



UNIVERSITI PUTRA MALAYSIA

***PESTICIDE EXPOSURE, BLOOD CHOLINESTERASE LEVEL AND
NEUROBEHAVIORAL PERFORMANCE AMONG PADDY FARMERS
AT TANJUNG KARANG, SELANGOR***

**BY
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ABSTRACT

PESTICIDE EXPOSURE, BLOOD CHOLINESTERASE LEVEL AND NEUROBEHAVIORAL PERFORMANCE AMONG PADDY FARMER AT TANJUNG KARANG, SELANGOR

IZZAT M. O., ZAILINA H., VIVIEN H.

Pesticides are widely used throughout the world especially in the agriculture and pest control as well as for community health purposed. Agriculture workers are exposed to pesticide primarily throughout mixing, spraying, and loading and clean up container placed the pesticides. The aim of this study was to determine whether pesticide exposure, blood cholinesterase level will affect the neurobehavioral performance score of the paddy field farmers. To fulfill this objective, total 94 of paddy farmers as exposed group and 30 farmers as control group completed a set of questionnaire, capillaries blood collected from finger prick technique for blood cholinesterase level by using cholinesterase test kit model LOVIBOND 412870 AF287 and Neurobehavioral Core Test Battery (NCTB) for neurobehavioral performance. From the result, it showed that mean of blood cholinesterase level for exposed group was lower than control group which was 34.841 and for control group was 88.333. The mean of total NCTB performance for exposed group was 350.24 while for control group was 388.27 and there were significant difference ($p < 0.05$) between both groups for entire NCTB test including the total NCTB performance. There were significant association ($p < 0.05$) between blood cholinesterase level with Digit Span Test, Digit Symbol Test, Reaction Time/Movement Test, Trail Making Test, Pursuit Aiming Test and the total NCTB performance. Duration of work (year) was the most significant variable that influence blood cholinesterase level ($p \leq 0.001$). Blood cholinesterase level was the most variable which influence the neurobehavioral performance, specifically for Benton Visual Retention Test ($p = 0.037$), Age and education level (year) were the most variables which influenced Reaction Time/Movement Test. In conclusion, duration of work (year) which indicated the exposure to pesticide decreased the blood cholinesterase level. The decreasing of blood cholinesterase level inversely Benton Visual Retention Test (visual memory function) and associated with neurobehavioral performance such as auditory memory, memory/manual dexterity coordination, response speed, motor steadiness and visual/steadiness coordination. Age and education level (year) were the variables which significantly influence Reaction Time/Movement Test (response speed function).

Keyword: Pesticide, Neurobehavioral test, Cholinesterase enzyme

ABSTRAK**PENDEDAHAN TERHADAP RACUN MAKHLUK PEROSAK TANAMAN,
PARAS KOLINESTERASE DALAM DARAH DAN PRESTASI
NEUROTINGKAHLAKU DI KALANGAN PESAWAH PADI DI TANJUNG
KARANG, SELANGOR****IZZAT M. O., ZAILINA H., VIVIEN H.**

Racun makhluk perosak tanaman digunakan secara meluas di seluruh dunia terutama dalam sektor pertanian dan kawalan serangga. Petani terdedah kepada racun makhluk perosak tanaman melalui aktiviti membancuh, menyembur dan membersihkan bekas racun yang digunakan. Tujuan kajian adalah untuk menentukan sama ada pendedahan terhadap racun makhluk perosak tanaman, paras kolinesterase dalam darah akan mempengaruhi prestasi neurotingkahlaku di kalangan pesawah padi. Sejumlah 94 orang pesawah padi dipilih sebagai kumpulan terdedah dan 30 orang petani kecil yang tidak menggunakan racun makhluk perosak tanaman dipilih sebagai kumpulan kawalan. Mereka telah menjawab satu set borang soal selidik, persampelan darah melalui teknik tusukan jari bagi analisis paras kolinesterase dalam darah menggunakan model LOVIBOND 412870 AF28, dan Ujian Teras Bateri Neurotingkahlaku (NCTB). Keputusan ujian menunjukkan bahawa paras kolinesterase dalam darah bagi kumpulan terdedah adalah lebih rendah berbanding dengan kumpulan kawalan di mana min kumpulan terdedah adalah 34.841 sementara min kumpulan kawalan adalah 88.333. Min skor keseluruhan NCTB bagi kumpulan terdedah adalah 350.24 dan min skor keseluruhan NCTB bagi kumpulan kawalan iaitu 388.27. Terdapat perbezaan yang signifikan ($p < 0.05$) antara kedua-dua kumpulan bagi prestasi kesemua ujian termasuk prestasi keseluruhan NCTB. Terdapat hubungan yang bererti ($p < 0.05$) antara paras kolinesterase dalam darah dengan Ujian Digit Span, Ujian Digit Simbol, Ujian Masa Tindakbalas/Pergerakan, Ujian Membuat Jejak, Ujian Membuat Target dan keseluruhan NCTB prestasi. Tempoh bekerja (tahun) mempengaruhi paras kolinesterase dalam darah ($p \leq 0.001$). Manakala paras kolinesterase dalam darah mempengaruhi prestasi neurotingkahlaku, khususnya untuk Ujian Pengstoran Visual Benton ($p = 0.037$). Umur dan tahap pembelajaran (tahun) mempengaruhi Ujian Masa Tindakbalas/Pergerakan. Kesimpulannya, tempoh bekerja (tahun) iaitu menunjukkan pendedahan terhadap racun perosak tanaman merendahkan paras kolinesterase dalam darah. Paras kolinesterase yang rendah mempengaruhi fungsi ingatan visual dan terdapat hubungan yang bererti terhadap fungsi ingatan pendengaran, pergerakan/memory koordinasi, masa tindakbalas, ketepatan dan koordinasi mata/ketepatan. Umur dan tahap pendidikan (tahun) mempengaruhi Ujian Masa Tindakbalas/Pergerakan (fungsi masa tindakbalas).

Kata Kunci: Racun makhluk perosak tanaman, ujian neurotingkahlaku, enzim kolinesterase

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LIST OF ABBREVIATIONS

<	Less than
>	More than
=	Equal to
%	Percent
N	Sample size
P	Significant value
r	Correlation
R ²	R square
SD	Standard deviation
IQR	Interquartile range
et. al.	And others
NCTB	Neurobehavioral Core Test Battery
AChE	Acetylcholinesterase enzyme
ACh	Acetylcholine
SOP	Standard operating procedure
WHO	World Health Organization
PPE	Personal protective equipment

CHAPTER 1

INTRODUCTION

1.1 Background

Pesticides are toxic chemicals that are widely used throughout the world. It used extensively throughout the world in agriculture and in pest control as well as for community health purposes (Farahat et al., 2003 ; Rastogi et al., 2010). The main application of pesticides is in agriculture setting, although its use for public health program such as malaria or rodent control. Agriculture workers are exposed to pesticides primarily through mixing of chemicals, loading into dispensers, application clean up, and disposal of empty chemical containers (Farahat et al., 2003).

Pesticides can cause a wide range of health problems, ranging from acute and persistent injury to the nervous system, injury to reproductive systems, birth defects, cancer and skin damage (Alliance For Health Home, 2011), but primarily it damages the nervous system. There are many types of pesticides used in the agriculture such as

insecticides, algacides, bactericides, fungicides, rodenticides, nematocides, miticides, virucides, and avicides.

The types of insecticides pesticides consist of organophosphate, organochlorine, carbamates, and pyrethroids. While the common types of herbicides includes 2,4-dichlorophenoxyacetic acid, Acetochlor, Atrazine, Dicamba, Glyphosate, Mecoprop, Metolachlor, Paraquat, Pendimethalin, and Propanil.

Organophosphate (OP) compounds are extensively used as pesticides and industrial chemicals. They are primarily neurotoxic and produce well-defined muscarinic, nicotinic and cholinergic neurosymptoms involving both central and peripheral nervous systems. Increasing in both central and peripheral neurologic symptoms are also found in many studies on moderate exposure. Increased symptom prevalence may provide early evidence of neurologic dysfunction, before clinically measureable signs are evident (Rastogi et al., 2010).

Herbicides compounds are extensively used in agriculture sectors especially at rice field. Herbicides are the compounds that used to kill weeds before the plantation process. In general, herbicides have a low acute toxicity to humans because the physiology of plants is different than that of humans. However, there are exceptions; many can be dermal irritants since they are often strong acids, amines, esters, and phenols. Inhalation of spray mist may cause coughing and a burning sensation in the

nasal passages and chest. Prolonged inhalation sometimes causes dizziness. Ingestion will usually cause vomiting, a burning sensation in the stomach, diarrhea, and muscle twitching (Organic Consumer Association, 2007).

Tanjung Karang is the largest paddy producer in Selangor after Kedah. These paddy fields are worked by the Bumiputera. It is a reality that the Malay community livelihood is still dependent on agriculture sources as their main source of income. This paddy field at Kampung Sawah Sempadan spans an area of approximately 2, 300 hectares of Tanjung Karang sub district (Komuniti Desa, 2011).

1.2 Problem Statement

Pesticides are widely used in agriculture sector to kill a pest. Pesticides are any substance or mixture of substance intended for, preventing, destroying, repelling or mitigating any pest. Approximately 16 000 pesticide products are registered with the EPA. These products are based on approximately 600 active ingredients. Most pesticide products (approximately 80 percent by volume) are used by the agricultural industry (Krishna, 2009).

The World Health Organization (WHO) estimate that each year, 3 million workers in agriculture in developing world experience severe poisoning from pesticides. Poisoning from pesticides affects 68 000 farmers and workers every day. Annually, as

many as 25 million workers suffer from pesticide poisoning through the world. Agriculture worker and pesticide sprayer are exposed to pesticides directly when they are mixing and spraying the pesticides, especially in developing countries such as Asia (Krishna, 2009).

Pesticide poisoning is one of the most prevalent health problems in the Philippines. In a study by Department of Health (DOH) from 1991 – 1995, organophosphates accounted for the highest number of poisoning cases while organochlorines caused the most number of deaths (Lu, 2009).

Some evidence for the presence of an undiagnosed reservoir of chronic neurotoxic disease related to pesticide exposure was found in a pilot study in the apple farming industry in Western Cape in 1992 (London et al., 1998).

Acute effects for pesticides poisoning include nausea, vomiting, diarrhoea, abdominal cramps, general weakness, headache, tremors and excessive sweating. In serious cases, respiratory failure and death can occur (Tapia et al., 2005).

For chronic effect it is frequently involves a neurotoxin effect. Another effect include birth defects, toxicity to fetus, production of benign or malignant tumors, genetic changes, blood disorders, nerve disorder, endocrine disruption and reproduction effects (Rohlman et al., 2006).

Few studies have investigated health effects in humans of low level chronic exposure to organophosphate. The potential effects of such low-level exposures on neurobehavioral functioning are particularly relevant for fetus and young children, who may be especially vulnerable to neurotoxicants because of their immature nervous systems, their rapid rate of brain growth and development in utero and during early childhood, and their low levels of enzymes involved in the metabolism and detoxification of organophosphate (Eskenazi et al., 1999 ; Huen et al., 2009).

Health effects of herbicide paraquat exposure such as burning in mouth, throat, chest, upper abdomen diarrhea, giddiness, headache, fever, lethargy, dry, cracked hands, and ulceration of skin while for glyphosate toxic effect includes Irritating to skin, eyes, and respiratory tract (Organic Consumer Association, 2007).

1.3 Study Justification

Organophosphate are a closely related group of compounds that affect the function of the nervous system in humans. They are used on many food crops, in residential and commercial buildings, and for ornamental plants and lawn care, which people are potentially exposed to during regular basis and by different routes (Salvador, 2006).

Organophosphate are very effective in the eradication of insect and they are not as persistent in the environment as organochlorine pesticides. However, organophosphate can cause acute adverse human health effects. At certain doses, organophosphate have adverse effects on insects and humans. Organophosphate inhibit acetylcholinesterase enzymes (AChEs) at nerve ending that result in a built up of acetylcholine (Ach). Ach is an important neurotransmitter. When accumulates at a synapse due to jamming of information the passing of messages between nerve cells is prevented (Jaipieam, 2009).

Paraquat herbicides is very potent and it specifically to pulmonary toxicant (Squibb, 2002). The effect of paraquat herbicides includes of burning in mouth, throat, chest, upper abdomen, diarrhea, giddiness, headache, fever, lethargy, dry, cracked hands, and ulceration of skin. While for glyphosate herbicides will give acute effect such as Irritating to skin, eyes, and and chronic effect to the respiratory tract (Organic Consumer Association, 2007).

Safety measures are generally poorly implemented, and workers lack proper knowledge or training in the safe handling of these chemicals. These may produce populations with higher exposures than described in the other studies reported to date (Farahat et al., 2002).

The study of pesticide usage especially organophosphate, paraquat and glyphosate with their effects on neurocognitive performance are few, particularly among farmers. Since farmers are usually self employed, it is difficult to carry out health promotion or programs so that their health is not threatened as well as to promote a safety in their jobs. That is why research related to this field is needed to disseminate the information through program to avoid and reduce the exposure of pesticide among farmers.

1.4 Conceptual Framework

Figure 1.1 shows that the conceptual framework of the study. It was used to assist and guide researcher in implementing the study. The aim of this study is to determine the relationship between the blood cholinesterase level due to pesticide exposures with the neurobehavioral performance among paddy farmers.

From the framework, organophosphate, paraquat and glyphosate are the type of pesticides used in the agriculture industry especially at paddy field at Tanjung Karang. There are three pathways the pesticides can enter human body; by ingestion of pesticides contaminated food or water (ingestion), by inhaling the air contaminated with pesticides (inhalation) and by direct skin contact with the pesticides or its contaminated air (direct contact). These exposure will give an adverse health effect to human system such as the respiratory, cardiovascular and the central nervous system.

This research was focused on the effect to nervous system, where the exposure to pesticides contaminated has been monitored by determining the individual blood cholinesterase level by using cholinesterase test kit Model LOVIBOND 412670 AF267, while the effect on nervous system were evaluated by using Neurobehavioral Core Test Battery (NCTB) (World Health Organization, 1986).



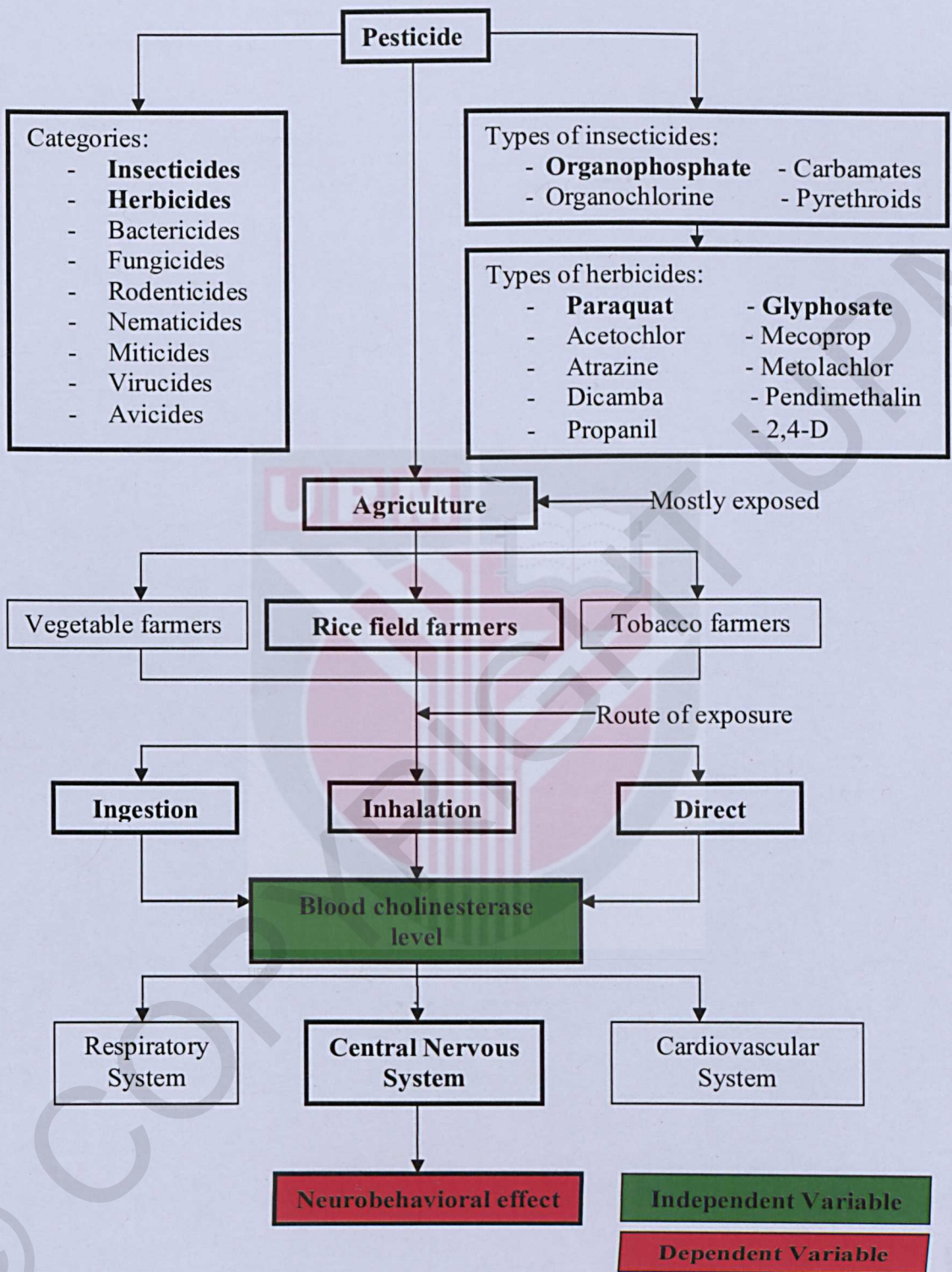


Figure 1.1: Conceptual Framework of the study

1.5 Research Objective

1.5.1 General Objective

To determine the association between blood cholinesterase level due to pesticide exposure with neurobehavioral performance among paddy farmers in Tanjung Karang, Selangor.

