the reading, set up the data logger first (Figure 3.9)

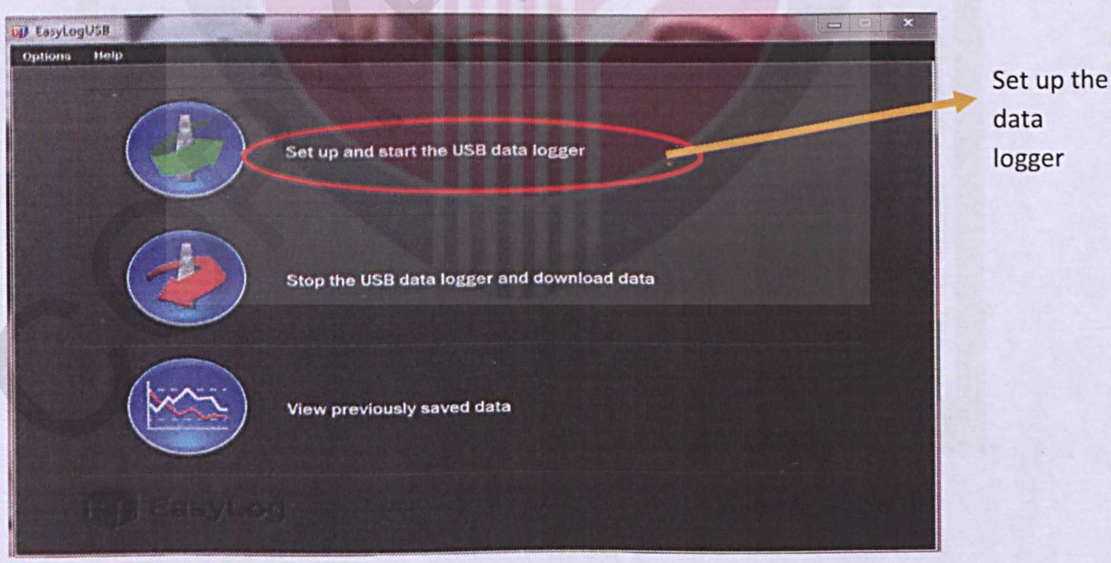

Figure 3.9 Set up USB data logger before taking the reading measurement.

6. When setup is complete, the data logger should be removed from USB port to begin recording.

7. Press the button on the data logger to start the reading measurements.

8. After finished recording the data, insert the data logger USB port into PC again to stop the USB data logger and download data.

9. Save the download data of data logger and view previously saved data by using this software (Figure 3.9 and Figure 3.10)

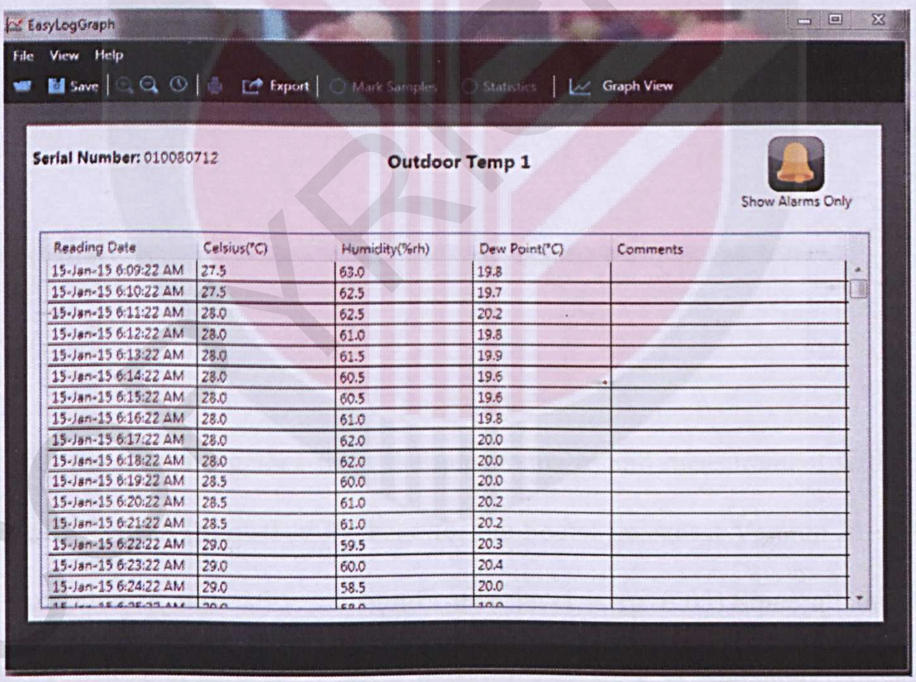

Figure 3.10 Data saved view of data logger previously

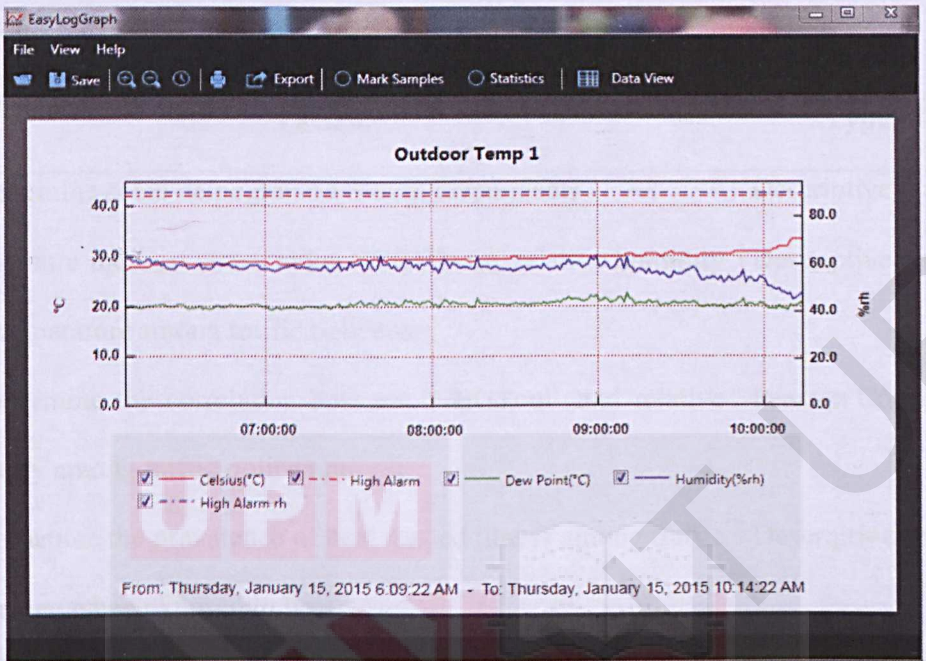

Figure 3.11 Data saved graph view of data logger previously

3.8 Data Analysis

All the data are gather from the questionnaire and measurement will analyze by using IBM SPSS (Statistical Package for the Social Sciences) Version 21 software. The assumption of normality for significance level is ($p>0.05$).Since all the data is normally distributed, parametric test is perform. The types of data analysis that is use in this study are shown in the following Table 1.

