



UNIVERSITI PUTRA MALAYSIA

***EVALUATION OF PHYSIOLOGICAL CHANGES AND HEAT RELATED
ILLNESS AMONG GLOVE INDUSTRY WORKERS UNDER HEAT
STRESS CONDITION***

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**EVALUATION OF PHYSIOLOGICAL CHANGED AND HEAT RELATED
ILLNESS AMONG GLOVE INDUSTRY WORKERS UNDER HEAT STRESS
CONDITION**

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, University Putra Malaysia**

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ABSTRACT

EVALUATION OF PHYSIOLOGICAL CHANGES AND HEAT RELATED ILLNESS AMONG GLOVE INDUSTRY WORKERS UNDER HEAT STRESS CONDITION

NURAZIRAH BINTI MOHD KASSIM

Background: Glove industry production involved work processes with high temperature. However, less study has been conducted on the hazards of high temperature among the workers here. **Objective:** This study was conducted to evaluate the physiological changes and heat related illness among Gloves Industry workers under heat stress. **Method:** This cross-sectional study was conducted in glove factories at Selangor. Total workers (n=82) were interviewed using adapted questionnaire. Heat stress assessment (WBGT_{in}) and the level of air velocity were measured using QUESTTemp[®]34 Thermal Environment Monitor and TSI Velocicalc[®]Air Velocity Meters respectively. Omron MC-510 Gentle Temperature ear thermometer (measure core body temperature), POLAR Heart Rate FT60 (measure heart rate) and OMRON T3 Automatic Blood Pressure Monitor (measure blood pressure) were used in the physiological measurement of the workers. All of these parameters were taken in three sessions; before the shift, after 2 hours working and after 8 hours working. **Result and Discussion:** All the work sections in glove industry were exceeded Threshold Limit Value (TLV) (>28°C). There is a no significant correlation between environmental heat and air velocity (r=0.73, p= 0.07). The highest prevalence of heat related illness on respondents was dehydration (82.2%), followed by heat exhaustion (81.1%), heat cramps (23.2%), heat rashes (22.2%), heat stroke (5.6 %) and the heat syncope (4.4%). There is significant in physiological parameters (core body temperature F= 153.96, P<0.001); heart rate, (F=326.463, p<0.001); and blood pressure, (F= 93.718, p<0.001). **Conclusion:** The workers in glove industry are exposed to high level of heat stress. All the three physiological parameters (core temperature, heart rate and blood pressure) of respondent were significant differences between three periods of time. The air velocity at majority work sections in production area were low, however the results indicated that there is a no significant correlation between environmental and air velocity. The highest prevalence of heat related illness on respondents was dehydration, followed by heat exhaustion, heat cramps, heat rashes and heat stroke.

Keywords: Heat stress, heat related illness, glove industry, physiological

ABSTRAK

PENILAIAN PERUBAHAN FISILOGI DAN PENYAKIT BERKAITAN HABA DALAM KALANGAN PEKERJA KILANG SARUNG TANGAN DIBAWAH TEKANAN HABA

NURAZIRAH BINTI MOHD KASSIM

Latar Belakang: Pengeluaran kilang sarung tangan melibatkan proses kerja dengan suhu yang tinggi. Namun, masih kurang kajian dilakukan berkenaan bahaya bekerja dalam keadaan suhu yang tinggi dalam kalangan pekerja di sini. **Objektif:** Tujuan kajian ini dijalankan adalah untuk menilai perubahan fisiologi dan penyakit berkaitan haba dalam kalangan pekerja kilang sarung tangan dibawah tekanan haba. **Metodologi:** Kajian keratan rentas ini telah dijalankan di dua kilang sarung tangan di Selangor. Jumlah pekerja (n=82) telah ditemuramah menggunakan borang soal selidik kajian lepas yang disesuaikan dengan kajian semasa. Penilaian tekanan haba (WBGTin) dan tahap halaju udara diukur dengan menggunakan pemantau suhu persekitaran (QUESTTemp³⁴) dan pengukur halaju udara (TSI Velocicalc®). Omron MC-510 (mengukur teras suhu badan), POLAR FT60 (mengukur kadar denyutan nadi) dan OMRON T3 (mengukur tekanan darah) telah digunakan bagi mengukur perubahan fisiologi pekerja. Semua parameter ini telah diambil sebanyak tiga sesi iaitu sebelum syif, selepas 2 jam bekerja, dan selepas 8 jam bekerja. **Keputusan dan Pembincangan:** Keputusan membuktikan bahawa suhu persekitaran di semua bahagian kerja dalam kilang sarung tangan telah melebihi Nilai Had Ambang (TLV) (>28°C). Nilai WBGTin tiada korelasi dengan bacaan halaju udara (r=0.73, p= 0.07). Prevalens paling tinggi bagi penyakit berkaitan haba adalah dehidrasi (82.2%), diikuti oleh keletihan haba (81.1%), kekejangan haba (23.2%), ruam panas (22.2%), strok haba (5.6 %) dan pengsan haba (4.4%). Terdapat perbezaan yang signifikan dalam parameter fisiologi (suhu badan teras, F= 153.96, P<0.001); kadar denyutan nadi, (F=326.463, p<0.001); dan tekanan darah, (F= 93.718, p<0.001). **Kesimpulan:** Pekerja-pekerja di kilang sarung tangan telah terdedah kepada suhu yang sangat tinggi. Semua parameter fisiologi (teras suhu badan, kadar denyutan nadi dan tekanan darah) responden mempunyai perbezaan yang signifikan di antara tiga ukuran masa. Halaju bagi kebanyakan bahagian kerja di kawasan pengeluar adalah rendah, namun keputusan menunjukkan bahawa tiada korelasi antara WBGTin dan halaju. Prevelens paling tinggi bagi penyakit berkaitan haba adalah dehidrasi, diikuti oleh keletihan haba, kekejangan haba, ruam panas, strok haba dan pengsan haba.

Kata kunci: Tekanan haba, penyakit berkaitan haba, kilang sarung tangan, fisiologi

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ACGIH	American Conference of Governmental Industrial Hygienists
BMI	Body Mass Index
bpm	beats per minute
DOSH	Department of Occupational Safety and Health
ILO	International Labor Organisation
m/s	meter per second
mmHG	millimeter per mercury
MREPC	Malaysia Rubber Export Promotion Council
NIOSH	National Institute for Occupational Safety and Health
NWSWFO	National Weather Service Weather Forcast Office
OSHA	Occupational Safety and Health Administration

SOCISO	Social Security Organisation
TLV	Threshold Limit Value
WBGT _{in}	Wet Bulb Globe Temperature indoor
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia is the world's sixth largest producer of natural rubber with export of RM12.0 billion in 2010 and RM15.2 billion in 2014 (MREPC, 2015). The latex products are the largest contributor to Malaysian exports of rubber products of RM12.2 billion in 2014 (MREPC, 2015). In 2011, Malaysia is the largest supplier of gloves that meets about 63% of global demand (Jason, 2010). Since Malaysia is the largest producer of glove, there must a big number of manufacturing involve to meet the export demand. All this manufacturing process must be a high production process that may involve a large number of workers with long duration of working. Most of the glove production is non stop production with twenty-four hour process.

Rubber glove industry can be categorized into upstream, midstream and downstream sectors. The upstream sector includes owners of rubber plantations and latex concentration plants. The midstream sector includes all rubber glove companies manufacturing both natural rubbers and synthetic gloves. Lastly, the downstream sector includes distributors (Jason, 2010). In glove industry, most workers were exposed to high temperature due to the ovens (between 100°C to 125°C) in glove production area. The production of glove involved burning and drying process by using ovens. An Industry which involves with a furnace in their process such as oven can be a major contributor to heat stress, which also known as a radiant heat source (Kishor et al., 2012). Thus, by using the oven at production area, workers in the glove production area are exposed to high level of heat.

The previous study proved that the heat stress can be affected by high temperature working environment which can affect the physiological changes of blood pressure, heart rate and body core temperature, and lead to heat-related illness (Athirah, 2014). Since, the production of glove involving high temperature process, the physiological parameter of the workers may be affected and may lead to heat-related illness. According to study the external environmental factors that contributed to the heat stress among workers in hot working areas where temperature, humidity, radiant heat and air velocity (Ahasan, 2001). Thus, the air velocity and humidity also be measured in this study as an environmental factor that may contribute to high level of heat exposure to workers.

Heat stress related to occupational is one of the major problems affecting the health status of workers, especially in tropical countries such as Malaysia (Tawatsupa et al., 2010). Workers that working in high temperature conditions must ensure constant core body temperature for his body functioning well. To maintain a stable temperature, body needs release heat to the surrounding environment at the same rate as heat is produced (Adrew, 2011). Heat stress will happen if body failed to control internal temperature. In glove production area the heat related illness could happen since the process involving high level of heat production around 800, 000 kcal/hour of heat production. This may caused the physiological parameter increases and may lead to heat related illness.

1.2 Problem Statement

Most studies conducted on heat stress among workers in various workplaces and shown significant effect between high environmental temperature and negatively impact the worker's performance, attitude and satisfaction level. This include the effect on the workers physiological parameter and may lead to heat-related illness. Azlis (2007) stated that there are many industries in Malaysia that have high potential involving heat stress to their employees. Social Security Organization (SOCSO) statistic also showed that there are high numbers of accident caused by heat exposure of workers. In the year

2009, there are 233 accident cases reported cause by exposure to heat and 398 cases accident reports due to contact with hot objects. In the year 2010 and 2011, there are 197 cases and 441 cases, respectively which involved exposure to heat. Meanwhile, accident cause by contact with hot objects had recorded 169 cases and 355 cases, respectively for the year 2010 and 2011.

In glove industry, most workers were exposed to high temperature due to the main ovens in glove production area. Since, the heat produced for each capacity is high the workers in glove production will highly exposed to heat. The process of glove production is involving dipping of coagulant and latex, drying, vulcanizing, leaching and others (Top Glove, 2011). Besides, the drying process is involving using of main ovens, coagulant oven, oven 1&2, and final drying oven. The entire oven's temperature ranks are between 100°C to 125°C which the highest is a main oven. The figure 1.1 showed the relationship between the main oven and the consequent effect on the worker's health.

Thus, this study is conducted to evaluate the heart rate, blood pressure, body core temperature change and heat related illness among Gloves Industry workers under heat stress at Selangor. According to study the external environmental factors that contributed to the heat stress among workers in hot working areas were temperature, humidity, radiant heat and air velocity (Ahasan, 2001). Besides, the previous study proved that the heat stress can be affected by high temperature working environment

which can affect the physiological changes of blood pressure, heart rate and body core temperature, and lead to heat-related illness (Athirah, 2014).

The figure 1.1 showed that when the glove production worker exposed to high level of heat, the physiological parameters such as, blood pressure, heart rate and body core temperature tend to increase. Since the physiological change and this may lead to heat related illness as shown in diagram below.