1.5.2 Specific Objectives

- i) To determine the blood cholinesterase level due to pesticide exposure of the respondents.
- ii) To determine the neurobehavioral performance of the respondents.
- iii) To compare the difference in the neurobehavioral performance between the exposed and unexposed respondents.
- iv) To identify the relationship between bloods cholinesterase level of the respondents with the neurobehavioral performance of respondents.
- v) To identify the selected variables that influences the blood cholinesterase level of the respondents.
- vi) To identify the selected variables that influences the neurobehavioral performance of the respondents.

1.6 Research Hypothesis

- i) The neurobehavioral performance score of exposed group is significantly lower than the neurobehavioral performance score of the control group.
- ii) The higher blood cholinesterase level, the lower the neurobehavioral performance score of the respondents.
- iii) The duration of exposure period is the factor which significantly influences the blood cholinesterase level.
- iv) The cholinesterase level is the factor which significantly influences the neurobehavioral performance score.

1.7 Definition of Term

1.7.1 Conceptual Definition

a) Pesticides

A pesticide is a chemical used to prevent, destroy or repel insects, mice and other animals, weeds, fungi or microorganisms such as bacteria and viruses (Environmental Protection Agency, 2011). Most pesticides may classified according to the pests they kill such as algicide (algae), avicide (birds), bactericide (bacteria), fungicide

(fungi), herbicide (weeds), insecticide (insects), miticide (mites), molluscicide (snail, slugs), nematicide (nematodes), piscicide (fish) and rodenticide (rodents) (British Columbia, 2011).

b) Agriculture Group

Group of workers in several occupational may be exposed to pesticide by preparing pesticide for use, such as mixing or loading pesticide into application equipment and applying the pesticides.

c) Central Nervous System

Central Nervous System (CNS) is structure that controls actions and functions of body. It composes of brain and spinal cord, their nerve and the ganglia and fibre forming the autonomic system (E Medicine health, 2012).

d) Neurobehavioral Core Test Battery (NCTB)

NCTB is an efficient and effective neurobehavioral testing that can provide a quantitative data which are widely used to detect nervous system dysfunction among occupational settings.

1.7.2 Operational Definition

a) Pesticides

Pesticides is widely used by agriculture workers especially rice field farmers at Tanjung Karang to kill pest. The widely used is organophosphate, paraquat and glyphosate.

b) Agriculture Group

The paddy field farmers that work in rice growing area located at Tanjung Karang, Selangor.

c) Central Nervous System (CNS)

Central Nervous System is consists of all the nervous that transmit signal between the CNS and the rest of the body.

d) Neurobehavioral Core Test Battery (NCTB)

A series of test used to measure potential adverse health effect to nervous system. It is consists of seven test that is Benton Visual

Retention Test, Digit Span Test, Digit Symbol Test, Santa Ana
Manual Dexterity Test, Time Reaction/Movement Test, Trial Making
Test and Pursuit Aiming Test.



CHAPTER 2

LITERATURE REVIEW

2.1 Characteristic and Types of Organophosphate

2.1.1 Characteristic

All organophosphate share some common chemical properties. Organophosphate contain a central phosphorus atom with a double bond to either sulfur or oxygen, R1 and R2 groups that are either ethyl or methyl in structure, and a leaving group which is specific to the individual organophosphate (National Pesticide Information Centre, 2011). The general structure of organophosphates and a specific example (chlorpyrifos) appear below:

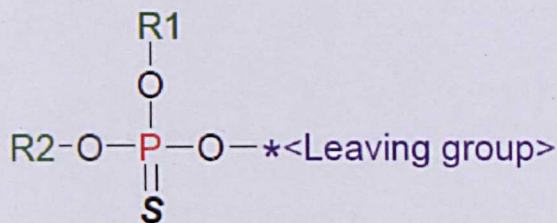


Figure 2.1: General structure of organophosphate

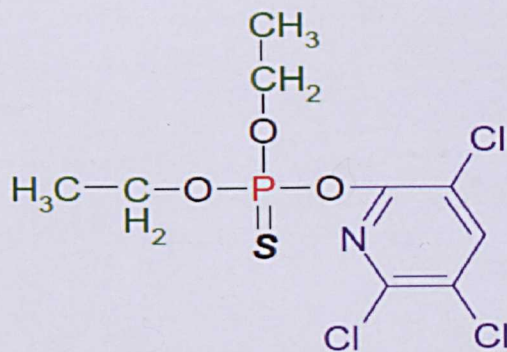


Figure 2.2: Structure of Chlorpyrifos

2.1.2 Types and Empirical Formula of Organophosphate

Table 2.1: Types and Empirical Formula of Organophosphate

Compound (alphabetically)	Empirical Formula
Azinphos Methyl	$C_{10}H_{12}N_3O_3PS_2$
Chlorpyrifos	$C_9H_{11}C_{13}NO_3PS$
Diazinon	$C_{12}H_{21}N_2O_3PS$
Dicrotophos	$C_8H_{16}NO_5P$
Disulfoton	$C_8H_{19}O_2PS_3$
Ethion	$C_9H_{22}O_4P_2S_4$
Ethoprop	$C_8H_{19}O_2PS_2$
Fenamiphos	$C_{13}H_{22}NO_3PS$
Fonofos	$C_{10}H_{15}OPS_2$

Malathion	C10H19O6PS2
Methamidophos	C2H8NO2PS
Methyl Parathion	C8H10NO5PS
Mevinphos (E)	C7H13O6P
Monocrotophos (Z)	C7H14NO5P
Parathion	C10H14NO5PS
Phorate	C7H17O2PS3
Ronnel	C8H8Cl2O3PS
Sulprofos	C12H19O2PS3
Terbufos	C9H21O2PS3

2.2 Characteristic of Paraquat and Glyphosate

Paraquat is the trade name for *N,N'*-dimethyl-4,4'-bipyridinium dichloride, one of the most widely used herbicides in the world. It also synonyms with Paraquat dichloride; Methyl viologen; Crisquat; Dexuron; Esgram; Gramuron; Ortho Paraquat CL; Para-col; Pillarxone; Tota-col; Tocer Total; PP148; Cyclone; Gramixel; Gramoxone; Pathclear; AH 501 (Material Safety Data Sheet, 2011).

The molecule of glyphosate can be envisioned as a polydentate and/or monodentate ligand that binds to “substrates” via the oxygen atoms. These molecular characteristics of glyphosate have major implications in its mode of herbicide action (Environmental Protection Agency, 2011).

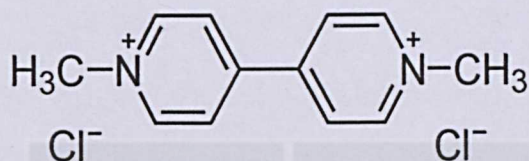


Figure 2.3: Structure of Paraquat

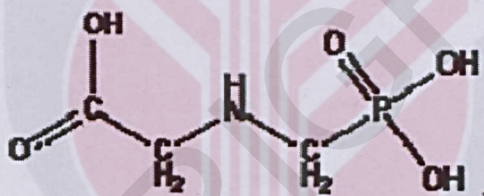


Figure 2.4: Structure of Glyphosate

2.3 Pesticide Exposure and Route of Transmission

The presence of pesticide in air, soil, food and water occurs during mixing, loading and application of pesticide in the work task of the paddy field farmers. Farmers are directly and indirectly exposed to the pesticide residues either by inhalation during mixing, loading, or application of pesticides, by ingestion through artesian well water, or

by dermal exposure from contact with soil residue, pesticide residues on plants, or while handling the pesticides (Jaipieam, 2009).

2.4 Mechanisms of Pesticide Affect Neurobehavioral Function

Organophosphate pesticide is the inhibitor for cholinesterase enzyme (Smith et al., 1983). Cholinesterase is one of many important enzymes needed for the proper function of the nervous system of human, other vertebrates and insects. Two types of cholinesterase are found in blood: “true” cholinesterase (acetylcholinesterase) in red blood cells and “pseudocholinesterase” (acylcholineacylhydrolase) in serum (plasma). Low serum cholinesterase activity may relate to exposure to insecticide or to one of a number of variant genotypes. Dibucaine and fluoride numbers are useful to phenotype such as homozygous and heterozygous individuals, who are genetically sensitive to succinylcholine (Evans et al., 1978).

Certain chemical classes of pesticide, such as organophosphate and carbamate work against undesirable bugs by interfering with or ‘inhibiting’ cholinesterase. While the effects of cholinesterase inhibiting products are intended for insect pests, these chemicals can also be poisonous, or toxic to humans in some situations (smith et al., 1983).

The development of organophosphate is primarily credited to a German chemist Gerhad Schrader in the late 1930's. Their toxicity is due primarily to the inhibitory effect on acetylcholinesterase (AChE), an enzyme whose function is to inactivate the neurotransmitter acetylcholine (ACh) at the junction of various nerve endings. Enzyme inhibition results in an abnormal accumulation of ACh at the cholinergic receptor sites, leading to "over-stimulation". Human exposure to cholinesterase inhibiting chemicals can result from inhalation, ingestion, and skin contact during manufacture, mixing, or applications of these pesticides (Smith et al., 1983).

The presence of cholinesterase inhibiting chemicals prevents the breakdown of ACh. ACh can then build up, causing a "jam" in the nervous system. Thus when a person receives to a greater extent of exposure to cholinesterase inhibiting chemicals, the body is unable to break down the ACh. The stimulation signal end up failed to stimulate (Smith et al., 1983).

A typical synapse in the body's nerve system, in which a muscle is being directed by a nerve to move. An electrical signal, or nerve impulse, is conducted by ACh across the junction between the nerve and the muscle (the synapse) stimulating the muscle movement. Normally, after the appropriate response is accomplished, Cholinesterase is released which break down the ACh terminating the stimulation of the muscle. The enzyme ACh accomplishes this by chemically breaking the compound into other compounds and removing them from the nerve junction. If acetylcholinesterase is

unable to break or remove acetylcholine, the muscle can continue to work uncontrollably (Smith et al., 1983).

2.5 Signs, Symptoms and Effect of Pesticide Exposure

Organophosphate and carbamate insecticides inhibit the activity of cholinesterase, resulting in a buildup of acetylcholine in the body. An increase in acetylcholine results in the uncontrolled flow of nerve transmissions between nerve cells. The nervous system becomes “poisoned”; the accumulation of acetylcholine causes the continual transmission of impulses across the synapses.

The effects of organophosphate or carbamate poisoning can result in both systemic and topical symptoms. Direct exposure of the eye, for example, can cause topical symptoms such as constriction of the pupils, blurry vision, an eyebrow headache, and severe irritation and reddening of the eyes. Symptoms and signs of systemic poisonings are almost entirely due to the accumulation of acetylcholine at the nerve endings.

The onset of symptoms depends on the route of entry and the severity of the poisoning. Gastric symptoms such as stomach cramps, nausea, vomiting, and diarrhea appear early if the material has been ingested. Similarly, salivation, headache, dizziness, and excessive secretions that cause breathing difficulties are initial symptoms if the

material has been inhaled. Involvement of the respiratory muscles can result in respiratory failure. Stomach, intestinal, and respiratory symptoms usually appear at the same time if the pesticide is absorbed through the skin. In children, the first symptom of poisoning may be a convulsion.

In advanced poisonings, the victim is pale, sweating, and frothing at the mouth. The pupils are constricted and unresponsive to light. Other symptoms include changes in heart rate, muscle weakness, mental confusion, convulsions, and/or coma. The victim may die if not treated.

Paraquat herbicides are very potent and it specifically to pulmonary toxicant (Squibb, 2002). The effect of paraquat herbicides includes of burning in mouth, throat, chest, upper abdomen, diarrhea, giddiness, headache, fever, lethargy, dry, cracked hands, and ulceration of skin. While for glyphosate herbicides will give acute effect such as Irritating to skin, eyes, and and chronic effect to the respiratory tract (PSFS, 2009).

2.6 Neurobehavioral Core Test Battery (NCTB)

Neurobehavioral Core Test Battery (NCTB) testing is a non-invasive method used to evaluate the performance of the central nervous system in an individual or group with similar exposures. Test batteries consist of tasks that measure performance of particular neurologic function, such as ability to learn, reaction time, memory, and

coordination. It used widely to detect the dysfunction of nervous system that caused by neurotoxin agent.

The NCTB consists of seven test, which are made up of the Benton Visual Retention Test, Digit Symbol Test, Digit Span Test, Pursuit Aiming Test, Time Reaction/Movement Test, Santa Ana Manual Dexterity Test and Trial Making Test (Sains Malaysiana UKM, 2007). Table 2.2 below shows the function of each test.

Table 2.2: NCTB test and the function of each test

Test	Function
1. Benton Visual Retention	Visual perception/memory
2. Time Reaction/Movement	Attention/ response speed
3. Santa Ana Manual Dexterity	Manual dexterity
4. Trail Making	Motor & visual coordination/steadiness
5. Pursuit Aiming	Motor steadiness
6. Digit Symbol	Perceptual motor speed
7. Digit Span	Auditory memory

2.7 Cholinesterase Test Kit Model LOVIBOND 412670 AF267

The Lovibond Cholinesterase Test Kit is designed for rapid field-testing of exposure to organic phosphorus insecticide and for determining the level of Cholinesterase poisoning of operators after crop spraying using organo-phosphorous pesticides. The kit has been designed for use in situations where rapid analysis is urgently required and where there are no laboratory facilities. This kit can also be used to alert users (farmers, spray operators, research workers) of their exposure to these chemicals and unsafe working practices.

CHAPTER 3

METHODOLOGY

3.1 Study Location

This research conducted at the paddy field in Tanjung Karang, Selangor which called Sawah Sempadan for exposed group while for control group has been conducted at Hulu Selangor.

3.2 Study Design

The study design is a cross-sectional comparative study that is to assess the effects of neurobehavioral performance due to pesticide exposure in occupational settings.

3.3 Sampling

3.3.1 Sampling Population

The population of the respondents consists of paddy field farmers who handle pesticide in their job tasks. While the control population are consists of small scale farmers who not exposed to pesticide.

3.3.2 Sample Frame

The sampling frame of this study was from the name lists of farmers obtained from the Tanjung Karang Farmer's Organizations Officer.

3.3.3 Study Sample

The study sample are consists of 115 paddy field farmers who exposed to pesticide in their work tasks and 30 farmers who never handle pesticide in their work task. The sample size calculation is as below (Robinson & Neutens, 1987):-

$$N = (Z/e)^2 (P)(1-P)$$

Where:

N = Sample size

Z = Standard score significant level

P = estimation incidence in population

For 95 percent significant level, Z = 1.96 and e = 0.10

Calculation for Exposed Group:

P = 0.5 (M. Azli, 2010)

$N = (1.96/0.10)^2 (0.5)(0.5)$

$N = (384.16) (0.25)$

$N = 96.04, = 96$

Account for any missing data during data collection, add about 20 percent = 19.