Table 3.1: Types of data analysis

Variable	Type of analysis
To determine socio demographic data of respondents	Descriptive Analysis
To measure the heat stress index (WBGT $_{out}$), relative humidity and temperature among traffic policemen	Descriptive Analysis
To determine the correlation between WBGTout and relative humidity among traffic policemen	Pearson Correlation
To determine the prevalence of heat related illness among traffic policemen when exposed to heat.	Descriptive Analysis
To determine physiological parameters between before shift, after 2 hours working, and after 8 hours working among respondents	Descriptive Analysis
To compare the differences of blood pressure before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.	Repeated Measure ANOVA
To compare the differences of heart rate before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.	Repeated Measure ANOVA
To compare the differences of core body temperature before shift, after 2 hours working, and after 8 hours working among traffic policemen exposed to heat.	Repeated Measure ANOVA

3.9 Study Limitation

3.9.1 Information Bias

The information bias might be happened when the respondent not remember some important information related to this study or their answer given do not reflect the situation that they are facing. This can give bad effect to the outcome of this study. Meanwhile, they also can reluctance to tell undesirable social behavior such as consumption of alcohol and drug.

3.9.2 Smoking

Smoking will temporarily increase the blood pressure and heart rate of the smoker (WebMD, 2014).Smoking caused a significant acute increase of heart rate and systolic blood pressure at 15 minutes after smoking. However, the blood pressure will return to the normal level when that stop smoking. Thus, respondent was asked not to smoking for an hour before the measurement taken (Moo-Yong, 2006).

3.9.3 Diet

This study does not take account the diet of its respondents, thus the taking of supplements or certain types of food, like coffee or anything high in caffeine, has the ability to influence the readings obtain from the measurements. Certain supplements and types of food can influence a person's heart rate or even increase a person's temperature and rate of sweating. It was difficult to measure diet intake by respondents since most of them have variations of diet. In addition, it was difficult to conclude the diet factor in one measurement and respondents might be difficult to recall information about their daily intake in specified period of time. Respondents were asked to do not take any food and drink for 30 minute before measurement taken.

3.9.4 Anxiety

Anxiety is a feeling that respondents may feel when their physiological measurements were taken by the researcher which also known as white coat syndrome. This phenomenon can elevated the blood pressure to high reading even the respondents were not in high blood pressure condition. It cannot be eliminated but it can be reduced by asking the respondents to relax and calm down within 5 to 10 minutes and the physiological measurements should take at three times to get the accurate reading.

3.10 Research Ethics

All respondents briefed about the study and ask to participate in the study on a voluntary basis. Consent forms given and be read and sign it. All respondents given a choice to continue participating in the study or to pull out at any time they choose to do so. Finally, all the information about the respondents involved in this research remains confidential. No individual comments will be stated in the writing. The study proposed and have the approval of the Ethic Committee for Research involving Human Subjects of Universiti Putra Malaysia (JKEUPM) before performed.

CHAPTER 4

RESULTS

4.1 Respondent's Background Information

This study aims to determine the heat stress exposure and physiological effect among traffic policemen in Kuala Lumpur.Data were collected beginning from 12th February 2015 until 18th March 2015.This study was conducted among 55 traffic policemen in Kuala Lumpur.

Data on age, race, marital status, Body Mass Index (BMI) and duration of employment were determined for the socio-economic information. Besides that, pervious medical history working condition and acute symptom of health during working task were asked through questionnaire provided to the traffic policemen.

Table 4.1 show the background of respondents studied. All the respondents are Malaysian, male in the age group between 23 to 36 years old. Among the fifty-five respondents, majority of them were between 30-35 (72.7%) years old. The mean for age is 27.22 ± 3.14. Majority of respondents are Malay (61.8%).Most of them (50.9%) were married status. More than half respondents (54.6%) had a normal BMI in the range of 18.5 to 24.9 kg/m².Majority of respondents has normal weight and the mean for BMI is 24.45 ± 3.84.All of respondent are working between 9 months until 9 years and the mean for years of employment is 2.87 ± 2.36. (76.4%) of them completed education until secondary school.

Table 4.1: Socio-demographic of the traffic policemen who participated in the study (N=55)

Variable	Mean ± SD	Range
Age	27.22 ± 3.14	23-36
Weight (kg)	70.96 ± 10.99	53 - 99
Height (cm)	170.50 ± 5.21	157 - 182
Body Mass Index (kg/m³)	24.45 ± 3.84	18.56 – 33.27
Work Duration (month/year)	2.87 ± 2.36	9 months -9 years
	Total	**Percentage (%)**
Age group (years)		
≤ 23	4	7.3
24-29	40	72.7
30-35	9	16.4
≥36	2	3.6
Race		
Malay	34	61.8
Chinese	1	1.8
Indian	2	3.6
Others	18	32.7
Marital Status		
Bachelor	27	49.1
Married	28	50.9
Widower/Widow	0	0
Body Mass Index (BMI)		
Underweight (<18.5)	0	0
Normal (18.5-24.9)	30	54.6
Overweight (25.5-29.9)	21	38.2
Obese (>30)	4	7.3
Education		
No formal education	0	0
Primary school	0	0
Secondary school	42	76.4
Higher education	13	23.6

4.2 WBGT out, Relative humidity and Temperature

The distribution of Heat Stress Index value (WBGTout),temperature and relative humidity among traffic policemen in Kuala Lumpur is illustrated in Table 4.2.The WBGTout results indicated that the temperature lies between 16.7˚C to 30.2˚C and the mean value was 22.19˚C.The result show that WBGTout had not been exceeded the Threshold Limit Value (TLV) by ACGIH which 28.0˚C.The temperature illustrated that it lies between 27.9 ˚C to 36.5˚C.Overall,the mean reading for the temperature was 31.26˚C.Meanwhile,in the relative humidity results showed the range of relative humidity was between 43.4% to 84.7%.Overall,the mean of the relative humidity was 58.05%.

Table 4.2: Exposure profile for WBGTout, temperature and relative humidity among traffic policemen.