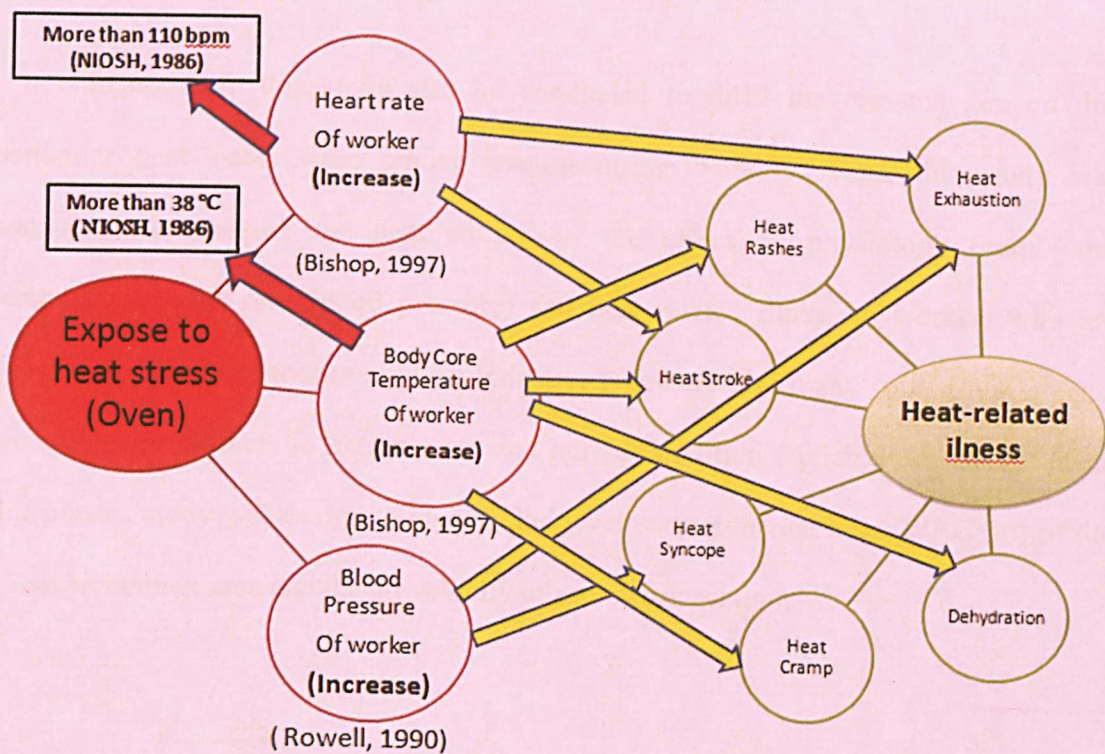


Figure 1.1: The relationship between the workers exposed to oven and the heat-related illness.

1.3 Study Justification

The study of heat stress among the workers has been commonly conducted and published. However, there was lack of study has been conducted in Malaysia, particularly among the gloves production workers. Therefore, this study was conducted to develop data onto the level of heat stress at the glove industry in Malaysia.

In addition, this study also be conducted to fulfil the research gap on this particular heat stress issue among manufacturing workers. Thus, this study was conducted to measure the heat stress and the effect on physiology (body core temperature, heart rate, blood pressure) and heat related illness to workers who are exposed to high temperature at glove industry. There are also many work environments were exposed workers to extreme hot and humid condition (Aziah et al, 2011). Thus, this present study was design to identify the level environmental heat (WBGT_{in}) of the glove production area and the air velocity of each work sections.

In addition, there was still no specific regulation regarding heat stress in Malaysia. Thus, this study can provide baseline data onto heat stress in the glove industry. The data and information about this study can also contribute to the Department of Occupational Safety and Health in Malaysia for developing of guideline of heat stress in the future.

1.4 Objectives

1.4.1 General objective

To evaluate the heart rate, blood pressure, body core temperature change and heat related illness among Gloves Industry workers under heat stress at Selangor.

1.4.2 The specific objectives of this study are:

- 1.4.1.1 To determine socio-demographic data of respondent.
- 1.4.1.2 To determine the heat stress index (WBGT_{in}) and metabolic workload at gloves production area.
- 1.4.1.3 To determine the air velocity and relative humidity at gloves production area.
- 1.4.1.4 To determine the correlation between WBGT_{in} and air velocity in glove production area.
- 1.4.1.5 To determine the prevalence of heat related illness among worker while exposed to heat.
- 1.4.1.6 To determine heart rate, blood pressure, body core temperature change between before shift, after 2 hours working and after 8 hours working among respondents.
- 1.4.1.7 To compare the differences of blood pressure before shift, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.4.1.8 To compare the differences of heart rate before shift, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.4.1.9 To compare the differences of core body temperature before shift, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.5 Study Hypothesis

H₁: There is significant correlation between WBGT_{in} and air velocity in glove Industry.

H₂: There is a significant difference in blood pressure between before working, after 2 hours working, and after 8 hours working among workers exposed to heat.

H₃: There is a significant difference in heart rate between before working, after 2 hours working, and after 8 hours working among workers exposed to heat.

H₄: There is a significant difference in core body temperature between before working, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.6 Definition of Term

1.6.1 Heat stress

1.6.1.1 Conceptual Definition

Heat stress is a combination of heat load in individual and environmental factor impose on workers' bodies which give effect to workers' performance, safety and health. (Rasoul Hemmatjo et al., 2013).

1.6.1.2 Operational Definition

Heat stress level will be determined by using Questemp[®]34 Thermal Environmental Monitor to measure environmental temperature in degree Celsius.

1.6.2 Physiological Change

1.6.2.1 Conceptual Definition

Physiological change is physiological adaptations when the body tend to increase the temperature, heart rate, and blood pressure when expose to the high level of temperature (Barbara & Patricia, 2002).

1.6.2.2 Operational Definition

Body core temperature will be measured by using Omron MC-510 Gentle Temperature Ear Thermometer and OMRON Blood Pressure Monitor Model T3 will be used to measure blood pressure. While heart rate, it will be measured by using Polar Heart Rate Monitor Watch.

1.6.3 Heat Related Illness

1.6.3.1 Conceptual Definition

Heat-related illness is a person with symptoms including headache, nausea, and fatigue after exposure to the heat (MedicineNet.com, 2013). It is a set of preventable conditions ranging from mild forms such as heat exhaustion and heat cramps to potentially fatal heat stroke (Jonathan et al., 2011).

1.6.3.2 Operational Definition

Heat-related illness will be measured by using adapted questionnaire. The questionnaire consists of all symptoms related with heat effect after exposure to high level of temperature.

1.6.4 Natural Wet Bulb Temperature

1.6.4.1 Conceptual Definition

Natural wet bulb temperature is which the air is allowed to flow over the sensor naturally rather than being forced. When air flow is less than 3 m/s (meter per second), the temperature reduce for the same absolute humidity and air movement (Barbara & Patricia, 2002).

1.6.4.2 Operational Definition

Wet bulb temperature is the temperature that can be measured by using thermometer with sensor that covered by wetted cotton wick and exposed only to the natural air movement (NIOSH, 1986).

1.6.5 Globe Bulb Temperature

1.6.5.1 Conceptual Definition

Globe temperature responds to radiant heat from the solid surroundings and convective heat with the ambient air. It is used to estimate the average wall temperature of the surrounding (Barbara&Patricia, 2002).

1.6.5.2 Operational Definition

The globe temperature can be measured by using sixth inch, thin-walled, coppers sphere, painted matte black on the outside. The temperature sensor is placed at the center of the globe (Barbara&Patricia, 2002).

1.6.6 Dry Bulb Temperature

1.6.6.1 Conceptual Definition

Dry bulb temperature is the direct measure of air temperature. The temperature sensor is surrounded by air, which is allowed to freely flow around the sensor (Barbara&Patricia, 2002).

1.6.6.2 Operational Definition

Dry bulb temperature can be measured by using a thermal sensor that is shielded from direct radiant energy sources (U.S. Department of Labor, 1999).

1.7 Conceptual Framework

Heat stress is one of the main hazards Operational Definition in production of gloves. Workers in production areas were exposed to high temperature which caused physiological effect. In this conceptual framework the source of heat is a main oven. The variable that concerned is environment variables which are humidity, air velocity, air temperature and radiant temperature. While for individual activity, consist of metabolic rates and workload.

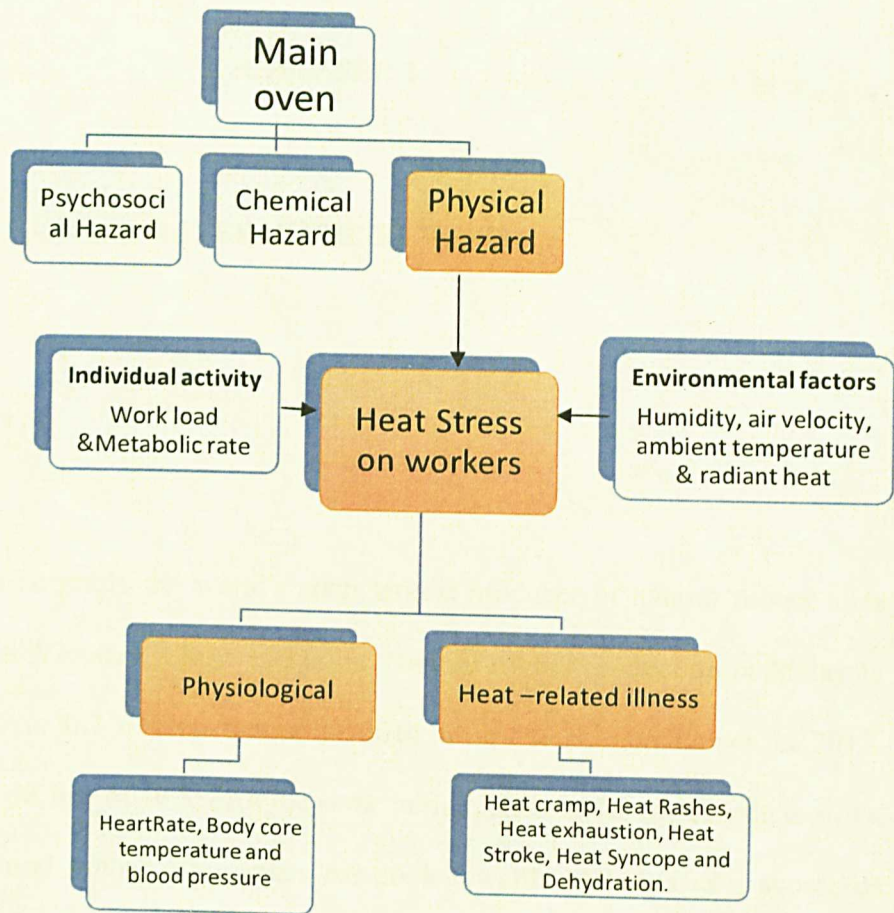


Figure 1.2: Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

2.1 Glove Industry

Malaysia is currently the world's sixth largest producer of natural rubber after Thailand, Indonesia, Vietnam, China and India. Natural rubber production in Malaysia declined by 20.7% to 0.7 million tonnes in 2014 from 0.8 million tonnes in 2013. Exports recorded a decline of 10.5% for the same period. Nonetheless, Malaysia is still a net exporter of natural rubber. Consumers can look towards Malaysia as a source of supply for quality raw rubber of SMR (Standard Malaysian Rubber) grades, specialty rubber such as ENR, DPNR and TPENR and latex concentrates including Low Protein Latex. (MREPC, 2015).

Malaysia's top producer started out in 1991 with only one factory and three production lines. Today, it is the world's largest rubber glove manufacturer, with 20 factories (four of which are in Thailand and two in China) and 379 production lines. The company has a total capacity of 33.75 billion pieces of gloves/year, sells to 180

countries worldwide and has a 23% share of the global market. The glove industry is building four more plants costing about RM160 million. This will add 80 production lines to raise the company's capacity by 7.5 billion pieces to 41.25 billion pieces/year. The target is to corner 30% of the world market by next year when the plants are fully commissioned. It makes 13 types of gloves include latex (powdered), latex (powder-free), vinyl and nitrile that designed to meet a whole range of requirements (RJA, 2011).

In glove industry the basic process involving dipping chemical process, machinery process and burning process by using oven. Based on report from Quanzhou Taifeng Machinery Technology on June 2014, the heating process involves in glove production line including natural gas, steam and heat conduction oil. Besides, the highest capacity of glove productions is 9000 pieces per hour with the heat of 800 000 kcal/hour. Since, the heat produced for each capacity is high the workers in glove production will highly exposed to heat. Table 2.1 and figure 2.1 shown that glove production involves many units of oven for burning and drying process which the temperature range within 100°C to 125°C. Thus, this process will lead to high exposure of workers to high level of heat that may lead to physiological changes and heat related illness.