$N = 96 + 19$

$N = 115$

3.4 Instrumentation

3.4.1 Questionnaire

A set of self-constructed questionnaire was used to get information from the respondents such as personal information, socio-demographic, socio-economic, occupational background information, use of personal protective equipment (PPE), their knowledge on pesticide and health status of the respondents.

3.4.2 Neurobehavioral Core Test Battery (NCTB)

Neurobehavioral assessment was conducted by using NCTB (WHO, 1986) to evaluate the neurobehavioral performance among respondents. This assessment includes seven tests that have their specification in analysis neurobehavioral symptoms. The test were includes Benton Visual Retention Test, Digit Symbol Test, Digit Span Test, Pursuit Aiming Test, Time Reaction/Movement Test, Santa Ana Manual Dexterity Test and Trial Making Test.

3.4.2.1 Benton Visual Retention Test

The Benton Visual Retention Test is an individually administered test for adult that measures visual perception and visual memory. It can also be used to help identify

possible learning disabilities. The respondents were showed 10 geometrical designs, one at a time, and then asked to determined which from the A, B, C and D answer are the same design with the geometrical design has been shown in one minutes. Then the answer is recorded on the NCTB form.

3.4.2.2 Digit Symbol Test

The Digit Symbol Test of psychomotor performance and its computer based alternative, the symbol digit test of complex scanning and visual tracking, constitute the most widely used and sensitive tests in human behavioural neurotoxicology research. These tests present nine symbols, each paired with a number between 1 and 9 in a matrix or 2×9 table. Below the matrix is a similar matrix but with only the number (digit symbol) or symbol (symbol digit), and the respondent must add the missing member of each pair, as quickly as possible just in 90 minutes.

3.4.2.3 Digit Span Test

The Digit Span Test is a simple test of attention in which a series of numbers between 1 and 9 are read to a respondent who must, after the series is completed, repeat the series orally. The test is then repeated with new numbers, but respondent are to repeat them backwards that is, reverse of the order in which they were read. The last series where the respondent can repeated had been considered as the final result.

3.4.2.4 Pursuit Aiming Test

The Pursuit Aiming Test requires the subject use a pencil to place one dot inside the centre of each circle following the pattern given on the printed pursuit aiming test sheet. This task is to be performed as quickly as possible for 60 seconds.

3.4.2.5 Reaction Time/ Movement Test

The Reaction Time/Movement Test of response speed presents a visual or auditory stimulus to which the respondent is to respond as quickly as possible by transferring their finger from bottom to top button. The respondents need to respond if the green LCD appears. The result is recorded in the form.

3.4.2.6 Santa Ana Manual Dexterity Test

In this test a plastic base plate with pegs fitted in rows of 12 was used. Each peg was to be removed, turned 180 degrees and replaced in its slot. The objective is to turn as many pegs as possible in 30 seconds. The test is repeated twice with the dominant hand and twice with the non-dominant hand. The number of pegs successfully turned is recorded as the test score.

3.4.2.7 Trail Making Test

This test used to measures attention, visual conception and psychomotor function. The worksheet contains 2 pages, the first page contains numbers only and the second one contains numbers and letters inside circles. The respondent task is to draw a line connecting numbers to numbers in the first page and letters to numbers in the correct order in the second page from the number 1 to the letter A, to number 2 to the letter B and so on. The time in second is recorded after the respondent completed the task.

3.4.3 Cholinesterase Test Kit Model LOVIBOND 412670 AF267

The individual blood cholinesterase level has been collected and analyzed by using cholinesterase test kit Model LOVIBOND 412670 AF267. This is a rapid method for testing the cholinesterase level in blood. The test kit requires only 0.01 ml blood for each respondent, which may be easily obtained from a finger prick sample. There are two type of reagent used in this test which is indicator solution and substrate solution. The indicator solution consists of Bromothymol Blue which was dissolved in 250ml of deionised water (CO₂ free) while for substrate solution which consists of 0.25g of Acetylcholine Perchlorate was dissolved in 50ml of deionised water (CO₂ free). The entire test was completed in about 4 minutes, facilitating the rapid evaluation of poisoning status.

The cholinesterase activity in the blood from the respondent is expressed as a percentage of the activity in normal blood. Table 3.1 indicates the percentage of cholinesterase activity in the blood.

Table 3.1: Percentage and category of cholinesterase activity in blood

Percentage (%)	Indicator
100.0 – 75.0	Normal
74.9 – 50.0	Over exposure
49.9 – 25.0	Serious over exposure
24.9 – 0.0	Very serious and dangerous over exposure

3.5 Data Collection Procedures

Permission letter has been forwarded to the owner of the paddy field before data collection. Written consent had been obtained from the respondents.

A set of self-constructed questionnaire has been distributed to the respondents in order to obtain information about their personal details, working background, socio-demographic, socio-economic, and health information.

The NCTB test which consists of seven types of test was held before the blood sampling. Then, the 0.01 ml blood sample has been obtained from each respondent from a finger prick. Then, the sample has been analyzed by using the cholinesterase test kit Model LOVIBOND 412670 AF267. This step takes around 4 minutes to get the result of blood cholinesterase level.

The data collection approaches for unexposed group conducted in the same procedures with the exposed group. NCTB data were computed through the following formula (3.6) in order to quantify the standard score for comparison purposive. Blood cholinesterase level was recorded during field analysis.

3.6 Computation of Standard Score for NCTB

The raw score (raw data) from NCTB test was modified to make it comparable to score which was collected from other studies. The standard score for NCTB requires the computation of mean and standard deviation from all subjects from each test. The standard score formula are shown below:

$$\text{Standard Score} = [(\text{raw score} - \text{mean}) / \text{SD}] \times 10 + 50$$

3.7 Data Analysis

Univariate analysis was performed to determine the frequency, percentage, mean, and standard deviation of the socio-demographic, working background and health information. Bivariate analysis which is Mann-Whitney U test was used to determine the different of blood cholinesterase level and NCTB performance between exposed and control group while Spearman Rho' test was used to determine the association of blood cholinesterase level with NCTB performance for both groups. Multivariate analysis which is Multiple Linear Regression was used to determine the significant factors which influence the blood cholinesterase level and NCTB performance. All the data was analyzed by using Statistical Package for Social Science (SPSS) version 17.0. The significant value was set at $p \leq 0.05$.

3.8 Quality Control

Pre-test of questionnaire was conducted among 10 percent of the total respondent which aimed to ensure the validity and reliability of the questions set. Standard Operating Procedure (SOP) of blood finger prick method was followed in order to ensure sample is collected stored and transferred in appropriate manner. The World Health Organization (WHO 1986) SOP for NCTB test was followed and training among researchers has been conducted before the testing in order to improve validity and

reliability of result. The respondents were briefed and trained once before run the each test. This is to make sure the results are accurate and comparable to other result.

3.9 Study Ethic

This study was conducted by considering ethical issues as stated by medical ethical committee from Faculty of Medicine and Health Science, Universiti Putra Malaysia:

- i) The research proposal has been reviewed and endorsed by the ethical committee.
- ii) Permission letter from Ministry of Agriculture was obtained before carrying out the research.
- iii) The individual consent from respondents were requested before involving them in the study.
- iv) The respondent has been given some explanation about the whole of the study activities involved.
- v) The respondent has been given some explanation about the purpose of the blood taken and explanation about the method of blood sampling.
- vi) Standard operating procedure has been followed in order to get the blood sample from respondent and also in running the NCTB test.

- vii) The respondent has been given some explanation about the NCTB test that will be held to them in term of the purpose of the test, the procedure taken, and also respondents' right in this study.

3.10 Study Limitation

The limitations of the study are:

- i) Lack of respondents participated in this study is because they refused to participate in this study due to blood sample involvement, as well as NCTB test which estimated to complete in 20 – 30 minutes for the entire tests.
- ii) Lack of control group respondents due to lack of farmers who not used pesticide in their work activities.
- iii) Lack of time to collect blood sample as baseline for comparing the blood cholinesterase level after the farmers handling pesticides.

CHAPTER 4

RESULT

4.1 Study Location

This study was conducted at Kampung Sawah Sempadan, Tanjung Karang, Selangor where Tanjung Karang was the largest paddy producer in Selangor after Kedah and Perak. It has approximately about 2, 300 hectares of paddy field at this village.

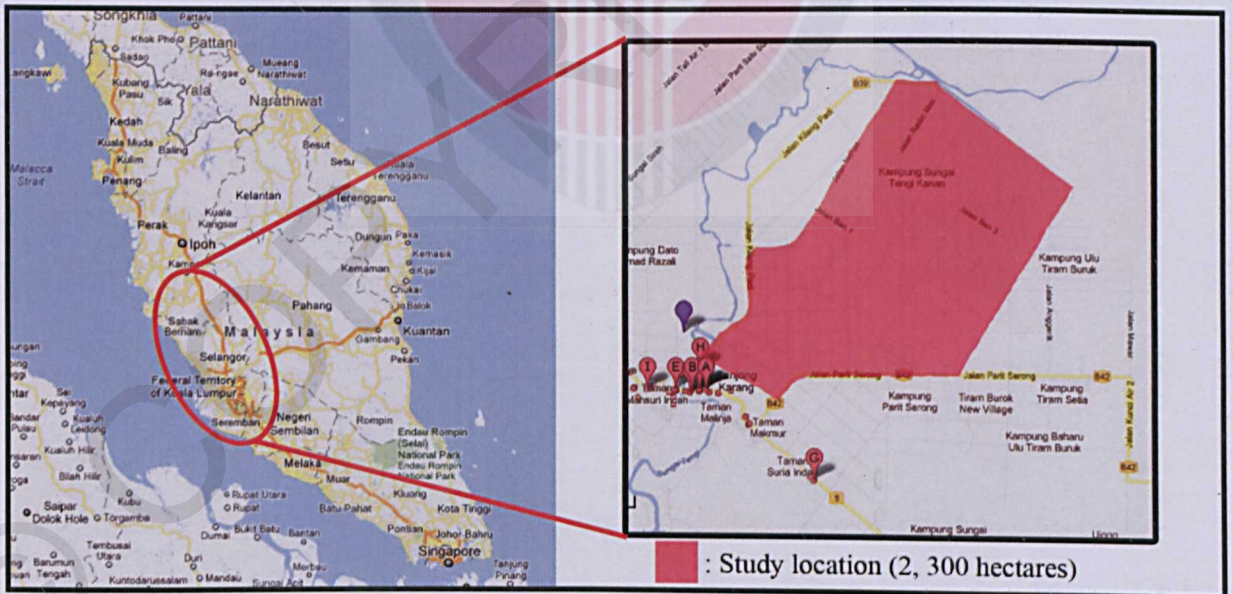


Figure 4.1: Map of the study location

4.2 Process of Paddy Cultivation

From the Agriculture Department of Kuala Selangor, the paddy cultivation process carried out twice a year, with each cycle of paddy cultivation takes around 6 months to harvest the final product. Paddy cultivation process includes several steps such as preparation of the soil, irrigate paddy block, planting the seed, fertilizing/pesticide control, and harvesting.

The farmers used pesticides for the land preparation in which they used herbicide to control the growth of weed. In the process of irrigating the paddy block, they used herbicide to control weed growth and also rodenticide to control the rat population in the paddy field. Pesticides were not used during the seed planting and it will only be used widely for soil fertilization and pest control. During this process, they used insecticide, herbicide as well as molluscicide widely (Figure 2).

Insecticide widely used at Tanjung Karang paddy field were Avisect and Chlorpyrifos, while for herbicide they widely used Paraquat and Glyphosate. They also widely used molluscicide to control the Golden Apple Snail population.

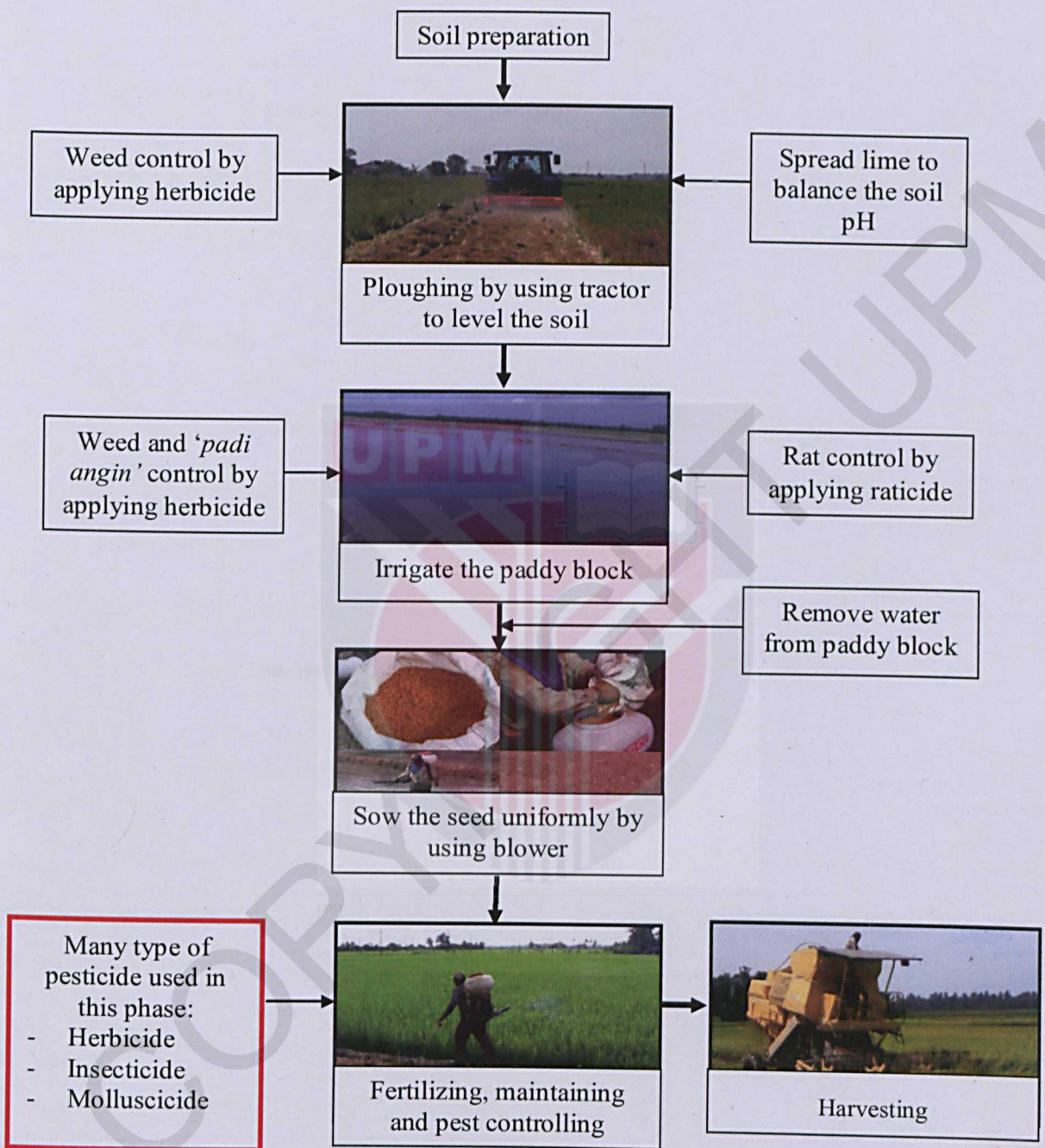


Figure 4.2: Paddy Cultivation Stages

4.3 Study Sample

This study aimed to determine the pesticide exposure and neurobehavioral performance of the paddy farmers, who used pesticide frequently and were highly exposed to the pesticide.

This study was conducted among 94 paddy field farmers exposed to pesticide during mixing, loading and spraying activities. While for the control group was conducted on 30 farmers who were not exposed to the pesticide.

4.4 Respondents' Socio-demographic Background

4.4.1 Age

The mean age of exposed group was 40.65 and standard deviation was 12.69, while for control group the mean age was about 47.63 and standard deviation was 8.54. Shapiro-Wilk test was applied to determine the normality of respondents' age distribution. Mann-Whitney U test was performed to identify the difference between exposed and control group. Result showed that there was a significant difference ($z = -2.869$, $p = 0.004$) in age, between the exposed with the control group.