Variable	Mean ± SD	Range
WBGTout (˚C)	22.19 ± 2.25	16.7 – 30.2
Temperature (˚C)	31.26 ± 2.04	27.9 – 36.5
Relative Humidity (%)	58.05 ± 8.31	43.4 – 84.7

4.3 Correlation between WBGTout and relative humidity

The correlation between WBGTout and relative humidity results was showed in Table 4.3.The results indicated that there is a significant correlation between WBGTout and relative humidity ($r = 0.76, p < 0.001$)

Table 4.3 Correlation between WBGTout and relative humidity among traffic policemen (N=55)

Variable	Mean ± SD	r	p
WBGTout (˚C)	22.19 ± 2.25	0.76	< 0.001**
Relative Humidity (%)	58.053 ± 8.31		

****p-value is significant at p<0.001**

4.4 Prevalence of Heat Related Illness

The third objective of this study was to determine the prevalence of heat stress among traffic policemen in Kuala Lumpur.Table 4.4 shows acute symptoms that occur among the traffic policemen regarding heat stress symptoms. The greatest prevalence of heat related illness complaints among traffic policemen when exposed to outdoor heat exposure was dehydration (89.1%), followed by heat exhaustion (80%), heat cramps (29.1%) and heat syncope (25.5%).Whereas heat stroke (12.7%) was the least heat related illness reported by traffic policemen.

Table 4.4: Prevalence of heat related illness complaints among workers (N=55)

Heat Related Illness	Frequency(n)	Percentage (%)
Heat Exhaustion	44	80.0
Heat Stroke	7	12.7
Dehydration	49	89.1
Heat Rashes	10	18.2
Heat Syncope	14	25.5
Heat Cramps	16	29.1

4.5 Descriptive value physiological parameters (body core temperature, diastolic blood pressure, systolic blood pressure and heart rate)

The result of mean in three parameters of physiological between three different sessions is presented in Table 4.5.However, the results for differences of physiological measurements is illustrated in Table 4.6 by using a repeated measure ANOVA with a Greenhouse-Geisser correction. Table 4.5 shows the descriptive value for physiological parameters (body core temperature, diastolic blood pressure, systolic blood pressure and heart rate).From the result, mean values of core body temperature after 8 hours was higher compared to before shift and after 2 hours. The mean values for systolic blood pressure was higher after 8 hours working compared to before shift and after 2 hours work. Meanwhile, mean values for diastolic blood pressure was higher after 8 hours working compared to before shift and after 2 hours work. The mean values for heart rate are much higher after 8 hours of working compared to heart rate before shift and after 2 hours working. Therefore, there was significant differences ($p<0.001$) of body core temperature, diastolic and systolic blood pressure, and heart rate between before shift, after 2 hours working, and after 8 hours working. Thus, the post hoc test using the Bonferroni (Table 4.7) was used to determine the significant differed between three session.

Table 4.5: Descriptive analysis of core body temperature, heart rate and blood pressure between before, after 2 hours and after 8 hours working among traffic policemen.

Variable	Mean ± SD	Range
Systolic blood pressure (mm/Hg)		
Before	127.20 ± 11.15	108-156
After 2 hours	129.76 ± 10.65	109-150
After 8 hours	131.89 ± 9.13	115-149
Diastolic blood pressure (mm/Hg)		
Before	82.25 ± 8.98	62-109
After 2 hours	82.44 ± 8.92	64-105
After 8 hours	82.85 ± 7.15	68-98
Heart Rate (bpm)		
Before	79.64 ± 12.49	48-114
After 2 hours	82.11 ± 12.15	50-118
After 8 hours	83.13 ± 8.93	53-104
Body Core Temperature (˚C)		
Before	36.07 ± 0.38	35.2-37.1
After 2 hours	36.36 ± 0.33	35.2-37.1
After 8 hours	36.69 ± 0.44	33.9-37.1

4.6 Differences of Core Body Temperature, Heart Rate and Blood Pressure Between Before, After 2 Hours and After 8 Hours Working.

The result of mean in three parameters of physiological between three different sessions is presented in Table 4.5.Meanwhile, the results for differences of physiological measurement is presented in Table 4.6 by using a repeated measure ANOVA with a Greenhouse-Geisser correction. There was significant differences ($p<0.001$) of core body temperature, heart rate and blood pressure between before, after 2 hours and after 8 hours working.Thus,the post hoc tests using the Bonferroni (Table 4.7) was used to determine the significant differed between three session.

4.6.1 Differences of Core Body Temperature between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

The results showed that mean was differed statistically significant F (1.93, 104.05) =33.19, $p<0.001$ between sessions in body core temperature. A post hoc Bonferroni correction test revealed that the body core temperature before shift (36.07 ± .38˚C) was significantly ($p<0.001$) different to 2 hours working (36.36 ± .33˚C) and after 8 hours working (36.69 ± .44˚C).However, only a slight increased occurred in core body temperature from 2 hours working to after 8 hours working which was not statistically significant (*p*= 1.00)

4.6.2 Differences of Heart Rate between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

The results showed that the heart rate significantly differed across time (F (1.28, 106.30) = 3.71, p< .001). A post hoc Bonferroni correction test shown that heart rate had been slightly increased from after 2 hours working (82.11 ± 12.15bpm) to after 8 hours working (83.13 ± 8.93 bpm) which was not differed in significant (p> 0.05).However, the mean value before shift (79.64 ± 12.49 bpm) had been drastically increased which was significantly different between after 2 hours working (p < 0.001) and after 8 hours working (p<0.001). Hence, it highlighted that there is a significant different of heart rate between before shift, after 2 hours and after 8 hours working.

4.6.3 Differences of Blood Pressure between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

A repeated measures ANOVA with Greenhouse-Geisser correction determined that mean systolic blood pressure statistically significantly difference over time (F (1.90, 129.539) =1.912, p<0.001). Post hoc tests using the Bonferroni correction showed that the significant differences (p>0.05) between before shift (127.20 ± 11.15 mm Hg) with after 2 hours working (129.76 ± 10.65 mm Hg) and after 8 hours working.However,there is no significantly (p = 1.00) differences between after 2 hours of working (129.76 ± 10.65mm Hg) and after 8 hours working (131.89 ± 9.13 mm Hg).

A repeated measures ANOVA with Greenhouse-Geisser correction determined that mean diastolic blood pressure statistically significantly difference over time ($F_{(1.92, 103.71)} = 3.094$, $p<0.001$). Post hoc tests using the Bonferroni correction showed that the significant differences ($p>0.001$) between before shift (82.25± 8.98 mm Hg) with after 2 hours working and after 8 hours working.However,there is significantly ($p = 1.00$) differences between after 2 hours (82.44 ± 8.92 mm Hg) and after 8 hours working (82.85 ± 7.15 mm Hg).

Table 4.6 Differences of systolic blood pressure, diastolic blood pressure, heart rate and body core temperature before shift, 2 hours of working and after 8 hours among traffic policemen.

