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EFFECT OF HEAT EXPOSURE ON HEALTH AMONG ORGANIC AND CONVENTIONAL PADDY FARMERS AT SIK, KEDAH

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THE EFFECTS OF HEAT EXPOSURE ON HEALTH AMONG ORGANIC AND CONVENTIONAL PADDY FARMERS AT SIK, KEDAH

BY

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ABSTRACT

EFFECT OF HEAT EXPOSURE ON HEALTH AMONG ORGANIC AND CONVENTIONAL PADDY FARMERS AT SIK, KEDAH

NUR AFIQA MARYAM BAHARUDIN, VIVIEN. H

Background: Heat is one of the environmental hazards among agricultural workers due to its nature of working outdoor directly to sunlight which can cause changes in physiological factors of the body such as core body temperature, blood pressure and heart rate, as well as causing blood glucose and blood cholesterol intolerance. This may contribute to the occurrence of heat-related illness and other metabolic diseases among farmers. **Objective:** This study aims to determine the potential health effects from heat exposure among organic and conventional paddy farmers at Sik, Kedah. **Methodology:** This study was conducted at the paddy field of Sik, Kedah by recruiting 33 organic and 25 conventional paddy farmers. The adapted questionnaire was used to obtain the respondent's background information. In addition, the environmental and physiological measurements were carried out to determine the heat stress index and physiological strain index. The heat stress index was monitored by using QUESTemp °36 Thermal Environment while the physiological indicators were measured by using Temperature Ear Thermometer, Blood Pressure and Heart Rate Monitor and Cholesterol and Glucose Monitor Kit. **Results and Discussion:** Study shows that there is significant difference between heat stress index, blood pressure and blood glucose levels among organic and conventional paddy farmers. Besides, there is significant association among blood glucose and blood pressure with pesticide used and non-pesticide used among farmers. **Conclusions:** The findings of this study shows that the used of pesticide may act as a synergistic effect that produce greater health effects to those who exposed to heat at their work environment. The difference of heat-related health effects among pesticide used and non-pesticide used's farming community could serve as an important factor to take into account while implementing workplace heat stress program by government at the agricultural industry.

Keywords: Heat exposure, heat-related symptoms, blood glucose and blood cholesterol

ABSTRAK

KESAN PENDEDAHAN HABA TERHADAP KESIHATAN DALAM KALANGAN PETANI PADI ORGANIK DAN KONVENSIONAL DI SIK, KEDAH

NUR AFIQA MARYAM BAHARUDIN, VIVIEN. H

Pengenalan: Haba adalah salah satu daripada bahaya alam sekitar di kalangan petani kerana mereka bekerja secara langsung di bawah cahaya matahari yang dapat menyebabkan perubahan pada faktor fisiologi tubuh seperti suhu badan teras, tekanan darah dan degupan jantung, serta menyebabkan intoleransi kepada glukosa darah dan kolesterol darah. Ini boleh menyumbang kepada berlakunya penyakit yang berkaitan dengan haba dan penyakit metabolik lain di kalangan petani. **Objektif:** Kajian ini bertujuan untuk menentukan potensi kesan kesihatan dari pendedahan haba di kalangan petani padi organik dan konvensional di Sik, Kedah. **Metodologi:** Kajian ini dijalankan di sawah padi Sik, Kedah dengan merekrut 33 petani organik dan 25 padi konvensional. Soal selidik yang disesuaikan digunakan untuk mendapatkan maklumat latar belakang responden. Di samping itu, ukuran alam sekitar dan fisiologi dijalankan untuk menentukan indeks tekanan haba (HSI) dan indeks ketegangan fisiologi (PSI). Indeks tekanan haba diukur dengan menggunakan Persekitaran Termal QUESTemp °36 sementara penunjuk fisiologi diukur dengan menggunakan Thermometer Telinga Suhu, Tekanan Darah dan Monitor Kadar Jantung dan Kit Monitor Kolesterol dan Glukosa. **Keputusan dan Perbincangan:** Kajian menunjukkan terdapat perbezaan yang signifikan antara indeks tekanan haba, tekanan darah dan tahap glukosa darah di kalangan petani organik dan konvensional. Selain itu, terdapat hubungan yang signifikan antara glukosa darah dan tekanan darah dengan racun perosak yang digunakan dan bukan racun perosak yang digunakan petani. **Kesimpulan:** Penemuan kajian ini menunjukkan bahawa penggunaan racun makhluk perosak boleh bertindak sebagai kesan sinergi yang menghasilkan kesan kesihatan yang lebih besar kepada mereka yang terdedah kepada panas di persekitaran kerja mereka. Perbezaan kesan kesihatan yang berkaitan dengan komuniti pertanian yang digunakan dan bukan racun perosak digunakan sebagai racun perosak boleh menjadi faktor penting untuk diambil kira semasa melaksanakan program tekanan haba tempat kerja di industri pertanian.

Kata kunci: Pendedahan haba, gejala yang berkaitan dengan haba, glukosa darah dan kolesterol darah

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LIST OF ABBREVIATIONS

<	Less than
>	More than
°C	Degree Celcius
AL	Action Limit
BMI	Body Mass Index
bpm	beats per minute
GDP	Gross Domestic Product
HDL	high density lipoprotein
HSI	heat stress index
LDL	low density lipoprotein
m/s	meter per second
mL	militre
mmHg	milimeter per mercury
PPE	personal protective equipment
PSI	physiological strain index
Rh	relative humidity
SkBF	skin blood flow
T_{db}	dry-bulb temperature
T_g	globe temperature
T_{nwb}	Natural wet-bulb temperature
$WBGT_{out}$	Wet Bulb Globe Temperature Outdoor

CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture is one of the leading sectors in Malaysia which contributes to National Gross Domestic Product (GDP) especially in paddy production. In fact, National Agro-Food Policy (2011-2020) is targeted to increase the paddy production in order to ensure the country's demand in the future (Rajamoorthy, Khalid, & Munusamy, 2015). In view of this, this sector provides major employment especially in rural areas and is targeted to increase more than 109,000 by 2020 (Rozhan, 2015). To date, agriculture can be divided into two (2) types of farming which are conventional and organic farming. Conventional farming is the farming system that uses pesticides, fertilizers and herbicides to grow the crop while organic farming is the alternative to conventional farming. Instead of using pesticides like conventional farming, organic farming use manure, compost and crop residues to grow the paddy.

As the rice production demand increases due to the increases in the rapid growth of population, the work demand will also increase proportionally which inevitably expose farmers to outdoor extreme temperature over a long period of time. Since agriculture is one of the sectors that listed in the First Schedule of Occupational Safety and Health Act 1994 (Act 514) which the workers' safety, health and welfare shall be safe guarded and concerned. As Malaysia is well-known with its climate that is hot and humid, occupational heat exposure cannot be avoided among the farmers either in the conventional or organic farming.

Heat exposure can lead to the occurrence of heat stress which the body fails to control its internal temperature. Exposure to heat over a long period of time can lead to the occurrence of heat-related symptoms which are heat rash, heat cramps, heat exhaustion and heat stroke. Heat exposure can be contributed by the metabolic heat, environmental heat and personal protective equipment (PPE) worn. In addition, the physiological changes also happened during the heat exposure in order to maintain the internal temperature of the body. Body core temperature, blood pressure and heart rate are the usual physiological indices measure in the response to heat exposure.

Besides, in the conventional farming as the body starts to sweat in order to cool down the body temperature, the pesticides residues are able to absorb through hot and sweaty skin more quickly than through cool skin (MacFarlane et al, 2013). Heat can increase the absorption of pesticides in the body which act as synergistic effects which can increase the risk of getting health problems (Holmstrup et al, 2009). Organic farming, on the other hand, is known as free from using pesticides throughout their farming activities are presumed to have avoided from the synergistic effects of heat-induced metabolic health risks. Even though farmers in both the farming system are associated with heat-related symptoms while working under the extreme heat temperature, the level of health risks can be different considering the different of their farming activities.

1.2 Problem Statement

Occupational heat exposure is very common among farmers as they work outdoor under the extreme hot working environment. Even so, environmental heat, metabolic heat and personal protective equipment (PPE) are the main contributors for the heat exposure among farmers (Guidelines on Heat Stress Management at Workplace, 2016). For instance, pesticide handlers among conventional farmers are at high risk as they wear the required PPE that can limit the cooling process (Hostler et al, 2009). According to Mirabelli et al. (2010) among 161 heat related fatalities, 45% occurred in farmers. Other study suggested that heat stress was responsible for approximately 40% of baseline symptoms including heat exhaustion, fainting and heat fatigue (Zamanian et al, 2017).

Apart from the heat-related symptoms induced from heat exposure, Yardley et al (2013) stated that metabolic health risks such as diabetes are associated with the impairments in temperature regulation during exposure to thermal stress. Type 1 and 2 diabetes mellitus are both associated with decrease in ability to maintain core temperature during thermal stress. This is due to the impairments in the body's ability to release heat mediated via increases in skin blood flow and sweating during heat stress (Kenny et al, 2016). Conventional farmers are presumed to at increased risk of getting diabetes that there is significance association between the occurrences of diabetes (Juntarawijit & Juntarawijit, 2018). It was found that the prevalence of diabetes was positively associated with exposure to all types of pesticides, including insecticides, herbicides, fungicides, rodenticides, and molluscicides, with exposure to rodenticides being statistically significant (Juntarawijit & Juntarawijit, 2018).

Besides diabetes, farmers may have a high risk of getting cardiovascular disease when exposed to heat for a long period of time. Halonen et al (2010) had stated that changes in high density lipoprotein (HDL) and low density lipoprotein (LDL) levels are associated with an increase in ambient temperature may be among the underlying mechanisms of temperature-related cardiovascular mortality. Elevations in skin blood flow (SkBF) and sweating are the primary heat exchange mechanisms in humans that protect against heat-related injury. These heat dissipating responses are accompanied by critical cardiovascular adjustments, which are under autonomic control. If the body fails to adjust to these adjustments, then thermal regulation can be compromised during exercise and/or exposure to elevated environmental temperatures (Cui & Sinoway, 2014). Thus, the severely impaired cardiovascular and autonomic function in congestive heart failure (CHF) could contribute to heat intolerance. Congestive heart failure is condition that affects the ability of heart to pump the blood to all parts of the body. Again, conventional farmers are presumed to be more vulnerable than organic farmers of getting cardiovascular health risk due to the fact that chronic exposure to pesticide are associated with the elevation in the total cholesterol level (Aminov et al, 2013). The problem statement is summarized in the Table 1.1 which states the difference between organic and conventional paddy farming system.

Table 1.1: The Summary of the Difference between Organic and Conventional Paddy Farming System

<table>
<tr><td>Differences</td><td>Conventional Farming</td><td>Organic Farming</td></tr>
<tr><td>Nature of Work</td><td>Use pesticides (e.g.: fungicides, herbicides, and insecticides) to grow the paddy</td><td>No pesticides use (Use compost, manure and organic fertilizer)</td></tr>
<tr><td>Dose of Chemical Exposure</td><td>Exposed to pesticides when routinely spray pesticides in the early crop growth period.</td><td>Not exposed to chemical (pesticides) along the paddy growth period.</td></tr>
<tr><td>Dose of Heat Exposure</td><td colspan="2">• Heat stress (According to Mirabelli et al. (2010) among 161 heat related fatalities, 45% occurred in farmers)
• Farmers are at risk of heat stress due to direct exposure to sunlight for a long period and Malaysia is one of the countries that has hot and humid climate.</td></tr>
<tr><td>Possible Synergistic Effect</td><td>Exposure to pesticide and heat.</td><td>Exposure to heat.</td></tr>
</table>

Figure 1.1: Difference between Organic and Conventional Paddy Planting Process

Conventional Paddy Farming		Organic Paddy Farming
Water irrigation	Land preparation	Water irrigation
Seedlings in 4 days	Germination	Seedlings in 4 days
Multiple seed per place	Planting	A seed per place
No weeding process	Weeding	In day 10,20,30 & 40
Use pesticides	Fertilizer/ Pest control	Use organic matter
Gather all the crop	Harvest	Gather all the crop
Dry the paddy	Post harvest	Dry the paddy

1.3 Study Justification

Heat exposure is one of the serious issues in occupational health as it can cause detrimental health risks among the workers especially farmers involved the most in outdoor and exposed directly to the sunlight. Most of the farmers do not take this issue seriously as they considered the heat exposure as their routine exposure and can be adapted to it. The awareness among them should be increased as they are unaware of the severity of the heat exposure and its consequence health effects. Therefore, it is crucial for farmer to understand the background of heat exposure and subsequent health risks and the mitigation measures to tackle the detrimental health effects bring by the extreme heat exposure.

The importance of this study is that it will provide new insights - increase the awareness of heat exposure and health effects to the farmers by examining their physiological changes which includes core body temperature, heart rate and blood pressure. Besides, the effects on the glucose level and cholesterol level would also be emphasized as this can be the contributing factors of getting various metabolic diseases such diabetes mellitus, cardiovascular disease and liver disorders when exposed to heat for a long period of time. By communicating the result of this study to the farmers, the heat hazards can be identified and the risk of getting heat-related symptoms and other diseases can be reduced.

On the other hand, this study can benefit the employers to ensure that the employees' safety and health are secured at the highest level in order to increase the productivity and to avoid the occurrence of any disease. In addition, the benefit of this study also goes to the authority who responsible to monitor the health and safety of the employees. They also can use this study as the platform to strengthen the enforcement on the implementation of the guidelines and acts in securing the safety, health and welfare of the employees especially the farmers.

To date, there is still limited study examining the potential health effects of using pesticide and its synergistic effects while exposing to extreme temperature during working hours. By comparing the difference of these rice farming systems currently applied in Malaysia, this study will provide evidence on whether organic farming has an additional advantages of human health than the conventional farming, considering that farmers are generally working under the hot sun.

1.4 Objectives

1.4.1 General Objective:

To determine the effects of heat exposure on health among organic and conventional paddy farmers at Sik, Kedah.

1.4.2 Specific Objectives:

i. To examine the socio-demographic of organic and conventional paddy farmers.
ii. To compare the heat stress index (WBGTout values) of organic and conventional paddy farmers.
iii. To compare the heat-related symptoms and physiological parameters (Blood Pressure, Core Body Temperature, Heart Rate, Blood Glucose, Blood Cholesterol) among organic and conventional paddy farmers.
iv. To compare the physiological strain index among organic and conventional paddy farmers.
v. To determine the association between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers.
vi. To determine the relationship between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers

1.5 Hypothesis

H_1: There is significant difference between heat stress index (WBGTout values) of organic and conventional paddy farmers.