4.4.2 Monthly Income

Respondent monthly income was obtained as an indicator of respondent's health status. Since the normality test shows the variables was not normally distributed, Mann-Whitney U test was performed to determine the different between exposed and control group. The mean for the exposed group was 1299.36 and standard deviation was 473.20. While the mean for control group was 1874.33 and standard deviation was 267.11. There was significant difference in the monthly income among exposed and control group ($z = -6.722, p \leq 0.001$).

4.4.3 Work Period

The total years of work was used to indicate the exposure duration of the respondent to the pesticide. Shapiro-Wilk test showed the variable was not normally distributed. Hence, Mann-Whitney U test was performed to determine the difference between both groups. The results showed the working years of respondents were significant different ($z = -0.342, p = 0.732$) between exposed and control group. The mean of work duration for exposed group was 16.15 and standard deviation was 13.18, while the mean for control group was 13.97 and standard deviation was 6.66.

4.4.4 Number of Children

The normality test showed the variable was not normally distributed. Hence, Mann-Whitney U test showed the number of children was significantly different for both groups ($z = -4.358$, $p \leq 0.001$). The mean for exposed group was 2.38 and standard deviation was 2.10. While for control group the mean was 4.33 and standard deviation was 1.79.

4.4.5 Marital Status

Since this variable showed not normally distributed for both group, Mann-Whitney U test was performed to determine the difference in the marital status between exposed group with control group, and it showed there was significant difference between the exposed group with control group for marital status ($z = -3.616$, $p \leq 0.001$).

4.4.6 Educational Level

The respondent education level was obtained to reflect on the perceived knowledge of respondent on pesticide exposure and health effect from the exposure. Shapiro-Wilk test was applied to determine the normality of this variable and result showed that both exposed and control group was not normally distributed. Hence, Mann-Whitney U test was performed to determine the different among exposed and

control group's education level. The result showed there was a significant difference between education level among exposed and control group ($z = -2.715, p = 0.007$).

Table 4.1: Respondents' socio-demography information

Variables	Mean (SD)		z	p
	Exposed (N = 94)	Control (N = 30)		
Age (Year)	40.65 (12.69)	47.63 (8.54)	-2.869	0.004*
Monthly Income (RM)	1299.36 (473.20)	1874.33 (267.11)	-6.722	$\leq 0.01^*$
Work Period (Year)	16.15 (13.18)	13.97 (6.66)	-0.342	0.732
Number of children	2.38 (2.10)	4.33 (1.79)	-4.358	$\leq 0.01^*$
Marital status	-	-	-3.616	$\leq 0.01^*$
Educational Level	-	-	-2.715	0.007*

N = 124

SD = Standard Deviation

*Significant at $p \leq 0.05$

4.5 Respondents' Socio-lifestyle

The result from descriptive analysis showed that 63 people (67%) of exposed group are smokers while 31 people (33%) are non-smokers. Personal hygiene practice was evaluated based on the frequency of daily shower and change of clothes. About 76 people (81%) took bath after their field work activity while only 18 people (19%) did not take their bath after their field work. Nevertheless, all respondents claimed that they changed their working clothes daily. For the control group, 21 people (70%) are smokers and 9 people (33%) are non-smokers. The data showed that 28 people (81%) took shower after their daily work activities. Nevertheless, all respondents claimed that they changed their working clothes daily (Figure 4.3).

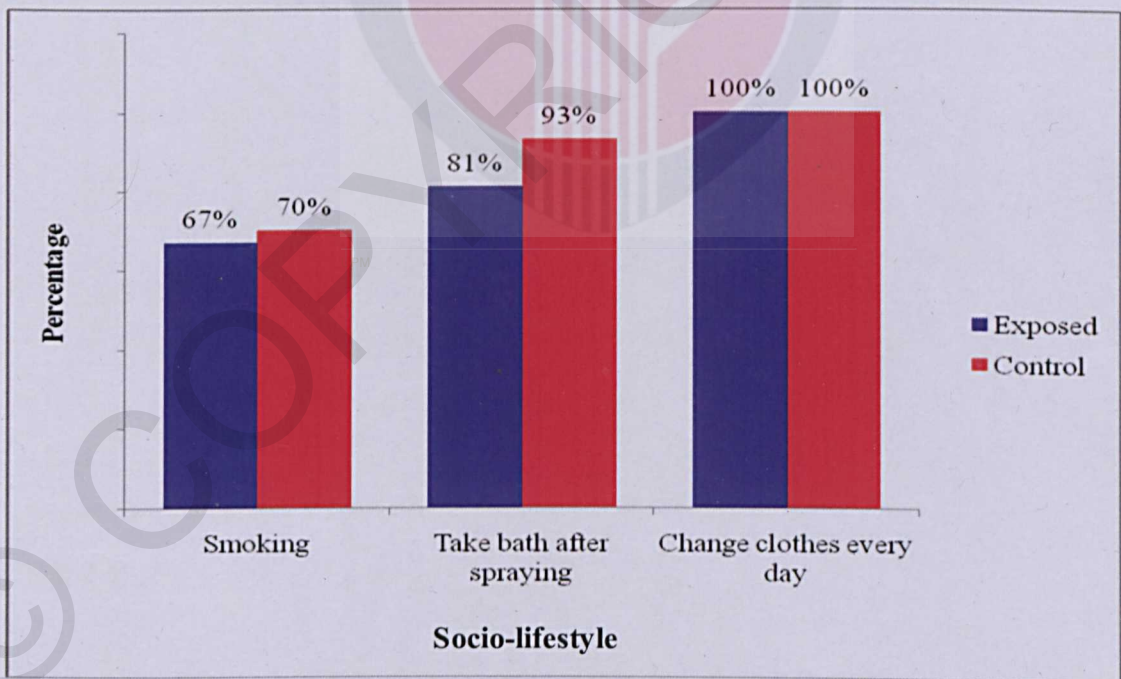


Figure 4.3 Socio-lifestyle of the respondent

4.6 Type of Pesticides Used by Exposed Group

In order to fulfill the high market demands of rice supply, paddy farmers tend to use different type of pesticides in order to raise the rice production. In this study, result showed 88 people (93.6%) apply insecticides in their paddy field, followed by 83 people (88.3%) apply herbicides in their paddy field and 82 people (87.2%) used mollucicide (Figure 4.4).

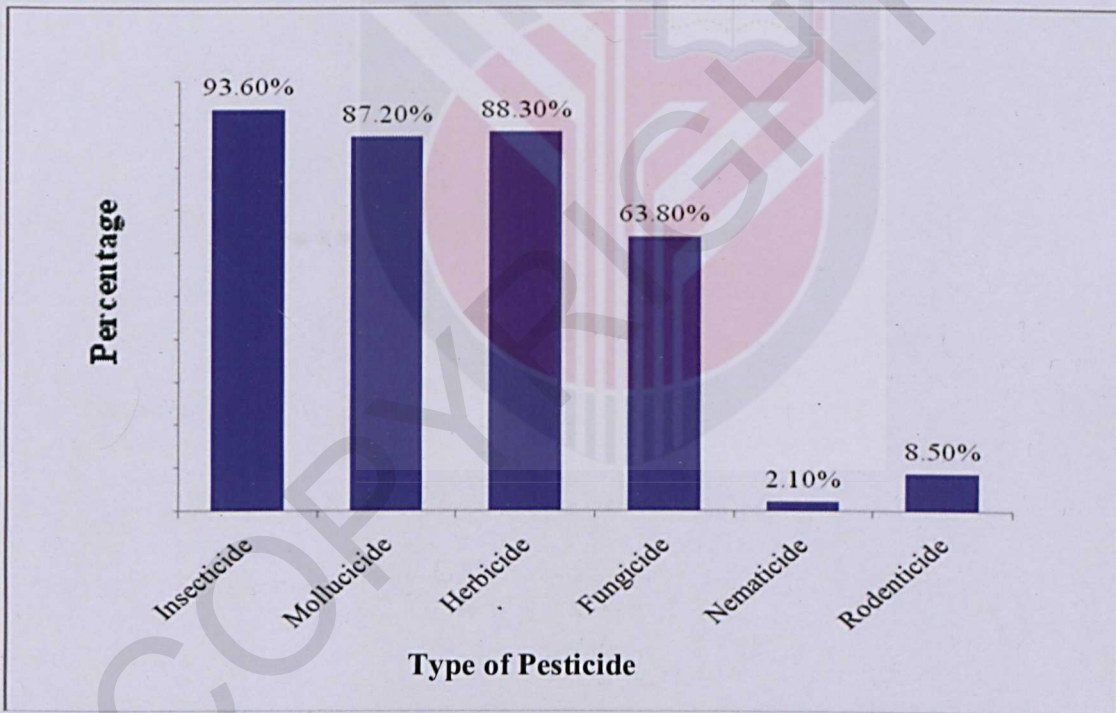


Figure 4.4: Types of pesticide used by exposed group

4.7 Work Activities of Exposed Group

Work activities summarized in Figure 4.5 were used to determine the different types of work activities performed by paddy farmers. Different job tasks are important to hypothesize the frequency and duration of pesticide usage throughout the rice cycle, e.g. from mixing to harvesting phase. From the result, it showed that the major three work activities performed by respondents were mixing, spraying, and fertilizing activities. One hundred percent of the respondents were involved in mixing and spraying activities while 89 people (94.70%) were involved in the soil fertilizing activity.

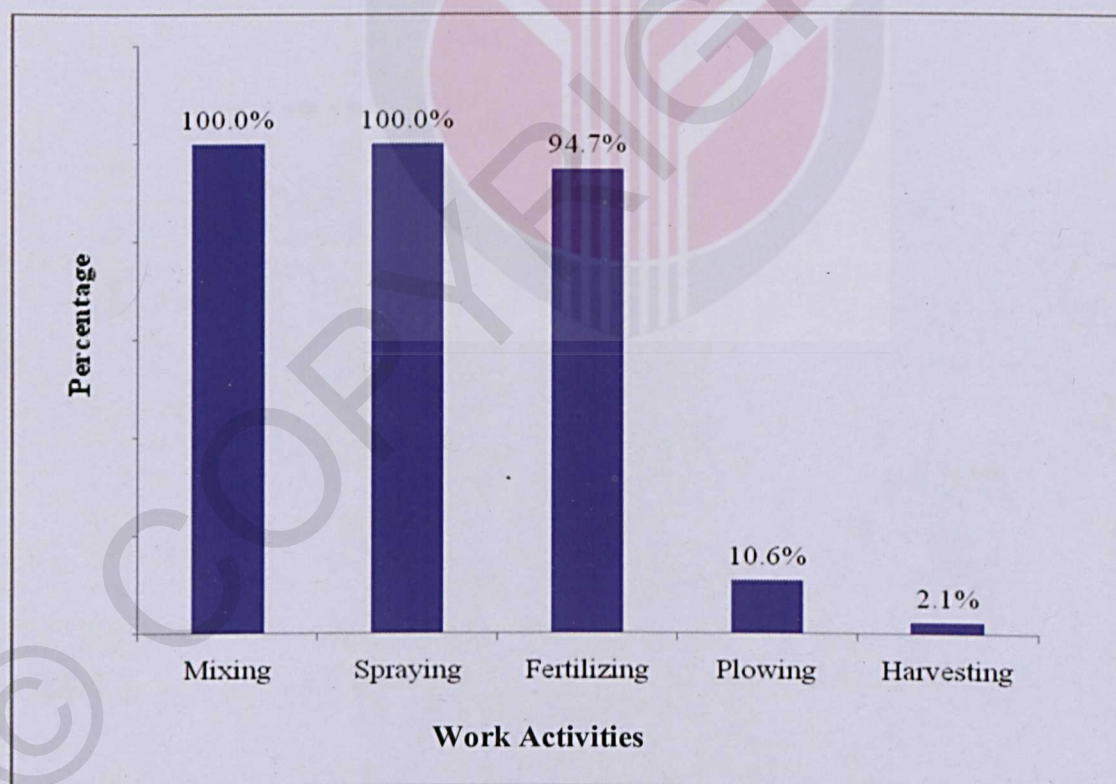


Figure 4.5: Work activities carried out by exposed group

4.8 Type of Sprayers

There were different types of sprayers used in the paddy field. The trend of pesticide sprayer used in study is as showed in Figure 4.6. Both manual and motorized type of pesticide handling device were widely used by the paddy farmers. Type of sprayers device used also indicated the exposure magnitude among the respondents when handling pesticide. From the result, 88 respondents (93.6%) used mist sprayer to spray the pesticide while 29 respondents (30.9%) used knapsack sprayer.

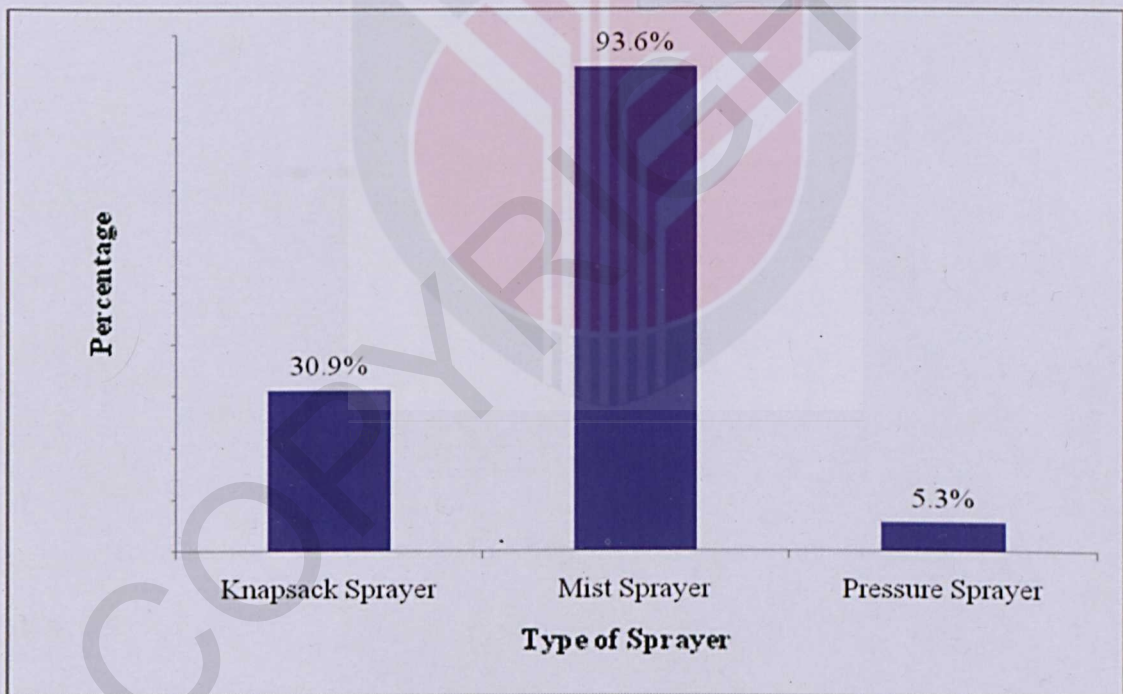


Figure 4.6: Types of sprayer used by exposed group

4.9 Use of Personal Protective Equipment (PPE)

Table 4.2 summarize the different type of PPE worn by respondents. During field observation, it is recorded that respondents were not keep on wearing PPE when handling pesticide. Thus, the result showed that majority of the exposed group worn mask (89.4%), head cover (83.0%), and safety boot (71.3%).

Table 4.2: Use of personal protective equipment (PPE)

Variables	Yes	No
	n (%)	n (%)
Safety boot	67 (71.3)	27 (28.7)
Coverall	11 (11.7)	83 (88.3)
Respirator	2 (2.1)	92 (97.9)
Gloves	31 (33.0)	63 (67.0)
Goggle	34 (36.2)	60 (63.8)
Mask	84 (89.4)	10 (10.6)
Head Cover	78 (83.0)	16 (17.0)
Others	14 (14.9)	80 (85.1)

N = 94

4.10 Signs of Acute Exposure

General signs after acute exposure to pesticide are as summarized in Table 4.3, which showed that the most significant sign that suffered by exposed group were diarrhea (25.5%), excessive sweating (16.0%), shivering (16.0%), eye redness (11.7%), muscle weakness (11.7%), and difficulties in breathing (10.6%).