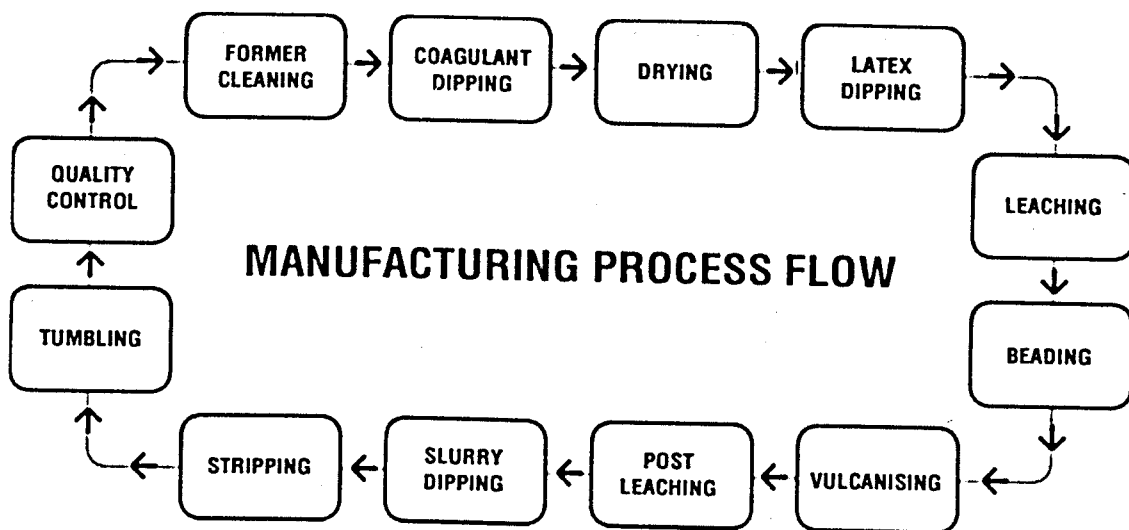


Figure 2.1: Process Flow Chart of the Glove production

Table 2.1: The process of glove production and the temperature involve

Process	Temperature	Work Task
1) Acid tank	Below 50 °C	
2) Small Washing Brush 1	Below 50 °C	
3) Alkaline Tank 1& 2	Below 50 °C	
3) Small Washing Brush 2	Below 50 °C	
4) Roller Brush Tank	Below 50 °C	<ul style="list-style-type: none"> • Online packing
5) Water Rinsing Tank 1 &	Below 50 °C	<ul style="list-style-type: none"> • Striping
6) Coagulant Tank & Oven	Within 100 °C	<ul style="list-style-type: none"> • Stamping
7) Latex Tank & Oven 1 & 2	Within 100 °C	<ul style="list-style-type: none"> • Former
8) Pre-Leaching Tank 1,2,3 & 4	Below 50 °C	

9) Beading Station	Below 50 °C	operation
10) Main Oven	More than 125°C	• Quality control
11) Cooling Tank 1,2,3	Below 50 °C	• Line operation
12) Chlorination Tank 1&2	Below 50 °C	
13) Soak Rinsing Tank	Below 50 °C	
14) Post-Leaching Tank 1 & 2	Below 50 °C	
15) Final Drying Oven	Within 100 °C	
16) Robotic Arm Stripping	Below 50 °C	
17) Auto-Stacking	Below 50 °C	

2.2 Heat Stress

Heat stress occurs when human body experience problem in adapting to the over exposure of heat to environment (World Health Organization, 1969). This situation happened when the worker exposed to the low humidity and high temperature for a long period of time. The external environmental factors that contributed to the heat stress among workers in hot working area were temperature, humidity, radiant heat and air velocity (Ahasan, 2001).

The heat transfer to human body is by three mechanisms which are conduction, convection and radiation. Conduction involves the heat transfer directly from the molecule to other through solid, liquid or gas. Barbara and Patricia (2002) said that the variance of temperature between the skin and solid surface, the thermal conductivity of the solid body that the person contacts and clothing that may separate the person from the body surface are three depending factors of heat transfer rate. Besides, convection involve the cooling of the air around the body by the cooler air passing over the warm skin that are exposed (Warren et al.,2013). When the body temperature is higher than environmental temperature, thermal balance is maintained by convection of heat to the skin and radiation of heat to the environment (Brukner & Khan, 2012).

Based on Barbara and Patricia (2002) the rate of convection depends on the magnitude of the temperature differences, the amount of air motion and the clothing. . Barbara and Patricia (2002) define radiant heat as a net heat flow of the solid bodies in different temperature from the hotter to cooler surface in the infrared wavelength of radiation. It affect by the surrounding solid surface of average temperature, skin temperature and clothing. The exchange rate of heat gradient of certain environmental condition can inhibit appropriate thermoregulation (Howe & Boden, 2007).

Physical work also plays a role in determining the heat load on the body. When level of physical work increased in hot working environment, the worker is at risk of increased core body temperature which above 38 °C, and it will lead to reducing in physical work capacity (Kerslake, 1972; Bidger, 2003), mental task ability (Ramsey, 1995), increased accident risk (Ramsey 1983) and eventual heat stroke and death (Hale, 1987). The individual reaction to heat depends on personal characteristics such as age, weight, lifestyle, medical condition and level of acclimatization. (Belding & Hatch, 1955). The most studied were conducted on the heat stress is in the firefighting industry (Barr et al., 2010; Budd, 2001b; Cheung, et al., 2010; Van Gelder et al., 2008). This is because it had distinctive job task, work physicality and also high exposure to heat source as well as high pressure situation (Cheung et al., 2010).

The main instrument use to measure the heat is wet bulb globe temperature (WBGT). The WBGT commonly used to combine the environmental heat including air temperature, relative humidity, and radiant heat (Eric, 2013). WBGT is method that recommended by American Conference of Governmental Industrial Hygienists, National Institute for Occupational Safety and Health and Occupational Safety and Health Administration. The $WBGT_{in}$ was calculated in shaded areas where as the $WBGT_{out}$ was calculated under condition of direct sunlight. The calculation as below:

$$\text{WBGT}_{\text{out}} = 0.7 T_{\text{nw}} + 0.2 T_{\text{g}} + 0.1 T_{\text{db}}$$

$$\text{WBGT}_{\text{in}} = 0.7 T_{\text{nw}} + 0.3 T_{\text{g}}$$

Where,

T_{nw} = Natural wet-bulb temperature

T_{g} = Globe temperature

T_{db} = Dry bulb temperature

Natural wet bulb temperature (T_{nw}) is the temperature of air flow over sensor naturally which is very sensitive to relative humidity and air movement. However, the radiant heat is detected by globe temperature (T_{g}) from the solid surroundings and convective heat with the ambient air. Dry bulb temperature (T_{db}) is measure air temperature directly from the environment.

The metabolic rate needs to determine to know the rate of internal heat generate from the body to maintain thermal equilibrium with the surrounding (Barbara & Patricia, 2002). Metabolic rates can be measured by estimation of ACGIH created the Threshold Limit Value (TLV) which includes an empirically-derived table of tasks to be converted into metabolic rate (kcal/min). The three components to consider are based metabolism value, body position or movement and type of work being performed (Table 2.1).

Table 2.2: Guideline for metabolic rate based on body position or movement and type of work being performed.

Type of Work		Average (kcal/min)	Range (kcal/min)
Hand Work	Light	0.4	0.2-1.2
	Heavy	0.9	
One Arm Work	Light	1.0	0.7-2.5
	Heavy	1.7	
Both Arm Work	Light	1.5	1.0-3.5
	Heavy	2.5	
Work Whole Body	Light	3.5	2.5-15.0
	Moderate	5.0	
	Heavy	7.0	
	Very Heavy	9.0	

The following equation showed calculation average metabolic rate :

$$\text{Average} = \frac{(M_1)(t_1) + (M_2)(t_2) + \dots + (M_n)(t_n)}{t_1 + t_2 + \dots + t_n}$$

Where : M = metabolic rate
 t = time in minutes

Then, the average metabolic rates for each task has been catagorised into light work (up to 200 kcal/hour), medium work (200-350 kcal/hour) or heavy work (350-500 kcal/hour).

2.3 Physiological changes

According to ACGIH, peripheral blood circulation and sweating are the major adaptive mechanisms of the body. Physiological is the body reach with thermoregulatory response and initiated central nervous system and body's heat loss mechanisms of vasodilatation and perspiration (Bolulant, 2000; Romanovsky, 2007). Besides, when body temperature increase the blood flow through the skin will also increase. Thus, the

increasing in blood flow through skin is at the expense of the circulatory system and other organ to eliminate heat to the environment by convection and radiation (Ramsey & Bernard, 2000). Convection, conduction and evaporation are the natural method for cooling the temperature of the body. In addition, sweating help in adaptive mechanism during evaporation. It will evaporate through the skin as long as the humidity is not excessive (Bird, 2002). Through evaporation, the body tends to loss water and electrolyte such as sodium and chloride which are needed in balance body fluid in human body (Tawatsupa et al, 2012). In addition, the heart rate also another physiological indicator that associated with heat stress (U.S. Department of Labor, 1999; Givoni, 1973 & International Labor Organization, 1983).

Through short term exposure to heat, the blood pressure at exercising muscle area will increase while the blood circulation at renal, splanchnic and non-exercising muscle will decrease (Athirah, 2014). The blood flow will increase to skin to lose the excess heat in maintaining stability of the internal environment since the body over exposure to heat (Athirah, 2014). The warm blood from body core will cooler and act as radiator (Gary & Kevin, 1997). When the body temperature increased, it will form stress that triggers the sympathetic nervous system and induce physiological change which most obvious in cardiovascular response (Rowell, 1990). Researchers have shown that during heat stress, peripheral vascular resistance is reduced and blood volume shifts from the central body to the periphery to facilitate heat exchange (Luurila, 1992).

Heat strain can be represented by internal body temperature which it indicate the total heat content of the body (Bishop, 1997). Ishii et al. (1993) reported the validity of mean ear canal temperature as a stable measure of mean core temperature. A correct reading of ear canal temperature is more important than rectal temperature which represent the brain temperature (Knochel, 1996). The limit of the body core temperature is 38°C which sustained over the course of the work day (Barbara & Patricia, 2002). NIOSH also stated that deep body temperature should not exceed 38°C which is not acceptable for an average industrial workforce. The core body temperature between that limit will trigger shivering and initiate sweating, which call inter-threshold zone and it will be maintained by autonomic nervous system within that limit (Andrew, 2011).

According to NIOSH (1986), there are four methods assessing heart rate which is recovery heart rate, peak heart rate and average heart rate over 8 hour duration. Besides, set of averages heart rate over typical exposure period also one of the methods can be use. For effective control of heat stress, the recovery heart rate should be less that 100 beat per minutes (bpm) at one minute (HRR1). In addition, the heart rate at three minutes (HRR3) should be less than 90 bpm or the value between HRR1 and HRR3 should be less than 10 bpm (Barbara & Patricia, 2002). If the average daily heart rate exceeds 110 bpm, this strenuous work may cause by heat stress. This limit is recommended by the WHO experts and conformed in laboratory and field studies. The thermal rise in heart rate closely related to increases in core body temperature, with 33 bpm increase in heart rate corresponding to a 1°C increase in body temperature

(DiCorleto et al., 2003; International Organization for Standardization, 2004). Bishop (1997) and WHO (1996) also stated that heart rate closely reflects the change of body core temperature which making heart rate is the best index of physiological strain.

2.4 Heat Related Illness

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 the environment can cause heat related illness (Hoa et al., 2013). From the relatively minor heat rash and cramp to the critical heat exhaustion and heat stroke and can present together headache, nausea, fatigue, loss of consciousness and may cause death (Adrew, 2011). Dehydration is the major factor of these symptoms which cause an excessive rise in body temperature (Backer et al., 1999; Adrew, 2011). The body temperature of 39°C may cause acute heat related illness while body temperature 40.6°C can lead to life-threatening severe hyperpyrexia or thermal injury (Leithead & Lind, 1964). About 20% of those experience heat stroke will lead to damage vital organ such as heart, liver, kidneys or nervous system (Yeo, 2004). Figure 2.4 shown the normal responses to the heat stress in body and how it can lead to the heat related illness (Barbara & Patricia, 2002).