H_2: There is significant difference between the heat-related symptoms and physiological parameters (Blood Pressure, Core Body Temperature, Heart Rate, Blood Glucose, Blood Cholesterol) among organic and conventional paddy farmers.

H_3: There is significant difference between the physiological strain index among organic and conventional paddy farmers.

H_4: There is significant association between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers.

H_5: There is significant relationship between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers.

1.6 Definition of Terms

1.6.1 Heat Stress

1.6.1.1 Conceptual Definition

Heat stress is overall heat load to which an individual may be exposed from the combined contributions of metabolic heat, environmental factors and clothing requirements. This causes the body absorbed too much heat and fails to control the internal temperature (Guidelines on Heat Stress Management at Workplace, 2016).

1.6.1.2 Operational Definition

The heat stress index measures the effects of six (6) parameters in any human thermal environment. The six (6) parameters are air temperature, radiant temperature, humidity, air movement, metabolic heat generated by human activity and clothing worn by a person (Parsons, 1993).

1.6.2 WBGT (Wet Bulb Globe Temperature Outdoor) Environmental

1.6.2.1 Conceptual Definition

The instrument used to measure and calculate four (4) parameters of heat stress index; outdoor WBGT value (WBGTout), dry bulb temperature (DB), natural wet bulb temperature (NWB), globe temperature (GT), and relative humidity (RH) (QUEST Technologies, 2008).

1.6.2.2 Operational Definition

QUESTemp 36° Thermal Environmental Monitor is used to measure heat stress index of the workplace that exposed to heat either directly or indirectly. It measures and records the reading for average hours of working period. The WBGTout is calculated in the value of degree Celcius (°C) while the time base for measurement of WBGT shall be taken in total one hour corresponding to the maximum heat stress (Guidelines on Heat Stress Management at Workplace, 2016).

1.6.3 Dry Bulb Thermometer

1.6.3.1 Conceptual Definition

Dry bulb thermometer is used to measure ambient air temperature by measuring the outdoor WBGT when there is presence of high solar radiant heat load (QUEST Technologies, 2008).

1.6.3.2 Operational Definition

The dry bulb thermometer measures the ambient air temperature. This measurement is used in the outdoor WBGT calculation when a high solar radiant heat load may be present. The series of white plates surrounding the sensor shield it from radiant heat (QUEST Technologies, 2008).

1.6.4 Natural Wet Bulb Temperature

1.6.4.1 Conceptual Definition

Natural Wet bulb thermometer is the indication of the effects of humidity on an individual which considered the relative humidity and wind speed (QUEST Technologies, 2008).

1.6.4.2 Operational Definition

The natural wet bulb thermometer measures the relative humidity by exposing a wet sensor, such as wet cotton wick fitted over the bulb of a thermometer, to the effects of evaporation and convection taking place at a thermometer (Guidelines on Heat Stress Management at Workplace, 2016).

1.6.5 Globe Bulb Temperature

1.6.5.1 Conceptual Definition

Globe thermometer is the indication of radiant heat exposure on an individual due to either direct sunlight or hot objects in the environment (QUEST Technologies, 2008).

1.6.5.2 Operational Definition

The globe thermometer measure radiant air temperature by using a black globe with a thermometer inserted in the centre. Radiant air temperature is measured by assessing the combined effects of radiation, air temperature and air velocity on human comfort (Aparicio, 2015).

1.6.6 Blood Pressure and Heart Rate

1.6.6.1 Conceptual Definition

Blood pressure is the amount of force exerted against the walls of the arteries as blood flows through them (Nordqvist, 2017). The heart rate measures the number of times the heart beats per minute (bpm). It can vary as a result of physical activities and emotional responses (MacGill, 2017).

1.6.6.2 Operational Definition

Blood pressure is measured in millimetres of mercury (mmHg) and divided into systolic and diastolic blood pressure. The normal blood pressure in an individual is 120/80 mmHg. The blood pressure and heart rate are measured using Omron T3 Blood Pressure and Heart which it can simply generate the measurement digitally on the screen.

1.6.7 Core Body Temperature

1.6.7.1 Conceptual Definition

Core body temperature is the ideal body temperature (98.6°F or 37.7°C) for the internal organs and bodily systems to function at optimal level (Gale, 2007).

1.6.7.2 Operational Definition

Core body temperature is measured by using Omron MC-510 Gentle Temperature Ear Thermometer which is easily portable to be used. The instrument measures the temperature of the individual's body when exposed to heat through ear canal to ensure the accuracy of the measurement.

1.6.8 Physiological Strain

1.6.8.1 Conceptual Definition

Physiological strain is the change produced in the physiological system of the body in response to the stress.

1.6.8.2 Operational Definition

Physiological Strain Index (PSI) is measured the combined effects of heart rate and ear canal temperature and the value of PSI will then describe on the scale of 0 to 10. This index imitates the combined load on the thermoregulatory and cardiovascular systems. Thermoregulatory strain measures by the efficiency of heat dissipation mechanisms while the metabolic heat production uses the heart rate (HR) as indicator corresponds to demands placed on the circulatory system (Pokora & Zebrowska, 2016).

1.6.9 Blood Glucose and Blood Cholesterol

1.6.9.1 Conceptual Definition

The amounts of glucose present in the blood of individual which depends on what, when and how much food eaten and also vary as a result of physical activities. The amounts of cholesterol present in the blood of individual which can vary by age, weight and gender. It is measured in three (3) categories which are total cholesterol, LDL and HDL (Fletcher, 2017).

1.6.9.2 Operational Definition

The level of blood glucose and blood cholesterol is measured using Glucose and Cholesterol Level Meter that require the respondents' blood to measure the glucose and cholesterol level in the body. This instrument consists of blood collection needle and test strips.

1.7 Conceptual Framework

The variables that are included in this study are heat stress index, physiological strain index (core body temperature, heart rate and blood pressure), health indicators (blood glucose level and blood cholesterol level) and self-reported health effects. The heat stress index consists of environment temperature, globe temperature, wet bulb temperature and dry bulb temperature.

The contributing factors such as usage of PPE, working hours and duration of work will also be considered as exposure to heat. Both farmers in organic and conventional farming exposed to heat may cause changes in physiological response. Thus the physiological strain index will be measured to evaluate the effect of exposure. This is important to know the effect on heat-related symptoms when exposed to heat. Besides, heat exposure may cause other Non-communicable diseases (NCD) such as diabetes and cardiovascular disease which are among the leading diseases compared to other NCDs. This can be examined by measuring the level of blood glucose and blood cholesterol.

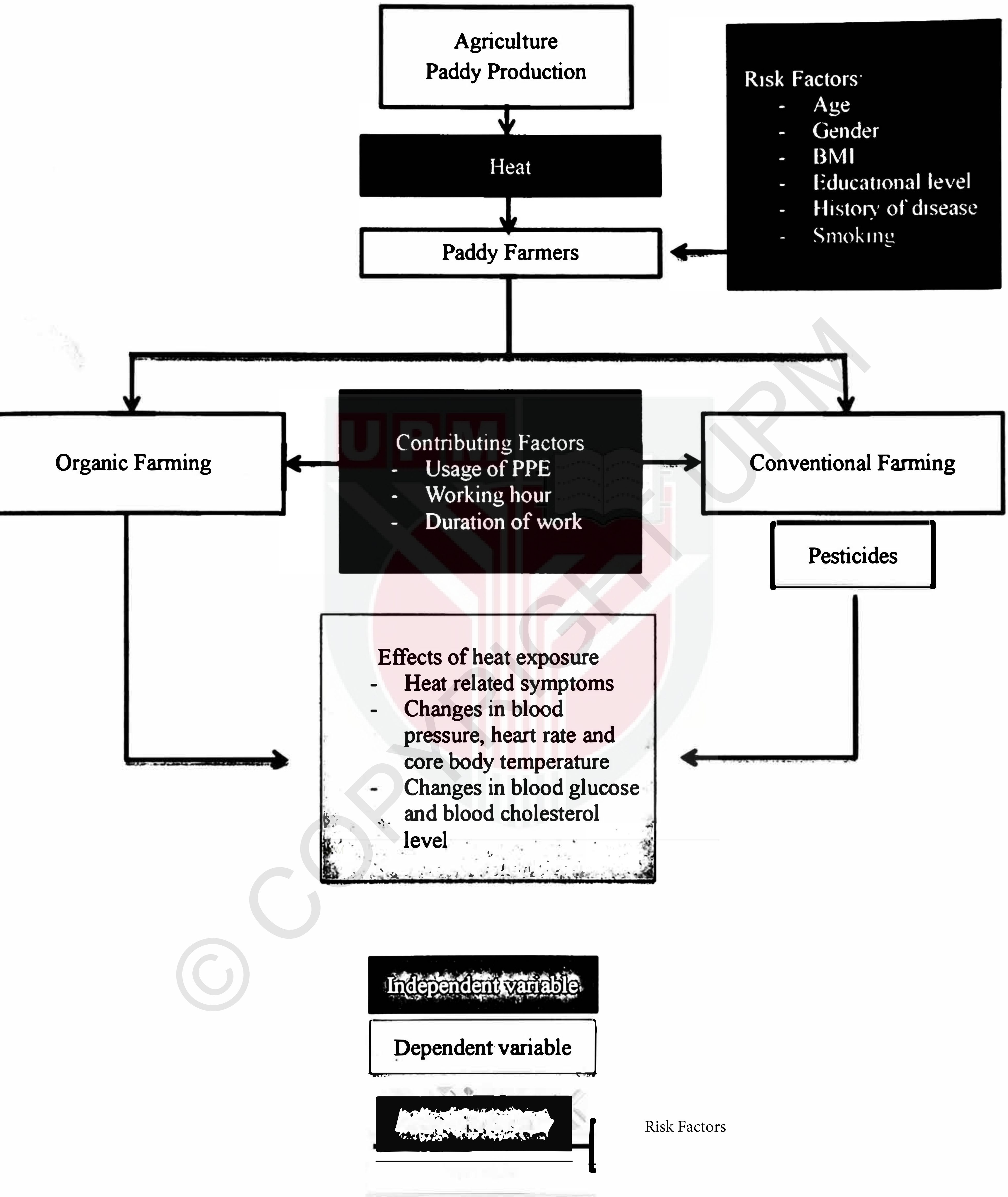

Figure 1.2: The Conceptual Framework of the Study

Variable

CHAPTER 2

LITERATURE REVIEW

2.1 Agriculture Sector

Agriculture has become the most crucial sector not only in Malaysia but also globally as it is the main sector that ensures the continuous supply of food either directly or indirectly. As the rate of population grows rapidly, the agriculture sector has developed greatly in terms of food production. Specifically, rice is the main staple food that supports the life of more than half world's population (IRRI, 2006). For about 137 million ha had been harvested (88% of global rice harvested) in 2010 in order to meet the demand of total population worldwide (FAOSTAT, 2012). Agriculture can be divided into two (2) farming system which are conventional and organic farming. Conventional faming is related to the usage of chemical such as pesticides in increasing the crop production while organic farming is the alternative of conventional farming which can enhance the sustainability of current food production system. Organic farming is related to the usage of natural substances such as manure, organic fertilizers and slurry. However, both of these farming systems have their own pros and cons and the crop production not just depends on the type of farming system, but also the meteorological patterns of agricultural areas (Teasdale & Cavigelli, 2017). In order to meet the demand of food production in future, the production of food will be increased by opening the new land for agriculture. Thus agriculture sector open the job opportunity to the community especially in rural areas (Asiwe, 2015).

2.2 Heat Stress

Heat exposure is very common among workers who work in outdoor environment especially in the Malaysia's climate which is hot and humid. Exposure to heat over a long period may lead to the occurrence heat stress which is one of the environmental hazard for the worker's health especially farmers in agriculture sector. Besides decreased the productivity of the farmers, heat stress also may cause various human health impacts such as heat-related symptoms which include heat rashes, heat exhaustion, heat cramps and heat stroke. Heat stress is the total heat load experience by an individual exposed to combination factors of metabolic heat, environmental (i.e. air temperature, humidity, air movement, and radiant heat), and clothing requirements. The failure in regulating internal body temperature can lead to the heat stress (Guidelines on Heat Stress Management at Workplace, 2016). However, the occurrence of heat stress becomes more common among farmers as it directly exposed them to the sunlight which is the radiant heat source. Farmers who exposed to radiant heat source are more likely to experience a greater heat burden and at high risk of getting heat-related symptoms and other related diseases (Hosokawa, 2018).

Heat stress index is one of the common methods used to assess heat stress level experience by the individual who exposed to heat. It generates the value that combined the factors of thermal, physical and personal which affecting the mechanism of heat transfer between the individual and the environment (Mohameed Youssef & Ramsey, 1988). This can be measured by using Wet Bulb Globe Temperature (WBGT) which includes the measurement of air temperature, humidity, air velocity and radiant heat temperature. Then the equation below is used to total up the heat transfer between the individual and the environment.

WBGT (indoor) = 0.7WB + 0.3G (denoted as "WBGTi" on the display)

WBGT (outdoor) = 0.7WB + 0.2G + 0.1DB (denoted as "WBGTo" on the display)

WB = Wet Bulb Temperature

G = Globe Temperature

DB = Dry Bulb Temperature

Source: [QUEST Technologies, 2008]

Besides, the metabolic heat and clothing insulation are also being taken into account in measuring heat stress index. Metabolic heat is the heat dissipated by the body via chemical processes, exercise, hormones activity and others. While clothing plays an important roles which causes either heat comfort or discomfort to the individual as it can act as insulator or barrier to heat balance by preventing evaporative and convective cooling (Guidelines on Heat Stress Management at Workplace, 2016).

Table 2.1 Metabolic rate of Workers by Job Category

Work Category	Metabolic Rate	Examples of physical work
Rest	115 W	Sitting
Light	180 W	Sitting with manual work with hands or hands and arms and driving Standing with some light arm work and occasional walking
Moderate	300 W	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking Moderate lifting
Heavy	415 W	Intense arm and trunk work, carrying, shoveling, manual sawing, pushing and pulling heavy loads and walking at a fast pace. Heavy metal handling
Very Heavy	520 W	Very intense activity at fast to maximum pace.