Table 4.3: Signs and symptoms of the exposed group

Variables	Yes	No
	n (%)	n (%)
Nausea	4 (4.3)	90 (95.7)
Vomiting	3 (3.2)	91 (96.8)
Diarrhea	24 (25.5)	70 (74.5)
Headache	8 (8.5)	86 (91.5)
Shiver	15 (16.0)	79 (84.0)
Excessive sweating	15 (16.0)	79 (84.0)
Blurred vision	9 (9.6)	85 (90.4)
Difficulty in breathing	10 (10.6)	84 (89.4)
Eye redness	11 (11.7)	83 (88.3)
Mental confusion	3 (3.2)	91 (96.8)
Muscle weakness	11 (11.7)	83 (88.3)

N = 94

4.11 Blood Cholinesterase Level

Cholinesterase enzyme is a biological indicator of acute and chronic for pesticide exposure. Blood capillaries were drawn from finger prick technique among respondents who volunteered to participate in this study. Shapiro-Wilk test showed that both groups were not normally distributed data. Hence, Mann-Whitney U test was used to determine the different between both groups. The mean for exposed group was lower than control group which is 34.841 and 88.333 respectively. As shows in Table 4.4, there was a significant difference of blood cholinesterase level between exposed and control group ($Z = -8.151, p \leq 0.001$).

Table 4.4: Blood Cholinesterase Level

Variable	Mean (SD)		Z	p
	Exposed N = 94	Control N = 30		
Blood Cholinesterase Level (%)	34.841 (23.324)	88.333 (8.644)	-8.151	$\leq 0.001^{***}$

N = 124

SD = Standard Deviation

***Significant at $p \leq 0.001$

4.12 Neurobehavioral Performance

Seven test of NCTB were performed and normality test was carried out to determine the distribution of data for both groups. Since all of NCTB test score showed not normally distribution, Mann-Whitney U test was used to determine the difference in NCTB score between the two groups.

The result showed that there were significant difference between both groups in all of neurobehavioral tests namely Benton Visual Retention Test ($z = -2.727$, $p = 0.006$), Digit Span Test ($z = -3.451$, $p = 0.001$), Digit Symbol Test ($z = -4.743$, $p \leq 0.001$), Santa Ana Manual Dexterity Test ($z = -3.019$, $p = 0.003$), Reaction Time/Movement Test ($z = -3.669$, $p \leq 0.001$), Trail Making Test ($z = -3.162$, $p = 0.002$) and Pursuit Aiming Test (-5.848 , $p \leq 0.001$). The total NCTB score also showed significant difference between both groups ($z = -3.845$, $p \leq 0.001$) (Table 4.5).

Table 4.5: Comparison of neurobehavioral performance between both groups

Variable	Mean (SD)		Z	p
	Exposed N = 94	Control N = 30		
Benton Visual Retention Test	50.17 (10.384)	57.23 (12.336)	-2.727	0.006**
Digit Span Test	50.04 (10.013)	57.23 (9.460)	-3.451	0.001**
Digit Symbol Test	50.00 (10.071)	63.23 (12.947)	-4.743	≤ 0.001***
Santa Ana Manual Dexterity Test	49.97 (10.095)	57.30 (11.027)	-3.019	0.003**
Time Reaction/Movement Test	49.91 (10.376)	54.50 (7.487)	-3.669	≤ 0.001***
Trail Making Test	50.04 (10.093)	44.47 (7.070)	-3.162	0.002**
Pursuit Aiming Test	50.04 (10.065)	65.30 (11.853)	-5.848	≤ 0.001***
Total NCTB Score	350.24 (39.088)	388.27 (39.918)	-3.845	≤ 0.001***

SD = Standard Deviation

**Significant at $p \leq 0.01$

***Significant at $p \leq 0.001$

4.13 Relationship between Blood Cholinesterase Level and Neurobehavioral Performance

Spearman's rho test result showed that there were significant associations ($p < 0.05$) between the 5 tests namely Digit Span Test, Digit Symbol Test, Reaction Time/Movement Test, Trail Making Test, and Pursuit Aiming Test. The result also showed significant association between total NCTB score with blood cholinesterase level (Table 4.6).

Table 4.6: Relationship between blood cholinesterase levels with neurobehavioral performance

Variable	Cholinesterase Level (%)	
	r	p
Benton Visual Retention Test	0.080	0.380
Digit Span Test	0.193	0.032*
Digit Symbol Test	0.253	0.005**
Santa Ana Manual Dexterity Test	0.171	0.058
Reaction Time/Movement Test	-0.251	0.005**
Trail Making Test	-0.248	0.006**
Pursuit Aiming Test	0.476	≤ 0.001 ***
Total NCTB Score	0.195	0.030*

N = 124

*Significant at $p \leq 0.05$

** Significant at $p \leq 0.01$

***Significant at $p \leq 0.001$

4.14 Selected Variables Which Influenced Blood Cholinesterase Level among the Exposed Group

Multiple Regressions analysis was carried out to identify the selected predictor factors (independent variable) which may significantly influenced the blood cholinesterase level. In this test, the dependent variable was blood cholinesterase level while independent variable was age, monthly income, duration of work (year), duration of work daily (hour), PPE, smoking habit and smoking frequency (year).

Model I:

$$\text{Cholinesterase Level} = 45.869 - 0.683 (\text{duration of work in years})$$

$$R^2 = 0.149 \text{ (15\% fit the model)}$$

From the equation, noticed that duration of work in years showed significant correlation and inverse relationship with cholinesterase level in blood. Table 4.7 showed another selected factors significant was blood cholinesterase level among the paddy farmers.

Table 4.7: Selected variables which influenced blood cholinesterase level

Dependent Variable	t	p	F	p
(Constant)	12.953	≤ 0.001		
Age	1.378	0.172		
Monthly Income	-0.437	0.663		
Duration of Work (Year)	-4.010	$\leq 0.001^{***}$	16.082	$\leq 0.001^{***}$
Duration of Work Daily (Hour)	-0.812	0.419		
PPE	0.516	0.607		
Smoking Habit	0.051	0.960		
Smoking Frequency (Year)	0.384	0.702		

Regression Method = Stepwise

*Significant at $p \leq 0.05$

***Significant at $p \leq 0.001$

4.15 Selected Variables Which Influenced Total NCTB performance among Exposed Group

Multiple Regression analysis was carried out to identify independent variable which significantly influenced the total NCTB performance among the exposed group. In this test, the dependent variable was total NCTB performance while independent variables were age, education years, duration of work (year), duration of work daily (hour), cholinesterase level, PPE, smoking habit and smoking frequency (year). From the result, at the 5% significant level, it showed that existing selected factors are not significantly influences the total NCTB performance among exposed group.

4.16 Selected Variables Which Influenced Each NCTB Test

Multiple Linear Regression (stepwise method) analysis is used to identify independent variable which significantly influenced the skin symptoms. Among the 7 NCTB test that have been analyzed, only Benton Visual Retention Test and Reaction Time/Movement Test showed significant relationship between the predictor factors of neurobehavioral performance due to pesticide exposure. The rest NCTB test which are Digit Span Test, Digit Symbol Test, Santa Ana Manual Dexterity Test, Trail Making Test and Pursuit Aiming Test were not included in the test as the result shows there is no significant relationship between the test performance and the selected variables.

4.16.1 Selected Variables Which Influenced Benton Visual Retention Test

Multiple Regression analysis was carried out to identify independent variable which significantly influenced the Benton Visual Retention test score among the exposed group. In this test, the dependent variable was Benton Visual Retention test score while independent variables were age, education years, duration of work (year), duration of work daily (hour), cholinesterase level, PPE, smoking habit and smoking frequency (year).

Model I:

$$\text{Benton Visual Retention} = 53.506 - 0.096 (\text{cholinesterase level})$$

Test score

$$R^2 = 0.046 \text{ (5\% fit the model)}$$

From the equation, noticed that cholinesterase level in blood showed significant correlation and inverse relationship with Benton Visual Retention Test score. Table 4.8 showed another selected factors related with Benton Visual Retention Test among the paddy farmers.

Table 4.8: Selected variables which influenced Benton Visual Retention Test

Independent Variable	t	p	F	p
(Constant)	28.200	≤ 0.001		
Age	-0.122	0.903		
Education (Year)	1.122	0.265		
Duration of Work (Year)	0.251	0.802		
Duration of Work Daily (Hour)	-0.268	0.789	4.462	0.037*
Cholinesterase Level	-2.112	0.037*		
Smoking Habit	0.309	0.758		
Smoking Frequency (Year)	-0.443	0.659		
PPE	-0.831	0.408		

Regression Method = Stepwise

*Significant at $p \leq 0.05$

4.16.2 Selected Variables Which Influenced Reaction Time/Movement Test

Multiple Regression analysis was carried out to identify independent variable which significantly influenced Reaction Time/Movement Test score among the exposed group. In this test, the dependent variable was Reaction Time/Movement Test score while independent variables were age, education years, duration of work (year), duration of work daily (hour), cholinesterase level, PPE, smoking habit and smoking frequency (year).

Model II:

$$\text{Reaction Time/Movement Test} = 33.608 + 0.235 (\text{age}) + 0.732 (\text{education years})$$

$$R^2 = 0.117 \text{ (12\% fit the model)}$$

From the equation, we noticed that age and education years showed significant correlation and positive relationship with Reaction/Time/Movement Test. Table 4.9 showed the another selected factors related with Reaction Time/Movement Test among the paddy farmers.

Table 4.9: Selected variables which influenced Reaction Time/Movement Test

Independent Variable	t	p	F	p
(Constant)	6.960	≤ 0.001		
Age	2.948	0.004**		
Education (Year)	2.375	0.020*		
Duration of Work (Year)	0.649	0.518		
Duration of Work Daily (Hour)	0.337	0.737	6.037	0.003**
Cholinesterase Level	-0.513	0.609		
Smoking Habit	0.127	0.899		
Smoking Frequency (Year)	-0.429	0.669		
PPE	0.097	0.923		

Regression Method = Stepwise

*Significant at $p \leq 0.05$

**Significant at $p \leq 0.001$

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

5.1.1 Socio-demography Background

This study involved 124 farmers which made up of 94 respondents from paddy farmers as exposed group while 30 respondents from small scale farmers as control group. The paddy farmers were selected as exposed group due to their widely usage of pesticide especially organophosphate and herbicide. While the small scale farmers were selected as control group because they never use of pesticide throughout their work task.

The respondents were selected based on the inclusive criteria such as age from 18 to 60, not alcohol consumption, literate, and not color blind. According to World Health Organization WHO (1986), matching process is very important when comparing between two study groups. This is because the confounding factors may influence the study. In this study, age, alcohol consumption, literates and not color blind were the

major confounding factors because these variables might influence the neurobehavioral performance.

As people go through aging process, their brain and nervous system go through natural changes simultaneously. The brain and spinal cord will gradually lose nerve cells and weight. Nerve cells may begin to transmit messages more slowly than in the past. Waste products can collect in the brain tissue as nerve cells break down, causing abnormal structures called plaques and tangles to form. A fatty brown pigment (lipofuscin) can also build up in nerve tissue. The breakdown of nerves can affect the senses. Elderly might have reduced or lost reflexes or sensation, leading to problems with movement and safety. Some slight slowing of thought, memory, and thinking seems to be a normal part of aging (Medline Plus, 2012).

Alcohol affects the nervous system by stamping down the signals between the spinal cord, nerve system and the brain. The alcohol is absorbed by the blood which results into the slaking of the nerve tissues and they become totally numb when in this state of 'drunkenness'. At this time, the digestive system cannot digest the alcohol. There are two human body systems, namely - the voluntary body system and the involuntary body system. The voluntary system controls the movements of the muscles, while the involuntary system controls the speed of the body parts, the heart beats and the electrical signals that pass from the brain through neurons. The involuntary body system gets affected largely if someone is consuming excessive quantities of alcohol. Alcohol is

most probably the biggest depressant of the central nervous system. It also enhances the activities of the 'gamma aminobutyric acid' (GABA), and weakens 'glutamine'. As a result the person's behavior gets torpid. Lack of coordination and dimming behavior are the basic effects seen, when a person is drunk (Buzzle.Com, 2012).

In rats there is evidence that alcohol suppresses pyramidal cells in the CA1 region of the hippocampus, cells which are important for forming memories of events. Alcohol suppresses them in a dose-dependent manner, similar to the BAC effect on blackouts in humans (Alderazi, 2007).

The result showed the differences in number of children between exposed and control group which is the control group have more number of children compare to the exposed group. According to the study of effect from pesticide exposure to the human sperm, 13 studies from 20 studies reported an association between exposure and semen quality; 6 studies evaluating DNA damage, of which 3 reported an association with exposure; and 6 studies assessing sperm aneuploidy or diploidy, of which 4 reported an association with exposure (Perry, 2008). In this study, the less number of children among exposed group might be hypothesized due to the exposure to pesticide.

According to the result showed there were few respondents did not take bath after the work activities or after exposed to pesticide. This is due to the attitude of some farmers that not concerned about their exposure to the pesticide. Through the face to

face interview conducted during questionnaire, we found that farmers have lack information about the potential of pesticide contamination to their skin and clothes which may enter into the bloodstream if personal hygiene is not practiced. The ingestion risk is observed during field observation as farmers tend to visit food premises without proper clean-up after work activities. This 'culture norm' was being practiced by farmers decade ago.

There are three common types of pesticide used by the respondents as in the result which is insecticide, herbicide, and molluscicide. According to the respondents, most of them claimed that they faced the same problem in the field where they have experienced of attacking by the crops pest such as Brown Planthopper, Golden Apple Snail and also weed. This result was supported by the Pejabat Pertanian Daerah Manjung (2011), which reported that the main paddy pest were Brown Planthopper, Stem Maggots, Rats and Golden Apple Snail. It also stated that one reason for the decline of paddy production is come from the weed. This is why the respondents tend to increase the quantity of insecticide, herbicide and molluscicide used in their paddy field.

According to the work activities result, majority of exposed group respondents performed mixing and spraying activities other than fertilizing, plowing and harvesting. This result supported by the previous study which state that agriculture worker and pesticide sprayer are exposed to pesticides directly when they are mixing and spraying the pesticides, especially in developing countries such as Asia (Krishna, 2009). As such

as the previous study, mixing and spraying activities conducted by the respondents showed that there were exposure of pesticide occurred among the respondents.

Using PPE is not fully practiced by the respondents as they only apply safety boot, mask and head cover during the spraying of the pesticide. Throughout field observation during face to face interview, most of the respondent claimed that the PPE were not commonly used among farmers due to the discomfortness perceived during mixing and spraying of pesticide. Although they aware of the important of using PPE which is to prevent them against directly expose to the pesticide that can be harmful to their body, the uncomfortable become the main complain which keep them from fully support the usage of PPE during work activities.

There were respondents who reported suffer health problems such as diarrhea, shivering, excessive sweating, difficulties in breathing and eye redness although the numbers of complaints are not widely seen among respondents. This result supported by previous study that reported the possible symptoms and sign from acute effect for pesticides poisoning include nausea, vomiting, diarrhea, abdominal cramps, general weakness, headache, tremors and excessive sweating. In serious cases, respiratory failure and death can occur (Tapia et al., 2005).

5.1.2 Blood Cholinesterase Level

Biological monitoring is the measurement of biomarker as indicator of exposure to a chemical. It involves the determination of the concentration of the chemical or its metabolites or the metabolic effects they produce from analysis of biological specimen like blood, urine, saliva, feces, hair, nails, expired air and so on. It provides information on the “internal dose” of the substance or the effects of exposure to the substance, thus providing a better picture of the exposure risk of the workers.

In biological monitoring for pesticide exposure, blood usually will be used as the biomarkers. This is because the pesticide is the inhibitor for cholinesterase enzyme in blood. According to the previous study which stated that organophosphate pesticide is the inhibitor for cholinesterase enzyme. Cholinesterase is one of many important enzymes needed for the proper function of the nervous system of human, other vertebrates and insects. The presence of pesticide in blood prevents the breakdown of acetylcholinesterase and then causing a “jam” in the nervous system (Smith et al., 1983).

In order to evaluate the degree of exposure of the workers in the organophosphorus pesticides industries, the determination of plasma and serum cholinesterase is absolute and seems to be superior to red blood cell cholinesterase as an indicator of ‘sub-clinical’, asymptomatic or low level exposure, whereas the red blood cell cholinesterase is a reliable indicator of acute intoxication with anticholinesterase

pesticides. It is the best and most practical method for assessing exposure to organophosphorus insecticides (Stefanidou et. al., 2003). Another previous study also showed that the exposure assessment by determining the blood cholinesterase level for each farmer of possible effect of pesticides in the biological system (Leilanie, 2007).