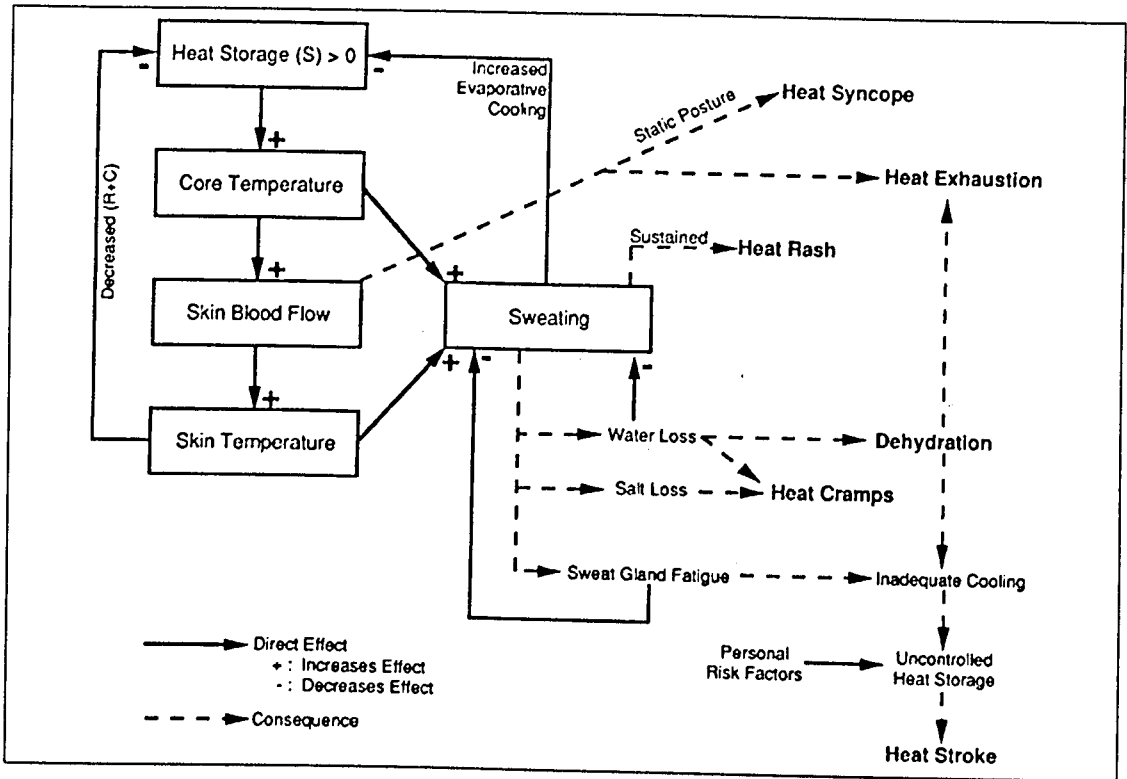


Figure 2.2: Normal response to heat stress exposure and how it lead to heat-related disorder

Heat exhaustion defines as depletion of water or salt when the body subjected exposed to the more heat that it can handle which commonly happen in high environment temperature and humidity (Bauchama & Knochel, 2002). Heat exhaustion is a moderate heat illness which it occurs when blood pressure and sustain adequate cardiac output unable to maintain which cause by strenuous physical activity, high temperature of environment, acute dehydration and energy depletion. The sign includes

weakness, dizziness, headache, nausea and high core body temperature (American Academy Pediatrics, 2011).

Heat rashes also known as miliaria rubra is the mildest form of heat illness. According to Allyson et al. (2007), heat rash is caused by profuse sweating that saturates the skin and clogs the sweat duct. These mostly happened in areas that covered by cloth such as waist, groin and trunk. In occupational setting, heat rashes had been reported (Donoghue & Sinclair, 2000) and state that the heat rashes had significant implication for health and performance (Pandolf et al., 1980).

Dehydration is a water loss in the body and inadequately replaced which lead to reduce the water level in the body below the normal range (Adrew, 2011). In occupational field, the sweat range must between 0.5 2.0 liter per hour and the rate become higher during wearing protective clothing that drastically limits the heat loss by evaporation (Kenefick & Sawka, 2007). Sawka et al. (1985) stated that in the core body temperature increases with the extend of dehydration which the body temperature increase up to 0.15°C for each 1% decrease in body mass due to sweat loss. Gonzales-Alonso et al (1997) reported that dehydration also effect blood flow to the skin which reducing stroke volume during heat stress when hydrated. Thus, heart rate is increased to maintain cardiac output, but it tends to decline with dehydration.

Micheal et al. (1998) defines heat cramps as a spasm of muscles of the arms, legs or abdomen which is a warning sign of developing heat stress. Muscle spasm or cramps are painful and involuntary contraction of skeletal muscle that happened commonly among athletes and in occupational setting which involve prolonged activity when exposed to the heat stress (Schwellnus et al., 2004; Cooper et al., 2006; Donoghue et al., 2000). Proponent of dehydration and electrolyte depletion theory by Bergeron (1996) and Sheares (1990) stated that cramps occur during activity involve profuse sweating and depletion of salt due to hypotonic fluid replacement.

According to Macnigt and Mistry (2005), heat syncope occurs with orthostatic hypertension resulting from venous pooling and peripheral vasodilatation. Prolonged standing after significant exertion and rapid change in position of the body after exertion may lead to heat syncope which proceeded by mild headedness and weakness (Barrow & Clark, 1998).

According to American Academy of Pediatrics (2011), heat stroke is a severe heat illness which characterized by abnormalities of central nervous system such as coma, convulsion, endotoxemia, circulatory failure, organ and tissue damage which results from high body temperature ($>40^{\circ}\text{C}$) and high environmental heat stress. Heat stroke may cause the individual not impaired when sweating and unable to cool down quickly enough after doing an activity (Williams, 1997).

2.5 Other Factors

Heat stress usually relates to body core temperature, heart rate and blood pressure which differentiate the individual exposed to heat. However, personal factor also can influence the individual's risk on heat stress. According to Bernard and Kenny (1994) and Windham (1974) discovered that acclimatization, prescription drugs, illness or disease, age, and diet can give negatively impact on an individual's thermoregulation and directly influence the degree of heat strain experienced.

Acclimatisation is the process of adaptation to any condition especially whether (Armstrong, 2000; Moran et al., 1998). Sawka et al., 1996 and Wenger et al. (1988) stated that human has remarkable ability to adapt to heat stress by giving adequate water and sun protection which healthy acclimated persons can tolerate to the extended exposure in any natural weather related with the heat stress. The physiological adaptation from acclimatisation will reduce heat strain experienced by the individual, increase their tolerance to work in heat, and lower the risk of developing heat illness. However, the adaptation is failure if exposure is not consistent or discontinued (Adrew, 2011). According to NIOSH (1986) and WHO (1969) when the exposure to heat stress end after three and four weeks it will cause an adaptation to heat stress physically will be gradually disappeared. Recent studied stated that the favorable acclimatization effect of heart rate and temperature of body was still detectable 26 days after the most recent heat exposure (Weller et al., 2007). The acclimatization rises the sweat rate of individuals

working in heat, lower the threshold for sweating imitation and increase the sensitivity of the response (Nielsen et al., 1993; Fumio & Kunshige, 2003).

Drugs also can give effect the body thermoregulatory process in individual's body. The drugs such as antidepressants and bronchodilators can alter the reading of heart rate and decrease the sweat rate. Besides, drugs for heart and blood pressure such as beta blockers can reduce the blood flow (Eric, 2013). According to Platt et al. (2010), anti-histamines can both reduce the level of blood flow and increase body temperature as well as diuretic medication which will change the balance of fluid in the body.

If an individual is suffering from cardiovascular disease (CVD) and diabetic, their thermoregulatory response may affect and lead to high risk of heat illness compared to healthy person. Besides, the individual experience hypothyroidism and hyperthyroidism may cause effect to metabolism and directly affect body temperature (Platt et al., 2010).

Many studies were already conducted on the effect of aging on heat tolerance by comparing difference groups of ages for their blood flow and sweating rate response when exposed to heat. The result shown that over 55 years old group had lower response in blood flow to skin compare to the group that less than 30 years old (Ho et al., 1997; Kenny & Ho; Kennt et al; 1997; Thomas et al., 1999). Similar finding also founded

between those age groups when exposed to heat (Inoue et al, 1998; Martin et al., 1995). Besides, the total amount of water in the body will decrease with age which may give effect to the individual's body (Brother et al., 2011).

Besides other factor, diet also is one of the factors that can effect the physiological change of individual's body. Carrillo and Benitez (2000) found that the heart rate is increases slightly after caffeine intake among respondents. The result of the acute studies indicates that caffeine can induce increased in systolic reading between range 5 to 55 mmHg and 5 to 10 mmHg for diastolic blood pressure reading (James 1991c, Green et al.,1996).

CHAPTER 3

METHODOLOGY

3.1 Study design

The study use is cross-sectional study where the exposure and the health effects was measured and observed at the specific point of time.

3.2 Study Location

This study was conducted at two Glove factories at Selangor.

3.3 Study Population

The study population involved the workers in the production area of the factory which were exposed to main oven heat at work area.

3.4 Sampling

3.4.1 Sampling Frame

The sampling frame was taken from the name list of all employees working at the production area of factory. The name list determined from the Human Resource Department of factory. Figure 3.1 show the production layout for each work section involve workers that exposed to oven.

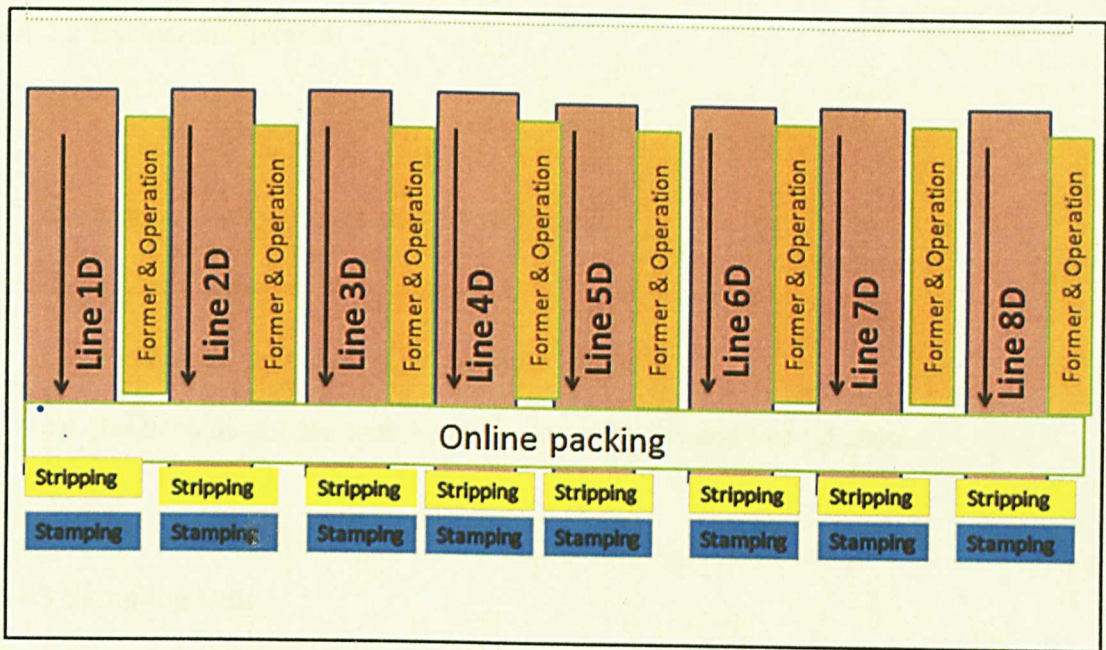


Figure 3.1: The production layout for each work section involve workers that exposed to oven.

3.4.2 Selection Criteria

3.4.2.1 Inclusion criteria:

- a) Worker that employed not less than 3 months (ACGIH, 2001)
- b) Age between 18-55 years old.
- c) Workers that exposed to high temperature ($>28^{\circ}\text{C}$) at the production area.
- d) Has not been diagnosed with hypertension, diabetes and heart disease.