Source: Guidelines on Heat Stress Management at Workplace 2016, DOSH Malaysia

Table 2.2 Screening Criteria for TLV and AL based on ACGIH TLV

	SCREENING TLV				SCREENING AL			
% WORK	LIGHT	MODERATE	HEAVY	VERY HEAVY	LIGHT	MODERATE	HEAVY	VERY HEAVY
75-100	31.0	28.0	-	-	28.0	25.0	-	-
50-75	31.0	29.0	27.5	-	28.5	26.0	24.0	-
25-50	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0-25	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Source: Guidelines on Heat Stress Management at Workplace 2016, DOSH Malaysia

2.3 Physiological changes

Physiological changes are the common indicators used to measure changes of body system when exposed to heat over a long period. Physiological parameters such as core body temperature, heart rate and blood pressure are very sensitive towards the presence of heat as it is to ensure the body is capable to adapt to the changes in the environment. This is very crucial response to react by the body in order to ensure the heat produced within the body and heat lost to the environment are balanced. The unstable changes of physiological parameter can cause harm to the body as heat waves can exceed the physiological adaptive capacity. For example, the continuous rises in body core temperature can cause heat illness or even death (Kenny et al, 2010). Individual should always maintain their body temperature at normal value which is 37°C or equivalent to 98.6°F (Osilla & Sharma, 2018). In addition, physiological system is being controlled by maintaining the cardiac output and blood pressure approximately to normal levels (Kenney, 1971). This is important in order to avoid the occurrence of heat stroke when strike with heat waves.

2.4 Blood Glucose Level

Glucose is the source of energy for the body to work especially during physical activity and it is stored in the body as glycogen. Blood glucose level is measured to know the amount of sugar contain in the blood which health effect like hypoglycaemia or hyperglycaemia or diabetes mellitus occur in an individual when the amount of glucose in blood below or above normal level (Whitmore, 2013). The increased in the level of blood glucose is associated with the heat exposure but it may cause from the increased in hepatic glucose output due to increase in sympathetic drive (Dumke et al., 2015). In addition, it was reported that heat waves support the occurrence of type 2 diabetes and this condition causes the individual has high risk fir heat-related illness or even death (Schwartz, 2005). On the other hand, the previous study stated that the exposure to pesticides can elevate the blood glucose level. Starling et al. (2014) stated that the organophosphates which are fonofos (OR = 1.56; 95%CI 1.11–2.19), phorate (OR = 1.57; 95%CI 1.14–2.16) and parathion (OR = 1.61; 95%CI 1.05–2.46) are the diabetic risk compounds. While Saldana et al. (2007) also claimed that diabetes and pesticide exposure are related with odds ratios of 2.2 (95%CI 1.5–3.3).

2.5 Blood Cholesterol Level

Cholesterol is the product manufactured by the body and can be divided into two types which are high density lipoprotein (HDL) and low density lipoprotein (LDL). HDL is the good cholesterol as it helps the cholesterol to be transported to the liver and removed from the body. While LDL is the bad cholesterol as it accumulates at the wall of arteires which impede the blood flow. It can cause good effects in small amount but as amount of cholesterol increase largely, it can cause serious health effects [MacGill, 2017]. However, many of us do not know that the exposure to heat can elevate the blood cholesterol level. Halonen et al. [2010] had claimed that HDL decreased −1.76% (95% CI: −3.17 – −0.32, lag 2 days), and −5.58% (95% CI: −8.87 – −2.16, moving average of 4 weeks) for each 5°C increase in mean ambient temperature. While LDL increased by 1.74% (95% CI: 0.07 – 3.44, lag 1 day) and 1.87% (95% CI: 0.14 – 3.63, lag 2 days) for the same increase in mean ambient temperature. On the other hand, Aminov, Haase, Pavuk, & Carpenter

[2013] had stated that polychlorinated biphenyls is positively related to the increase in total lipids, total cholesterol and triglycerides, however not with HDL or LDL cholesterol.

This study will relate heat stress to core body temperature, heart rate and blood pressure which each of them has shown significantly affected and differentiates the individual exposed to heat. According Mohd Kassim (2016), there are several personal factors that can influence and affect workers towards heat stress. There are acclimatisation, prescription of drugs, illness or disease, age and diet can give significantly negative impact to an individual's thermoregulation. This will directly change the degree of heat strain experienced.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This study was the comparative cross-sectional study which was to determine the effect of heat exposure on physiological health among organic and conventional paddy farmers.

3.2 Study Location

This study was conducted at the district of Sik, Kedah and this state was chosen as it is the biggest paddy producer in Malaysia which contributes about 70% of paddy production. For the organic farming, the study was conducted at Sri Lovely Organic Farm at Kampung Lintang, Sik. This farm was built since 2009 and has about 32 acre of paddy field. While for conventional farming, it was conducted at Kampung Tupai, Sik where the paddy farming was the community's main economic activities.

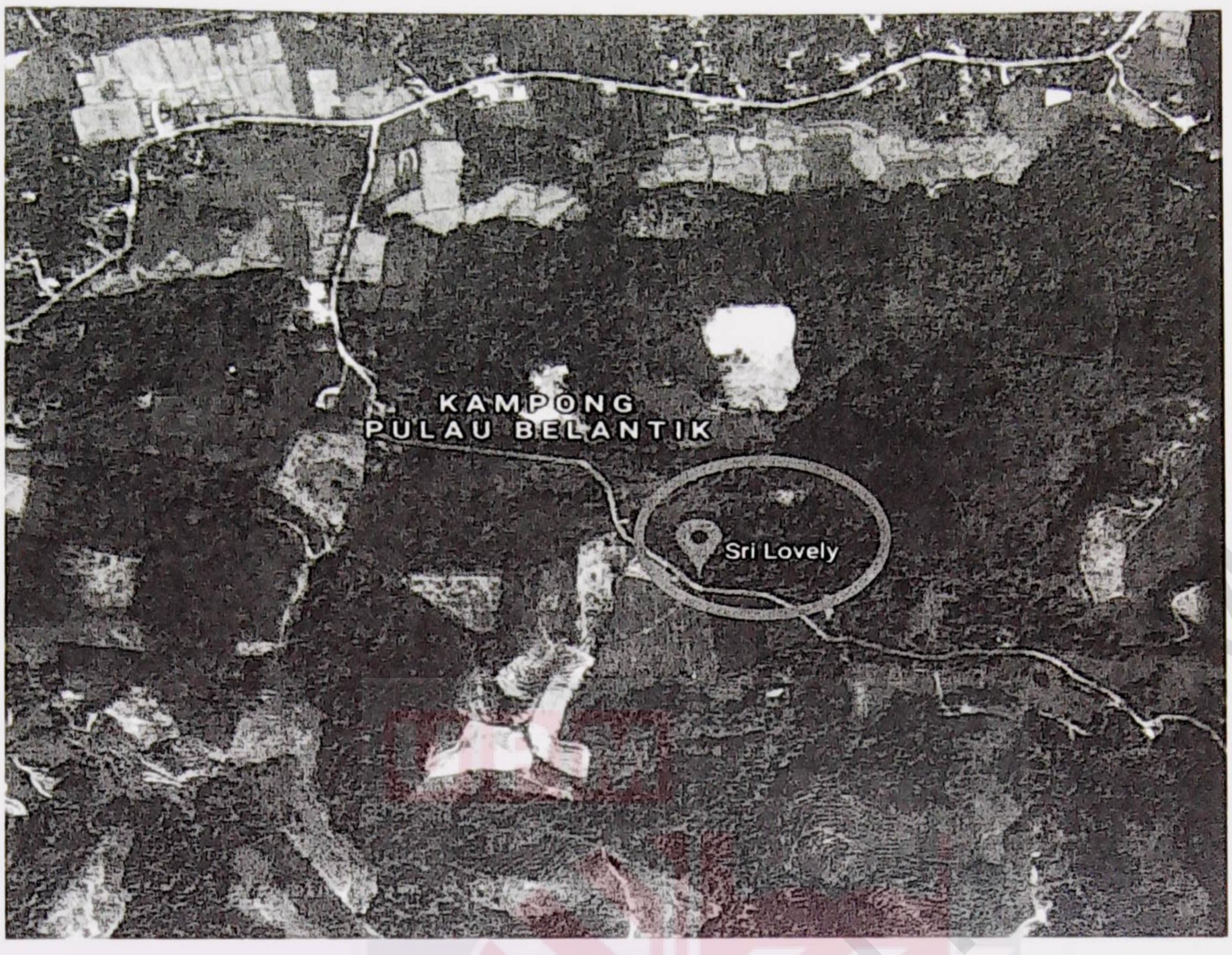

Figure 3.1 Mapping of Study Location for Organic Paddy Farming

(6.047414, 100.842257)

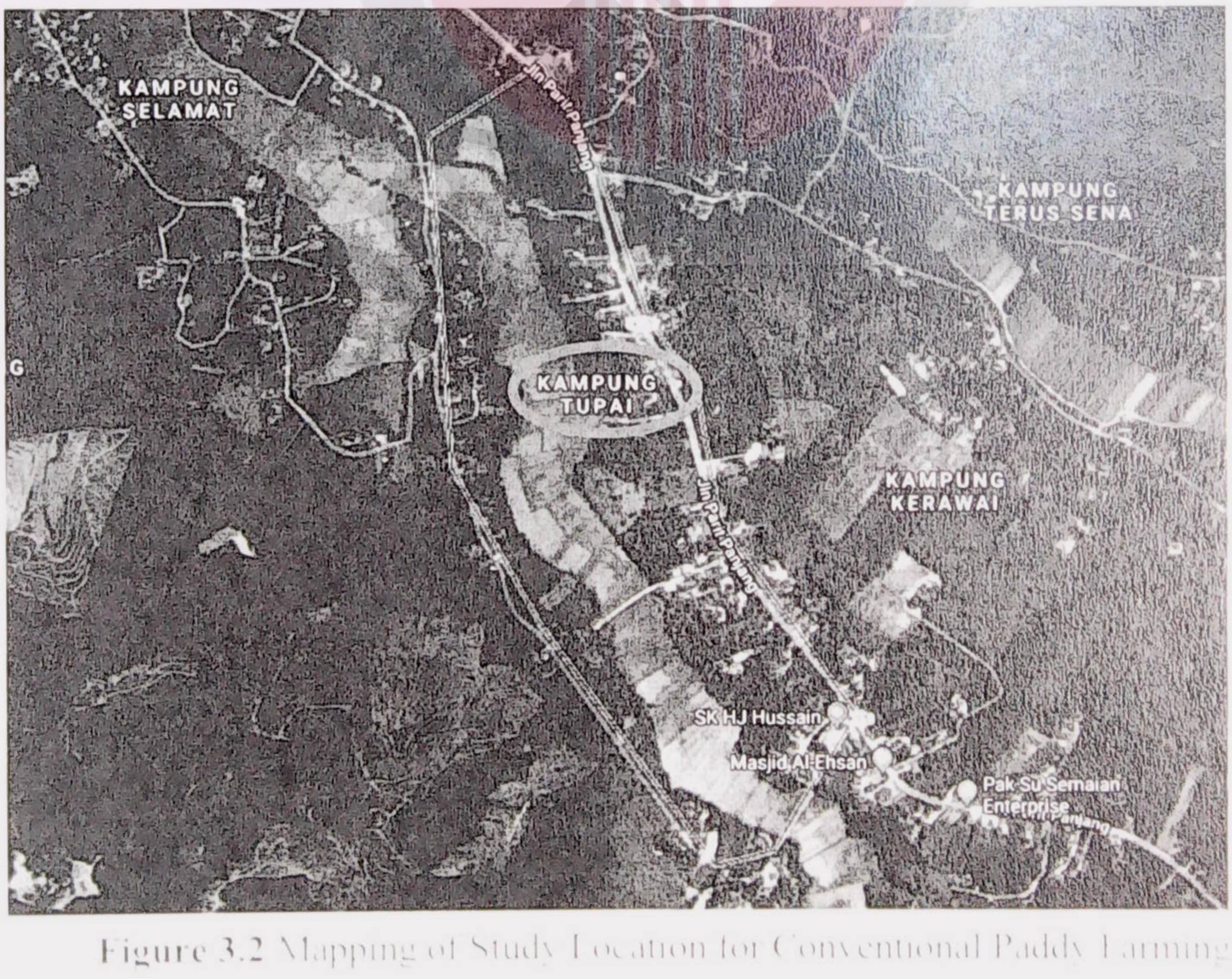

Figure 3.2 Mapping of Study Location for Conventional Paddy Farming

(5.761992, 100.712077)

3.3 Study Population

The target population were among male paddy farmers in Sik, Kedah who involved in organic and conventional paddy farming. Both farming system exposed the paddy farmers to heat and cause heat-related physiological health effects.

3.4 Sampling

3.4.1 Sampling Frame

The paddy farmers' name list were obtained from management of Sri lovely Organic Farm for Organic paddy farmers while for conventional paddy farmers were obtained from the individual farmers.

3.4.2. Selection Criteria

3.4.2.1 Inclusion Criteria:

a) Male paddy farmers work at organic or conventional paddy farming
b) Exposed to heat while working
c) Age range between 20-60 years old
d) Paddy farmers who employed more than 3 months (Mohd Kassim, 2016)
e) Do not consume alcohol and any medication (such as diuretics, Angiotensin converting enzyme (ACE) inhibitors) that may reduce heat tolerance and increase risk of heat illnesses.

3.4.2.2 Exclusion Criteria

Respondent who do not fulfil the inclusive criteria will be excluded from this study. Based on conceptual framework (Figure 1.1), the risk factors will be controlled through inclusive criteria in this study.

3.4.3 Sampling Unit

The paddy farmers who worked in organic or conventional farming that fulfil with inclusive criteria were selected as sampling unit.

3.4.4 Sampling Size

The sample size estimation is calculated by comparing two means and based on the study conducted by Mohd Kassim [2016]. The samples that involved in this sample size calculation are as follows:

$$\text{Number of sample size (n)} = \frac{2\sigma^2[Z_{1-\alpha/2}+Z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

σ = estimated standard deviation

μ_1 = estimated mean (larger)

μ_2 = estimated mean (smaller)

$Z_{1-\alpha/2}$ = two-sided Z value (e.g. Z = 1.96 for 95% confidence interval)

$Z_{1-\beta}$ = power (usually 80%)

$$n = \frac{2(\sigma)^2(1.96+0.842)^2}{(\mu_1-\mu_2)^2}$$

$$n = \frac{2(6.185)^2(1.96+0.842)^2}{(126.93-122.68)^2}$$

n = 33 paddy farmers

In considering any likelihood of refusal by the respondents, 20% of the sample size is added. Thus both organic and conventional paddy farmers required sample size of 40 for each group. So the total sample size of both groups is 80 respondents.

However, there some limitations in obtaining enough respondents in this study. The total respondents for organic paddy farmers obtained were only 33 respondents while 25 respondents for conventional paddy farmers. These were because organic paddy farming sectors in Malaysia were only small scale farming as compared to conventional paddy farming. Thus, the number of organic paddy farming involved in this farming was too small. For conventional paddy farmers, it was difficult to obtain enough respondents as by the time of data collection, it was near to harvesting season so there were only some farmers who did pesticides spraying. This study only included the conventional farmers who did pesticides spraying in order to get accurate result of parameters measured.