Variable	MD ± SE	*p*	*F*
Systolic blood pressure (mm/Hg)			
Before shift – After 2 hours	1.436 ± 1.138	< 0.001**	1.912
Before shift – After 8 hours	-.691 ± 1.200		
After 2 hours – After 8 hours	-2.127 ± .981		
Diastolic blood pressure (mm/Hg)			
Before shift – After 2 hours	2.509 ± 1.024	< 0.001**	3.094
Before shift – After 8 hours	2.091 ± 1.188		
After 2 hours – After 8 hours	-.418 ± 1.022		
Heart Rate (bpm)			
Before shift – After 2 hours	-2.473 ± 1.284	< 0.001**	3.710
Before shift – After 8 hours	-3.491 ± 1.398		
After 2 hours – After 8 hours	-1.018 ± 1.267		
Body Core Temperature (˚C)			
Before shift – After 2 hours	-.298 ± .065	< 0.001**	37.188
Before shift – After 8 hours	-.620 ± .076		
After 2 hours – After 8 hours	-.322 ± .075		

**p-value is significant at $p < 0.001$

Table 4.7 Post hoc test (Bonferroni correction) of physiological parameters at three different sessions

Variable (Pair)	*p*
Systolic blood pressure (mm/Hg)	
Before shift – after 2 hours	< 0.001**
Before shift - After 8 hours	< 0.001**
After 2 hours - After 8 hours	0.103
Diastolic blood pressure (mm/Hg)	
Before shift – after 2 hours	< 0.001**
Before shift - After 8 hours	< 0.001**
After 2 hours - After 8 hours	1.000
Heart Rate (bpm)	
Before shift – after 2 hours	< 0.001**
Before shift - After 8 hours	< 0.001**
After 2 hours - After 8 hours	0.946
Body Core Temperature (˚C)	
Before shift – after 2 hours	< 0.001**
Before shift - After 8 hours	< 0.001**
After 2 hours - After 8 hours	0.607

**p-value is significant at p <0.001

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

5.1.1 Respondent's Background Information

This study was carried out involving fifty- five respondent which they are consist of traffic policemen in morning shift from Point Duty Department in Kuala Lumpur Police Station. Normally respondents start their morning shift from 6.00am until 2.00pm. They were worked in Point Duty Department of up 6 months. The inclusion and exclusion criteria were respondents should not been diagnosed with hypertension, diabetes and heart disease, exposed to high temperature at the workplace, and employed not less than 3 months.

Overall respondents in this study consisting of male traffic policemen aged between 23-35 years old. The mean age of respondents was 27.22 years which considered an average for the working population. According to Analysis of labour Force in Malaysia stated that more than 60% of the employed person included of aged 23 years and older, which showed that the average age is well with this respondents' population (Mahari et al., 2011).About half of the respondents in this study are within the normal Body Mass Index (BMI).The BMI had influenced in body response to heat stress. According to Soteriades (2005) stated that obese individuals had high risk in heat stress due to the fat layer composition and lower density of sweat glands which can decrease heat loss.

The duration of the employment for all traffic policemen in Kuala Lumpur was 9 months and above. The education level for respondents is 76.4% in secondary while 23.6% at higher education level. Majority of them had completed education until secondary school. This results are similar with Labour Force Participation Rate (LFPR) Malaysia 2011 where the secondary education recorded the highest increase compare to other level of education (Mahari et al., 2011).

5.1.2 WBGT out, Relative humidity and Temperature

The result for the Heat Stress Index for outdoor was in the range between 16.7 °C to 30.2 °C.The highest value was recorded among traffic policemen was 30.2 °C.In this present study, the mean value of WBGTout among traffic policemen was 22.19°C. Based on the ACGIH (American Conference of Governmental Industrial Hygienists), all of the temperature were not exceeded the Threshold Limit Value (TLV) (< 28.0 °C) for moderate workload level with 75% work, 25% rest regimen. The standard value (ACGIH) for moderate metabolic workload category was between 200-350kcal/hour which the temperature should 28°C and below.Meanwhile,the mean temperature for this study was 22.19 °C.Thus,the heat exposure level with moderate workload in this study was suitable for 8 hours duration of the traffic policemen in Kuala Lumpur.

Meanwhile, the results for the relative humidity among traffic policemen were quite high which in the range of 43.4% to 84.7%.In this study, the value of relative humidity (58.05%) was high and exceed the standard (<52).The high level of humidity makes heat more dangerous to the exposed people. This is because it slows the evaporation of perspiration in human body. In other words, the human body feels warmer in high humidity conditions. According to Singh & Rasdan Ismail (2011) stated that low humidity does not generally cause thermal discomfort. However, when the relative humidity is slow, the apparent temperature can actually be lower than the air temperature. This condition is known as heat index.

The heat index is a specious temperature which it represent the actual feels of the temperature to the human body when the relative humidity is combined with the air temperature (Safety & Personnel, 1999). However, the results for the temperature among traffic policemen were slightly high which in the range of 27.9˚C to 36.5˚C.In this study, the high relative humidity (84.7%) was revealed among traffic policemen with 36.5˚C in temperature. Based on the calculation, the actual heat that traffic policemen may feel in outdoor environment was 50˚C (NWS, 2013).This showed that the traffic policemen were exposed to the very high temperature which it can lead to the high prevalence in heat related illness. Since all the traffic policemen were low exposed to WBGTout and high relative humidity (>52%), it means that all the workers were low exposed to heat stress (Table 1)

Table 5.1: The risk level of heat stress based on WBGT out and RH

Relative Humidity	WBGT value	Risk Level
50%	< 24˚C	Low
	24 – 28 ˚C	Moderate
	28 – 33˚C	High

5.1.3 Correlation between WBGTout and relative humidity

The results shown that there is a statistically significant correlation between relative humidity and $WBGT_{out}$ ($r = 0.76$, $p < 0.001$).This showed that the increases or decreases in relative humidity do significantly relate to increases or decreases in $WBGT_{out}$. The findings in this study was supported by the study done by Donoghue et al., (2000) which found the workers were exposed to high humidity index in their hot working environment. The combining effect of relative humidity and temperature of the workplace, the level of comfort showed those exposed groups were having great of discomfort with avoid exertion (ACGIH, 2001).Previous study has stated that it can support the results of this study which is reading of WBGT value has a significant relationship with relative humidity of the environment (Niosh, 2013).According to Bernard and Barrow (2012) stated that the measurement of WBGT value from the electronic instruments with the relative humidity method provide a good estimate of the WBGT from the standard instrument.