3.4.2.2 Exclusion Criteria:

- a) Worker that employed less than 3 months.
- b) Age not between 18-55 years old.
- c) Workers that exposed to temperature less 28°C .
- d) Has been diagnosed with hypertension, diabetes and heart disease.

3.4.3 Sampling Unit

The workers in the production area that expose to high level of temperature during work shift were selected as sampling unit.

3.4.4 Sampling Size

Study of sample size is determined by using Snedecor and Cochran (1982) formula. Calculation of sample size is done by using 95% confident interval (probability $\alpha \leq 0.05$).

$$N = \frac{4\delta^2}{L} \quad N = \frac{4(16.06)^2}{5^2} = 41.27 \approx 41$$

Where,

N= Sample size

δ = Standard deviation of systolic blood pressure (Siti Fawziah, 2002).

L = Level of significant is 5%

From the above calculation, the value of standard deviation was taken from Siti Fawziah (2002) studied which the value of systolic blood pressure after eight hours working gave larger sample size compares to other variables (Table 3.1). Calculation of sample is done by using 5 % level of significant. Since this study is going to conduct at two glove

factory that have same process with same machinery there are several factors has to be consider in adjust the sample size based on the number sample size above.

N = Factory 1 + Factory 2

= 41 + 41

= 82 Respondents

Table 3.1: The value of sample size based on Standard deviation for each type of variables from the Siti Fawziah (2002) studied.

Type of variable	Standard deviation	Sample size
Core body temperature		
Before shift	0.60	0.06
After 2 hours working	0.40	0.03
After 8 hours working	0.50	0.04
Blood pressure		
Before shift	14.80	35.05
After 2 hours working	13.97	31.23
After 8 hours working	16.06	41.27
Heart rate		
Before shift	3.96	2.51
After 2 hours working	4.89	3.83
After 8 hours working	3.44	1.89
WBGTin	3.22	1.66
Air Velocity	0.16	4.4 x 10 ⁻³

3.5 Instrumentation

3.5.1 Questionnaire

An adapted questionnaire was used in this study which consists of four parts:

- a) Part A : Socio demographic
- b) Part B : Occupational information
- c) Part C : Health information
- d) Part D : Lifestyle information
- e) Part E : Heat Related Illness complaints

3.5.2 Thermal Environment monitor

The environmental temperature was measured by using QUESTemp[®]34 Thermal environment monitor which calculate the wet bulb globe temperature (WBGT_{in}) (Figure 3.1). This instrument was placed between the heat source and workers in that particular area for eight hours.



Figure 3.2: QUESTemp°34 Thermal environment monitor

3.5.3 Air Velocity Meter

TSI Velocicalc® Air Velocity Meters was used to measure level of air velocity at work area (Figure 3.2). The measurement was taken in three sessions at morning, afternoon and evening.



Figure 3.3: TSI Velocicalc® Air Velocity Meters

3.5.4 Personal Body Core Meter

Omron MC-510 Gentle Temperature Ear Thermometer was used to measure respondent body core temperature (Figure 3.3). Measurement of body core temperature was taken before, during and after work shift where the sensor is inserted into the respondent's ear when taking a temperature reading.

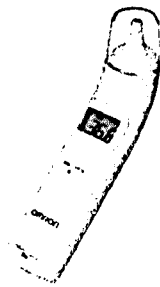


Figure 3.4: Omron MC-510 Gentle Temperature Ear Thermometer

3.5.5 Heat rate monitor watch.

POLAR Heart Rate FT60 was used in this study to measure heart rate of respondent in beat per minute (bpm) (Figure 3.4). The measurement was taken before work shift, 2 hours after work shift and 8 hours after work shift.



Figure 3.5: POLAR Heart Rate FT60

3.5.6 Blood pressure monitor

OMRON T3 Automatic Blood Pressure Monitor was used to measure blood pressure of respondents (Figure 3.5). The cuff is fastened onto the left arm when taking the blood pressure measurement. The respondent should not eat and drink at 15 minutes before measurement.



Figure 3.6: OMRON T3 Automatic Blood Pressure Monitor

3.5.7 Weighing scale and high meter

The SECA Body Meter was used to measure the height, and SECA Body Weighting use to measure weight of respondent (Figure 3.6 & Figure 3.7). This two data use to calculate the Body Mass Index (BMI) of the respondents.



Figure 3.7: SECA Body Meter



Figure 3.8: SECA Body Weighting

3.6 Quality Control

3.6.1 Pre-test study

The pre-test study was conducted before the real data collection of research. The respondent will undergo tests on adapted questionnaire to observe and evaluate their knowledge level of the questionnaire. The pre-test was conducted at one of the glove

factory at the study location among 10 workers that comply with the study inclusion criteria.

3.6.2 Calibration

The instruments were calibrated before data collection to ensure the instrument is in good condition and to minimize the error of the data and ensure the accuracy of the result. The instruments were calibrated by referring the standard procedure given.

3.6.3 Standard Operating Procedure (SOP)

During the measurement, the standard operating measurement was followed. Quest Technologies provided the SOP for the using QUESTemp³⁴ Thermal environment monitor. The SOP was circulated from NIOSH standard.

3.7 Data Analysis

All the data gathered from the questionnaire and measurement was analyzed by using IBM SPSS Version 22 software. The assumption of normality for significant level is ($p > 0.05$).

Table 3.2: Type of data analysis

Variable	Type of analysis
To determine socio demographic data of respondent.	Descriptive analysis
To determine the heat stress index (WBGTin) and metabolic workload at gloves production area.	Descriptive analysis
To determine the air velocity and relative humidity at gloves production area.	Descriptive analysis
To determine the correlation between WBGTin and air velocity in Top Glove production area.	Pearson correlation (If normal)
To determine the prevalence of heat related illness among worker while exposed to heat.	Descriptive analysis
To determine physiological parameter 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 workers 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 workers 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 workers exposed to heat.	Repeated measure ANOVA

CHAPTER 4

RESULT & DISCUSSION

4.1 Socio-Demographic Data of Respondents

All the respondents are male in the age group of 21 to 55 years old. From 82 workers majority of them were more than 30 (72.7%) years old and have a normal BMI (72.7%) in the range 18.5 to 24.9 kg/m². Half of the respondents had worked in the glove industry less than 3 years (56.8%). Most of the respondents are from low income (72.7%) which less than RM 1000 per months. More detail background information about the respondents is presented in Table 4.1.

From two glove industries in Selangor, eighty-two respondents were participated in this study. The respondents were selected based on complying with the inclusion criteria of this study. All the respondents completely fulfill the criteria. Thus, the response rates for this study was 100%, which was higher response rates than expected (>80%).

The mean age of respondents was 29 years old. In 2011, Analysis of Labour Force in Malaysia stated that there are more than 57 % of workers of age 25 years and older, which showed that the average age are well with this respondent population (Department of Statistics Malaysia, 2014). Thus, the respondents that exceed 55 years old were excluded from this study. Form previous studied had proved that age group more than 55 years old had lower response from blood flow to the skin compared to the group less than those aged (Kenny et al., 1997 & Thomas et al., 1999).

From this study, more than half respondents are with normal BMI. Chung and Pin (1996) and Bar Or et al. (1968) stated that people that obese tend to have a high risk of heat stress due to the fat layer composition and lower density of sweat glands which can decrease to heat loss. The majority of respondents had worked more than one year in glove industry and had a low income category which less that RM1000 per months.

Table 4.1: Socio-demographic of the workers who participated in the study (N=88)

Variables	Frequency (n)	Percentage (%)
Age group (years)		
<30	64	72.7
30-38	17	19.3
39-47	5	5.7
>47	2	2.3
Body Mass Index		
Underweight (<18.5)	2	2.3
Normal (18.5- 24.9)	64	72.7
Overweight (25.0-29.9)	21	23.9
Obese (>30)	1	1.1
Duration of employment (years)		
<3	50	56.8
4-10	37	42
>10	1	1.1
Income per months		
Low (<RM1000)	64	72.7
Middle (RM1000-RM2000)	11	12.5
High (>RM2000)	13	14.8

4.2 WBGTin and Metabolic Workload in Each Work Section

Table 4.2 represents the Heat Stress Index value (WBGT_{in}) in each workstation of production in the glove industry. From the result, the temperature is in the range of 32.4°C to 38.2°C. From this study, the mean WBGT_{in} was 35.4°C. Meanwhile, all the work sections had been exceeding the Threshold Limit Value (TLV) by ACGIH which 28 °C for medium metabolic workload level. The metabolic workload range was between 200 to 300 kcal/hour. Overall, the work regimen for all work section was 75% work, 25% regimen.

The online packing (38.2 °C) had the highest WBGT_{in} recorded where it is the nearest to the main oven which temperature that more than 125 °C and followed by stripping section (35.8 °C) where the work section second nearest to the main oven. Kishor et al. (2012) and Srivatsa et al. (2000) stated that the industry, which involves with the furnaces in their process such as industrial ovens can be major contributors to heat stress which also known as radiant heat sources. The radiant heat is a main element of the high temperature, which can cause overheating even though the air temperature is low (WorkSafeBC, 2007). In addition, workers at online packing exposed to the source of radiant heat of ovens were very close if compare to other work sections. Previous study stated that, an individual who exposed to the high temperature can lead to lower job performance (Geoffrey & Jisung, 2014) and task productivity (Wendt et al., 2007).

According to ACGIH, the standard value for medium metabolic workload categories are between 200 to 350 kcal/hour which the temperature should be 28°C and below. From this study the metabolic workload range was between 200 to 300 kcal/hours, which categorized as a medium and the temperature was 35.4 °C. Thus, the heat exposure level with medium metabolic workloads in this study was not compatible with 8 hours duration of the workers in glove industries.

Table 4.2: Exposure profile for WBGT_{in} and metabolic workload at various work sections

Work Section	Metabolic Workload (kcal/hour)	Metabolic Workload Category	WBGT_{in} (°C)
Online packing	210		38.2
Stripping	200		35.8
Stamping	210		35.3
Former operation	300	Medium	35.5
Quality Control	210		32.4
Line Operation	300		35.5

*WBGT_{in} above ACGIH standard, Threshold limit Value (TLV) = 28°C

4.3 Air Velocity and Relative Humidity in Each Production Lines

The air velocity and relative humidity distribution are shown in Table 4.3. The air velocity range was between 0.24 to 0.38 meters per second. The highest reading of air velocity was at online packing section and the lowest value of the quality control section. The mean of the air velocity at all production lines was 0.29 meters per second. Meanwhile, the relative humidity mean value was 44.96 %. The line operation section identified with the highest relative humidity and the lowest were at online packing section.

The online packing section (0.38 m/s) had the highest reading. However, based on Barbara Patricia (2002), the air velocity at each line is very low because for air temperature between 30°C to 35°C the air velocity should be between 1 to 2 m/s to enhance evaporative cooling and convective cooling.

Meanwhile, the relative humidity in all work sections was between 39.36% to 47.61%. Based on USA today (2008), the high level of humidity will cause heat more dangerous to the exposed people. This is because it will slow the evaporation of perspiration in the human body. Thus, the human body feels warmer in high humidity conditions. However, when the relative humidity is low the apparent temperature can actually be lower than the air temperature. This condition is known as heat index.

The heat index is apparent temperature, which represents the actual feels of the temperature to the human body when the relative humidity is combined with air temperature (NWSWFO, 2014). In this study, the high relative humidity (51.01%) was in line production section with temperature 35.5 °C. Based on calculation, the actual heat that the workers may experience was 45 °C (NWS, 2013). This actual heat exposure categorized as great discomfort and must avoid exertion to workers. Since the majority of workers was exposed to temperatures more than 32.4°C and the relative humidity more than 39.36%, this means that all the workers are exposed to the heat stress with discomfort and dangerous zone for workers. Thus, the air velocity should be increased by adding more fans and rest room with air condition should be provided for workers.

Table 4.3: Exposure profile for air velocity and relative humidity at production lines.