3.4.5 Sampling method

This comparative cross-sectional study uses purposive sampling to obtain the respondent with inclusive criteria from the whole number of population of farmers. The population of farmers were obtained management for the farm and individual farmers. This is to ensure the study has enough sample size of respondents. The selected respondents who fulfil with the inclusive criteria which determined through questionnaire were going through physiological changes monitoring and health indicators monitoring.

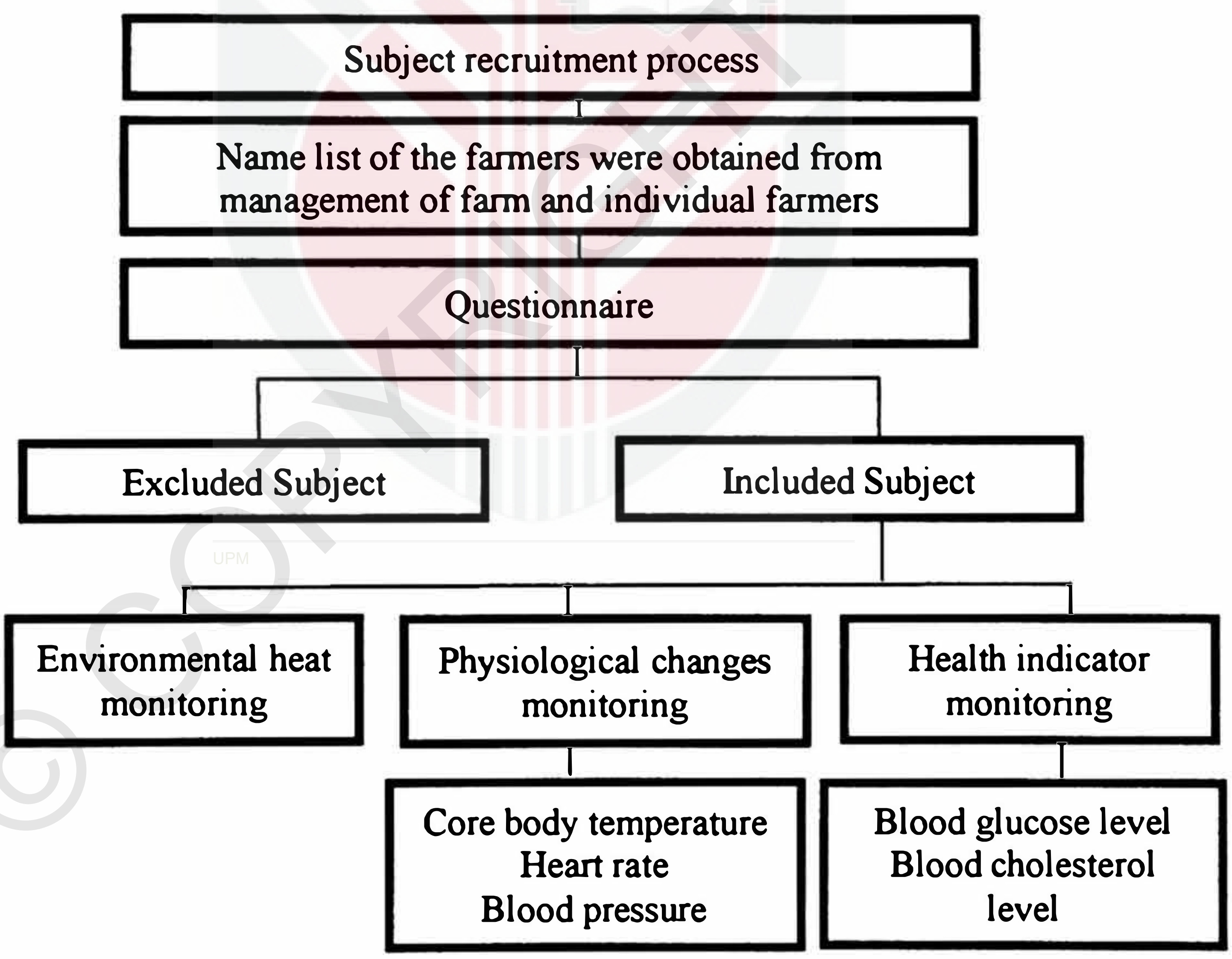

Figure 3.3: Data Collection Method

3.5 Instrumentation

3.5.1 Questionnaires

The questionnaire from the previous study (Kassim et al, 2018) was adapted which consists of five sections:

a) Part A: Socio-Demographic
b) Part B: Occupational Information
c) Part C: Health Information
d) Part D: Lifestyle Information
e) Part E: Employment Health Complaints

3.5.2 QUESTemp °36 WBGT Thermal Environment Monitor

The objective of this instrument was to measure the heat stress index in the work areas. As WBGT is connected to the 3 sensors, each sensor was placed at different levels which are at 0.1m, 1.1m and 1.7m. The parameters of WBGT were:

1. Dry Bulb Temperatue, T_{db}

- Measured by a thermal sensor, such ordinary mercury in glass thermometer, that is shielded from direct radiant energy sources.

2. Natural Wet Bulb Temperature, T_{nwb}

- Measured by exposing a wet sensor, such as wet cotton wick fitted over the bulb of a thermometer, to the effects of evaporation and convection. The term natural refers to the movement of air around the sensor.

3. Globe Temperature, T_g

- The temperature measured inside a blackened, hollow, thin copper globe.

4. Relative Humidity, Rh

The ratio of the quantity of water vapour actually present in any volume of air to the quantity of water which was required to saturate that volume of air (at the same temperature).

5. Wet Bulb Globe Temperature, WBGT

- Composite temperature used to estimate the effect of temperature, humidity, wind speed, and solar radiation on human. The WBGT was used to determine appropriate exposure and activity levels to high temperatures.

6. Air velocity

- Wind, whether generated by body movements or air movements, is the rate in feet per minute (fpm) or meters per second (m/sec) at which the air moves and is important in heat exchange between the human body and the environment because of its role in convective and evaporative heat transfer.

For the placement of this instrument during data collection, it wasplaced on the stable farmland and not interfere with the working activities where the farmers work. This instrument measures and records the reading for 4 hours of working period. The monitoring procedures are as follow:

1. The WBGT was calibrated by using calibrator.

2. The tripod stand was set up with WBGT and each sensor is connected to WBGT at different levels which were 0.1m, 1.1m and 1.7m (the position of standing worker).

3. The wet bulbs of the 3 sensors were filled with distilled water for at least 1/3.

4. The set up WBGT was placed to the high heat exposure area (on the farmland).

5. After 20 minutes (to ensure the sensors stabilize to the new environment and the wick of the wet bulb already absorbed the water), the WBGT was run by pressing the RUN/STOP key for monitoring the heat at the exposed area.

6. After 4 hours of monitoring, the WBGT was stopped by pressing the RUN/STOP key.

7. Finally, the excess distilled water in wet bulb was removed and the data obtained during the monitoring was transferred to the computer.

Source: (QUEST Technologies, 2008)

Besides, some steps of quality control should be complied in order to obtain an accurate result such as:

1. The QUESTemp° 36 and calibrator was calibrated to ensure the heat stress meter in its appropriate range which the dry and the natural wet-bulb thermometers should be -5°C to +50°C, with an accuracy of ±0.5°C.

2. The tripod mounting was placed unit away from anything that might block the radiant heat or airflow.

3. The wet bulb was filled with distilled water instead of tap water, as tap water may leave contaminants after evaporation. When this happened, it will shorten the life of wick and cause high reading.

4. The bottom of the wick was ensure to be in down of the reservoir and the wick was kept wet with distilled water for half of an hour before the monitoring.

5. The WBGT was left to be stabilized with the environment for 20 minutes.

Figure 3.4: QUESTemp °36 WBGT Thermal Environmental Monitor

Source: (QUEST Technologies, 2008)

After the data collection of heat stress index, the data obtained was calculated as follow by considering the cloth thermal insulation and metabolic rate of each subject.

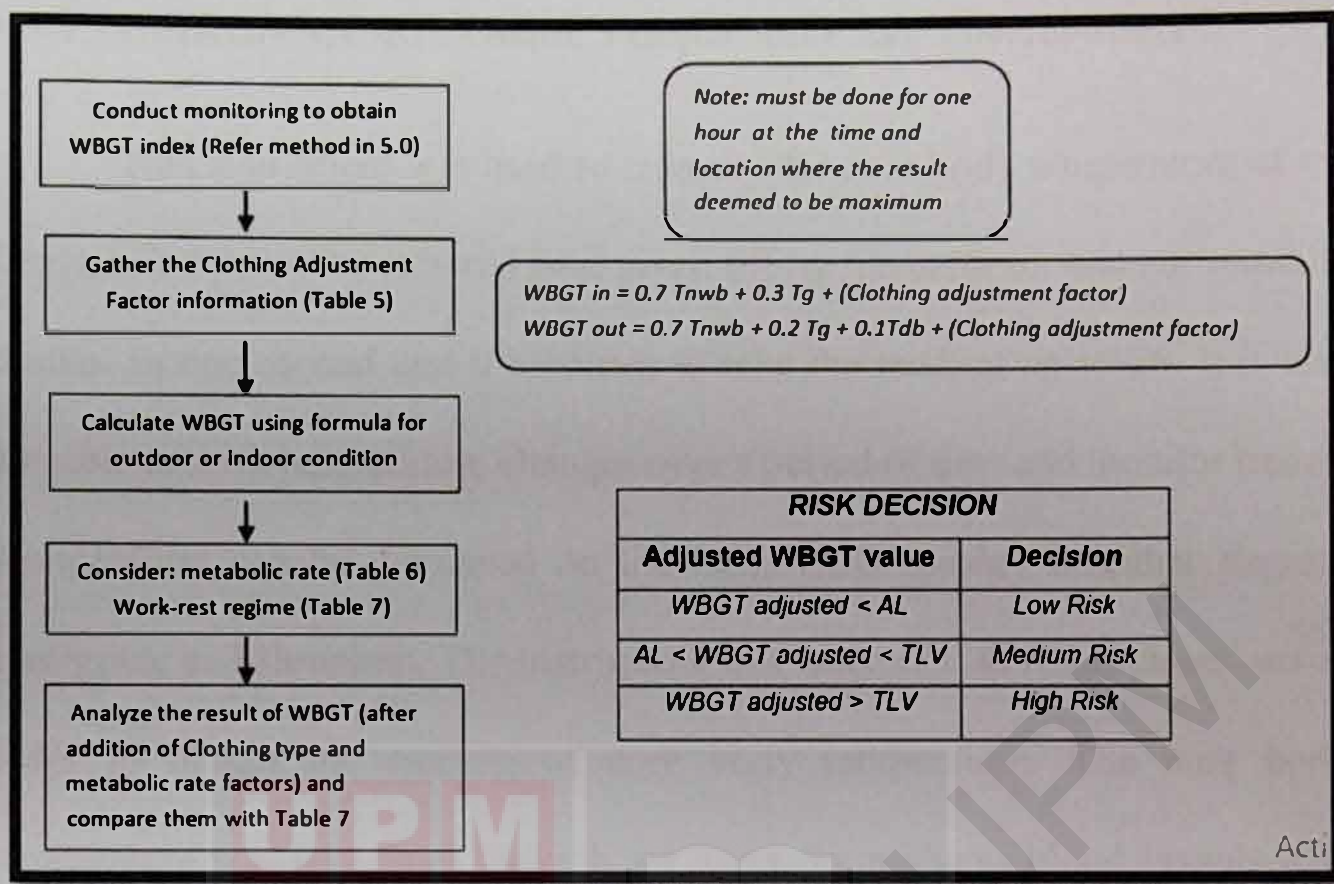

Figure 3.5: Calculation of Heat Stress Index

Source: (QUEST Technologies, 2008)

3.5.3 Weighing Scale and Height Meter

The SECA Body Meter was used to measure the height of respondents and the SECA Body Weighting was used to measure the weight of the respondents. The data obtained from these devices were recorded in the questionnaire.

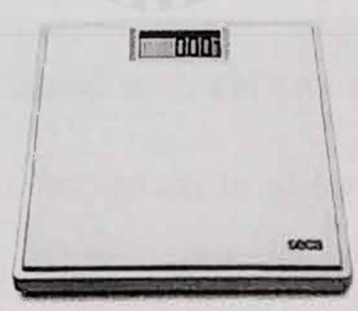

Figure 3.6: SECA Body Weight

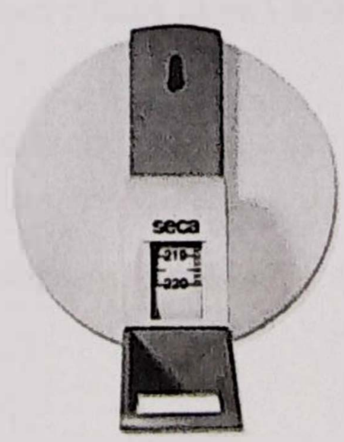

Figure 3.7: SECA Body Meter

3.5.4 OMRON MC-510 Gentle Temperature Ear Thermometer

This instrument was used to measure the core body temperature of the farmers. It detects the infrared heat given off by the eardrum and surrounding tissues, in one second and it capables to take the reading up to 25. It is also possible to track temperature changes over a period of time and monitor trends. Temperature can be displayed on the large LCD display in either degrees centigrade or Fahrenheit. The instrument was inserted into respondents' ear in order to obtain the reading of core body temperature. The core body temperature was measured through ear as eardrum shares blood vessels with the hypothalamus which responsible to control the body temperature. Thus, ear can be an accurate indicator to measure internal core body temperature. Some precautionary steps were taken when using this instrument. For example:

a) The probe cover was placed to avoid the infrared sensor from dirt or other substances. Thus, the accurate measurement can be obtained.

b) The probe cover was replaced with a new one when it was used by other individual or contaminated with earwax or other substances. The practice of personal hygiene is important in order to avoid any infectious diseases such as otitis external and to obtain a correct measurement.

The procedure of the measurement is as follow:

a) The probe cover was attached to the instrument until it clicks.

b) The power was turned on to ensure the instrument is ready for the measurement.

c) The probe was inserted into the ear as far as it goes in the direction of the eardrum. It then will produce a beeps sound which indicates the measurement is started.

d) The measurement was finished when the instrument starts to beep repeatedly.