5.1.4 Prevalence of Heat Related Illness

ACGIH (1992) stated that workers that exposed for more than eight hours to heat were susceptible to heat stress disorders. This study involved only one shift, with working shift of 8 hours; beginning from 6.00am until 2.00pm. Eichner (2006) noted that an increase in heat storage in the body will lead to adverse physiological changes, such as heat disorders.

The highest prevalence of heat related illness complaints among traffic policemen was dehydration (89.1%), followed by heat exhaustion (80%) and heat cramps (29.1%) due to high exposure of heat during eight working hours. The dehydration (89.1%) need to be taken into the consideration since it is the highest cases reported. This can be related to the facts that they drink less amount of water after their exposed to the heat during their working hours. However, traffic policemen also showed they were lack of consciousness on the hazardous heat related illness based on the interview with them. This is similar to previous study which found that 2% of dehydration could reduce in mental performance and affect the physical and psychological of the workers (Bates & Matthew.,1996).Thus, the high prevalence of dehydration should be taken seriously in this case to prevent any worst case happened.

Furthermore, the heat exhaustion (80.0%) also need to be taken into the consideration since it is the second highest cases reported was also high after dehydration. The heat exhaustion is a less extreme manifestation of heat related illness which it involve mild symptoms such as confused,weakness,dizziness and malaise (Howe,2007).However, the untreated heat exhaustion may contribute to the heat stroke due to the central nervous system (CNS) dysfunction such as coma and even death.

According to Encyclopedia of Occupational Health and Safety (2004), heat cramps is the first indicator of human body having difficulty in regulating body temperature. From this study, there was 29.1% of respondent reported having muscle cramps during working among the traffic policemen. This can be considered as the warning sign for heat-related emergency. The muscle cramps is the indicator of human body having difficulty in regulating body temperature (Helton et al., 2008).Heat cramps is one of severe heat stress disorder and immediate control measures should be taken to avoid the severity. Finally, 18.2% of the respondents developed heat rash lesion due to the heat exposure.

5.1.5 Differences of Core Body Temperature, Heart Rate and Blood Pressure Between Before, After 2 Hours and After 8 Hours Working.

The result of repeated measure ANOVA found that there is a significant difference of physiological parameters between before shift, after 2 hours and after 8 hours working ($p<0.001$).Meanwhile, by doing post hoc comparison between sessions, the significant differences was found between core body temperature, heart rate and blood pressure in before shift with after 2 hours working and before shift with after 8 hours working. However, there is no significant differences in other session.

According to Nga and Winkels (2013) stated that this can be related to the rest period between 2 hours and 8 hours working period where the traffic policemen were not exposed to hot environmental condition. Therefore, the rate of heat production in the body was drastically reduced in that period of time which give effect to the reading value at after 8 hours of working.

5.1.5.1 Differences of Core Body Temperature between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

The result indicate that there was significant difference (p<0.001) of core body temperature before shift (36.07 ± 0.38˚C) with after 2 hours and after 8 hours working. However, between after 2 hours (36.36 ± 0.33 ˚C) and after 8 hours working (36.69 ± 0.44˚C) there is no significance difference shown in ANOVA analysis. However, Nurul Ainun (2003) revealed that there is a significance difference ($p < .05$) after 2 hours and after 8hours working in the automotive industry. Generally, the human body being warm blooded, maintain a fairly constant internal temperature even though it is being exposed to varying environmental temperature (Charoonpatrapong et al., 2013)

The body keeps its core temperature constant at about 37˚C by physiological adjustment controlled by the hypothalamus where there are neuron sensitive changes a skin and blood temperature (Falahatkar et al., 2012).When the body expose to heat, body temperature rises. Skin warmth receptors and blood convey these changes to the hypothalamic thermostat, the sweat glands are triggered to bring the moisture to the skin surface. Blood vessels will widen to bring more blood closer to the outer layer of skin (Falahatkar et al., 2012)

According to Hermann (2003) in stated that humans are maintaining an average core temperature of 37 ± 0.5 degree Celsius. Core body temperature varies slightly due to environmental and metabolic factors. Exercise or physical activity may raise core temperature by up to 3 degrees.

This study was supported by other studies done by Siti Fawziah (2002) and Goh (2001) that there was increasing in core body temperature reading after physical work due to the body generate excess heat. Work rate is the single most important factors that determines how much heat is generated in the core (Toussaint et al., 2014). It is obvious that the more vigorously we use our muscles, the more heat we generate. When we stop to rest, the rate of heat production can drop dramatically (Berry et al., 2010).Whereas research from Lela & Frantz (2012) prove that when person performs heavy physical labor, the metabolic rate increase as does the production of internal heat.

This findings are supported by other previous study conducted by Nurul Ainun (2003) where she was conclude that there is an increase in core body temperature after being exposed to heat and doing some physical activities that require a lot of energy. She stated that there is an increase in core body temperature after doing some physical activities due to the releasing of excessive heat from body to produce energy.

Finding in this study also showed that core body temperature among exposed group of traffic policemen slightly increased, however still below 38˚C.Core body temperature among worker when exposed to heat was mildly increase and never exceeded 38˚C.According to ACGIH, the body temperature of below 38˚C is considered a safe exposure for the respondents.

5.1.5.2 Differences of Heart Rate between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

Sub of second objective of this study is to measure and compare the heart rate before shift, after 2 hours and after 8 hours working among respondents. The result for heart rate indicate that, it had drastically increased and have significance difference ($p<.0.01$) from before shift (79.64 ± 12.49bpm) to after 2 hours working (82.11 ± 12.15 bpm).However, there is slightly increased after 8 hours working (83.13 ± 8.93 bpm) which showed there is no significance difference in after 2 hours and after 8 hours working ($p>.05$).This study supported by Goh (2002) which is indicate that there is only significant difference in before shift with after2 hours and after 8 hours working.

Heart rate can be used as a measurement to determine exposure to heat and also metabolic workload.US Department of Health service Center (2010) state that heart rate are also play an important guideline in evaluating dangerous occurrence of employee related to heat stress. This study was found that range of heart rate is 48-118 per minutes. According to Iwagoshi (2011) from his article state that when performing of physical activity, heart rate increases in order to deliver oxygen quickly and directly where it is needed. The volume of blood to be moved to extremities during physical activities increases, requiring heart to pump harder and faster to accommodate the need.

According to Johnson (1965) state that although heart rate increases rapidly with the onset of activity providing physical activities intensity remains constant, heart rate will level off. This is known as steady-state heart rate where the demands of the active tissues can be adequately met by the cardiovascular system. However, there is an exception to this. During prolonged steady- state physical activities particularly in a hot environment, a steady state heart rate will gradually increase. This phenomenon is known as cardiac drift and is thought to occur due to increasing body temperature.