Production Line	Air Velocity (m/s)	Relative Humidity (%)
Online packing	0.38 ± 0.05	39.36 ± 0.70
Stripping	0.26 ± 0.02	43.53 ± 0.25
Stamping	0.32 ± 0.02	45.61 ± 0.20
Former operation	0.33 ± 0.02	46.02 ± 1.66
Quality control	0.24 ± 0.01	47.61 ± 0.42
Line operation	0.26 ± 0.02	51.01 ± 1.17

4.4 Correlation between WBGT_{in} and Air Velocity

The correlation between environment heat and air velocity result are shown in Table 4.4. The results indicated that there is a no significant correlation between WBGT_{in} and air velocity ($r=0.73$, $p= 0.07$).

Based on this study there is no statistically significant correlation between air velocity and WBGT_{in} ($r=0.73$, $p= 0.07$). Thus, the changing of air velocity did not significantly relate to the changing of WBGT_{in}. The online packing section (0.38 m/s) had the highest reading of air velocity as well as temperature (38.2°C). Meanwhile, the former operation was second highest reading (0.33m/s) for air velocity, but the third highest in WBGT_{in} (35.5°C). Thus, the different air flow may also affect by the different number of fans use for each work section. Meanwhile, the different reading of temperature may also influence by the distance of each work section of the oven. This may lead to poor air circulation and produce inconsistency in the WBGT_{in} result from level of air velocity in every work section.

Table 4.4: The correlation between air velocity and WBGT_{in}

Variable	Mean ±S.D	R	P
WBGT _{in} (°C)	35.4 ± 1.69	0.73	0.07
Air Velocity (m/s)	0.29 ± 0.05		

p-value is not significant at p>0.05

4.5 Prevalence of Heat Related Illness.

Table 4.5 represents the prevalence of heat related illness among workers when exposed to heat. The highest prevalence of heat related illness on respondents was dehydration (82.2%), followed by heat exhaustion (81.1%), heat cramps (23.2%), heat rashes (22.2%) and heat stroke (5.6 %). The heat syncope (4.4%) was the least heat related illness experienced by respondents. Based on previous studies (Patel et al., 2006; Kishor et al., 2012 & Donoghue, 2004), the heat exhaustion among most commonly occurred at hot environment of occupational study.

The heat exhaustion is less extreme manifestations of heat related illness which involves mild symptoms such as thirst, weakness, dizziness and malaise (James & Glazer, 2005). This result is different from a previous study (Athirah, 2014) where the heat exhaustion recorded the highest prevalence compares to others. This is because the dehydration is the main cause that leads to the heat exhaustion and other heat-related

diseases. This is because the majority workers drink less amount of water. According to report by Ministry of Health, Labour and Welfare of Japan, workers at industries should Intake one or two cups of 0.1 to 0.2% salt water, sports drink containing 40 to 80 mg sodium per 100 mL, or oral rehydration solutions every 20 to 30 minutes. The heat exhaustion is most often preceded by dehydration and it's usually associated with unacclimatised workers (Thomas & Francis, 2009). However, untreated heat exhaustion may lead to heat stroke causing by central nervous system (CNS) dysfunction such as coma and even death. Thus, the high prevalence of heat exhaustion should be taken seriously.

Meanwhile, dehydration (82.2%) was a major problem of workers involves this study. Most of the workers drink less of water after they exposed to high intensity of heat during working hours. Based on the survey, majority of workers drink only 50 mL of water for every 30 minutes. Previous study (Horie, 2013) stated that industries workers should drink 150 to 250 mL water every 20 to 30 minutes. In addition, there was a lack of awareness regarding of dangerous health effect causing by heat exposure shown by employee. Dehydration can make the respondents more prone to overheating because it will decrease sweating and could progress to heat stroke (Thomas & Francis, 2009). More heat stress training should be emphasis to increase the work performance among workers. Based on previous studies by Bates and Matthew (1996) stated that 2% of dehydration could reduce in mental performance and effect physical and cognitive of the workers.

From this study heat stroke reported was 5.6% despite all the workers were acclimatized which higher than previous study which 4.6 % (Athirah, 2014). This statement is supported by a previous study which states that there is no relationship between heat acclimatization and the incidence of the heatstroke (Armstrong & Maresh, 1991).

Table 4.5: Prevalence of heat related illness complaints among workers (N=88)

Heat Related Illness	Frequency (n)	Percentage (%)
Heat Exhaustion	73	81.1
Heat Stroke	5	5.6
Dehydration	74	82.2
Heat Rashes	20	22.2
Heat Syncope	4	4.4
Heat Cramps	21	23.3

4.6 Differences of Core Body Temperature, Heart Rate and Blood Pressure Between Before Shift, After 2 hours and after 8 hours working.

Table 4.6 illustrated the result of mean of the three parameters of physiological between three work sessions. Meanwhile, the results of differences in physiological measurement are shown in Table 4.7 by using repeated measure ANOVA with Greenhouse-Geisser correction. There were significant differences ($p < 0.001$) of core body temperature, heart rate and blood pressure between before the shift, after 2 hours working and after 8 hours working. Thus, the post hoc tests using Bonferroni (table 4.8) were used to determine the significant differences between three sessions.

This is shown that the workers continuously expose to heat at every work session. Therefore, the body produced heat increased gradually between before the shift, after two hours and after eight hours working shift.

4.6.1 Difference of Core Body Temperature between Before, After 2 hours and After 8 Hours Working among Workers.

The results shown that there were significant differences ($F= 153.96$, $P<0.001$) between sessions in core body temperature. A post hoc Bonferroni correction test showed that the core body temperature before shift ($35.59 \pm 0.39^{\circ}\text{C}$) was significantly ($P<0.001$) differences between after 2 hours working ($35.89 \pm 0.26^{\circ}\text{C}$) and after 8 hours working ($36.20 \pm 0.34^{\circ}\text{C}$). Moreover, Nur Athirah (2014) showed that there is significant differences ($p<0.05$) after 2 hours and 8 hours working in palm oil mill. Therefore, the physiological change patterns in industry were significantly different for each session.

ACGIH (as cited in Derrick & Graham, 2002) stated that deep body temperature which exceeds 38°C was unacceptable for an average industrial workforce in an 8 hours working period. In this study, core body temperature was range between 34.3°C to 36.9°C . This was shown that the workers body core temperature still under safe limits of industrial. Even though the pattern of workers' body core temperature increases gradually with working sessions, it was still under acceptable limits.

4.6.2 Difference of Blood Pressure between Before, After 2 hours and After 8 Hours Working among Workers.

From the results, the mean of blood pressure was statistically difference between time ($F= 93.718$, $p<0.001$). Post hoc tests using Bonferroni correction showed that the significant difference ($p<0.001$) between before shift (122.68 ± 7.17 mmHg) with after 2 hours working (126.93 ± 5.19 mmHg) and 8 hours working (130.72 ± 6.61 mmHg).

From this study, the systolic blood pressure was one of the indicators of physiological measurement. This is supported by Adrian et al. (2007) which proved that the systolic blood pressure had statistically significant effect of temperature changes. Besides, higher indoor temperature level represents the strong significant acute effect of systolic blood pressure compare to the high outdoor temperature.

This was shown that the workers were exposed to high intensity of heat gradually with working shift. This will result the workers will start more sweating and heat in the body due to changing of the normal environment in the hot environment increasing across the working shift.

This result was supported by previous studied which there is an increase significant differences in between before shift and after 8 hours working shift (Muznita,

2004; Hidayah, 2005; & Durbashini, 2004). Roine et al. (1992) stated that during high temperature, peripheral vascular resistance is reduced and blood volume shifts of the central body to the periphery to facilitate heat exchange which it can lead to increased in blood pressure. However, these symptoms will decrease with time depends on individual body adaptation toward heat known as acclimatization.

4.6.2 Difference of Heart Rate between Before, After 2 hours and After 8 Hours Working among Workers.

There was significantly difference the mean of heart rate across time ($F=326.463, p<0.001$). A post hoc Bonferroni correction test indicated that heart rate had been increased significantly differences ($p<0.001$) between before shift (75.25 ± 7.011 bpm) to after 2 hours working (82.32 ± 5.025 bpm) and after 8 hours working (88.45 ± 4.482 bpm).

From this study, the heart rate of workers increased gradually between before the shift, after two hours and after eight hours working shifts. Based on Barbara and Patricia (2002), the mean value of the heart rate of this present study was still under limit value was 82 .01 bpm as it does not exceed 110 bpm. Based on previous studies, stated that when the heart level was above the limit, the work period for the next shift should be

shortened by one third. Since the mean of heart rate in this study beyond the limit the rest period should be maintained as usual (U.S. Department of Labor, 1999).

Table 4.6: Descriptive profile of core body temperature, heart rate and blood pressure between before shift, after 2 hours working and after 8 hours working.

Variable	Mean \pm S.D.
Core Body Temperature	
Before shift	35.58 \pm 0.39°C
After 2 hours working	35.88 \pm 0.26°C
After 8 hours working	36.20 \pm 0.34°C
Blood Pressure	
Before shift	122.68 \pm 7.17 mmHg
After 2 hours working	126.93 \pm 5.20 mmHg
After 8 hours working	130.72 \pm 6.61 mmHg
Heart Rate	
Before shift	75.25 \pm 7.01 bpm
After 2 hours working	82.32 \pm 5.03 bpm
After 8 hours working	88.45 \pm 4.48 bpm

Table 4.7: The differences of core body temperature, heart rate and blood pressure between before shift, after 2hours working and after 8 hours working.

Variable	Mean \pm SE	<i>P</i>	F
Core Body			
Temperature			
Before shift-after 2 hours working	-0.30 \pm 0.03		
Before shift-after 8 hours working	-0.62 \pm 0.04	<0.001***	153.96
After 2 hour –after 8 hours working	-0.32 \pm 0.03		
Blood Pressure			
Before shift-after 2 hours working	-4.25 \pm 0.57		
Before shift-after 8 hours working	-8.03 \pm 0.69	<0.001***	93.72
After 2 hour –after 8 hours working	-3.78 \pm 0.47		
Heart Rate			
Before shift-after 2 hours working	-7.07 \pm 0.47		
Before shift-after 8	-13.21 \pm 0.63	<0.001***	326.64

hours working	
After 2 hour –after 8	-6.14 ± 0.42
hours working	

Table 4.8: Post hoc test (Bonferroni correction) of physiological parameters at three different sessions.

Variable (Pair)	<i>P</i>
Core Body Temperature	
Before shift-after 2 hours working	<0.001***
Before shift-after 8 hours working	<0.001***
After 2 hour –after 8 hours working	<0.001***
Blood Pressure	
Before shift-after 2 hours working	<0.001***
Before shift-after 8 hours working	<0.001***
After 2 hour –after 8 hours working	<0.001***
Heart Rate	
Before shift-after 2 hours working	<0.001***
Before shift-after 8 hours working	<0.001***
After 2 hour –after 8 hours working	<0.001***

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

To be concluded, the workers in the glove industry are exposed to high level of heat stress. However, the mean value of heart rate and body core temperature were still in the acceptable range, which represent the acclimatization of the workers. All the three physiological parameters which are body core temperature, heart rate and blood pressure of respondent were significant different between three periods of time. The air velocity at majority work sections in production area were low, however the results indicated that there is a no significant correlation between environmental heat and air velocity. The highest prevalence of heat related illness on respondents was dehydration, followed by heat exhaustion, heat cramps, heat rashes and heat stroke. Since, all the work section had recorded a high level of environmental temperature, the majority of workers had reported with high prevalence in heat related illness.