According to the Cholinesterase Test Kit Model LOVIBOND 412670 AF267, the normal percentage of blood cholinesterase level was from 100 percent to 75 percent, over exposure level was from 75 percent to 50 percent, serious over exposure was from 50 percent to 25 percent and lastly serious and dangerous over exposure was from 25 percent to 0 percent (Table 3.1).

The principle of test kit is based on the colorimetric concept which the changes of colour depends on the pH vary when blood cholinesterase liberates acetic acid. When the solution is mix with exposed respondent blood whose blood contain acetic acid due to pesticide contamination, the blood become acidic, makes the color of solution changed from blue to yellow. When the yellow color appears, the comparator kit were shown the low percentage. It means that the lower the percentage levels, the higher the cholinesterase level so that it showed the higher exposure to pesticide.

5.1.3 Neurobehavioral Performance and Comparison Between Exposed with Control Group

Appropriate testing methods that can be used for hazard evaluation and health surveillance are required to protect workers against the effect of neurotoxic agents. In 1983, an international panel of experts surveyed the field of neurotoxicology for WHO. From their review came a set of recommended neurobehavioral tests that can be used to evaluate the effects of neurotoxicants on working population, which called Neurobehavioral Core Test Battery (NCTB) (World Health Organization, 1986). NCTB testing is a non-invasive method used to evaluate the performance of the central nervous system in an individual or group with similar exposures. Test batteries consist of tasks that measure performance of particular neurologic function, such as ability to learn, reaction time, memory, and coordination. It used widely to detect the dysfunction of nervous system that caused by neurotoxin agent.

The NCTB consists of seven test, which are made up of the Benton Visual Retention Test, Digit Symbol Test, Digit Span Test, Pursuit Aiming Test, Time Reaction/Movement Test, Santa Ana Manual Dexterity Test and Trial Making Test (Sains Malaysiana UKM, 2007). Table 2.2 shows the function of each test.

Previous studies showed that the widely usage of NCTB as neurobehavioral assessment due to neurotoxicant exposure support this study in using NCTB as the tools

to determine the neurological effects. WHO-NCTB was introduced into Korea early in the 1990s and has been applied to the study of workers exposed to neurotoxic chemicals. Thirteen studies using the WHO-NCTB have been reported in Korean journals (Kang, 2000). Study on neurobehavioral performance related to low blood lead level in Kelantan, Malaysia also showed that they administered the WHO NCTB in standard order to measure the neurobehavioral performance (Norlen et. al, 2004). Another study showed NCTB has been used to evaluate pesticide effects on cognitive and psychomotor function (Kamel et. al., 2004).

According to Table 4.5, the result showed mean score for exposed group was lower than control group in six NCTB tests except Trail Making Test. The higher mean for total NCTB score also showed among the control group compared to the exposed group. All of test showed the significant different between exposed and control group. Similar findings were reported in previous study, where organophosphate poisoned populations have shown a consistent pattern of deficits when compared to a non-exposed or non-poisoned population on measures of neurobehavioral performance (Rohlman et. al., 2006). The finding also supported by another study on neurobehavioral performance which says non-AG controls performed better on 12 out of 16 NB measurements compared with 92 farm workers (Rothlein et. al., 2006). A study on exposure to organic solvent and the neurobehavioral performance showed that the high exposure group had lower performance than both the low and moderate exposure groups on the entire neurobehavioral performance test (Seong et. al., 2005).

The higher neurobehavioral performance score among control group is the evidence of the effect of pesticide poisoning to the neurobehavioral performance. This is based on the types of work performed by the control group which is planting and harvesting only. Without using the pesticide, their neurobehavioral performance was much better compared to exposed group who largely depends on pesticide in their work activities.

5.1.4 Relationship of Blood Cholinesterase Level with Neurobehavioral Performance

The result showed significant relationship between blood cholinesterase levels with neurobehavioral performance for five tests except for Benton Visual Retention test and Santa Ana Manual Dexterity test. This showed that the level of cholinesterase in blood affect the neurobehavioral domain function for example, response speed, motor and visual coordination, steadiness, perceptual motor speed, and auditory memory.

Cholinesterase levels can vary considerably between individuals, so a baseline must be established for each person prior to handling such pesticides or at least 30 days from the most recent exposure to carbamates and organophosphates. Establishing an accurate baseline value often requires that two tests to be performed at least 72 hours

apart, but not more than 14 days apart. Handlers of carbamates and organophosphates should have their cholinesterase levels monitored periodically, so they can compare results with the previously established baseline level (Fishel, 2012).

In this study, capillaries blood was collected in about two to three hour after the farmer perform their daily job task which is mixing, loading, and spraying the pesticide and the data collection for neurobehavioral test was conducted before the blood taken. In other words, this explained the reason of no significant relationship between cholinesterase levels with neurobehavioral performance. A more proper approach is recommended as accordance to previous (Fishel, 2012) where a baselines value and after pesticide exposure value of cholinesterase level shall be recorded when analysis for the chronic neurobehavioral performance.

5.1.5 Selected Variables Which Influenced Cholinesterase Level among Exposed

Group

The result showed that duration of exposure (years) to pesticide was the only variables which significantly influences the blood cholinesterase level and support the hypothesis, which stated that the variable that influence blood cholinesterase level was duration of exposure.

Many of variables can be confounding which could influence the cholinesterase level in blood. These variables were age, monthly income, educational level and also their total year of work with pesticide. Nevertheless, this result was supported by previous study (Mekonnen, 2005) which showed that an abnormal reduction in cholinesterase activity of workers exposed to chemical pesticides is almost always a result of absorption of an anti-cholinesterase compound. As a result, exposure of workers to organophosphate or carbamate pesticides is the main cause for significant depression of cholinesterase activity.

Absorption of anti-cholinesterase compound into the blood capillaries will occur after the workers have an exposure to the pesticide. A study of 98 Nebraska farmers and pesticide applicators who routinely handled organophosphate pesticides found that 30 percent of the group had reduced levels of blood cholinesterase, an indication of significant exposure, and 22 percent actually exhibited symptoms including headache, nausea, or diarrhea. One study in Nicaragua found that residents living next to cotton fields regularly sprayed with insecticides had depressed cholinesterase levels an effect typical of exposure to organophosphate or carbamate pesticides (World Resources Institute, 2002).

5.1.6 Selected Variables Which Influenced Neurobehavioral Performance of Exposed Group

From the analysis, it showed that no variables which influence the total NCTB performance, but there are few variables which significantly influence certain NCTB test. The regression analysis showed that cholinesterase level was the variables which influence the most on the Benton Visual Retention Test.

According to previous study (Wesseling, 2002), cholinesterase inhibitors bind to acetylcholinesterase, the enzyme that controls the transmission of the nerve impulses at the cholinergic synapses throughout the nervous system. This results in the accumulation of acetylcholine at the neurojunctions and the appearance of a cholinergic syndrome.

The same study also stated that workers previously poisoned with cholinesterase inhibiting pesticides tended to perform less well on psychomotor and visual motor tests as compared with a non-poisoned control group. Age and education level (year) tend to be the most significant variables which influences the Reaction Time/Movement Test. Changes to the body can make movement slower and more difficult. These changes affect everyone to some degree, but tend to have less impact on people who stay fit and active. Some changes might notice as a people get older includes decreased muscle strength, decreased flexibility and mobility, limited range of movement and poorer coordination and dexterity (Queensland Government, 2012). Numerous studies have

shown that aging is associated with slow responses. Senior adults' movements are typically slower, more variant, less smooth and less coordinated than their younger counterparts. This is due to longer reaction time and slower movement time. Prolonged reaction time and movement time occurs at advancing age (Desai, 2006).

5.2 Conclusion

In short, the neurobehavioral performance between exposed and control group showed the different where the control group who not exposed to pesticide showed the higher performance as compared to exposed group. The blood cholinesterase level also showed the different level between both groups where the control group showed the higher level of blood cholinesterase compared to the exposed group. Though no association was showed between blood cholinesterase level and two of neurobehavioral performance, the blood cholinesterase level actually showed significantly influence to the neurobehavioral function such as visual memory. While age and educational level showed significantly influence the response and movement speed. This might recommended that, a proper approach in collecting blood cholinesterase must be reviewed for future field study. Besides, the different scoring on neurobehavioral performance and blood cholinesterase level between exposed and control group further support the saying that, farmers who highly exposed to pesticide reduce their blood cholinesterase level and affect their neurobehavioral performance in long-term basis as compare to control group farmers. Occupational pesticides, thus, in one of the

neurotoxin chemical which shall highly be controlled and prevented for long-term usage in the future.

5.3 Recommendation

5.3.1 Hierarchy of Control

There are four steps of control which can be applied in order to reduce the pesticide exposure among the paddy field farmers. There are substitution, engineering control, administrative control and also use of personal protective equipment (PPE).

The first way to reduce the exposure of pesticide is substitution. The farmers are recommended to use sprayer tractor rather than use of manual/motorized knapsack sprayer. By this approach, the exposure to pesticide can be reduced. The farmers can also perform engineering control by installing pesticide spraying system at their field. This is the approach used for water splashing system at vegetable farm. By this, the farmers will be prevented from direct contact with pesticide such as spraying and loading into container. Farmers organization is advised to involve in reducing the exposure of farmers from pesticide by introducing the appropriate pesticide with low lethal dose to human, provide information about usage of pesticide such as Material Safety Data Sheet (MSDS) and so on. PPE is the last resort which recommended to use

in order to reduce direct exposure to pesticide such as used coverall, masks, glove and goggle.

5.3.2 Health Surveillance and Medical Services

Medical examination is an important step to prevent and control any disease especially disease that come after exposure to the pesticide. Periodic medical examination should be maintained among all of the farmers who may be exposed to pesticide and other chemicals.

5.3.3 Training

Adequate training also needed on safety work environment, training the usage of PPE and training of emergency response plan. This step should be conducted by farmers organization, government under Department of Agriculture and also non-government agency such as Padiberas Nasional Berhad (Bernas).

5.3.4 Personal Hygiene

Personal hygiene should be the first prevention step to be practiced among individual. These practices shall include the proper procedures for hand washing and clothes cleaning. Pesticide contamination on skin and clothes is inevitable during work

activities. Thus an appropriate hygiene practices is highly recommended to reduce any potential take-home route of exposure.



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APPENDIX 1

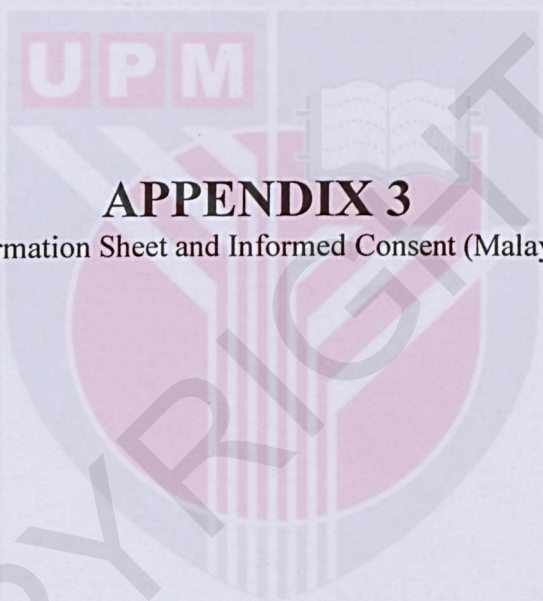
(Schedule of Study for Research Project)

PLANNING/MONTH	2011					2012				
	SEPT	OCT	NOV	DEC	JAN	FEB	MAC	APR	MAY	
Propose title for the project										
Submit the proposal										
Title presentation										
Attach supervisor										
Permission letter to selected company										
Submission on methodology										
Proposal presentation										
Pre- tested questionnaire										
Resubmission of proposal										
Ethical Clearance										
Receive approval letter from company										
Visit the company for project sources										
Give and collect the consent letter from respondents										
Collect data										
Analyze data										
Preparing the complete thesis										
Submission of final thesis and presentation										



APPENDIX 2

(Evidence of Approval Ethic by Medical Research Ethics Committee)



APPENDIX 3

Subject Information Sheet and Informed Consent (Malay Version)

PENERANGAN MAKLUMAT KEPADA RESPONDEN

Tajuk Kajian:

Perkaitan antara pendedahan racun makhluk perosak tanaman dengan kesan kesihatan di kalangan pesawah di Tanjung Karang, Selangor.

Pendahuluan:

Kajian ini bertujuan untuk menentukan kesan-kesan kesihatan pekerja disebabkan terdedah kepada racun perosak tanaman sepanjang kitaran pengeluaran padi. Seperti yang diketahui, pesawah padi sangat terdedah kepada pelbagai racun perosak tanaman kerana penanaman padi memerlukan pelbagai jenis racun perosak tanaman sepanjang kitaran tersebut untuk mengawal perosak seperti serangga, rumpai, kulat dan tikus. Kesan kesihatan terhadap pesawah dilihat seperti fenomena 'aisberg', di mana kesan kesihatan tersebut lebih banyak tidak dapat dikenalpasti. Oleh itu, adalah perlu untuk mengenalpasti jenis-jenis masalah kesihatan yang mungkin disebabkan oleh penggunaan racun makhluk perosak tanaman tersebut. Kajian ini termasuk pemantauan kesihatan kulit, penamptuan paras enzim kolinesterase, ujian fungsi hati, ujian neurokognitif dan ujian genotoxicity. Hasil kajian ini akan digunakan sebagai maklumat rujukan dalam melindungi kesihatan pesawah padi melalui pelaksanaan system pekerjaan yang praktikal.

Berapakah bilangan responden yang akan terlibat dalam kajian ini?

Seramai 100 orang pesawah akan diambil menjadi responden berdasarkan kriteria seperti umur antara 18 hingga 65 tahun, tidak mengambil dadah dan alcohol, dan telah bekerja sebagai pesawah padi lebih daripada satu tahun dan ke atas.

Apakah potensi risiko dalam kajian ini?

Kajian ini mungkin melibatkan peserta dalam beberapa risiko fizikal dan psikologi yang telah dikawal oleh penyelidik sebelum mengumpul data:

- a. Responden akan diminta untuk memasuki sebuah bilik gelap untuk mendapatkan bacaan skor kulitpendafluor selepas pendedahan racun perosak. Sesiapa yang mempunyai clithrophobia tidak digalakkan menyertai kajian ini.
- b. Sebanyak 5 ml darah melalui venapuncture akan diambil oleh seorang jururawat yang berdaftar dengan Kementerian Kesihatan Malaysia.
- c. Sebanyak 0.5 ml darah akan diambil pada jari responden oleh penyelidik.

Apakah manfaat yang akan didapati melalui kajian ini?

- a) Sebagai responden kajian:

Hasil kajian berguna kepada pesawah kerana keputusan kajian ini akan digunakan untuk mengenalpasti masalah kesihatan yang di sebabkan pendedahan terhadap racun

makhluK perosak tanaman. Pengawasan kesihatan di peringkat awal sangat membantu dalam mencegah kesan penyakit kronik dan mengurangkan komplikasi kesihatan yang mungkin berlaku disebabkan pendedahan tersebut. Pengendalian racun perosak tanaman akan dicadangkan pada akhir kajian ini untuk meningkatkan kesedaran pesawah tentang kesihatan dan mengurangkan pendedahan jangka panjang terhadap racun perosak tanaman tersebut.

b) Sebagai penyelidik kajian:

Kajian ini bertujuan untuk menentukan kesan kesihatan yang mungkin disebabkan oleh pendedahan kronik racun perosak tanaman di kalangan pesawah dan pada masa yang sama menggalakkan kesedaran kesihatan di kalangan kumpulan petani. Maklumat kajian ini mungkin akan digunakan sebagai garis panduan dalam menggubal polisi kesihatan dan program pembangunan dalam penjagaan kesihatan di kalangan petani untuk jangka masa panjang.

Adakah maklumat kajian ini akan dirahsiakan?

Data dari setiap individu akan dirahsiakan dan dikategorikan sebagai sulit. Tiada sebarang perbincangan individu akan dilakukan dalam kajian ini. Keputusan kajian hanya akan diberikan kepada responden jika diminta sahaja.

Apakah sebarang bayaran akan dikenakan kepada responden?

Sebarang pembayaran tidak akan dikenakan kepada responden dan semua perbelanjaan akan ditanggung oleh penyelidik.