Majority of traffic policemen in Kuala Lumpur had worked for more than 6 months and thus had acclimatized themselves well with the environment. When exposure to heat takes place over an extended period in workplace, a process of physiological adaptation called acclimatization occur (Welch et al., 2003).It is manifested as the reduction in the heart rate and internal body temperature of the expense of increased sweating.

5.1.5.3 Differences of Blood Pressure between Before, After 2 Hours and After 8 Hours Working among Traffic Policemen.

In this study, the systolic blood pressure was one of the elements in physiological measurements. According to Tawatsupa (2013) stated that the systolic blood pressure have significantly effect on temperature changes. Sub of third objectives in this study was to measure and compare the systolic and diastolic blood pressure among respondents.

The mean value for systolic blood pressure was 127.20 ± 11.15 mm Hg (before shift), 129.76 ± 10.65 mm Hg (after 2 hours working) and 131.89 ± 9.13 mm Hg (after 8 hours working).Post hoc test showed that the mean value was increase significantly ($p<.001$) between before shift, after 2 hours working and after 8 hours working.

The mean value for diastolic blood pressure was 82.25 ± 8.98 mm Hg (before shift), 82.44 ± 8.92 mm Hg (after 2 hours working) and 82.85 ± 7.15 mm Hg (after 8 hours working).Post hoc test showed that the mean value was increase significantly ($p < .001$) between before shift, after 2 hours and after 8 hours of working. This can be related to the facts that the workers were involved with high intensity of work in early shift.

Blood pressure is a helpful indicator of the body's internal .It is the measure of force against the arteries as blood pumped throughout the body .In order for the blood to move to the skin surface the heart must pump faster and the blood pressure will become greater (Borden & Langford, 2008)

Astrand et al., (2008) stated that in acute heat exposure, the skin blood flow increases at the expense of the blood flow through other tissues. Measurements of total blood volume during acclimatization to heat produce conflicting results, but most studies seem to indicate an increase in blood volume and will lead to increase in systolic and diastolic blood pressure (Joubert & Bijlsma, 2010)

Shinde and Raut (2015) stated that there is a competition for blood flow between the skin and the muscles. The muscles need increased blood flow to meet the demands of the metabolic activity and the skin needs increased blood flow to dissipate heat from the core of the body. They also stated that the combined needs of the skin and muscle for blood flow may exceed the cardiac output. However, cardiac output in a hot environment is achieved by a highest heart rate and a lower stroke volume. The reduction in stroke volume during hot conditions occurs because of vasodilation in the cutaneous vessels.

However, there were opposite findings by Gerson & Rappaport (2013) where found the blood pressure of the traffic policemen was decreased as the workday progressed due to the traffic policemen tend to acclimatized. In order to increase the body's ability to lose heat. It also supported by study done by Ryu (2011) where found that the systolic and diastolic blood pressure decreased when the subjects exposed to heat environment.

According to Prada and Yoshioka (2010) were found that the systolic and diastolic blood pressure of traffic policemen exposed to heat was increased as the temperature increased. He noted that this occurred due to the body gain and store heat when the air temperature increase and this heat gain causes the heart works a lot harder to pump blood to periphery for heat loss, giving the rise in the blood pressure.

5.2 Conclusion

As a conclusion, the traffic policemen in Kuala Lumpur are low exposed to heat stress.However,the mean value of heart rate and core body temperature were still in the acceptable range which represent the acclimatization of the employees. The relative humidity in outdoor environment indicates more air humid which contribute to have significant correlation with $WBGT_{out}$. The high prevalence of heat related illness among traffic policemen were dehydration, heat exhaustion, and heat cramps. Generally, the majority of the traffic policemen had reported high prevalence in heat related illness which recorded high level of environmental temperature. Nevertheless, there was significant differences in all physiological parameters between three differences in all physiological parameters between three difference periods of time.

5.3 Recommendation

The findings of this study shows that the traffic policemen in Kuala Lumpur were less exposed to high value of WBGTout than suggested standard value by ACGIH which below 28°C.This automatically make the traffic policemen less exposed to the high level of heat stress which also can lead to the heat related illness.

Therefore, several control measures have been suggested in order to minimize the exposure of heat among the traffic policemen.

i. Administrative control

Administrative control is an alternative approach to engineering techniques for controlling heat stress. The example of the administrative controls are limiting or modifying the duration of exposure time, reducing the metabolic component of the totals heat load, enhancing the heat tolerance of the traffic policemen by heat acclimatization and physical conditionings and training traffic policemen in safety and health procedures for work in hot environment.

There are several ways to control the daily length of time exposure to high temperature to the exposed workers. The top management in organization chart in police traffic should schedule the traffic policemen who are exposed to high environmental temperature for the cooler part of the day and having plenty of cold water during performed the job task. Other than that, top management can also provide cool area which is air conditioning system in the room of Kuala Lumpur Traffic Police Station to the traffic policemen for rest and recovery after riding the motorcycle during job task. Besides that, add extra traffic policemen also reduce the exposure time for each member in point duty unit during workshift.Top management must permit freedom for the traffic policemen to interrupt work when they feel heat discomfort.

Heat acclimatization can significantly increase heat tolerance among traffic policemen. A properly designed and applied heat acclimatization program will increase the ability of traffic policemen to work at high temperature. It also will decrease the risk of heat related illness and unsafe acts among traffic policemen. For traffic policemen with previous experience with job, the acclimatization regiment should be, exposure for 50% on day 1,60% on day 2,80% on day 3 and 100%on day 4.For new traffic policemen the schedule should be 20% on day 1 and 20% increase an each additional day.

Training is the key to good work practices. Top management and traffic policemen should be trained in recognizing the sign and symptoms of the various types of heat induced illness. The traffic policemen who use heat protective clothing such as wear clean, light colored, loose fitting clothing made of breathable fabric should be instructed in their proper care and use. Other than that, the traffic policemen who work in high outdoor environmental temperature should be instructed about the effect of other factor on tolerance to heat stress.

ii. Heat stress hygiene practice

Heat stress hygiene practices are the actions taken by the exposed traffic policemen to reduce the risks of heat disorder. The individual should responsible for practicing good heat stress hygiene such as drink more quantities of water as frequently as possible to avoid excessive of water lost from the body. Besides, they should not skip meals because food will replace the minerals lost in sweat as well as calories.

A healthy lifestyle is also significant to lowering the risk of heat related illness. Traffic policemen should have adequate sleep and a good diet to increase the job routine when working in high environmental temperature. A healthy lifestyle also means no abuse of alcohol or drugs, which have been implicated and have strong related with heat strokes.