Source: (OMRON Instruction Manual, 2003)

Figure 3.8: OMRON MC-510 Gentle Temperature Ear Thermometer

3.5.5 OMRON T3 Blood Pressure and Heart Rate Monitor

This instrument was used to measure the blood pressure and heart rate of farmers before they start their work and after they finish their work. This model offers dual settings for two users and a memory storage space for up to 60 readings, in order to ensure the data obtained is reliable information necessary for managing heart health. The cut-off point for blood pressure is 140/90 mmHg and the heart rate is 60-100 beats per minute. Besides averaging the last three readings of heart rate and blood pressure, it also displays the date and time of the measurement.

OMRON T3 Blood Pressure and Heart Rate Monitor measures the blood pressure and heart rate by placing the arm cuff to the upper arm of the subject. The START/STOP button was pressed to start the measurement. The monitor of the instrument displays the blood pressure and heart rate reading when the measurement was completed. However, some precautionary steps were taken to obtain accurate and reliable reading of blood pressure and heart rate. For example, the subject should avoid eating, smoking and exercising for at least 30 minutes before the measurement and need to wait for at least 2-3 minutes before taking another measurement.

Source: (OMRON Instruction Manual, 2004)

Figure 3.9: OMRON T3 Blood Pressure and Heart Rate Monitor

. Based on the measurement reading obtained for core body temperature and heart rate, the physiological strain index (PSI) can be calculated in order to determine the PSI before and after working schedule among organic and conventional paddy farmers. PSI is calculated based on the formula below:

$$PSI = 5(Tty_T - Tty_o) \cdot (39.5 - Tty_o)^{-1} + 5(HR_T - HR_o) \cdot (180 - HR_o)^{-1}$$

Tty_T = baseline aural canal temperature

Tty_o = endpoint aural canal temperature

HR_T = baseline heart rate measurements

HR_o = endpoint heart rate measurements

Source: (Pokora & Zebrowska, 2016)

3.5.6 Glucose and Cholesterol Level Monitor

This instrument was used to measure the level of glucose, cholesterol and uric acid. However in this study, it was used only to measure the level of glucose and cholesterol in the blood which may have significant relationship with heat stress index. This 3 in 1 multi-monitoring meter requires less blood collection which just 0.7 μL. It can produce the result for less than 30 seconds for each measurement. For example it takes 10 seconds to measure glucose level while 26 seconds for cholesterol level. Besides, it is capable to store the data of 460 groups. The procedures of using this instrument are as follow:

a) The test strip (either glucose or cholesterol test strip) was inserted to the monitoring meter and the detection system will automatically start.
b) The lancet was used to prick the fingertip of the subject for the blood.
c) The blood was touch to the edge of the test strip and the result was generated in a few seconds.

d) Finally, the result was displayed on the screen based on the test strip used either glucose or cholesterol test strip.

Some precautionary steps were taken to obtain an accurate result of either blood glucose or blood cholesterol level. It includes:

a) The hand was first be washed with warm and soapy water to remove any dirt or other substances from the fingertip or used the alcohol swab before the prick.

b) By using the unused and clean lancet to prick the fingertip of the subject to avoid cross-contamination.

c) Calibrating the monitor meter together with the test strip and placing the control solution in order to check whether or not the value shown on the monitor matches the value stated on the manual (Pickering & Marsden, 2014).

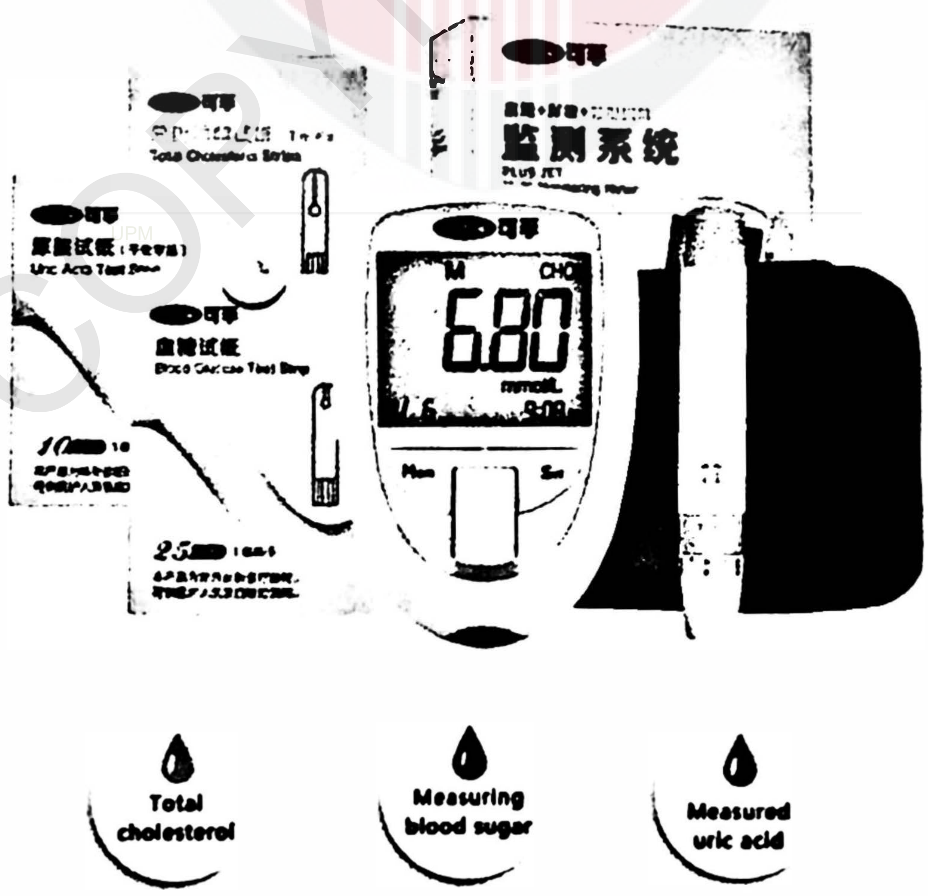

Figure 3.10: Cholesterol and Glucose Level Monitor

(Model: Cofoe Medical)

3.6 Quality Control

3.6.1 Questionnaire

The pre-test of qestionnaire was conducted to ensure the validity and reliability of the questionnaire for among 10 percent of total respondents.

3.6.2 Physiological Health Monitoring

All the precautionary steps stated for each measurement for core body temperature, heart rate, blood pressure, blood glucose and blood cholesterol level were followed in order to obtain the accurate results.

3.6.3 Environmental Heat Monitoring

WBGT used in this study have calibrated before the data collection had started in order to ensure all of them is in good condition and minimize any data error. This also has enhanced accuracy of the result. The calibration process has referred the standard procedure given.

3.7 Data Analysis

All the collected data from questionnaire and measurement has been analyzed by using IBM SPSS Version 25 Software. The assumption of normality for significant was ($p>0.05$).

Table 3.1: Data Analysis

Variable	Type of Analysis
1. To examine the socio-demographic or organic and conventional paddy farmers.	Descriptive analysis
2. To compare the heat stress index (WBGTout values) of organic and conventional paddy farmers.	Mann Whitney U
3. To compare the heat-related symptoms and physiological parameters (Blood Pressure, Core Body Temperature, Heart Rate, Blood Glucose, Blood Cholesterol) among organic and conventional paddy farmers.	Mann Whitney U & Independent T test
4. To compare the physiological strain index among organic and conventional paddy farmers.	Independent T test
5. To determine association between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers.	Chi Square (Goodness of Fit)
6. To determine the relationship between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers.	Simple and Multiple Linear Regression

3.8 Study Ethic

This study had obtained approval by Ethics Committee for Research involving Human Subjects (JKEUPM). Besides, the individual consent was also obtained and they were given a brief explanation about the study before their involvement in this study.

CHAPTER 4

RESULTS

4.1 Socio-Demographic Data of Respondents

Study population comprises of both organic and conventional paddy farmers at the state from Kedah, Malaysia was determined in this study. A total of 33 organic paddy farmers and 25 conventional paddy farmers were recruited from January – February 2019. At this section, result is tabulated to demonstrate respondent's socio-economic background as showed in Table 4.1.

This study recruited farmers at the age of 20 to 60 years old. The result shows at least 36.4% of organic farming are handled by young adult at the age of 20 to 30 years old, whereas 40% of conventional farming are handled by adults at the age of 51 – 60 year of ages. At least 57.6% of organic farmers are married and 63.6% of them received higher education training up to degree levels whereas, most of conventional farmers (76.0%) were married and 88.0% of them attended until secondary school of education. 66.7% of organic farmers are smokers while 52% of conventional farmers are smokers where none of them reported with alcoholic consumer. Overall, most of the farmers reported to have normal BMI which organic paddy farmers were 60.6% conventional paddy farmers were 52.0%.

Table 4.1: Respondents' Socio-Demographic Information (N=58)

Group		Organic Paddy Farmers (n=33)		Conventional Paddy Farmers (n=25)	
Variables		N	%	N	%
Age	20-30	12	36.4	4	16.0
	31-40	11	33.3	5	20.0
	41-50	4	12.1	6	24.0
	51-60	6	18.2	10	40.0
Race	Malay	24	72.7	25	100.0
	Chinese	3	9.1	0	0
	Indian	1	3.0	0	0
	Others	5	15.2	0	0
Status	Single	14	42.4	6	24.0
	Married	19	57.6	19	76.0
Education level	Primary school	1	3.0	2	8.0
	Secondary school	11	33.3	22	88.0
	Certificate/Diploma/Degree	21	63.6	1	4.0
BMI	Underweight	1	3.0	1	4.0
	Normal	20	60.6	13	52.0
	Overweight	9	27.3	9	36.0
	Obese	3	9.1	2	8.0
Smoking status	Yes	22	66.7	21	84.0
	No	11	33.3	4	16.0

4.2 Heat Stress Index (WBGTout) of Organic and Conventional Paddy Farmers

The normality test on heat stress index between organic and conventional paddy farmers were both <0.001, therefore, non-parametric Mann Whitney U test was used to compare the mean different of heat stress index (WBGTout) among organic and conventional farmers as shown in Table 4.2. Overall, there is significant different of heat stress index (WBGTout) (<0.001) among conventional paddy farmers and organic paddy farmers. Conventional paddy farmers had perceived relatively higher heat stress as compared to organic paddy farmers.

Table 4.2: Heat Stress Index among Organic and Conventional Paddy Farmers (N=58)

Group	N	Median (IQR)	Z-statistics	p-value
Organic farmers	33	34.00 (5)		
Conventional farmers	25	36.00 (5)	-5.134	<0.001**

** *p*-value is significant at 0.001
[a] Mann-whitney U test

4.3 Heat-related Symptoms and Physiological Parameters (Blood Pressure, Heart Rate, Core Body Temperature, Blood Glucose Level and Blood Cholesterol Level) among Organic and Conventional Paddy Farmers

A total of 21 items of self-reported heat-related symptoms were asked, with the answer of "yes" reported by the paddy farmers and the total of "yes" score were used in data analysis. Mann Whitney U test was performed to compare between heat-related symptoms among organic and conventional paddy farmers. Table 4.3 showed no significant difference between both groups with p>0.05 while conventional paddy farmers (4.00, 4.00) had median and interquartile higher than organic paddy farmers (5.00, 2.00).

Table 4.3: Comparison of the Self-Reported Heat-Related Symptoms among Organic and Conventional Paddy Farmers (N=58)

	Organic Paddy Farmer (n=33)	Conventional Paddy Farmer (n=25)	Z-value	p-value
Number of Heat-related symptoms[a] (Median, IQR)[b]	4.00(4.00)	5.00(2.00)	-1.335	0.182

[a] The total number of heat-related symptoms examined was 21 , such as fatigue, dry skin, muscle cramps and others.
[b] Mann Whitney U test

Table 4.4 showed that blood pressure (systolic and diastolic), body temperature, heart rate, blood glucose and blood cholesterol level were compared between both groups of paddy farmers. Blood pressure for both systolic and diastolic and blood glucose level shows that there were significant difference ($p<0.05$) between both groups for organic and conventional paddy farmers. However, body temperature, heart rate and blood cholesterol level shows no significant difference between both groups of paddy farmers.

Table 4.4: Comparison of the Physiological Parameters (Blood Pressure, Heart Rate, Core Body Temperature, Blood Glucose Level) among Organic and Conventional Paddy Farmers (N=58)

	Organic Farmer (n=33)	Conventional Farmer (n=25)	t^a/Z^b-value	p-value
Blood Pressure Systolic (Mean ±SD)	123.27 ± 14.69	142.20 ± 16.50	-4.608	<0.001**
Blood Pressure Diastolic (Mean ±SD)	75.48 ± 9.65	87.48 ± 13.93	-3.873	<0.001**
Core Body Temperature (Mean ±SD)	38.35 ± 0.99	38.560 ± 0.85	-0.841	0.404
Heart Rate (Mean ±SD)	85.88 ± 12.15	92.00 ± 16.82	-1.610	0.113
Blood Glucose Level (Median, IQR)	5.50, 2.05	6.20, 2.85	-2.830	0.005*
Blood Cholesterol Level (Mean ±SD)	4.63 ± 0.58	4.75 ± 0.78	-0.704	0.484

[a]- Independent T-test, [b]-Mann Whitney U-test
***p*-value is significant at 0.001 level
**p*-value is significant at 0.005 level

4.4 Physiological Strain Index (PSI) among Organic and Conventional Paddy Farmers

Physiological strain index was calculated based on core body temperature and heart rate. An independent t test was used to compare the PSI among organic and conventional paddy farmers. As shown in Table 4.5, there was no significant difference between the PSI for organic paddy farmers with 3.73, (1.72) and conventional paddy farmers with 3.52, (1.74) conditions, t (56) =0.455, p=0.651.

Table 4.5: Physiological Strain Index (PSI) among Organic and Conventional Paddy Farmers (N=58)

Group[a]	N	Mean ± SD	t-statistis (df)	p
Organic	33	3.73 ± 1.72	0.45 (56)	0.65
Conventional	25	3.52 ± 1.74		

[a] Independent t-test

4.5 Association between Heat Stress Index, Blood Pressure, Blood Glucose and Blood Cholesterol Level among Organic and Conventional Paddy Farmers

A chi-square goodness of fit test was calculated to determine the association between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers. As summarize in Table 4.6, blood pressure, blood glucose level and heat stress index shows significant association between organic and conventional paddy farmers.

For blood pressure, organic paddy farmers were more likely to have normal range of blood pressure while prehypertension and hypertension (stage 1 and stage 2) were common among conventional paddy farmers.

In terms of blood glucose level, majority (60.6%) of organic paddy farmers were more likely to have normal level of blood glucose while the percentage of farmers have pre-diabetes and diabetes were higher among conventional paddy farmers with 44.0% and 40.0% respectively, as compared to organic paddy farmers.