Apakah hak anda sebagai responden?

Kajian ini dijalankan secara sukarela. Dengan itu, responden mempunyai hak untuk berhenti daripada menyertai kajian ini pada bila-bila masa sahaja jika sepanjang kajian ini responden berasa tidak selesa atau melanggar hak-hak asasi manusia.

Apakah yang perlu anda lakukan?

Anda hanya perlu menurunkan tanda tangan anda pada surat peserta sebagai bukti anda berminat untuk menyertai kajian ini sebagai responden. Ujian ini hanya akan dimulakan selepas anda menandatangani borang tersebut dan setelah anda memahami kandungan surat serta ujian-ujian yang akan dijalankan. Surat persetujuan tersebut perlulah dipulangkan kepada penyelidik sebelum sesi soal selidik dan ujian dijalankan. Jika anda mempunyai sebarang pertanyaan atau memerlukan penjelasan, anda boleh menghubungi mana-mana penyelidik yang disenaraikan di bawah.

Kepada siapakah anda boleh berhubung sekiranya ada sebarang persoalan berkenaan kajian ini sepanjang ianya berjalan?

Sebarang persoalan sepanjang kajian ini berjalan boleh diajukan kepada penyelidik, Muhammad Izzat bin Othman dengan berjumpa secara terus ataupun melalui telefon bimbit, 013-4049621.

Terima kasih atas kerjasama yang anda berikan.

MUHAMMAD IZZAT BIN OTHMAN
Penyelidik,
BS (Kesihatan Persekitaran dan Pekerjaan)





BORANG PERSETUJUAN (RESPONDEN)

TAJUK KAJIAN:

Perkaitan antara pendedahan racun makhluk perosak tanaman dengan kesan kesihatan di kalangan pesawah di Tanjung Karang, Selangor.

PENYELIDIK:

Saya No. Kad pengenalan
alamat.....

..... dengan ini secara sukarela bersetuju untuk mengambil bahagian dalam penyelidikan klinikal (kajian klinikal, kajian soal selidik / dadah percubaan) yang dinyatakan.

Saya telah dimaklumkan tentang penyelidikan klinikal dari segi metodologi, kemungkinan kesan buruk dan komplikasi (rujuk Helaian Maklumat). Saya faham bahawa saya mempunyai hak untuk menarik diri dari kajian klinikal ini pada bila-bila masa tanpa memberikan apa jua sebab. Saya juga faham bahawa kajian ini adalah sulit dan semua maklumat yang diberikan mengenai identiti saya akan kekal sulit dan persendirian.

Saya *ingin tahu / tidak ingin tahu keputusan ujian yang dilakukan ke atas saya.

* potong yang tidak berkenaan

Tanda tangan
(Responden)

Tandatangan
(Saksi)

Tarikh :

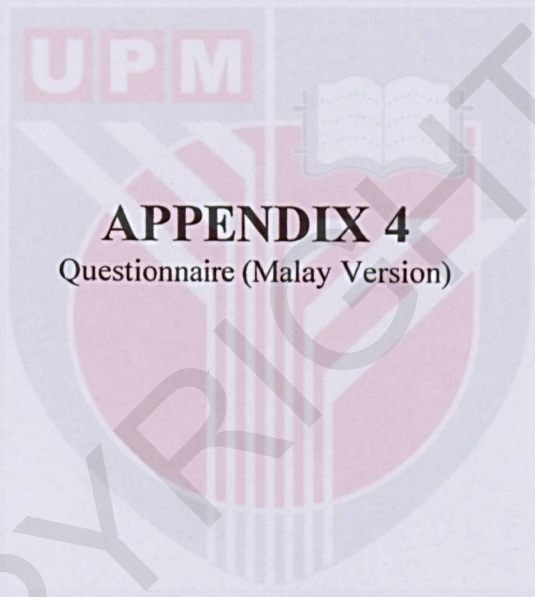
Nama :

No. I/C :

Saya mengesahkan bahawa saya telah fahan dan jelas berkenaan penyelidikan klinikal tersebut.

Tarikh:

Tanda Tangan:
(Penyelidik)



APPENDIX 4
Questionnaire (Malay Version)

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi sebelas (11) bahagian iaitu:

Bahagian A	: Maklumat diri
Bahagian B	: Gaya hidup
Bahagian C	: Latar belakang pekerjaan
Bahagian D	: Maklumat penggunaan racun serangga di tempat kerja
Bahagian E	: Maklumat penggunaan kelengkapan pelindung diri
Bahagian F	: Sejarah pendedahan sekeliling
Bahagian G	: Maklumat kesihatan am
Bahagian H	: Maklumat kesihatan neurokotingkahlaku

2. Anda diminta menjawab semua soalan yang ada dalam buku soalan ini.

3. Untuk menjawab, anda perlulah menandakan (\checkmark) pada ruangan kotak yang disediakan. Contoh yang terbaik ialah seperti berikut:



4. Borang soal selidik ini hendaklah diserahkan semula kepada pengkaji setelah selesai menjawab semua soalan.

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

BAHAGIAN A: MAKLUMAT DIRI

1. Umur: tahun A1
2. Jantina: Lelaki Perempuan A2
3. Bangsa: Melayu Cina India A3
 Lain-lain (Sila nyatakan):
4. Status: Bujang Berkahwin Duda/Janda A4
5. Taraf pendidikan: A5
- | | |
|---|--|
| <input type="checkbox"/> Tidak bersekolah | <input type="checkbox"/> Diploma |
| <input type="checkbox"/> Sekolah Rendah | <input type="checkbox"/> Ijazah Sarjana Muda |
| <input type="checkbox"/> Sekolah Menengah | <input type="checkbox"/> Sarjana Muda |
| <input type="checkbox"/> Sijil | <input type="checkbox"/> Doktor Falsafah |
6. Jumlah pendapatan sebulan: A6
- | | |
|--|--|
| <input type="checkbox"/> RM 0.00 – RM 1 000.00 | <input type="checkbox"/> RM 2 000.01 – RM 3 000.00 |
| <input type="checkbox"/> RM 1 000.01 – RM 2 000.00 | <input type="checkbox"/> RM 3 000.00 dan ke atas |
7. Bilangan anak: orang anak A7
8. Berat: kg A8
9. Tinggi: cm A9
10. Adakah anda rabun warna? A10
- Ya Tidak

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

BAHAGIAN B: GAYA HIDUP

11. Adakah anda merokok?

Ya

Tidak

B1

12. Pada umur berapakah anda mula merokok?

tahun

B2

13. Berapa batang rokok anda hisap dalam sehari?

batang

B3

14. Adakah terdapat perokok lain di dalam rumah anda?

Ya

Tidak

B4

15. Adakah anda mengambil minuman keras / arak?

Ya

Tidak

B5

16. Berapa banyak botol anda minum dalam sehari?

Botol sehari

B6

17. Apakah hobi anda pada waktu lapang?

Fotografi
 Berkebun

Bermain bola sepak
 Berbasikal / berjogging

Bertukang
 Berenang

B7

18. Adakah anda mandi sebelum ke tempat kerja?

Ya

Tidak

B8

19. Adakah anda mandi selepas pulang dari tempat kerja?

Ya

Tidak

B9

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

20. Adakah anda menukar pakaian kerja anda setiap hari?

Ya

Tidak

B10

BAHAGIAN C: LATAR BELAKANG PEKERJAAN

21. Jawatan pekerjaan terdahulu:

C1

22. Jumlah tahun bekerja di tempat terdahulu: tahun

C2

23. Jawatan pekerjaan sekarang:

C3

24. Bilangan tahun anda bekerja di tempat sekarang: tahun

C4

25. Jumlah hari bekerja dalam seminggu: hari seminggu

C5

26. Jumlah masa bekerja dalam sehari: jam sehari

C6

**BAHAGIAN D: MAKLUMAT PENGGUNAAN RACUN SERANGGA DI TEMPAT
KERJA**

27. Apakah jenis racun makhluk perosak tanaman yang digunakan di tempat kerja anda
sekarang?

D1

- a. Racun Serangga
- b. Racun Kulat
- c. Racun Siput
- d. Racun Cacing

- e. Racun Rumpai
- f. Racun Tikus
- g. Racun Anai-anai
- h. Lain-lain (nyatakan).....

28. Apakah jenis aktiviti yang anda lakukan di tempat kerja?

D2

- a. Membancuh racun
- b. Meracun
- c. Membaja
- d. Membajak
- e. Menuai

29. Nyatakan tempoh masa anda menggunakan racun makhluk perosak tanaman tersebut:

D3

Minit

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

30. Apakah jenis penyembur racun yang anda gunakan?

D4



a. Penyembur racun manual



b. Penyembur racun bermotor



c. Penyembur racun bertekanan

31. Nyatakan kekerapan anda menggunakan racun makhluk perosak tanaman dalam sehari:

D5

Pagi	0 – 1 jam	
	2 – 3 jam	
	3 – 4 jam	
	4 jam ke atas	
Petang	0 – 1 jam	
	2 – 3 jam	
	3 – 4 jam	
	4 jam ke atas	
Sepanjang masa bekerja		

32. Adakah anda mandi di tempat kerja selepas menggunakan racun serangga?

D6

Ya

Tidak

33. Apakah formulasi racun serangga yang kerap anda gunakan?

D7

- a. Cecair
 b. Pepejal
 c. Butiran

- d. Serbuk
 e. Aerosol, asap atau kabus

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

BAHAGIAN E: MAKLUMAT PENGGUNAAN KELENGKAPAN PELINDUNG DIRI

34. Adakah anda menggunakan sebarang kelengkapan pelindung diri semasa bekerja?

E3

Ya

Tidak

Jika ya, sila jawab soalan no 35.

Jika tidak, sila terus menjawab soalan no 38.

35. Apakah jenis kelengkapan pelindung diri yang anda gunakan semasa bekerja?

E4

- | | | | |
|--------------------------|------------------------------|--------------------------|-------------------|
| <input type="checkbox"/> | a. But/kasut keselamatan | <input type="checkbox"/> | f. Sarung tangan |
| <input type="checkbox"/> | b. Apron | <input type="checkbox"/> | g. Cermin mata |
| <input type="checkbox"/> | c. Baju kalis air | <input type="checkbox"/> | h. Topeng |
| <input type="checkbox"/> | d. Alat pernafasan | <input type="checkbox"/> | i. Penutup kepala |
| <input type="checkbox"/> | e. Lain-lain (nyatakan)..... | | |

36. Apakah alasan anda jika tidak menggunakan kelengkapan pelindung diri semasa bekerja?

E5

- | | | | |
|--------------------------|---------------------|--------------------------|---------------------------------------|
| <input type="checkbox"/> | a. Tidak selesa | <input type="checkbox"/> | c. Tidak pasti cara penggunaannya |
| <input type="checkbox"/> | b. Tidak dibekalkan | <input type="checkbox"/> | d. Tidak pasti kebaikan penggunaannya |

37. Kekerapan anda menukar kelengkapan pelindung diri kepada yang baru:

E6

- | | |
|------------------------------|----------------------------------|
| a. Setiap hari | <input type="checkbox"/> |
| b. Seminggu sekali | <input type="checkbox"/> |
| c. Dua minggu sekali | <input type="checkbox"/> |
| d. Sebulan sekali | <input type="checkbox"/> |
| e. Lain-lain (sila nyatakan) | <input type="checkbox"/> : |

BAHAGIAN F: MAKLUMAT KESIHATAN AM

38. Adakah anda mempunyai masalah kesihatan?

F1

- | | | | |
|--------------------------|-------------------------------|--------------------------|------------------|
| <input type="checkbox"/> | a. Tekanan darah tinggi | <input type="checkbox"/> | c. Kencing manis |
| <input type="checkbox"/> | b. Sakit jantung | <input type="checkbox"/> | d. Asma |
| <input type="checkbox"/> | e. Lain-lain (nyatakan) | | |

39. Adakah anda mengalami masalah kesihatan selepas bekerja di tempat sekarang?

F2

- Ya Tidak

40. Adakah individu lain di tempat kerja anda mengalami perkara atau masalah yang sama seperti anda?

F3

- Ya Tidak

41. Adakah individu lain di rumah atau jiran anda mengalami perkara atau masalah yang sama seperti anda?

F4

- Ya Tidak

42. Bilakah anda mendapatkan rawatan terakhir daripada doktor untuk masalah yang anda hadapi ini?

F5

- | | | | |
|--------------------------|-------------------------------|--------------------------|---------------------|
| <input type="checkbox"/> | a. Minggu lepas | <input type="checkbox"/> | c. Dua minggu lepas |
| <input type="checkbox"/> | b. Sebulan lepas | <input type="checkbox"/> | d. Dua bulan lepas |
| <input type="checkbox"/> | e. Lain-lain (nyatakan) | | |

PERKAITAN ANTARA PENGGUNAAN RACUN MAKHLUK PEROSAK TANAMAN DENGAN KESAN KESIHATAN DI
KALANGAN PESAWAH PADI DI TANJUNG KARANG, MALAYSIA

BAHAGIAN G: MAKLUMAT KESIHATAN NEUROKOGNITIF

43. Adakah anda pernah mengalami tanda atau simptom masalah seperti di bawah?
(boleh memilih lebih daripada satu pilihan jawapan)

G1

a.Rasa loya	
b.Muntah-muntah	
c.Cirit-birit	
d.Sakit kepala	
e.Menggigil	
f.Peluh berlebihan	
g.Kabur penglihatan	

h.Kesukaran bernafas	
i.Mata kemerahan	
j.Sawan	
k.Berbuih di mulut	
l.Kekeliruan mental	
m.Lemah otot	
n.koma	

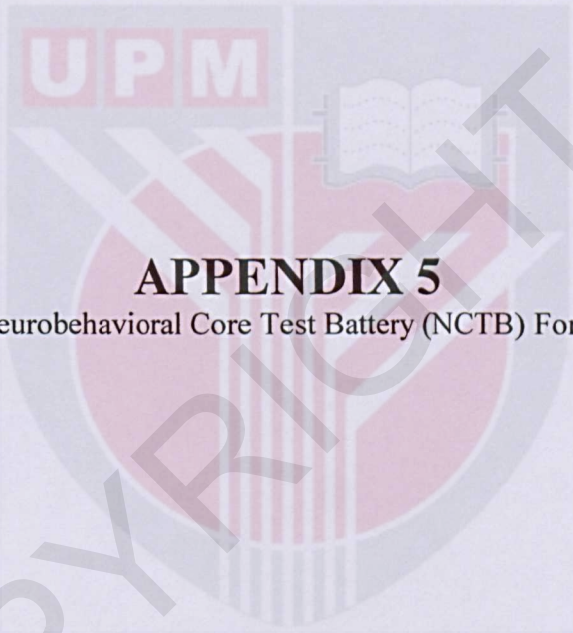
44. Adakah kebelakangan ini anda pernah mengalami masalah seperti di bawah?
(boleh memilih lebih daripada satu pilihan jawapan)

G2a
G2b
G2c
G2d
G2e
G2f
G2g
G2h
G2i
G2j
G2k

Masalah	Ya	Tidak
a.Mudah lupa apa yang dilihat		
b.Mudah lupa apa yang didengari		
c.Lambat bertindak apabila sesuatu hal berlaku		
d.Sukar memberikan tumpuan dalam sesuatu hal		
e.Mudah hilang tumpuan dalam sesuatu hal		
f.Sukar memahami/mempelajari sesuatu hal		
g.Sering keliru atau salah tanggapan mengenai sesuatu hal		
h.Kurang tangkas/cepat dalam melakukan sesuatu hal		
i.Cepat berasa letih/lemah apabila melakukan sesuatu hal		
j.Kurang semangat dalam melakukan sesuatu hal		
k.Mudah berasa tertekan dan bimbang		

~ Borang soal selidik tamat ~

Terima kasih atas kerjasama yang anda berikan.
Sekian.



APPENDIX 5

Neurobehavioral Core Test Battery (NCTB) Form

© COPYRIGHT UPM

No Pusat							
No Industri							
No. Responden	▼	▼	▼				
ID Responden							
Tarikh							

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

BENTON VISUAL RETENTION TEST

JAWAPAN

- | | | | | | | | | | |
|----|---|---|---|---|-----|---|---|---|---|
| 1. | A | B | C | D | 6. | A | B | C | D |
| 2. | A | B | C | D | 7. | A | B | C | D |
| 3. | A | B | C | D | 8. | A | B | C | D |
| 4. | A | B | C | D | 9. | A | B | C | D |
| 5. | A | B | C | D | 10. | A | B | C | D |

JAWAPAN BETUL

No Pusat						
No Industri						
No. Responden						
ID Responden						
Tarikh						

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

DIGIT SPAN TEST

1. Digits Forward Test

Arahan : Sila dengar dengan teliti nombor-nombor yang akan dibaca dan anda dikehendaki mengulangi balik sebutan secara ke hadapan.