5.2 Recommendation

From this study, the environmental temperature at majority work stations in the glove manufacturing production area have exceeded the standard value by ACGIH which must below 28°C. Thus, this lead to workers work under high level of heat stress which can result in heat related illness among workers. Therefore, some control measure should take consideration in order to minimize the exposure of heat among glove industry workers.

i. Engineering control

Engineering control is one of the effective methods to minimize the heat exposure to workers. Firstly, the number of fans at each work section should be increase, especially in quality control and stripping work section. There should be two fans at each work station to increase the air velocity in that area and reduce heat respectively. The current fan should be inspected to ensure the effectiveness of air flow from each fan can reduce the environmental heat. In addition, the air-conditioned restroom should be provided to help workers in cooling down their body temperature.

ii. Administration control

The training on heat stress in the way of control heat stress should be provided by employers. This training program can help in educating and create awareness among workers on the symptoms of heat related illness which can help in preventing any worst case of heat stress to occur. The training program may cover with the description of heat stress, including symptoms of heat related illness and the first aid measures for each disorder. Lastly, the water station should be provided to ensure the workers have enough drink of water. According to report by Ministry of Health, Labour and Welfare of Japan, workers at industries should Intake one or two cups of 0.1 to 0.2% salt water, sports drink containing 40 to 80 mg sodium per 100 mL, or oral rehydration solutions every 20 to 30 minutes.

In addition, workers should involve in medical surveillance on heat stress to screen and identify the individual risk as they exposed to high level of heat. The treatment should also be included as to reduce any significant effect from that heat exposure. This surveillance should be conducted at least once a year by licensed physicians. Furthermore, the signage of heat level of each work section should be put to ensure all the workers are alerted when enter at each work section.

Heat stress hygiene practices are the actions taken to reduce the risk of heat disorder. Each worker must be responsible in practicing good heat stress hygiene such as drinking enough water to replace the water loss from the body. When working in hot environments, each worker should be encouraged to quench their thirst all the time and consume at least 500 ml of water every hour (NIOSH, 2012). Besides, employers should provide cool drinking water at convenient and accessible locations (NIOSH, 2012). In addition, the employee must have a balanced diet without skipping any meal to replace the minerals lost in sweat as well as calories.

Healthy lifestyle should be practiced by all workers to reduce the risk of heat-related illness. The workers also need to have adequate sleep to increase their job quality and efficiency. Alcohol intake should be avoided, which can increase the risk of having a heat stroke. The most indicators to be highlighted are the commitment and support from top management itself and the involvement of all employees to maintain a productive and good health of the workers from excessive exposure to heat.

REFERENCES

- Author. (2015, October 29). *Rubber Industry*. Retrieved from <http://www.mrepc.com/industry.php>.
- Ahasan, M. R. & Parten, T . (2001). Occupational health and safety in the least developed countries—asimple case of neglet. *Podemiol*. 2001.
- Allyson, S., Howe, Barry, P., & Boden. (2007). Heat-Related Illness in Athletes. *American Journal Sports Medicine*, 35:1384.
- American Academy Of Pediatrics (AAP). (2011). Policy Statement-Climate Heat Stress and Exercising Children and Adolescent. *Committee On Sports Medicine And Fitness*.
- American Conference of Government Industrial Hygienist (ACGIH): *Industrial Ventilation*. Cincinnati, OH : ACGIH, 1992.
- Anderson, G., S. & Kenny, W., L. (1987). Effect of age on heat-activated sweat gland density and flow during exercise in dry heat. *Journal of Applied Physiology*, 63(3), 1089-1094.
- Andrew, H. P. (2013). Heat Strain, Hydration status, and Symptoms of Heat Illness in Surface Mine Workers. The School of Human Movement Studied and the Institute of Health and Biomedical Innovation, Queensland University of Technology. *Industry Economic Journal* 2002;2:1,1-10.

- Armstrong, L.E. (2000). *Performing in extreme environments*, Champaign, IL: Human Kinetics.
- Azlis, S. J., Zulhilman, D., Mohd Shahir, Faizal M. B., & Khalid, H. (2007). Heat stress investigation on laundry workers. *International Conference on Ergonomics 2007 (ICE07)*, Kuala Lumpur.
- Barbara A.P., & Patricia J.Q. (2002) *Fundamental of Industrial Hygiene 5th Edition. Part III: Thermal stress* (pp. 327-356). United State of America, U.S : National Safety Council.
- Barr, D., Gregson, W., & Reilly, T. (2010). The thermal ergonomics of firefighting reviewed. *Applied Ergonomics*, 41(1), 161-172.
- Barrow, M.W., & Clark, K.A. (1998). Heat Related Illness. *American Family Physician* 58(3):749.
- Belding, H. S., & Hatch, T. F. (1995). Index for Evaluating Heat Stress in Terms of Resulting Psychological Strain, Heating, Piping and Air Conditioning. Vol. 27. 129 – 136.
- Bergeron, M.F. (1996). Heat cramps during tennis: a case report. *International Journal of sport nutrition*, 6(1), 62-68.
- Bird, M.J. (2002). *Occupational exposure during routine activities in coal-fueled power plants*. The University of Georgia, Athens, Georgia.

- Bishop, P. (1997). Applied physiology of thermoregulation and exposure control. In S.R DiNardi (Ed.). *The occupational environment—its evaluation and control* (pp. 628-658). Fairfax, VA:AIHA Press.
- Bouchama, A., & Knochel, J.P. (2002). Heat Stroke. *New England Journal of Medicine* 346(25):1978.
- Boulant, J. A. (2000). Role Of The Preoptic-Anterior Hypothalamus In Thermoregulation And Fever. *Clin Infect Dis* .2000 Oct;31 Suppl 5:S157-61.
- Bridger, R.S. (2003). *Introduction to Ergonomics*. 2nd edition London: Taylor & Francis.
- Brothers, M., Keller, D., and Wingo, J. (2002). Heat-stress-induced changes in central venous pressure do not explain inter-individual differences in orthostatic tolerance during heat stress. *Journal Applied Physiology* 110(2011): 1283-1289.
- Brunker, & Khan.(2002). *Clinical Sports Medicine*. McGrawHill. Forth Edition.
- Budd, G. (2001b). How do wildland firefighter cope? Physiological and behavioural temperature regulation in men suppression Australian summer bushfire with hand tool. *Journal of Thermal Biology*. 26(4-5), 381-386.
- Carrillo, J. A., & Benitez, J. (2000). Clinically significant pharmokinetic interactions between dietary caffeine and medication. *Clin Pharmacokinet* 39(@): 127-53.

- Cheung, S. S., Petersen, S. R., & McLellan, T. M. (2010). Physiological strain and Counter measures with firefighting. *Scandinavian Journal of Medicine & Science in Sports*, 20 Suppl 3, 103-116.
- Cooper, E., Ferrara, M., & Broglio, S. (2006). Exertional heat illness and environmental conditions during a single football season in the southeast. *Journal of Athletic Training*, 41(3), 332-336.
- Dicorleto, R.D., Coles, G., and Firth, I. (Eds.). (2003). Heat Stress Standard and Documentation Developed For Use In The Australian Environment. Tullamarine: The Australian Institute of Occupational Hygienists.
- Doughue, A.M., Sinclair, M.J., & Bates, G.P. (2000). Heat exhaustion in a deep underground metalliferous mine. *Occupational & Environmental Medicine*, 57(3), 165-174.
- Eric, N.B. (2013). Evaluation of heat stress and strain in electricity utility workers. Public Health in Environmental Health Sciences. University of California, Los Angeles.
- Gary A. T., & Kavin T.P. (1997). The human body in health and disease. Elsevier-Health Sciences Division.
- Green, P.J., Kirby, R., & Suls, J. (1996). The effects of caffeine on blood pressure and heart rate: a review. *Annals of Behavioral Medicine*, 18, 201-216.
- Hales, J. R. S., & Richards, D. A. b. (1987). *Heat Stress: Physical Exertion and Environment*. Excerpta Medical: Amsterdam.

- Ho, C.W., Beard, J.L., Farrell, P.A., Minson, C.T., & Kenny, W.L. (1997). Age, fitness and regional blood flow during exercise in the heat. *Journal of Applied Physiology* 82(4), 1126-1135.
- Horie S, Kawanami S, Sunada K. Hot environment and human physiology. *Digest of Science of Labour*. 2011;66:330-335. (in Japanese)
- Hoa, D.T.M., Nguyet, D.A., Phuong, N.P., Phuong, D.T., Nga, V.T., Few, R., & Winkles, A. (2013). Heat Stress and adaptive capacity of low-income outdoor workers and their families in the city off Da Nang, Vietnam. *Asian Cities Climate Resilience*.
- Inoue Y., Shibasaki M., Hirata., and Araki T. (1998). Relationship between skin, blood flow and sweating rate, and age related regional differences. *European Journal of Applied Physiology & Occupational Physiology*, 79(1), 17-23.
- Ishii, K., Muraki, S., Komura, T., Kikuchi, K., Sato, K., & Maeda, K (1993). Usefulness of a simple device to measure aural canal temperature. *The Annals of Physiological Anthropology*, 12, 189-194.
- James, L., & Glazer, M.D. (2005). Management of heat stroke and heat exhaustion. *Am Fam Physician* 2005;71:2133-40, 2141-2.
- Jason, Y. (2010, June 12) . Demand Still Ahead of Supply. Retrieve from <http://www.jason.yap@my.OSKgroup.com>

- Jonathan, A., Becker, M. D., Lynsey, K., & Stewart M. D. (2011). Heat Related illness. *Am Fam Physician*. 2011 Jun 1 ; 83(11):1325-1330
- Kenefick, R. W., & Sawka M.N. (2007). Hydration ath the work site. *Journal of American College of Nutrition*, 26(supple 5), 597-603.
- Kenny, W. L.& Ho, C. W. (1995). Age alters regional distribution of blood flow during moderate-intensity exercise. *Journal of Applied Physiology*, 79(4), 1112-1119.
- Kerslake, D. M. (1972). *The stress of Hot Environments*. Cambridge University Press: Cambridge.
- Leithead, C.S. & Lind, A. R. (1964). *Heat stress and heat disorders*. London: Cassell.
- Luurila O.J.(1992). The sauna and the heart. *J Intern Med*. 231(4): 319-320.
- MacKnight, J.M., & Mistry, D. J. (2005). Allergic disorders in the athlere. *Clin Sports*.
- Martin, H.L., Loomis, J.L., & Katch, V.L. (1994). Maximal skin vascular conductance in subjected aged 5-58 yr. *Journal of Applied Physiology*, 79(1), 293-301.
- Micheal, W., Barow, M.D., Katherine, A., & Clark, D.O. (1998).Heat related illness. Wright State University School of Medicine, Dayton, Ohio *Am Fam Physiology*. 58(3): 749-756.
- MedicineNet.com. (2013). MedTerm dictionary : *Definition of heat related illness*. Retrieved from <http://www.medterm.com/script/main/art.asp?.articlekey=10160>

- Ministry of Health, Labour and Welfare. Promotion to Drink Tap Water for Health.
Retrieved from <http://www.mhlw.go.jp/topics/bukyoku/kenkou/suido/nomou/>.
Accessed May 2016. (in Japanese)
- Nur Athirah, M.Y.(2014). The Evaluation of Physiological Changes and Heat Related Illness Among Palm Oil Mill Workers Under Heat Stress Condition.
- Nielson, B., Hales, J. R., Strange, S., Christensen, N.j., Warberg, J., & Saltin, B. (1993). Human circulatory and thermoregulatory adaptations with heat acclimation and exercise in a hot, dry environment. *JPhysiol. Jam* 1993:460: 467-485.
- Platt, A., Localio, R., Brensinger, C., Cruess, D., & Christine, J. (2010). Can we predict daily adherence to warfarin? Results from the international normalized ratio adherence and genetics study. *Chest*, 137(4), 883-889.
- Ramsey, J. D. (1995). Task performance in heat : a review. *Ergonomics* 38, 154-165.
- Rasoul, H., Sajad, Z., Akbar, B, H., Abdolloh, H., & Hossin, G.(2013). Investigation of heat stress in workplace for different work groups according to ISO 7243 standard in mehr .
- Romanovsky, A. A. (2007). Thermoregulation: some concepts have changed. Functional architecture of the thermoregulatory system. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, 292(1): R37-R46.
- Rowell L.B. (1990). Hyperthermia: a hyperadrenergic state. *Hypertension* 1990;15(15): 505-507.