In addition, heat stress index shows the significant difference between both groups which 100% of organic paddy farmers experienced some discomfort when exposed to heat while some conventional paddy farmers (34.8%) experienced great discomfort when exposed to heat.

Table 4.6: Heat Stress Index, Blood Pressure, Blood Glucose and Blood Cholesterol Level among Organic and Conventional Paddy Farmers (N=58)

		Organic Farmer (n=33)	Conventional Farmer (n=25)	Chi Square (X^2)[a]	*p*-value
Blood Pressure	Normal	60.6%	16.6%		
	Prehypertension	27.3%	28.0%		
	Hypertension (Stage 1)	12.1%	48.0%	16.12	0.001**
	Hypertension (Stage 2)		8.0%		
Blood Glucose Level	Normal	60.6%	16.0%		
	Pre-diabetes	12.1%	44.0%	13.13	0.001**
	Diabetes	27.3%	40.0%		
Blood Cholesterol Level	Normal	84.8%	80.0%	0.628	0.731
	High Cholesterol	15.2%	20.0%		
Heat Stress Index	Some Discomfort	100.0%	65.2%	13.39	<0.001**
	Great Discomfort		34.8%		

***p*-value is significant at 0.001 level
[a] Chi-square test

4.6 Relationship between Heat Stress Index, Blood Pressure, Blood Glucose and Blood Cholesterol Level among Organic and Conventional Paddy Farmers

In order to determine the relationship between heat stress index, blood pressure, blood glucose and blood cholesterol level among organic and conventional paddy farmers, logistic regression was conducted for both simple and multiple logistic regression. This logistic regression was performed in order to examine the variation in the measured physiological parameters (heat stress index, blood pressure, blood glucose and blood cholesterol level) cause variation under the condition of using pesticide (conventional farmers) or not using pesticide (organic farmer).

In the context of blood pressure, conventional farmers has 3.89 times higher odd of reporting prehypertension and 15 times higher odd of reporting hypertension as compared to organic farmers after working under extreme temperature at the farmland for equal working duration. In terms of blood glucose, conventional farmers has 13.75 times higher odd of reporting pre-diabetes and 5.56 times higher odd of reporting diabetes as compared to organic farmers after working under extreme temperature at the farmland for equal working duration. Lastly, in terms of blood cholesterol, conventional farmers has 1.4 times higher odd of reporting high cholesterol as compared to organic farmers after working under extreme temperature at the farm land for equal working duration.

From the Table 4.7 below, conventional paddy farmers group were more likely to experience increase in blood pressure and blood glucose compared to organic paddy farmers group. For blood pressure, they were majority in the range of hypertension (stage 1) which adjusted OR was 35.62 with p-value of 0.018. However for blood glucose, majority of the farmer experienced pre-diabetes condition with adjusted OR was 18.74 with p-value was 0.024. Blood cholesterol and heat stress index did not show any significant relationship among the organic and conventional paddy farmers.

Table 4.7: Heat Stress Index, Blood Pressure, Blood Glucose and Blood Cholesterol Level among Organic and Conventional Paddy Farmers (N=58)

		Crude OR (95% CI)[a]	Adjusted OR[b]	*p*-value
Blood Pressure	Normal	1.00	1.00	0.127
	Prehypertension	3.89 (0.904 – 16.72)	22.31	0.036*
	Hypertension (Stage 1)	15.0 (3.153-71.367)	35.62	0.018*
	Hypertension (Stage 2)	-	-	-
Blood Glucose	Normal	1.00	1.00	0.063
	Pre-diabetes	13.75 (2.86-66.03)	18.74	0.024*
	Diabetes	5.56 (1.37-22.56)	15.31	0.684
Blood Cholesterol	Normal	1.00	1.00	-
	High Cholesterol	1.4 (0.375- 5.48)	-	-
Heat Stress Index	Some Discomfort	1.00	1.00	-
	Great Discomfort	-	-	-

[a] Simple Logistic Regression;
[b] Multiple Logistic Regression;
Method = Enter;
R^2= 0.533

CHAPTER 5

DISCUSSION

5.1 Socio-demographics of respondents

A total of 58 respondents included in this study consist of 33 organic paddy farmers and 25 conventional paddy farmers who fulfil the inclusive criteria were recruited in this study. The age of the respondents included in this study were 20 to 60 years old in which for organic paddy farmers, majority of them (36.4%) were between 20 to 30 years old and majority of conventional paddy farmers participated in this study were age of 51 to 60 years old (40.0%). Larose et al (2014) stated that young adults have better heat dissipation as compared to middle-aged and older adults which causes lower sweat production that lead the heat to trap more in the body. Thus, this condition causes middle-aged and older adults more vulnerable to experience greater level of heat strain, particularly among conventional farmers in this study.

In terms of education level, most of organic paddy farmers (63.6%) got higher education such as certificate, diploma and degree while majority of conventional paddy farmers (88.0%) only obtained secondary school education.

This may explain the difference of knowledge in the management of heat and pesticides exposure. For body mass index (BMI), majority of both groups of respondents were in the range of normal BMI. People with more than normal range of BMI lose the metabolic more slowly due to the subcutaneous adipose tissue that hinder heat loss in order to maintain normothermia (Savastano, 2009). Besides, the majority of organic (66.7%) and conventional (84.0%) paddy farmers are smokers in which Druyan et al (2017) stated that nicotine can increase physiological strain of the smokers. In other words, farmers who claimed themselves as smokers are also at high risks of getting metabolic health risks due to the fact that nicotine which released catecholamine in both local and systemic increase the heart rate and blood pressure (Mishra et al., 2015).

5.2 Heat Stress Index (WBGTout) of Organic and Conventional Paddy Farmers

Heat stress index was obtained by measuring six (6) parameters of thermal environment which were WBGTout, Wet bulb temperature, Dry bulb temperature, Globe temperature, relative humidity and air movement. The indices were categorized based on the Canada humidex range which considering both temperature and relative humidity. Humidex was used to describe how hot the weather feels to the average person among both organic and conventional paddy farmers during the exposure to hot weather.

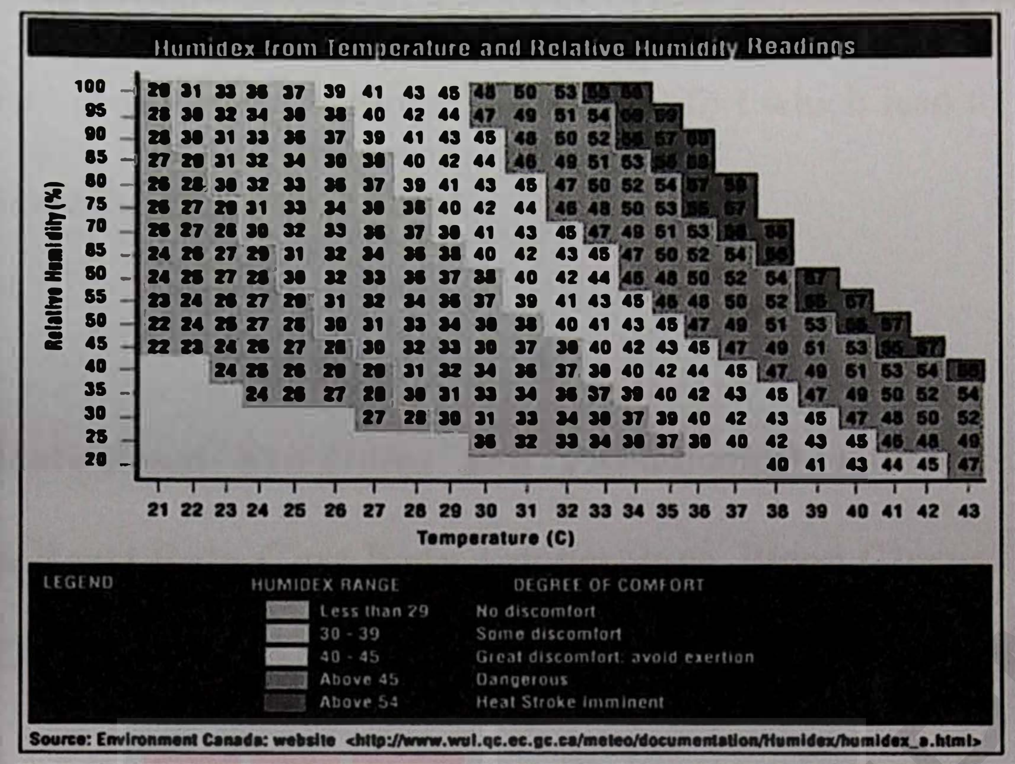

Figure 5.1: Humidex - Degree of Discomfort

Source: Environment Canada (2019)

The findings of this study found that there is significant different of heat stress index among conventional paddy farmers and organic paddy farmers. In other words, conventional paddy farmers have relative perceived higher heat stress as compared to organic paddy farmers. The result obtained might be influenced by the clothing factors and personal protective equipment (PPE) worn especially by conventional paddy farmers. As conventional paddy farmers usually wear double woven clothes, goggles, rubber gloves and rubber boots which protect them while spraying pesticides to the crops, they were more likely to experience heat stress as compared to the organic paddy farmers who only used long sleeve shirt and pant. According to Gavin (2003), clothing can act as a barrier for heat transfer and evaporation from the surface of the skin in which increase the thermal insulation thus lead to the increase in body temperature. Besides, Guidelines on Heat Stress Management at Workplace (2016) claimed that heat comfort is very much influenced by the insulating effect of clothes and wearing too much PPE. These environmental factors may be the main contributing factors to heat discomfort which lead to heat stress among conventional paddy farmers.

5.3 Heat-related Symptoms and Physiological Parameters (Blood Pressure, Heart Rate, Core Body Temperature, Blood Glucose Level and Blood Cholesterol Level) among Organic and Conventional Paddy Farmers

Heat-related symptoms and physiological parameters such as blood pressure, heart rate, core body temperature, blood glucose and blood cholesterol level were compared between organic and conventional paddy farmers. This study shows that heat-related symptoms have no significant difference between both groups of paddy farmers. This condition might be because of the same exposure to heat at similar time from 0700 to 1100 and 1600 to 1900. The common symptoms reported for both groups were fatigue, headache, muscle cramps, thirst, dry skin and over sweating.

Findings of this study shows that the average blood pressure and blood glucose level were higher among conventional paddy farmers as compared to organic paddy farmers. As conventional paddy farmers used pesticides in their farming system, it might be a contributing factor that influence the result. Goncharov et al. (2010) stated that pesticides like polychlorinated biphenyls (PCBs) had significant association with hypertension and elevation of blood pressure in individual without hypertension and it might be the contributing factor that regulates the changes in blood pressure. Other studies also found that organochlorine pesticides have positive association to insulin resistance among nondiabetic respondents (Lee et al. 2007). This is crucial as insulin resistance happened when too much insulin was produced by beta cell in pancreas which causes hyperglycemia and lead to the high risk of getting type 2 diabetes.

Core body temperature, heart rate and blood cholesterol level showed no significant difference between both groups of paddy farmers. As for core body temperature and heart rate, both were influenced by the same exposure to extreme weather. Heart rate elevated in response to the increase in core body temperature as blood need to be pumped to the rest of the body in order to dissipate heat out of the body for maintaining body thermoregulation. Besides, blood cholesterol shows no significant association between both groups as previous study also claimed that there was no significant correlation between heat exposure and changes of blood cholesterol level (Yamamoto et al., 2003). However, according to Halonen et al. (2010) high density lipoprotein (HDL) can decreased in response to increase in ambient temperature. But, this study only measured the total cholesterol level instead of HDL and low density lipoprotein (LDL).

5.4 Physiological Strain Index (PSI) among Organic and Conventional Paddy Farmers

Physiological strain index was calculated to evaluate heat strain experienced by the person exposed to extreme hot weather by combining the load of thermoregulatory (core body temperature) and cardiovascular system (heart rate) (Pokora & Zebrowska, 2016).

The result of this study shows that PSI among organic and conventional paddy farmers shows that there is no significant difference between both groups. However, organic paddy farmers generally have higher level of PSI as compared to conventional paddy farmers. According to Francis (2005), organic farming is more labor intensive as compared to conventional farming since organic farmers work extra efforts is needed to maintain soil fertility and protect crops against pest and weed without using pesticides. This shows that organic paddy farmers use a lot of energy during the farming activity which may increase the heart rate as the body needs to increase the cardiac output in order to deliver the adequate blood flow to the muscles. When energy used increase during exercise, more oxygen was used, thus it was necessary to deliver sufficient blood flow in order meet the oxygen demand (Boyette & Manna, 2019). This strenuous work performed under the hot environment causes physiological changes gradually to claim for metabolic heat strain and compensate for muscular activity. Thus, metabolic heat load should be balanced by transferring heat from the body to the environment equally in order to maintain ideal core body temperature. However, PSI increases when heat production increase with inadequate heat loss and this result to the increase in core body temperature (Pokora & Zebrowska, 2016). As heart rate and core body temperature were the main factors in determining the PSI, increase energy consumed, metabolic heat strain and muscular activity by organic paddy farmers might influence the values of PSI obtained by them. Nevertheless, PSI shows no significant different among both group of paddy farmers due to the fact that load carrying (pesticides tank sprayer) can also increase the average heart rate by 9 beats per minutes (Holewijn, 1990). This may influence the PSI values obtained by conventional paddy farmers. Thus, different energy output and type of activities performed by both groups of farmers showed no significant difference of PSI values when carrying out farming activities under the hot weather environment.

5.5 Association between Heat Stress Index, Blood Pressure, Blood Glucose and Blood Cholesterol Level among Organic and Conventional Paddy Farmers

The association result shows that blood pressure, blood glucose level and heat stress index have significant association between pesticide and non-pesticides used group of farmers, except for blood cholesterol. In the meantime, conventional paddy farmers were dominantly experienced prehypertension, hypertension (stage 1) and hypertension (stage 2) while organic paddy farmers mostly categorized within the normal range of blood pressure. Study by Kim et al. (2012) indicate that blood pressure would decrease with the increase in weather temperature as blood vessel expand in order to dissipate heat from the body. In this study, the increases of blood pressure among conventional farmers may because of pesticides used among conventional farmers act as surrogate factors in masking the effect of blood vessel from dissipate heat from the body (Goncharov et al., 2010) As similar to previous study (Everett et al., 2011), conventional farmers in this study has 3.89 times higher odd of reporting prehypertension and 15 times higher odd of reporting hypertension as compared to organic farmers after working under extreme temperature at the farmland for equal working duration. In other words, pesticides might be the main factor for elevation of blood pressure among conventional paddy farmers.