- | | | | |
|----------------------|--|-------------------|--|
| a. 5-8-2 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 6-9-4 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| b. 6-4-3-9 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 7-2-8-6 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| c. 4-2-7-3-1 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 7-5-8-3-6 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| d. 6-1-9-4-7-3 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 3-9-2-4-8-7 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| e. 5-9-1-7-4-2-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 4-1-7-9-3-8-6 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| f. 5-8-1-9-2-6-4-7 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 3-8-2-9-5-1-7-4 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| g. 2-7-9-8-6-2-5-8-4 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 7-1-3-9-4-2-5-6-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> |

2. Digits Backwards Test

Arahan : Sila dengar dengan teliti nombor-nombor yang akan dibaca dan anda dikehendaki mengulangi balik sebutan secara ke belakang.

- | | | | |
|--------------------|--|-----------------|--|
| a. 2-5 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 5-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| b. 6-2-9 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 4-1-9 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| c. 3-2-7-9 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 4-9-6-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| d. 1-5-2-8-6 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 6-1-8-4-3 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| e. 5-3-9-4-1-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 7-2-4-8-5-6 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| f. 8-1-2-9-3-6-5 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 4-7-3-9-1-2-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> |
| g. 9-4-3-7-6-2-5-8 | <input type="text"/>
<input type="text"/>
<input type="text"/> | 7-2-6-1-9-6-5-3 | <input type="text"/>
<input type="text"/>
<input type="text"/> |

No Pusat						
No Industri						
No. Responden	▼	▼	▼			
ID Responden						
Tarikh						

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

SANTA ANA MANUAL DEXTERITY TEST

TANGAN DOMINAN RESPONDEN: KANAN / KIRI
(potong yang tidak berkenaan)

	PERCUBAAN 1	PERCUBAAN 2	JUMLAH	PURATA
TANGAN DOMINAN				
TANGAN BUKAN DOMINAN				

No Pusat					
No Industri					
No. Responden					
ID Responden					
Tarikh					

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

TIME REACTION / MOVEMENT TEST

	BACAAN A	BACAAN B	BACAAN B-A	PURATA
1.				
2.				
3.				
	PURATA	PURATA	PURATA	PURATA

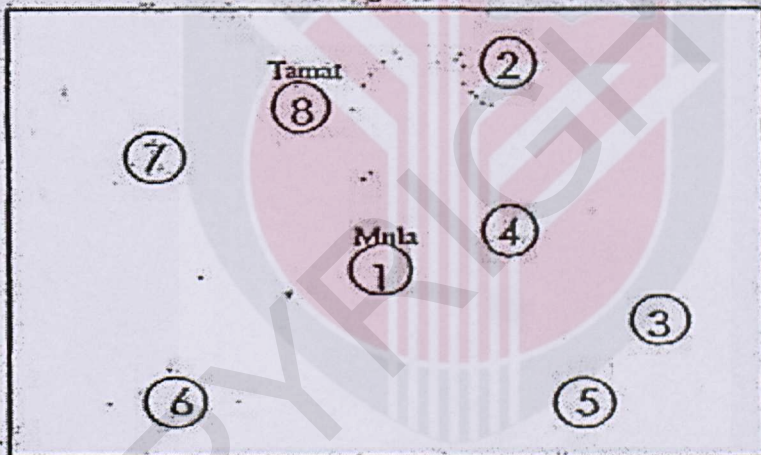
No Pusat						
No Industri						
No. Responden						
ID Responden						
Tarikh						

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

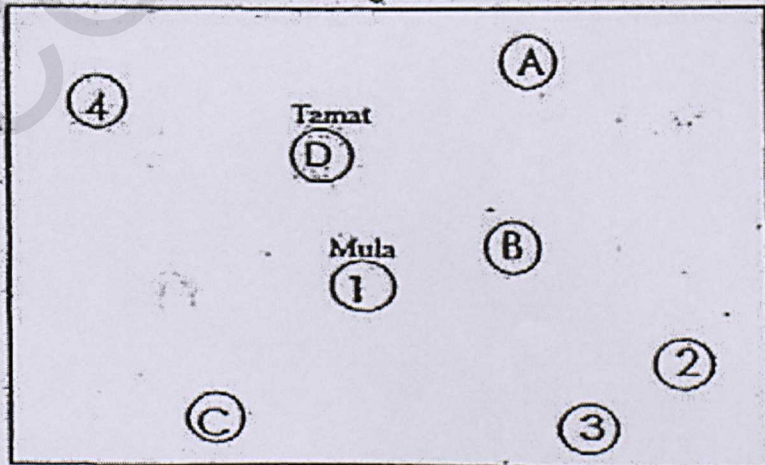
TRAIL MAKING TEST

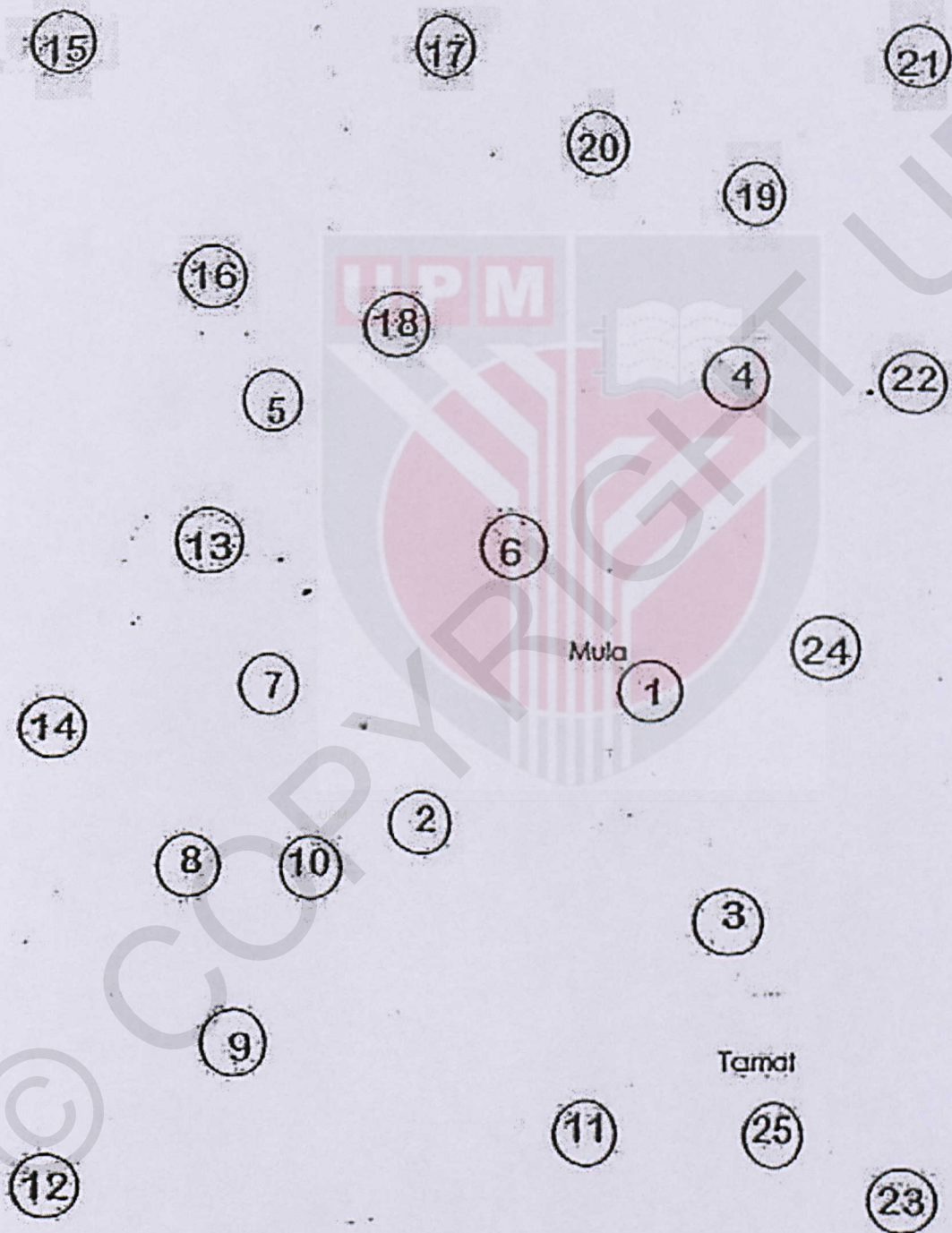
PERCUBAAN

Bahagian A.



Bahagian B





BAHAGIAN A

Tamoi

13

8

9

I

D

B

4

3

Mula

1

10

7

H

5

12

C

G

A

J

2

6

L

F

E

K

11

BAHAGIAN B

No Pusat							
No Industri							
No. Responden							
ID Responden							
Tarikh							

**UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)**

PERSUIT AIMING TEST

Arahan : Anda dikehendaki meletakkan satu titik atau bintik di bahagian dalam setiap simbol 'O' yang diberikan dengan mengikut arah setiap anak panah seperti yang ditunjukkan di bawah.
Tempoh masa yang diberikan adalah 60 saat.

LATIHAN

→	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	↓
																	O
	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	←
	O																
→	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	

Titik/bintik yang betul	:	Percubaan 1	<input type="text"/>	2.	<input type="text"/>	Jumlah betul	<input type="text"/>
Titik/bintik yang salah	:	Percubaan 1	<input type="text"/>	2.	<input type="text"/>	Jumlah salah	<input type="text"/>
						JUMLAH BESAR	<input type="text"/>

The logo of Universiti Putra Malaysia (UPM) is located in the top left corner of the page. It consists of the letters 'UPM' in white on a red rectangular background.

APPENDIX 6

Blood Cholinesterase Level Analysis Pictures
(Cholinesterase Test Kit Model LOVIBOND 412670 AF267)



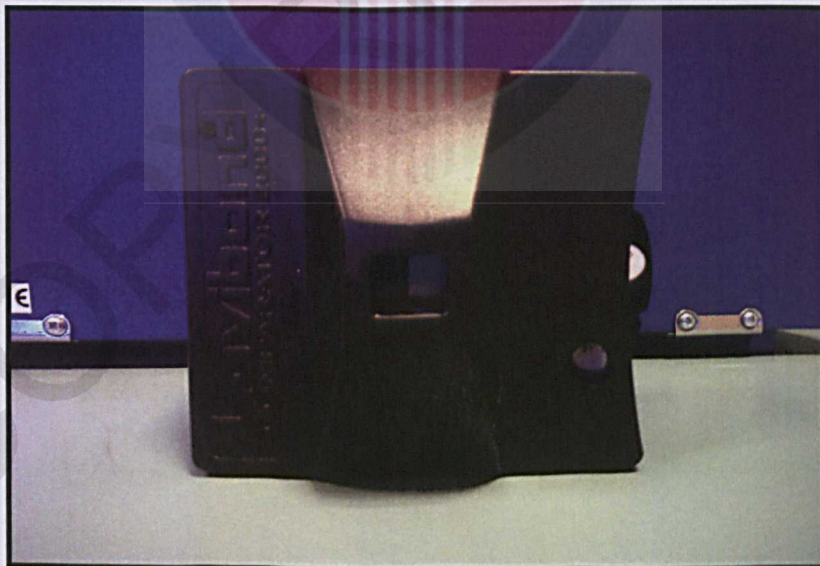
Equipment used in LOVIBOND 412670 AF267 Cholinesterase Test Kit



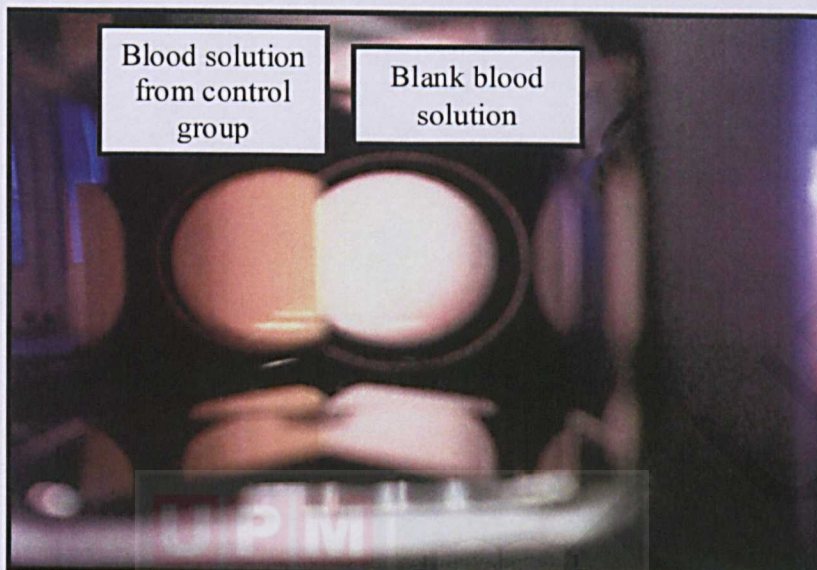
Solutions used in this test kit: Substrate solution, Bromothymol Blue solution and Deionised water



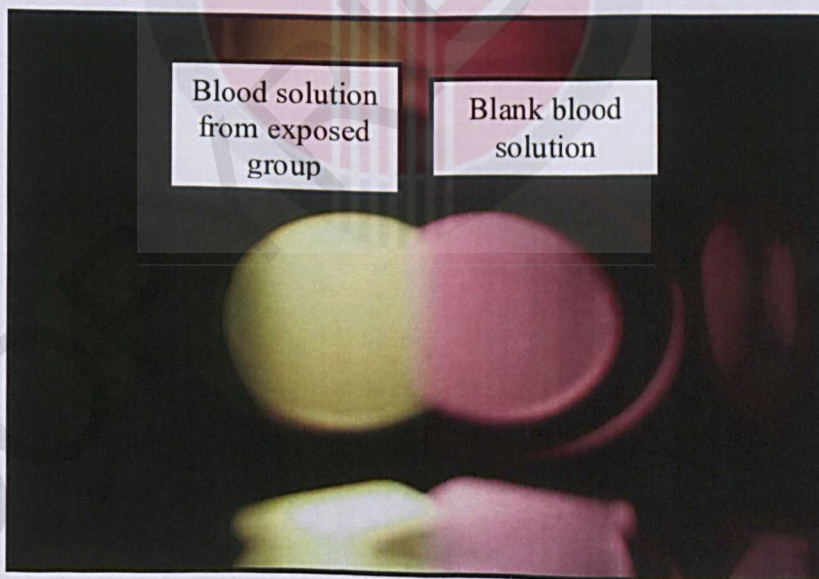
The solution with blood will stand for a few minutes to reach 100% activity color.



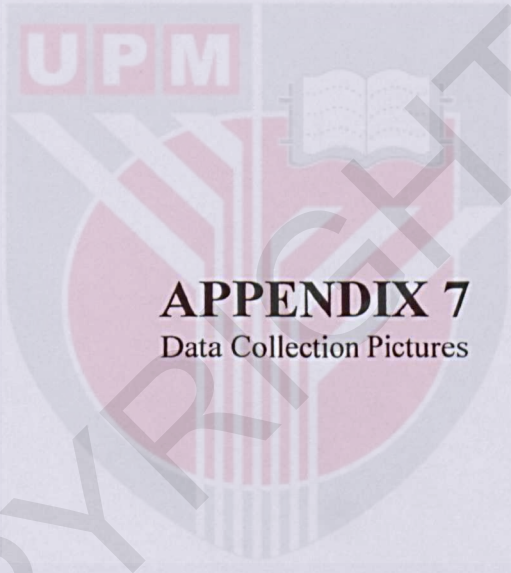
Match the color of solution by placing the cell contained solution in the compartment on the comparator and revolving the disc until the nearest match is found.



Color matching for 100% blood cholinesterase activities.



Color matching for 0.0% blood cholinesterase activities.



APPENDIX 7
Data Collection Pictures

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Data collection for questionnaire set



One of the respondents is doing Santa Ana Manual Dexterity Test



Instruction given by researcher to respondent in doing the Reaction Time/ Movement Test.