Most important thing to be taken into consideration is commitment from the top management itself and all traffic policemen in order to maintain productivity and health of the employees from excessive exposure to the heat.

iii. Personal Protective Equipment

The best approach to control heat stress effect during working shift is by wearing suitable clothes. Clothing worn is very important in controlling heat stress. The traffic policemen must wear a loose fitting clothe during the work shift. The clothe material should easily absorb the sweat, have good air circulation and not disturb the workers. Where the environmental outdoor is dusty, a mask must be worn.

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JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE :

Physiological Changes And Heat Related Illness Among Traffic Policemen Under Heat Stress Condition In Kuala Lumpur.

2. INTRODUCTION:

Purpose of this study is to determine heat stress and its effect among traffic policemen in Kuala Lumpur.This is because exposure to extreme heat stress level can overwhelm the body's coping mechanisma leading to a serious condition such as heat stroke and possibly fatal.Heat stress can happen when the body failed in controlling and maintaining its internal temperature which lead to increasing in body core temparature,heart rate and blood pressure of the exposed individual.These changes can result in heat stroke,heat exhaustion,heat cramps or heat syncope.Therefore,this study need to be done so,it can improve the safety of traffic policemen and health status can be improved and protected from heat stress.

3. WHAT WILL YOU HAVE TO DO?

You must sign consent form which is stated that you interest to participate in this study after you read and understand all the explaination given.You will need to answer a questionnaire for obtaining information about this study.Then,consent form and questionnaires should be returned to the reasearcher before blood pressure,heart rateand body temperature test are carried out.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Worker who work less than 3 months and has been diagnosed with hypertension and heart disease.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECTS?

Through this participation,the subject will be able to undergo a health test and find out the status of health for free.

(b) TO THE INVESTIGATOR?

It will help the investigator to determine the heat stress and its effect among traffic policemen in Kuala Lumpur.

6. WHAT ARE THE POSSIBLE RISKS?

There is no risk in this study

7. THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

The information and identify used in this study will remain confidential.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If you have any additional question,you may contact to Dr Karmegam Karuppiah,Supervisor of the study research at 013-5818331 or Nor Amalina binti Muhammad Sabri,the researcher at 014-5073716.

9. CONSENT

I .... Identity Card No. .... address...

....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature .... (Respondent)

Signature .... (Witness)

Date :...

Name :...

I/C No. :...

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .... Signature .... (Researcher)

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1. TAJUK KAJIAN

Perubahan Fisiologi dan Penyakit Berkaitan Haba Kalangan Polis Trafik Di Bawah Tekanan Haba di Kuala Lumpur.

2. PENGENALAN

Kajian ini bertujuan untuk mengenal pasti tegasan haba dan kesannya dalam perubahan fisiologi tehadap polis trafik di Kuala Lumpur.Ini kerana pendedahan kepada tahap tegasan melampau boleh mengatasi mekanisme di dalam badan yang membawa kepada keadaan yang serius seperti strok haba dan mungkin boleh membawa maut.Tegasan haba boleh berlaku apabila badan manusia gagal dalam mengawal dan mengekalkan sushu dalaman yang membawa kepada peningkatan dalam suhuteras badan,kadar dengupan jantung dan tekanan darah kepada individu yang terdedah.Kesannya,ia boleh menyebabkan strok haba,kelesuan haba,kekejangan haba,atau pengsan haba.Oleh itu,bagi meningkatkan keselamatan dan kesihatan pekerja,kajian ini perlu dilakukan agar status kesihatan pekerja dapat ditingkatkan dandilindungidaritegasanhaba

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda dikehendaki menandatangani boring penyertaan yang menyatakan minat anda untuk menyertai kajian ini selepas anda membaca dan memahami segala penerangan yang diberikan.Anda diminta untuk menjawab soal selidik untuk mendapatkan maklumat mengenai kajian ini.Borang penyertaan dan boring soal selidik perlu dikembalikan kepada penyelidik sebelum ujian tekanan darah,kadar dengupan jantung dan suhu badan dijalankan.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Polis trafik yang bekerja kurang daripada 3 bulan dan telah disahkan menghidap tekanan darah tinggi dan penyakit jantung.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Melalui kajian ini,peserta akan dapat menjalani ujain kesihatan dan mengetahui status

kesihatan diri secara percuma.

b) KEPADA PENYELIDIK?

Ia akan membantu penyelidik untuk menetukan tegasan haba dan kesannya dalam kalangan polis trafik di Kuala Lumpur

6. ADAKAH IA BERISIKO?

Tiada risiko di dalam kajian ini.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Maklumat dan identity yang digunakan dalam kajian ini akan kekal sulit.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMEPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Jika anda mempunyai sebarang soalan tambahan,anda boleh menghubungi Dr Karmegam Karuppiah,Penyelia kajian penyelidikan di 013-5818331 atau Nor Amalina binti Muhammad Sabri,penyelidik di 014-5073716.

9. PERSETUJUAN

Saya... No Kad Pengenalan. .... beralamat...

...........................dengan ini secara sukarela bersetuju membenarkan *anak / jagaan saya .... menyertai **penyelidikan tersebut di atas *(klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).**

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti yang tercatat dalam Helaian Penerangan). Saya memahami bahawa *anak / jagaan saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti *anak / jagaan saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang **melibatkan** *anak / jagaan saya.

I setuju/tidak bersetuju untuk imej/gambar/rakaman video/ rakaman suara berkaitan dengan anak/ jagaan saya digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .... Tandatangan ....
(*Ibubapa/ Penjaga*) (*Saksi*)

Tarikh :... Nama :...

No. K/P: ....

Saya mengesahkan bahawa saya telah menerangkan kepada ibubapa/penjaga responden mengenai sifat dan tujuan penyelidikan tersebut di atas.

Tarikh .... Tandatangan ....
(*Penyelidik*)

UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

KAJIAN DAN PENYELIDIKAN DALAM BIDANG KESELAMATAN DAN KESIHATAN PEKERJAAN TERHADAP POLIS TRAFIK DI MALAYSIA

NO. ID PEKERJA : ....

JABATAN : ....

TARIKH : ....

TANDA TANGAN : ....