In terms of blood glucose, the result reported that pre-diabetes and diabetes were dominant among conventional paddy farmers as compared to organic paddy farmers. Conventional farmers has 13.75 times higher odd of reporting pre-diabetes and 5.56 times higher odd of reporting diabetes as compared to organic farmers after working under extreme temperature at the farmland for equal working duration. Usage of pesticides among conventional paddy farmers might be the main culprit that increase the blood glucose level as Akyildiz et al., (2009) and Kumar and Nayak (2011) had claimed that organophosphates (OPs) can disrupt the glucose metabolism and increase the risk of getting type 2 diabetes. Besides, another study has showed that there was positive correlation between malathion level and insulin resistance (Raafat et al., 2012). Insulin resistance can elevate the production of hepatic glucose which was the cause of the occurrence of hyperglycemia thus lead to the risk of getting type 2 diabetes (Lasram et al., 2014). However, heat exposure might also contribute to the elevation of blood glucose level among both groups of paddy farmers. Previous study by Kimball et al. (2018) stated that acute exposure to heat stress increased the level of glucose and insulin by hepatic gluconeogenesis which drive the increase of fasting plasma glucose. This is also consistent with study conducted by Dumke et al. (2015) which stated that serum glucose increased in response to oral ingestion of carbohydrate at hot environment (43°C) compared to cold (7.2°C) and neutral (22.1°C) environment.

In terms of heat stress index, there was significant association between both groups of paddy farmers which all organic paddy farmers experienced some discomfort and 34.8% of conventional paddy farmers experienced great discomfort during the heat exposure. The difference in result obtained might be influenced by the usage of clothing and PPE among conventional paddy farmers during the pesticides spraying. These non-environmental (clothing and PPE) factors might act as the barrier that prevent the heat dissipation to the environment.

Meanwhile, blood cholesterol level shows no significant association between organic and conventional paddy farmers but conventional paddy farmers has 1.4 times higher odd of reporting high cholesterol as compared to organic paddy farmers after working under extreme temperature at the farm land for equal working duration. According to Yamamoto et al. (2003), there was no significant correlation between heat exposure and changes of blood cholesterol level. Halonen et al. (2010) also stated that there is no association between ambient temperature and total cholesterol but HDL and LDL showed increased and decreased respectively for each 5°C increase in mean ambient temperature. In addition, usage of pesticides by conventional paddy farmers might contribute to the changes in blood cholesterol level. HDL which is the good cholesterol helps to remove other forms of cholesterol from the bloodstream was significantly depressed when exposed to organophosphates pesticides (Samsuddin et al., 2015). Nonetheless, the result of blood cholesterol obtained in this study showed no significant association as total cholesterol was measured instead of HDL and LDL.

CHAPTER 6

CONCLUSION & RECOMMENDATION

6.1 Conclusion and Recommendations

In conclusion, blood pressure, blood glucose and heat stress index showed significant difference between organic and conventional paddy farmers. However, odd ratio of getting elevated blood pressure, blood glucose and heat stress index were higher among conventional paddy farmers as compared to organic paddy farmers. The findings of this study shows that the pesticide used may act as a synergistic effect that produce greater health effects to those who exposed to heat at their work environment. Thus, these findings can support in the minimizing of the use of pesticides in agriculture industry in order to fill the knowledge gaps between the occurrence of heat-related illness and other metabolic diseases with the exposure to heat and pesticides.

In addition, the difference of heat-related health effects among pesticide used and non-pesticide used farming community could serve as an important factor to take into account while implementing workplace heat stress program at the agricultural industry. This preventive actions can be taken to mitigate or minimize the occurrence of heat-related illness and other metabolic diseases such diabetes and cardiovascular diseases. On the other hand, since total blood cholesterol level did not show any significant association between pesticide and non-pesticide usage group of farmers, this study suggests to monitor HDL and LDL in the future study to further examine the potential metabolic health effects at the physiological levels.

6.2 Study Limitation

There were several limitations in this study and methods to overcome those that have been enumerated below.

i. **Inadequate number of study population**

   The total respondents for organic paddy farmers obtained were only 33 respondents while 25 respondents for conventional paddy farmers. These were because organic paddy farming sectors in Malaysia were only small scale farming as compared to conventional paddy farming. Thus, the number of organic paddy farming involved in this farming was too small. For conventional paddy farmers, it was difficult to obtain enough respondents as by the time of data collection, it was near to harvesting season so there were only some farmers who did pesticides spraying. This study only included the conventional farmers who did pesticides spraying in order to get accurate result of parameters measured. Thus, the number of respondents should be increased in future study to increase the power of the study.

ii. **Measurement of total cholesterol**

In this study, total cholesterol was measured in order to know the level of blood cholesterol after paddy farmers being exposed to heat and pesticides. However, the result did not show and significant association among both groups of paddy farmers. In addition, the study of Halonen et al. (2010) also stated that there is no association between ambient temperature and total cholesterol but HDL and LDL showed increased and decreased respectively for each 5°C increase in mean ambient temperature. However, study conducted by Samsuddin et al. (2015) stated that usage of pesticides by conventional paddy farmers might contribute to the changes in blood cholesterol level. HDL was significantly depressed when exposed to organophosphates pesticides. Thus, future study should measure specifically on the effect of heat and pesticides exposure on HDL and LDL.

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APPENDICES

APPENDIX 1

Gann Chart

GANTT

Month / Milestone	September	October	November	December	January	February	March	April	May	June
Proposal Preparation	■	■								
Proposal Submission to Ethical Committee		■								
Presentation to Ethical Committee				■						
Questionnaire Administration					■					
Clinical Measurement					■					
Environmental Measurement					■					
Data Analysis						■	■			
Report Writing								■	■	
Publication										■

APPENDIX 2

Ethical Clearance

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS (JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**The Effect of Heat Exposure on Health Among Organic and Conventional Paddy Farmers at Sik, Kedah**
Study Site	:	**Sik, Kedah**
JKEUPM Ref No.	:	**JKEUPM-2018-355**
Researcher	:	**Nur Afiqa Maryam binti Baharudin**
Supervisor	:	**Dr. Vivien How**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 29/10/2018
2. Respondent Information Sheet & Consent (English), Version 2 dated 14/12/2018
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 14/12/2018
4. Proposal (English), Version 2 dated 13/12/2018
5. Questionnaires/ Interviews (Malay), Version 1 dated 29/10/2018
6. Curriculum Vitae of:
   a. Dr. Vivien How

University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance the ICH-GCP Guidelines.

Decision by JKEUPM:

Approved

Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research

Disapproved

Please note that the approval is **VALID UNTIL 24 DECEMBER 2019**

Researchers should comply with the following:

Complete a Study Final Report upon study completion (Form 3.2).

Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse

APPENDIX 3

Penerangan dan Persetujuan Responden

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

BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

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

1.TAJUK KAJIAN: Kesan Pendedahan Haba Terhadap Kesihatan Dalam Kalangan Petani Padi Organik Dan Konvensional Di Sik, Kedah.

PENGENALAN

Pertanian adalah salah satu sektor yang terdedah kepada panas kerana sifat pekerjaan adalah luaran dan langsung kepada cahaya matahari. Oleh itu, petani adalah antara kumpulan yang terdedah kepada panas dan keadaan ini boleh menyebabkan pelbagai kesan kesihatan. Suhu persekitaran yang tinggi boleh menyebabkan perubahan dalam faktor fisiologi badan, tahap glukosa darah dan tahap kolesterol darah. Ini boleh menyumbang kepada berlakunya penyakit yang berkaitan dengan haba dan penyakit metabolik yang lain.

APAKAH YANG PERLU ANDA LAKUKAN?

Kajian ini akan menjalankan pengukuran persekitaran dan pengukuran klinikal. Pengukuran persekitaran menggunakan Suhu Mentol Globe Basah untuk menentukan indeks tekanan haba. Manakala untuk suhu badan klinikal, tekanan darah dan denyutan jantung diukur untuk menentukan indeks terikan fisiologi. Selain itu, paras glukosa darah dan kolesterol darah diukur untuk menentukan hubungan antara pendedahan haba dan perubahan paras glukosa darah dan paras kolesterol darah.

SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Petani perempuan bekerja dalam sistem padi organik dan konvensional

Berumur tidak di antara 25-55 tahun

Petani yang bekerja kurang daripada 3 bulan

d) Petani yang mengambil alkohol dan ubat-ubatan (seperti diuretics, Angiotensin converting enzyme (ACE) inhibitors) yang dapat mengurangkan toleransi kepada haba dan meningkatkan risiko mendapat simptom berkaitan haba (seperti kekejangan haba, strok haba)

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a)KEPADA ANDA SEBAGAI PESERTA?

Kajian ini dapat mengetahui tahap kesihatan anda dan dapat meningkatkan kesedaran tentang pendedahan haba di kalangan petani. Selain itu, keselamatan, kesihatan dan kebajikan anda akan dijamin oleh pihak berkuasa yang berkaitan seperti Jabatan Kesihatan dan Keselamatan Pekerjaan kerana hasil kajian ini dapat menunjukkan hubungan yang signifikan antara pendedahan haba dan kesan kesihatan. Penyertaan anda di dalam kajian ini adalah sukarela dan anda berhak untuk menarik diri daripada kajian ini tanpa dikenakan sebarang penalti.

b)KEPADA PENYELIDIK?

Kajian ini akan membantu penyelidik mendapatkan lebih banyak pengetahuan tentang bagaimana pendedahan haba menyumbang kepada berlakunya penyakit seperti diabetes dan penyakit kardiovaskular. Oleh itu, langkah pencegahan dan pembetulan boleh dicadangkan untuk mengurangkan kesan kesihatan tersebut.

6. ADAKAH IA BERISIKO?

Penyelidikan ini berisiko sederhana kerana sedikit sampel darah akan diambil melalui jari telunjuk dan diuji untuk mengetahui kadar glukosa dan kolesterol di dalam darah. Bagaimanapun, langkah berjaga-jaga (seperti mengunakan swab alkohol) di ambil untuk mengelakkan berlakunya infeksi.

ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Segala butiran maklumat akan kekal rahsia dan akan disimpan.

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

Jika terdapat soalan tambahan semasa mengikuti penyelidikan ini, boleh hubungi:

Dr. Vivien How
Ketua Penyelidik
Jabatan Kesihatan Persekitaran dan Pekerjaan
Fakulti Perubatan dan Sains Kesihatan
016-6193697
vivien@upm.edu.my

Nur Afiqa Maryam Binti Baharudin
Penyelidik Bersama
Jabatan Kesihatan Persekitaran dan Pekerjaan
Fakulti Perubatan dan Sains Kesihatan
011-12156164
maryamafiqa@gmail.com

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini ______

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*)

Tarikh :...

Tandatangan ....
(*Saksi*)

Nama :..

No. K/P: ....

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

Tarikh ....

Tandatangan ....
(*Penyelidik*)

APPENDIX 4

Respondent's Information Sheet & Consent

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

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

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

1. STUDY TITLE : Effects of Heat Exposure on Health Among Organic And Conventional Paddy Farmers at Sik, Kedah.

2. INTRODUCTION: Agriculture is one of the sectors that exposed to heat as its nature of work is outdoor and direct to sunlight. Thus, farmers are the vulnerable group that exposed to heat and this condition can cause various health effects. The high temperature of environment can cause changes in physiological factors of the body, blood glucose level and blood cholesterol level. This may contribute to the occurrence of heat-related illness and other metabolic diseases.

3. WHAT WILL YOU HAVE TO DO?

This study will conduct the environmental measurement and clinical measurement. The environmental measurement uses Wet Bulb Globe Temperature in order to determine the heat stress index. While for the clinical, core body temperature, blood pressure and heart rate are measured to determine the physiological strain index. Besides, the level of blood glucose and blood cholesterol are measured to determine the relationship between the heat exposure and the changes of blood glucose and blood cholesterol level.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

a) Female farmers work at organic or conventional paddy farming

b) Age not in range between 20-55 years old

c) Farmers that employed less than 3 months

d) Consume alcohol and any medication (such as diuretics, Angiotensin converting enzyme (ACE) inhibitors) that may reduce heat tolerance and increase risk of heat illnesses.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

From this study, the participant are able to know the level of their health and can increase awareness of heat exposure among farmers. In addition, your safety, health and welfare will be guaranteed by relevant authorities such as the Department of Occupational, Safety and Health as the result of this study can demonstrate a significant relationship between heat exposure and health effects. Your participation in this study is voluntary and you are entitled to withdraw from this study without incurring any penalties.

(b) TO THE INVESTIGATOR?

The study will help the investigator to gain more knowledge on how the heat exposure contributes to the occurrence of illnesses and diseases such as diabetes and cardiovascular disease. Thus preventive and corrective action can be proposed to mitigate those health effects.

6. WHAT ARE THE POSSIBLE RISKS?

This study is moderately has risk as little amount of blood sample will be pricked on the finger to be analysed in order to know the level of glucose and cholesterol in the blood. However, some precautionary steps (such as the usage of alcohol swab) will be taken to avoid infection.

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

All the information obtained will be remain confidential and kept safe.

9. CONSENT

…………………………………… Identity Card No. …………………………… address………...

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

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

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

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

* delete where necessary

Signature …………………………………… (Respondent)

Date :………………………………………..

Signature …………………………………… (Witness)

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 5

Questionnaire

KESAN PENDEDAHAN HABA TERHADAP KESIHATAN DALAM KALANGAN PETANI ORGANIK DAN KONVENSIONAL DI SIK, KEDAH

[redacted]

UPM
UNIVERSITI PUTRA MALAYSIA

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 KESAN PENDEDAHAN HABA TERHADAP KESIHATAN DALAM KALANGAN PETANI ORGANIK DAN KONVENSIONAL"

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi empat (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 yang ada di dalam buku ini

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 diperoleh di dalam kajian ini adalah rahsia dan hanya digunakan untuk tujuan pembelajaran semata-mata.