- Sawka, M.N., Burke, L.M., Eichner, E. R., Maughan, R. J., Montain, S.J., & Stachenfeld, N. S. (2007). ACSM position stand: Exercise and fluid replacement. *Medicine and Science in Sports on Exercise*, 39(2), 377-390.
- Sawka, M.N., Young A.J., Francesconi, R. P., Muza, S. R., Pandolf, K.B. (1985). Thermoregulatory and blood responses during exercise at graded hypohydration levels. *Journal of Applied Physiology*, 59(5), 1394-1401.
- Schweltnus, M.P., Nicol, C., Laubscher, R., & Noakes, T. (2004). Serum electrolyte concentrations and hydration status are not associated with exercise associated muscle cramps (EAMC) in distance runners. *British Journal of Sports Medicine*, 38, 48-492.
- Shearer, S. (1990). Dehydration and serum electrolyte changes in South African gold miner with heat disorders. *American Journal of Industrial Medicine*, 17(2), 225-239.
- Siti Fawziah, M. N. (2002). Tugas Hab dan Perubahan Fisiologi Pekerja Kilang Besi. Jabatan Kesihatan Komuniti, Fakulti Perubatan dan Sains Kesihatan, Universiti Putra Malaysia.
- Socio Security Organisation (SOCISO). (2011) Annual Report. Ministry of Human Resources, Malaysia. Retrived from http://www.perkeso.gov.my/images/Laporan_Tahunan_2011.pdf
- Thomas C.M., Pierzga, J.H., & Kenny, W.L. (1999). Aerobic training and cutaneous vasodilatation in young and older men. *Journal of Applied Physiology*, 86(5), 1676-1686.

- Twatsupa, B., Lim, LL-Y., Kjellstrom, T., Seubsman, S., Sleight, A., & the Thai Cohort Study team. (2010). The association between overall health, psychological distress, and occupational heat stress among a large national cohort of 40, 913 Thai workers.
- U.S. Department of Labor, Occupational Safety and Health Administration. (1999, January). *OSHA Technical Manual (OTM) Section III: Chapter 4 (Heat Stress)*. Retrieved from https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html.
- Van Gelder, C.M., Prager, L.A., Wiesmann, W.P., Stachenfeld, N., & Bogucki, S. (2008). An experimental model of heat storage in working firefighters. *Prehospital Emergency Care*, 12(2), 225-235. Vol.2. R.I. Harris. New York: John Wiley and Sons, Inc., 2000. Pp. 925-984.
- Victor, L. (2003). *Kajian Pendedahan Tegasan Haba dan Perubahan Fis Fisiologi Pekerja Kilang Besi*. Jabatan Kesihatan Komuniti, Fakulti Perubatan dan Sains Kesihatan, Universiti Putra Malaysia.
- Warren, R. Van, Z., Jaco, D., & Josua P.M. (2013). Single phase Convective Heat Transfer and Pressure Drop Coefficient in Concentric Annular. *Heat Transfer and Engineering* 34(13):1112-1123. doi:10.1080/01457632.2013.763550.
- Weller, A.S., Linnane, D.M., Jonkman, A.G., & Daanen, H.A. (2007). Quantification of the decay and re-induction of heat acclimation in dry-heat following 12 and 26 days without exposure to heat stress. *Eur J Appl Physiol*, 102(1): 57-66.

- Wendt, D. Van L.L.J.C., & Van M.L (2007). Thermoregulation during exercise in the heat. *Sport Medicine*, 37(8):669-680.
- Wenger, C.B.(1998). Human heat acclimatization, in Pandolf, K.B., M.N. Sawka and R. R. Gonzalez, eds., *Human performance Physiology and Environmental Medicine at Terrestrial Extreams*. Indianapolis, IN, Benchmark Press. Pp. 153-197.
- William R.D. (1997). When summertime gets too hot to handle. US Federal Drug Administration.
- Windham, C.H. (1974). The physiological and psychological effects of heat. *Mine Vent. Soc.of S.Africa* (1974):93-137.
- World Health Organization (WHO). (1969). *Health factor involve in working under condition of heat stress* (Technical Report Series No. 412). Geneva Switzerland: Author)
- Yeo T.P. (2004). Heat stroke: a comprehensive review. *AACN Clin Issues* 15(2): 280-293.



**JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
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BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

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

1. TAJUK KAJIAN

Penilaian Perubahan Fisiology dan Penyakit Berkaitan Haba dalam Kalangan Pekerja Kilang Sarung Tangan Getah Dibawah Tekanan Haba.

2. PENGENALAN

Kajian ini bertujuan untuk mengenalpasti tegasan haba dan impaknya dalam perubahan fisiologi pekerja kilang sarung tangan getah. Pekerja yang terdedah pada tahap ketegasan haba yang melampau boleh mengatasi mekanisme didalam badan yang boleh mnyebabkan kondisi yang bahaya seperti strok haba dan boleh membawa maut. Jika manuasia gagal mengawal dan mengekalkan suhu boleh menyebabkan berlakunya tegasan haba. Impaknya, boleh mnyebabkan strok haba, kelesuan haba, kekejangan haba, atau pengsan haba. Sehubungan itu, untuk memastikan keselamatan dan kesihatan pekerja, kajian ini perlu dijalankan bagi memastikan status kesihatan pekerja dapat ditingkatkan dan dilindungi dari ketegasan haba.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda dihendaki menandatangani borang penyertaan ini yang menyatakan anda berminat 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 borang soal selidik perlu dikembalikan kepada penyelidik sebelum ujian tekanan darah, kadar degupan jantung dan suhu badan dijalankan. Ujian tekanan darah, kadar degupan jantung dan suhu badan dijalankan sebanyak tiga kali iaitu pada sebelum waktu bekerja, dua jam selepas waktu bekerja dan setelah tamat waktu bekerja.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Pekerja yang bekerja kurang dari 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 ujian kesihatan dan mengetahui status kesihatan diri secara percuma.

9. PERSETUJUAN

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

.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian 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 tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan. Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

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

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan
(Responden)

Tandatangan
(Saksi)

Tarikh :.....

Nama :.....

No. K/P:

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh

Tandatangan
(Penyelidik)



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

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 :

Evaluation of Physiological Changes and Heat Related Illness among Glove Industry workers under Heat Stress Condition at Selangor.

2. INTRODUCTION:

Purpose of this study is to determine heat stress and its effect among workers in glove industry. This is because exposure to extreme heat stress level can overwhelm the body's coping mechanisms 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 leads to increasing in body core temperature, 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 needs to be done so it can improve the safety and health status.

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 explanation given. You will need to answer a questionnaire for obtaining information about this study. Then, consent form and questionnaires should be returned to the researcher before blood pressure, heart rate and body temperature test are carried out. The blood pressure, heart rate and body temperature test will be carry 3 times which are before work shift, after 2 hours work shift and after 8 hour work shift.

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 SUBJECT?

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

(b) TO THE INVESTIGATOR?

It will help the investigator to determine the heat stress and its effect among workers in glove industry.

6. WHAT ARE THE POSSIBLE RISKS?

There is no risk available in this study.

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)

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)

APPENDIX 1

**PROJEK PENYELIDIKAN TAHUN AKHIR
B.S. KESIHATAN PERSEKITARAN DAN PEKERJAAN
FAKULTI PERUBATAN DAN SAINS KESIHATAN
UNIVERSITI PUTRA MALAYSIA
SERDANG SELANGOR**



**BORANG SOAL SELIDIK BAGI KAJIAN TEGASAN HABA DAN KESANNYA TERHADAP PEKERJA DI
KILANG SARUNG TANGAN**

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi lima (5) bahagian iaitu:

BAHAGIAN A: MAKLUMAT DIRI
BAHAGIAN B: MAKLUMAT PEKERJAAN
BAHAGIAN C: MAKLUMAT KESIHATAN
BAHAGIAN D: MAKLUMAT GAYA HIDUP
BAHAGIAN E: MAKLUMAT SIMPTOM PENDEDAHAN HABA
2. Anda diminta untuk menjawab semua soalan.
3. Untuk menjawab, sila tandakan jawapan di bahagian jawapan yang telah disediakan.
4. Borang soal selidik hendaklah dikembalikan kepada pengkaji setelah selesai menjawab semua soalan.
5. Semua maklumat yang diperolehi didalam kajian ini adalah rahsia dan hanya digunakan untuk tujuan pembelajaran semata-mata.

Sekian, terima kasih.

BAHAGIAN A: MAKLUMAT DIRI

1.1 Tarikh lahir :

1.2 No. K/Pasport :

1.3 No. Telefon :

1.4 Umur : tahun

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

1.6 Warganegara : 1. Warganegara 2. Bukan warganegara

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

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

1.9 Gaji : RM

1.10 Tinggi : cm

1.11 Berat : Kg

1.12 Isi rumah : orang

BAHAGIAN B: MAKLUMAT PEKERJAAN

2.1 Apakah jawatan anda sekarang?

2.2 Di bahagian mana anda bekerja sekarang?

1. Online Packing

2. Line Boy

3. Former

4. Stripping

4. Roboting Arm

5. Housekeeping

6. Supervisor

7. lain: _____

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

_____ tahun

2.4 Berapa lamakah anda bekerja di kilang ini?

_____ tahun

2.5 Shift kerja:

1. Normal

2. Shift

2.6 Berapa hari anda bekerja dalam seminggu?

_____ hari

2.7 Adakah anda bekerja lebih masa (OT)?

1. Ya

2. Tidak

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

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?

_____ hari

2.10 Berapa jamkah anda bekerja dalam sehari?

_____ jam

2.11 Adakah anda menggunakan sebarang Peeralatan Perlindungan Diri (PPE)?

1. Ya

2. Tidak

2.12 Tandakan jenis PPE yang digunakan:

1. Kasut keselamatan

5. Pakaian perlindungan diri

2. Topi keselamatan

6. Respirator

3. Cermin mata keselamatan

7. Lain-lain: _____

4. Sarung Tangan

2.13 Adakah latihan penggunaan PPE diberikan?

1. Ya

2. Tidak

2.14 Adakah anda terdedah kepada sebarang hazard seperti di bawah:

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 mengidap penyakit berikut dan telah disahkan oleh doktor?

Penyakit (a)	1. Ya (b)	2. Tidak (c)	Adakah anda pernah mengambil sebarang ubat-ubatan untuk penyakit tersebut?	
			1. Ya (d)	2. Tidak (e)
3.2.1 Darah Tinggi				
3.2.2 Kencing Manis				
3.2.4 Jantung				

BAHAGIAN D: MAKLUMAT GAYA HIDUP (LIFESTYLE)

4.1 Adakah anda mengambil sebarang jenis dadah?

1. Ya 2. Tidak

4.2 Adakah anda merokok?

1. Ya 2. Tidak

Jika ya, _____ batang sehari

4.3 Adakah anda mengambil minuman beralkohol?

1. Ya 2. Tidak

BAHAGIAN E: MAKLUMAT SIMPTOM- SIMPTOM PENDEDAHAN HABA

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

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

5.2 Kategori waktu bekerja anda

- | | | |
|----|--------------------------|------------------------------------|
| 1. | <input type="checkbox"/> | Bekerja berterusan bagi setiap jam |
| 2. | <input type="checkbox"/> | 75% bekerja, 25% berehat |
| 3. | <input type="checkbox"/> | 50% bekerja, 50% berehat |
| 4. | <input type="checkbox"/> | 25% bekerja, 75% berehat |

E 5.2

5.3 Berapa lama anda terdedah kepada haba dalam pekerjaan seharian.

- | | | |
|----|--------------------------|-------------------|
| 1. | <input type="checkbox"/> | Kurang dari 2 jam |
| 2. | <input type="checkbox"/> | 2-4 jam |
| 3. | <input type="checkbox"/> | 4-6 jam |
| 4. | <input type="checkbox"/> | 6-8 jam |
| 5. | <input type="checkbox"/> | Lebih dari 8 jam |

E 5.3

-Terima kasih atas kerjasama anda dalam menjayakan kajian ini-