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi beberapa bahagian iaitu:
   BAHAGIAN A: MAKLUMAT DIRI
   BAHAGIAN B: MAKLUMAT PEKERJAAN
   BAHAGIAN C: MAKLUMAT KESIHATAN
   BAHAGIAN D : MAKLUMAT SIMPTOM PENDEDAHAN HABA
2. Anda diminta untuk menjawab semua soalan yang ada di dalam buku ini
3. Untuk menjawab, sila tandakan jawapan di bahagian jawapan yang telah disediakan
4. Borang soal selidik hendakalah dikembalikan kepada pengkaji setelah selesai menjawab semua soalan

Untuk kegunaan penyelidik

BAHAGIAN A: MAKLUMAT DIRI

1.1 Tarikh lahir : ☐☐ ☐☐ ☐☐☐☐ A 1.1

1.2 No. K/Pasport : ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ A 1.2

1.3 No. Telefon : ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ A 1.3

1.4 Umur : ☐☐ tahun A 1.4

1.5 Bangsa : 1. ☐ Melayu 2. ☐ Cina 3. ☐ India 4. ☐ Lain-lain A 1.5

1.6 Warganegara : 1. ☐ Warganegara 2. ☐ Bukan warganegara A 1.6

1.7 Status : 1. ☐ Bujang 2. ☐ Berkahwin 3. ☐ Bercerai A 1.7

1.8 Pendidikan : A 1.8
1. ☐ Tidak Bersekolah
2. ☐ Rendah/UPSR
3. ☐ Menengah/PMR/SPM/STPM
4. ☐ Sijil/Diploma/Ijazah

1.9 Gaji : RM ☐☐☐☐☐☐ A 1.9

1.10 Tinggi : ☐☐☐ cm A 1.10

1.11 Berat : ☐☐ kg A 1.11

1.12 Isi rumah : ☐☐ orang A 1.12

BAHAGIAN B: MAKLUMAT PEKERJAAN

2.1 Pernahkah anda bekerja di tempat lain sebelum ini? B 2.1

1. ☐ Ya 2. ☐ Tidak

2.2 Apakah jawatan anda sekarang? B 2.2

____

2.3 Berapa lamakah anda telah bekerja sebagai (pekerjaan seperti di atas)? B 2.3

______________ tahun

2.4 Berapa lamakah anda bekerja di sini? B 2.4

______________ tahun

2.5 Shift kerja: B 2.5

1. ☐ Normal
2. ☐ Shift

2.6 Berapa hari anda bekerja dalam seminggu? B 2.6

_________ hari

2.7 Adakah anda bekerja lebih masa (OT)? B 2.7

1. ☐ Ya 2. ☐ Tidak

2.8 Jika Ya, secara purata, berapa kerap anda bekerja lebih masa? **B 2.8**

1. ☐ Tiada
2. ☐ 1-3 kali sebulan
3. ☐ 3-5 kali sebulan
4. ☐ Lebih dari 5 kali sebulan

2.9 Berapa harikan anda bekerja dalam seminggu? **B 2.9**

________ hari

2.10 Berapa jamkah anda bekerja dalam sehari? **B 2.10**

________ jam

2.11 Adakah anda terdedah kepada sebarang hazad seperti di bawah: **B 2.1.1**

1. ☐ Bahan kimia
2. ☐ Panas melampau
3. ☐ Habuk
4. ☐ Bunyi bising
5. ☐ Binatang berbisa
6. ☐ Lain- lain:________________

BAHAGIAN C: MAKLUMAT KESIHATAN

3.1 Adakah anda mengalami sebarang simptom-simptom seperti yang di bawah? Tandakan.

Simptom	1. Ya	2. Tidak	
3.1.1 Keletihan			C 3.1.1
3.1.2 Pening kepala			C 3.1.2
3.1.3 Pedih mata			C 3.1.3
3.1.4 Sesak nafas			C 3.1.4
3.1.5 Berdebar-debar			C 3.1.5
3.1.6 Ruam			C 3.1.6
3.1.7 Loya			C 3.1.7
3.1.8 Muntah			C 3.1.8
3.1.9 Kekejangan otot			C 3.1.9
3.1.10 Strok			C 3.1.10
3.1.11 Pitam			C 3.1.11
3.1.12 Berdengung			C 3.1.12
3.1.13 Loya			C 3.1.13
3.1.14 Sakit telinga			C 3.1.14
3.1.15 Kehilangan pendengaran sementara			C 3.1.15
3.1.16 Batuk			C 3.1.16
3.1.17 Berpeluh			C 3.1.17

3.2 Adakah anda mengalami sebarang kecederaan di mana-mana bahagian anggota badan berikut: C 3.2

1. ☐ Kepala	5. ☐ Pinggul
2. ☐ Bahu	6. ☐ Peha
3. ☐ Tangan	7. ☐ Lutut
4. ☐ Tulang belakang	8. ☐ Kaki

3.3 Adakah anda menjalani aktiviti-aktiviti berikut: C 3.3

1. ☐ Pembedahan telinga
2. ☐ Terdedah bunyi bising
3. ☐ Ketenteraan
4. ☐ Senjata api
5. ☐ Lain-lain: ______________________

BAHAGIAN D: MAKLUMAT SIMPTOM-SIMPTOM PENDEDAHAN HABA

5.0 Adakah anda mengalami sebarang simptom-simptom seperti yang di bawah semasa atau selepas terdedah kepada suhu/haba yang tinggi (panas)? Tandakan.

Simptom	1. Ya	2. Tidak	
5.1.1 Pening kepala			D 5.1.1
5.1.2 Keletihan			D 5.1.2
5.1.3 Sesak nafas dan nadi lemah			D 5.1.3
5.1.4 Kelihatan pucat			D 5.1.4
5.1.5 Loya			D 5.1.5
5.1.6 Muntah			D 5.1.6
5.1.7 Ruam dan kulit kemerah-merahan selepas terdedah kepada panas			D 5.1.7
5.1.8 Berdebar-debar			D 5.1.8
5.1.9 Strok			D 5.1.9
5.1.10 Kekejangan otot			D 5.1.10
5.1.11 Terasa lenguh di bahagian kaki			D 5.1.11
5.1.12 Pitam			D 5.1.12
5.1.13 Sawan			D 5.1.13
5.1.14 Kekeliruan			D 5.1.14
5.1.15 Pengsan			D 5.1.15
5.1.16 Dahaga			D 5.1.16
5.1.17 Kulit kering			D 5.1.17
5.1.18 Kulit lembap dan terasa sejuk			D 5.1.18
5.1.19 Peluh berlebihan			D 5.1.19
5.1.20 Kadar dengupan jantung meningkat			D 5.1.20
5.1.21 Suhu badan yang sangat tinggi			D 5.1.21

5.2 Kategori waktu bekerja anda: E 5.2

1. ☐ Bekerja berterusan bagi setiap jam
2. ☐ 75% bekerja,25% berehat
3. ☐ 50% bekerja,50%berehat
4. ☐ 25% bekerja,75% berehat

5.3 Berapa lama anda terdedah kepada haba dalam pekerjaan seharian: E 5.3

1. ☐ Kurang dari 2 jam
2. ☐ 2-4 jam
3. ☐ 4-6 jam
4. ☐ 6-8 jam
5. ☐ Lebih dari 8 jam

~TAMAT~

TERIMA KASIH ATAS KERJASAMA ANDA.