Sekian, terima kasih

KESAN PENDEDAHAN HABA TERHADAP KESIHATAN DALAM KALANGAN PETANI ORGANIK DAN KONVENSIONAL DI SIK, KEDAH

[redacted]

BAHAGIAN A: MAKLUMAT DIRI

			code
1.1	Tarikh lahir	[ ][ ] Tarikh [ ][ ] Bulan [ ][ ][ ][ ] Tahun	A.1.1
1.2	No. Kad Pengenalan/Pasport	[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]	A.1.2
1.3	No. Telefon	[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]	A.1.3
1.4	Umur	[ ][ ] tahun	A.1.4
1.5	Bangsa	1. Melayu [ ] 2.Cina [ ] 3. India [ ] 4.Lain-lain [ ]	A.1.5
1.6	Warganegara	1. Warganegara [ ] 2. Bukan warganegara [ ]	A.1.6
1.7	Status	1. Bujang [ ] 2. Berkahwin [ ] 3. Bercerai [ ]	A.1.7
1.8	Pendidikan	1.Tidak Bersekolah [ ] 2.Rendah/UPSR [ ] 3.Menengah/PMR/SPM/STPM [ ] 4.Sijil/Diploma/Ijazah [ ]	A.1.8
1.9	Gaji	RM [ ][ ][ ][ ][ ][ ]	A.1.9
1.10	Tinggi	[ ][ ][ ] cm	A.1.10
1.11	Berat	[ ][ ][ ] kg	A.1.11
1.12	Isi rumah	[ ][ ] orang	A.1.12

BAHAGIAN B: MAKLUMAT PEKERJAAN

2.1. Apakah jawatan anda sekarang? ____________________ B.2.1

2.2. Berapa lamakah anda telah bekerja sebagai (pekerjaan seperti di atas)? __________ tahun B.2.2

2.3. Berapa lamakah anda bekerja di sektor ini? __________ tahun B.2.3

2.4. Waktu bekerja: B.2.4

1. 7am-11am ☐
2. 4pm-7pm ☐

2.5. Jenis penanaman padi: B.2.5

1. Organik ☐
2. Konvensional ☐

2.6. Kekerapan penyemburan racun serangga? B.2.6

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

2.7. Berapa jamkah anda bekerja dalam sehari? ________ jam B.2.7

2.8. Adakah anda menggunakan sebarang Peralatan Perlindungan Diri (PPE)? B.2.8

1. Ya ☐
2. Tidak ☐

2.9. Tandakan jenis PPE yang digunakan: B.2.9

1 Kasut keselamatan ☐
2 Topi keselamatan ☐
3 Cermin mata keselamatan ☐
4 Sarung tangan ☐
5 Pakaian perlindungan diri ☐
6 Respirator ☐
7 Lain-lain
Nyatakan: ____________

2.10. Adakah latihan penggunaan PPE diberikan?	1. Ya	☐	B.2.10
	2. Tidak	☐	
2.11. Adakah anda terdedah kepada sebarang hazad seperti berikut:	1. Bahan kimia	☐	B.2.11
	2. Panas melampau	☐	
	3. Habuk	☐	
	4. Bunyi bising	☐	
	5. Binatang berbisa	☐	
	6. Lain-lain: ____________	☐	

KESAN PENDEDAHAN HABA TERHADAP KESIHATAN DALAM KALANGAN PETANI ORGANIK DAN KONVENSIONAL DI SIK, KEDAH [redacted]

BAHAGIAN C: MAKLUMAT KESIHATAN

3.1. Adakah anda menghidap penyakit berikut dan telah disahkan oleh doctor? C.3.1 a-e

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

BAHAGIAN D: MAKLUMAT GAYA HIDUP

4.1 Adakah anda mengambil sebarang jenis ubat? D.4.1

1. Ya ☐
2. Tidak ☐

4.2 Adakah anda merokok? D.4.2

1. Ya ☐
2. Tidak ☐

Jika ya, ________ batang sehari

4.3 Adakah anda mengambil minuman beralkohol? D.4.3

1. Ya ☐
2. Tidak ☐

BAHAGIAN E: MAKLUMAT SIMPTOM-SIMPTOM PENDEDAHAN HABA

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

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

5.2 Kategori waktu bekerja anda E.5..

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

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

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

-TERIMA KASIH ATAS KERJASAMA ANDA DALAM MENJAYAKAN KAJIAN INI-

APPENDIX 6

Certificate of Calibration

VNA ENGINEERING SDN BHD (877649-P)
D11-8-G, Block 11, Pusat Perdagangan Dana 1, Jalan PJU 1A/46, 47301 Petaling Jaya, Selangor.
T: +603-7842 8928 F: +603-7842 8927 www.vnaengineering.com
CALIBRATION SOLUTIONS

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4304/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40412**

Calibrated Range : (30 to 90) %RH ; (15 to 35) °C
Specification : ± 5 %RH ; ± 0.5 °C
Readability : 1 %RH ; 0.1 °C

GLOBE

REFERENCE READ	RELATIVE HUMIDITY DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION		UNCERTAINTY, ± k = 2
			BEFORE ADJUST	AFTER ADJUST	
°C	%RH	°C	°C	°C	°C
15.0	54.8	15.2	-0.2	N/A	0.3
20.0	54.8	20.1	-0.1	N/A	0.3
25.0	54.9	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	35.0	0.0	N/A	0.3

RELATIVE HUMIDITY

REFERENCE READ	TEMPERATURE DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION		UNCERTAINTY, ± k = 2
			BEFORE ADJUST	AFTER ADJUST	
%RH	°C	%RH	%RH	%RH	%RH
29.3	23.0	33	-4	N/A	2.3
49.4	23.0	54	-5	N/A	2.3
69.0	23.0	74	-5	N/A	2.3
88.3	23.0	93	-5	N/A	2.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement.

Note :

1 : Set Temperature at 23°C during humidity measurement

2 : Set Humidity at 55 %RH during temperature measurement

3 : UUT - Unit Under Test.

4 : To derive True Value = User Instrument Reading - Correction

5 : Interpolation - Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs Correction (y-axis)

6 : Correction can be ignore if smaller than user specification, unless otherwise user shall apply correction to derive true value.

7 : If no adjusment done refer to "Correction Before Adjust" If adjusment was done refer to "Correction After Adjust" to derive the true value.

8 : N/A – No Adjustment done.

9 : Uncertainty = Parameter, associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand

10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.

of approximately coverage of k=2 stated an

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T: +603-7842 8928 F: +603-7842 8927 www.vnaengineering.com
CALIBRATION SOLUTIONS

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4304/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40412**

Calibrated Range : (15 to 35) °C **Specification** : ± 0.5 °C

Readability : 0.1 °C

WET

REFERENCE READ	RELATIVE HUMIDITY DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION		UNCERTAINTY, ± k = 2
			BEFORE ADJUST	AFTER ADJUST	
°C	%RH	°C	°C	°C	°C
15.0	54.8	15.2	-0.2	N/A	0.3
20.0	54.8	20.2	-0.2	N/A	0.3
25.0	54.9	25.2	-0.2	N/A	0.3
30.0	54.9	30.1	-0.1	N/A	0.3
35.0	54.9	35.1	-0.1	N/A	0.3

DRY

REFERENCE READ	TEMPERATURE DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION		UNCERTAINTY, ± k = 2
			BEFORE ADJUST	AFTER ADJUST	
%RH	°C	%RH	%RH	%RH	%RH
15.0	54.8	15.1	-0.1	N/A	0.3
20.0	54.8	20.1	-0.1	N/A	0.3
25.0	54.9	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	35.0	0.0	0.0	0.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement.

Note :

1 : Set Temperature at 23°C during humidity measurement

2 : Set Humidity at 55 %RH during temperature measurement

3 : UUT - Unit Under Test.

4 : To derive True Value = User Instrument Reading + Correction

5 : Interpolation = Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs. Correction (y-axis)

6 : Correction can be ignore if smaller than user specification. unless otherwise user shall apply correction to derive true value.

7 : If no adjusment done refer to "Correction Before Adjust". If adjusment was done refer to "Correction After Adjust" to derive the true value.

8 : N/A – No Adjustment done.

9 : Uncertainty=Parameter associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand

10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.

coverage otherwise.

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T: +603-7842 8928 F: +603-7842 8927 www.vnaengineering.com
CALIBRATION SOLUTION

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4305/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40413**

Calibrated Range : (15 to 35) °C **Specification** : ± 0.5 °C

Readability : 0.1 °C

WET

REFERENCE READ	RELATIVE HUMIDITY DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
°C	%RH	°C	°C	°C	°C
15.0	54.8	15.2	-0.2	N/A	0.3
20.0	54.8	20.2	-0.2	N/A	0.3
25.0	54.9	25.2	-0.2	N/A	0.3
30.0	54.9	30.1	-0.1	N/A	0.3
35.0	54.9	35.1	-0.1	N/A	0.3

DRY

REFERENCE READ	TEMPERATURE DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
%RH	°C	%RH	%RH	%RH	%RH
15.0	54.8	15.1	-0.1	N/A	0.3
20.0	54.8	20.1	-0.1	N/A	0.3
25.0	54.9	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	35.0	0.0	0.0	0.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement

Note :

1 : Set Temperature at 23°C during humidity measurement
2 : Set Humidity at 55 %RH during temperature measurement
3 : UUT - Unit Under Test
4 . To derive True Value - User Instrument Reading - Correction
5 : Interpolation = Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs. Correction (y-axis)
6 . Correction can be ignore if smaller than user specification, unless otherwise user shall apply correction to derive true value.
7 : If no adjustment done refer to "Correction Before Adjust". If adjustment was done refer to "Correction After Adjust" to derive the true value.
8 N/A – No Adjustment done.
9 . Uncertainty = Parameter associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand
10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.

a coverage otherwise.

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CALIBRATION SOLUTIONS

ilac-MRA
STANDARD MALAYSIA
MS ISO/IEC 170
CALIBRATION
SAMM NO.47

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4305/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40413**

Calibrated Range : (30 to 90) %RH ; (15 to 35) °C
Specification : ± 5 %RH ; ± 0.5 °C
Readability : 1 %RH ; 0.1 °C

GLOBE

REFERENCE READ	RELATIVE HUMIDITY DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
°C	%RH	°C	°C		°C
15.0	54.8	15.2	-0.2	N/A	0.3
20.0	54.8	20.1	-0.1	N/A	0.3
25.0	54.9	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	34.9	0.1	N/A	0.3

RELATIVE HUMIDITY

REFERENCE READ	TEMPERATURE DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
%RH	°C	%RH	%RH	%RH	%RH
29.3	23.0	33	-4	N/A	2.3
49.4	23.0	54	-5	N/A	2.3
69.0	23.0	74	-5	N/A	2.3
88.3	23.0	93	-5	N/A	2.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement.

Note :

1 . Set Temperature at 23°C during humidity measurement
2 Set Humidity at 55 %RH during temperature measurement
3 UUT - Unit Under Test
4 To derive True Value • User Instrument Reading • Correction
5 : Interpolation • Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs. Correction (y-axis)
6 : Correction can be ignore If smaller than user specification, unless otherwise user shall apply correction to derive true value.
7 : If no adjusment done refer to "Correction Before Adjust". If adjusment was done refer to "Correction After Adjust" to derive the true value.
8 N/A – No Adjustment done.
9 : Uncertainty = Parameter associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand
10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.

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CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4306/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40414**

Calibrated Range : (15 to 35) °C **Specification** : ± 0.5 °C

Readability : 0.1 °C

WET

REFERENCE READ °C	RELATIVE HUMIDITY DURING CALIBRATION %RH	UUT READ BEFORE ADJUST °C	CORRECTION BEFORE ADJUST °C	CORRECTION AFTER ADJUST °C	UNCERTAINTY, ± k = 2 °C
15.0	54.9	15.2	-0.2	N/A	0.3
20.0	54.8	20.2	-0.2	N/A	0.3
25.0	54.8	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	35.0	0.0	N/A	0.3

DRY

REFERENCE READ %RH	TEMPERATURE DURING CALIBRATION °C	UUT READ BEFORE ADJUST %RH	CORRECTION BEFORE ADJUST %RH	CORRECTION AFTER ADJUST %RH	UNCERTAINTY, ± k = 2 %RH
15.0	54.9	15.2	-0.2	N/A	0.3
20.0	54.8	20.2	-0.2	N/A	0.3
25.0	54.8	25.1	-0.1	N/A	0.3
30.0	54.9	30.0	0.0	N/A	0.3
35.0	54.9	34.9	0.1	0.0	0.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement.

Note :

1 Set Temperature at 23°C during humidity measurement
2 : Set Humidity at 55 %RH during temperature measurement
3 UUT - Unit Under Test
4 : To derive True Value = User Instrument Reading · Correction
5 : Interpolation - Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs. Correction (y-axis)
6 . Correction can be ignore if smaller than user specification, unless otherwise user shall apply correction to derive true value.
7 : If no adjusment done refer to "Correction Before Adjust". If adjusment was done refer to "Correction After Adjust" to derive the true value.
8 . N/A – No Adjustment done
9 Uncertainty=Parameter associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand
10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.

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CALIBRATION SOLUTIONS

ilac-MRA

STANDARDS MALAYSIA
MS ISO/IEC 17025
CALIBRATION
SAMM NO. 477

CALIBRATION CERTIFICATE

CERTIFICATE NUMBER : VNA/A4306/18

CALIBRATION RESULTS

Instrument Calibrated : **Thermal Environment Monitor**
ID. Number : **V40414**

Calibrated Range : (30 to 90) %RH
(15 to 35) °C

Specification : ± 5 %RH
± 0.5 °C

Readability : 1 %RH
0.1 °C

GLOBE

REFERENCE READ	RELATIVE HUMIDITY DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
°C	%RH	°C	°C	°C	°C
15.0	54.9	15.3	-0.3	N/A	0.3
20.0	54.8	20.3	-0.3	N/A	0.3
25.0	54.8	25.2	-0.2	N/A	0.3
30.0	54.9	30.1	-0.1	N/A	0.3
35.0	54.9	35.1	-0.1	N/A	0.3

RELATIVE HUMIDITY

REFERENCE READ	TEMPERATURE DURING CALIBRATION	UUT READ BEFORE ADJUST	CORRECTION BEFORE ADJUST	CORRECTION AFTER ADJUST	UNCERTAINTY, ± k = 2
%RH	°C	%RH	%RH	%RH	%RH
30.7	23.0	34	-3	N/A	2.3
49.9	23.0	54	-4	N/A	2.3
69.5	23.0	73	-4	N/A	2.3
88.9	23.0	94	-5	N/A	2.3

The uncertainty calculation is based on ISO Guide to Expression of Uncertainty in measurement.

Note :

1 : Set Temperature at 23°C during humidity measurement
2 : Set Humidity at 55 %RH during temperature measurement
3 : UUT - Unit Under Test.
4 : To derive True Value = User Instrument Reading + Correction
5 : Interpolation = Reading between 2 test point may be derive by interpolation and plot a straight line graph where Reference (x-axis) Vs. Correction (y-axis)
6 : Correction can be ignore if smaller than user specification, unless otherwise user shall apply correction to derive true value.
7 : If no adjusment done refer to "Correction Before Adjust". If adjusment was done refer to "Correction After Adjust" to derive the true value.
8 : N/A – No Adjustment done.
9 : Uncertainty = Parameter, associated with the result of measurement, that characterises the dispersion of the value that could reasonably be attributed to the measurand
10 : Calibration was perform according to international reference standard JIS B7306, JIS B7920, JIS Z8806, BS 1339.